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会　報
続日本生理学教室史（仮称）の編纂事業（酒井敏夫）……445
お知らせ
1986年国際宇宙生物科学シンポジウムの御案内……445
故塚原仲晃教授のこと　—教官公募に寄せて—（酒井敏夫）……446
報　告
昭和61年度生理学研究所
共同研究，研究会の採択課題について（金子章道）……446

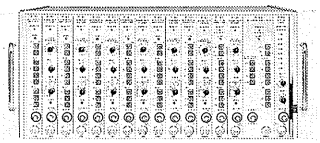
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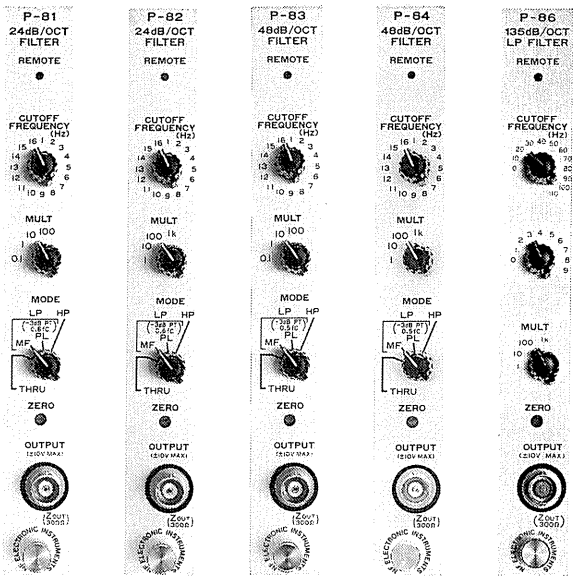
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第63回日本生理学会大会号目次

第63回日本生理学会大会を迎えて（当番幹事）…… 77

THE 63rd ANNUAL MEETING OF THE PHYSIOLOGIAL SOCIETY OF JAPAN…… 79

AUTHOR'S INDEX …… 431

第63回日本生理学会大会を迎えて

第63回日本生理学会大会
当番幹事　山形大学　望月政司・加藤宏司

第63回日本生理学会大会は，4月2日(水)～4日(金)の3日間，山形大学医学部で開催されます．皆様の御出を心からお待ち申し上げております．

日本生理学会大会が東北地方で開かれますのは，昭和51年（東北大学）以来10年ぶりです．また，戦後に新設された医学部（医大）で行われるのは，今回が初めてであります．本医学部も創設から13年目を数え，諸設備も大略整い，全国レベルの大会の開催も可能であると考えられるまでになりました．そこで，本医学部を見て頂きたい気持ちもあり，さらに，会場相互間の連絡の利便や経費の点なども考えて，伝統ある日本生理学会大会を本医学部の校舎で開催することに決めた次第であります．

会期につきましては，当初は気候の良い5月の連休頃にと考えたのですが，会場の設営準備，後片付をいれますと，会場（講義室）の使用が3日間以上にわたり，講義に差し支えること，また4月4日以降では講義の始まる日に近いとのことで，まだ少し寒さの残っているこの時期を会期とせざるを得ませんでした．

遠隔地であり，交通も不便なことから，参加，演題申し込みの数が例年よりもかなり減るのではないかと，心配しておりました．しかし，幸いにも，例年に勝る多数の申し込みを頂くことが出来ました．当番幹事としてこれ以上の喜びはなく，会員の皆様に心から厚く御礼申し上げる次第でございます．演題数は過去最高の824題，参加予定者は約1,400人にのぼりました．

この大会を準備するに当たりまして，常任幹事の先生方の御支援は云うにおよばず，最近の当番校（大阪，群馬，久留米の各大学）の先生方，ならびに東北大学の先生方に，直接，間接に種々御意見，御協力を仰ぎ，大会運営の基礎を得ることが出来ました．深く感謝申しあげる次第であります．

一般演題の募集につきましては，演題制限その他種々の意見もありましたが，慶大以来続いています「無制限」の方式を踏襲致しました．出来るだけ多くの会員の御研鑽の成果を自由に発表して頂こうとの考えによりました．824題を原則として希望により，32の分野に分け，それを9会場（口演はA—Hの8会場，ポスターはP会場）に纏め，プログラムをつくりました．分類された演題数の多寡に応じて会場の大小を割り当てましたが，演題数とその会場への聴衆の数とが比例しない場合も恐らく出てくることでありましょう．従いまして，会場が広すぎたり，逆に，狭すぎたりする場合もおこって来ないとも限りません．この点につきましては，過去の大会の各会場の聴衆の数を実際に数えてみたりして，幾分かの努力と配慮を致しましたが，きっと十分でないことと思われます．種々御不便のもとになるかと思われますが，御容赦下さいますよう願ってやみません．

従来，生理学会は「すべて会員は平等」を旨としております．本大会でもこの原則を守り「大会の目的は一般演題発表を重視することにあり」との主旨を貫きました．

本大会での新しい試みは，次の3点にあるかと思います．

1) 大会抄録の英文化：これは第53回生理学会大会の東北大方式の復活でもあります．英文抄録をもって大会予稿集に代えることによって英文抄録の価値を高めたいとの考えに

基づいてのことであります．ただ今回では和文のプログラムはそのままに残しました．2) モーニング・レクチャーの開催：研究分野の拡大と細分化，さらには急速な研究の進展により，他の分野の研究ははなはだ理解しにくくなっている現状です．そこで，とくに若い人達のために，今回は神経領域についての解説を，御三人の先生方にして頂くことに致しました．一般口演と重複しないように口演前の早朝の一時間を当て，「一般口演を重視する」との方針を守りました．3) 外国人学者による特別講演：研究の国際的レベルを保つこと，さらに研究の発展の一助にもと，代謝生理学で著明な3人の研究者を招くことに致しました．

学会関連行事として，各研究グループ毎の夕食会がすっかり定着して，年毎に盛んになりました．今年も13のグループディナーが予定されています．

会員の皆様の宿泊，交通につきましては東急観光が世話にあたりました．市内のホテルの数が十分でなく，ご希望のお部屋がとれなかった方々も大勢おいでございましょう．御容赦のほどお願い申しあげます．

生理学会の従来の方針として，大会は一切の飾りを廃して，質素，倹約を旨として，大会運営の実をあげるよう最善の努力をすることが暗黙のうちに了解されています．多からぬ予算の範囲内で最大限の努力をしたつもりでおります．しかし，御満足のいかない点も多かろうと存じます．これらの点につきましては，会員の皆様の御理解と御協力とさらに御寛恕を賜りたく，勝手ながらお願い申しあげます．

従来この欄は，「大会を終えて」という題で書かれて参りましたが，今回初めて「大会を迎えて」ということで御挨拶申し上げることになりました．会員の皆様には，これがあるいは慣れない奇異なことと映るかも知れませんが，意のある所をお汲み頂き，いささかでも大会参加，演題発表の参考になりますれば幸いに存じます．会員の皆様が恙なく山形の大会に参加下さいますよう心より願ってやみません．

THE 63rd ANNUAL MEETING
OF
THE PHYSIOLOGICAL SOCIETY OF JAPAN

Titles and Authors

Abstracts

April 2—4, 1986

Yamagata University School of Medicine

Narrate orally and poster exhibition (1—32)

1. Methodology (1—5)

1. A program to analyze black-and-white autoradiographic images.
Kawashima, T., Ueki, S., Satake, H., Matsunami, K. and Nakanishi, Y[1]. (Inst. Eqilibrium Res. Gifu Univ. Sch. Med., Gifu 500, Mitani Shoji Co.[1])……147
2. Circuitry changes of a PCM converter for applications as a DC-data recorder.
Ito, Y., Ohmori, H. (National Institute for Physiological Sciences. Okazaki 444)……147
3. L-band ESR for in vivo measurement.
Nishikawa, H. (Dept. Physiol., Kyoto Pref. Univ. Med., Kyoto 602) ……147
5. Telemetering injection system developed for conscious small animals.
Nishiura, N., Ninomiya, I., and Yonezawa, Y. (Dept. of Cardiac Physiol., Nat. Cardiovascular Center Res. Inst., Suita, Osaka 565 and Dept. of Electrical Engineering, Hiroshima Inst. of Technology, Itsukaichi, Hiroshima, 738) ……148

2. Molecular Physiology (6—25)

6. Interface between physiology and quantum dynamics.
O'hata, S., Aizawa, K., Kitahara, M., Sakai, S., Imagawa, M., Saito, H. and Yamao, M. (Dept. Physiol., Tokyo Med., Coll. Tokyo 160) ……149
7. A model of differential equations for membrane transport of non-electrolyte.
Matsuda, H. and Shinagawa, Y. (Information Processing Center of Medical Sciences and Department of Physiology, Nippon Medical School, Sendagi, Bunkyo-ku, Tokyo 113) ……149
8. Meaning of the microviscosity in biomembranes measured from fluorescence depolarization technique.
Araiso, T. and Koyama, T. (Division of Physiology, Res. Inst. Appl. Electr., Hokkaido University, Sapporo 060) ……149
9. Spin-labeled oriented multibilayer as revealed by vector electron paramagnetic resonance.
Watari, H., Kwan, C-Y., Murakami, M., and Seo, Y. (Dept. Molecular Physiol., Natl. Inst. Physiol. Sci., Okazaki 444) ……150
10. NMR relaxation study on the mobilities of water and Na^+ ions in the nucles of intervertebral disc.
Mifune, T., Kusaka, Y., Seo, Y., Nishikawa, H., Yamashita, F. and Sakakida, K. (Dept. Orthop. Surg. and Dept. Physiol., Kyoto Pref. Univ. Med., Kyoto 602) ……150
11. On the complex formation of the reduced D-amino acid oxidase with ligands.
Nishina, Y. and Shiga, K. (Dept. Physiol., Kumamoto Univ. Sch. Med., Kumamoto 860) ……150
12. ^{1}H-NMR studies on the structural transition of bovine mercaptalbumin (BMA).
Sogami, M., Era, S., Kuwata, K., Suzuki, E. and Watari, H[1]. (Dept. Physiol., Sch. Med., Gifu Univ., Gifu 500 and Dept. Mol. Physiol., Natl. Inst. Physiol. Sci., Okazaki 444[1])……151
13. Comparative studies on the conformations of the native(N-) and aged(A-) forms of bovine mercaptalbumin.

Kuwata, K., Era, S., Sogami, M. and Watari[1], H. (Dept. Physiol., Sch. Med., Gifu Univ., Gifu 500 and Dept. Mol. Physiol., Natl. Inst. Physiol. Sci., Okazaki 444[1])……151

14. Heterotropic effects of the N-terminal carbamylated hemoglobins.
Imaizumi, K., Imai, K[1]. and Tyuma, I[1]. (Lab. Physiol., Dept. Living and Health Sci., Joetsu Univ. of Educ., Joetsu, Niigata 943 and Dept. Physicochem. Physiol., Med. Sch., Osaka Univ., Osaka 530[1])……151

15. Effects of pH and temperature on membrane potential of newt erythrocytes.
Kawano, K. and Shinagawa, Y. (Information Processing Center of Medical Sciences and Dept. of Physiol., Nippon Medical School, Sendagi, Bunkyo-ku, Tokyo 113) ……152

16. Influence of magnetic field on erythrocyte flow.
Okazaki, M., Maeda, N. and Shiga, T. (Dept. Physiol., Sch. Med., Ehime Univ., Ehime 791-02) ……152

17. ^{1}H-NMR and high-performance liquid chromatographic(HPLC) studies on modified bovine plasma albumin (BPA*).
Fujii, H., Kuwata, K., Era, S., Suzuki, E., Sogami, M. and Watari, H[1]. (Dept. Physiol., Sch. Med., Gifu Univ., Gifu 500 and Dept. Mol. Physiol., Natl. Inst. Physiol. Sci., Okazaki 444[1])……152

18. High-performance liquid chromatographic(HPLC) studies on mercapt-nonmercapt conversion of human serum albumin.
Suzuki, E[1]., Era, S., Kuwata, K., Kida, K., Shigemi, J., Sogami, M., Miura, K[1]., and Sawada, S[2]. (Dept. Physiol., Dept. Int. Med., Sch. Med., Gifu Univ., Gifu 500[1] and Sawada Hospit., Gifu 500[2])……153

19. Comparative ^{1}H-NMR studies on water structure in hepatic tissue and protein sol or gel states.
Era, S., Kato, K.[1], Suzuki, E., Kuwata, K., Takahashi, M.*[1], Sogami, M. and Watari, H[2]. (Dept. Physiol., Dept. Pathol.[1], Sch. Med., Gifu Univ., Gifu 500 and Dept. Mol. Physiol., Natl. Inst. Physiol. Sci., Okazaki 444[2])……153

20. The "Fine" and "Coarse" fibrin gels observed from H-NMR T_1 and T_2 of water protons.
Tanaka, Y., Nakaya, S., Yoshioka, Y., Hasegawa, H., Kurosawa, N. and Yagi, S. (Dept. Physiol. II, Schl. Med., Iwate Med. Univ., Morioka, Iwate, 020) ……153

21. Water properties in narrow space.
Yoshida, A., Era, S[1]. and Sogami, M[1]. (SANNO Inst. Busin. Adminst., Tokyo 158 and Dept. Physiol., Sch. Med., Gifu Univ., Gifu 500[1]) ……154

22. Conformation of bradykinin.
Uyeda, M., Tanifuji, S. and Iwai, T. (Dept. Pysiol., Sch. Med., Gifu Univ., Gifu 500 and Dept. Applied Physics, Fac. Eng., Osaka City Univ., Osaka 558) ……154

23. Amount of singlet oxygen generated from porphyrins with different side chains.
Ohtani, T., Aizawa, K., Sakai, H., O'hata, S., Uchimoto, M., Fukuda, Y., Yamada, M., and Sawada, H. (Dept. of Physiol., Tokyo Medical college. Shinjuku-ku Tokyo 160 Hamari Chemicals LTD. Higashiyodogawa-ku Osaka-shi Osaka 533) ……154

24. Temperature dependence on the aggregation-disaggregation of phospholipid liposomes.
Ogihara, T., Satoh, K[1]. Mishima, K[2]. (Dept. of Physiol., Fac. of Hygienic Tech., Azabu Univ., Sagamihara, Kanagawa 229, Dept. of Physics, Jikei Univ. Sch. of Med., Chofu, Tokyo 182[1], and Dept. of Physics, Showa Univ., Fujiyoshida, Yamanashi 403[2])……155

25. Determination of the diffusion rate of oxygen in a hemoglobin solution.
Hashimoto, M., Isomoto, A., and Tyuma, I. (Dept. Physico-chemical Physiol., Osaka Univ. Sch. Med., Osaka 530) ····155

3. Cellular Physiology (26—71)

26. Intracellular Na activity and Na transport mechanisms of the mouse lacrimal gland acinar cells.
Saito, Y., Ozawa, T. and Nishiyama, A. (Dept. of Physiol., Tohoku Univ. Sch. of Med., Sendai 980) ····156

27. Na- and K-dependent Cl accumulation by the lacrimal gland acinar cells and effects of furosemide.
Ozawa, T., Saito, Y. and Nishiyama, A. (1st. Dept. of Physiol., Tohoku Univ. Sch. of Med., Sendai 980) ····156

28. Effect of pilocarpine on the Na, K-ATPase in dog submandibular glands.
Komabayashi, T., Tsuboi, M., Izawa, T. and Koshimizu, E. (Dep[t]. Pharmacol., Tokyo Coll. Pharma., Tokyo 192-03) ····156

29. Potentiation of α-adrenergic agonist- and cholinergic agonist-induced kallikrein release in rat submandibular gland by isoproterenol.
Hiramatsu, Y., Yoshimura, K., Kameda, K., Fukuda, H*[1]. (Dept. Physiol. and Dept. Oral Surg.[1], Hokkaido Univ. Sch. Dent., Sapporo 060) ····157

30. Modulation of isoproterenol-induced tissue cyclic AMP accumulation in rat parotid slices by α-adrenergic agonists.
Yoshimura, K., Nezu, E., and Yoneyama, T. (Dept. Physiol., Hokkaido Univ. Sch. Dent., Sappro 060) ····157

31. Impedance analysis in salivary gland.
Yoshida, H[1]., Nakahari, T. and Imai, Y. (Dept. of Biol[1]. and Dept. of Physiol. Osaka Medical College, Takatsuki, 569) ····157

32. Release of secretin-immunoreactivity from the vascularly perfused small intestine of guinea-pig.
Harada, E. and Kiriyama, H. (Dept. Physiol. Fac. Vet. Med., Hokkaido Univ., Sapporo 060) ····158

33. The role of Na^+-K^+ pump on secretory and redox response in the isolated perfused rat pancreas.
Kuriyama, H. and Kanno, T. (Dept. Physiol., Fac. Vet. Med., Hokkaido Univ., Kita-ku Sappro 060) ····158

34. Intracellular pH and its regulation by the Na^+/H^+ antiport in isolated enterocytes from rabbit.
Shimada, T. and Hoshi, T. (Dept. of Physiol., Fac. of Med., Univ. of Tokyo, Tokyo 113) ····158

35. Effect of ursodeoxycholate(U) and tauroursodeoxycholate(TU) on the transport maximum(Tm) of sulfobromophthalein in the rat.
Kitani, K. and Kanai, S. (First Lab. Clin. Physiol. Tokyo Metropolitan Institute of Gerontology, 35-2, Sakaecho, Itabashiku, Tokyo) ····159

36. Distribution of the increase in intracellular Ca ions at fertilization of hamster eggs : application of image intensification method.

Miyazaki, S[1]., Hashimoto, N[*2,3]., Yoshimoto, Y[*4]., Kishimoto, T[*2]., Igusa ,Y[1]. and Hiramoto, Y[4,5]. (Dept. Physiol., Jichi Med. Sch., Tochigi-ken, 329-04[1] ; Lab. Reprod. Biol[2]. and Cell Prolif., Natl. Inst. for Basic Biol., Okazaki, 444 ; Dept. zool., Fuc. Sci., Univ. of Tokyo, Tokyo, 113[4] ; Biol. Lab., Tokyo Inst. Technol. Tokyo, 152[5])·····159

37. Nonselective cation channel in sea urchin eggs (II).
Obata, S. and Kuroda, H. (Sugashima Marine Biological Laboratory, Sch. Sci., Nagoya Univ., Toba, Mie 517) ·····159

38. Voltage clamp study in Cynops blastomere——Measurement of Na/K pump current.
Ohara, A., Doida, Y., Murayama, K., Marunaka, Y. and Kitasato, H. (Dept. Biol. and Dept. Physiol., Shiga Univ. Med. Sci., Ohtsu 520-21, Japan) ·····160

39. Cytoplasmic free Ca^{2+} in exocytosis of mast cell granules.
Okada, T.[1], Nagasawa, T.[1], Hyono, A.[3], Sugiyama, M[*2]., Shibata, T[*4]. and Kinoshita, Y[1]. (Dept. Physiol[1]., Otolaryngol[2]. and Biophys[3]. Lab., Osaka City Univ. Med. Sch. and Osaka Prefect. Inst. Public Health, Osaka 545[4])·····160

40. Mechanisms of histamine release from mast cells by calcium reintroduction.
Sorimachi, M., Nishimura, S. and Yamagami, K. (Dept. Physiol., Kagoshima Univ. Sch. Med., Kagoshima 890) ·····160

41. Non-linear current-voltage relation in cultured mouse macrophage cell line (P388D1).
Takeo Maruyama (Dept. of Applied Physiol., Tohoku Univ., Sch. Med., Sendai 980) ·····161

42. Hyperpolarizing membrane potential changes in a cloned monkey kidney cell line (JTC-12).
Chang, H., Yamashita, N. and Kurokawa, K*. (Fourth Dept. Int. Med., Univ. Tokyo Sch. Med., Tokyo 112)·····161

43. Fibroblast responses to Clq-receptor stimulation.
Oiki, S., Ohno-Shosaku, T., and Okada, Y. (Dept. Physiol., Kyoto Univ. Sch. Med., Kyoto 606) ·····161

44. Control of homeostasis by the immunomodulative and tissue regeneration promoting effects of CAR and HCAR.
Nagai, K. (Dept. Physiol., Dent. Res. Center, Nihon Univ. Tokyo 101) ·····162

45. Effect of phorbol ester tumor promoter on dye-coupling between mouse epidermal cells.
Kanno, Y., Shiba, Y. and Enomoto, T. (Dept. Physiol., Hiroshima Univ. Sch. Dent., Hiroshima 734) ·····162

46. Effects of collagen and tumor promoters on colony shape and growth of cultured epithelial cells.
Shiba, Y., Sastrodihardjo, S*., Sasaki, Y. and Kanno, Y. (Dept. Physiol., Hiroshima Univ. Sch. Dent., Hiroshima 734) ·····162

47. Involvement of cytoskeletons in proliferation of adult rat hepatocytes in primary culture.
Hasegawa, K., Watanabe, K. and Koga, M. (Dept. Physiol., Dokkyo Univ. Sch. Med., Mibu, Tochigi 321-02) ·····163

48. Intracellular distribution of tissue-type plasminogen activator in a human melanoma cell line (Bowes).
Sakai, T., Okada, K., Fukao, H., Bando, H., Ueshima, S., Kikuchi, H. and Matsuo, O. (Dept. Physiol., Kinki Univ. Sch. Med., Sayama, Osaka 589) ·····163

49. Analysis of plasminogen activator in synovail fluid.
Kikuchi, H., Ueshima, S., Fukao, H., Okada, K., Bando, H., Sakai, T., Matsuo, O.

and Tanaka, S[1]. (Dept. Physiol. and Oothop[1]. Kinki Univ. Sch. Med., Sayama, Osaka 589) ····163

50. *In vitro* morphogenesis of normal and neoplastic mammary epithelial cells of the mouse.
Enami, J. and Koga, M. (Dept. of Physiol., Dokkyo Univ. Sch. of Med., Mibu, Tochigi 321-02) ····164

51. Study on differentiation and maturation system of thymic lymphocytes in streptozotocin-induced diabetic rats (2 nd report).
Okimoto, T., Hato, F., Tabata, T[1]., Toyokawa, T., Kimura, S., and Kinoshita, Y. (Dept. Physiol. and Internal Med[1]., Osaka City Univ. Sch. Med., Osaka 545) ····164

52. Separation of the thymic hormones from rat thymus epithelial cell culture supernatant and assay of the biological activities of the thymic hormones.
Toyokawa, T., Oshitani, N., Hato, F., Okimoto, T., Kimura, S., and Kinoshita, Y. (Dept. Physiol., Osaka City Univ. Sch. Med., Osaka, 545) ····164

53. The generation of field potentials recorded from the guinea pig olfactory cortical slice incubated under anoxia.
Fujii, T. (Kyoto Municipal Jr. College of Nursing, Higashi-takada, Mibu, Kyoto 604) ····165

54. Effect of cell surface irregularities on the 'apparent' membrane capacity as deduced from the impedance of spherical cell suspensions.
Irimajiri, A., Asami, K., Kinoshita, Y. and Ogawa, M. (Dept. Physiol., Kochi Med. Sch., Nankoku, Kochi 781-51) ····165

55. Effect of intracerebroventricular infusion of thyrotropin releasing hormone on redox change of cytochromes and electrical activity in perfused bullfrog brain.
Saito, T. and Kanno, T. (Dept. Physiol., Fac. Vet. Med., Hokkaido Univ., Kita-ku Sapporo 060) ····165

56. The roles of calmodulin-binding proteins in rat brain development.
Matsui, H., Itano, T., Doi, A., Hatase, O. (Dept. of Physiol., Kagawa Med. Sch., Miki, Kagawa, 761-07) ····166

57. Purification of calcium binding proteins from rat liver mitochondria and its physiological roles.
Itano, T., Matsui, H., Doi, A., and Hatase, O. (Dept. of physiol. Kagawa Med. Sch., Kagawa, 761-07) ····166

58. NMR studies on creatine kinase reaction in muscle.
Yoshizaki, K. (Dept. Physiol., Kyoto Pref. Univ. Med., Kyoto 602) ····166

59. Amino acid requirement for proliferation of rat hepatocytes in primary culture.
Koga, M., Watanabe, K. and Hasegawa, K. (Dept. of Physiol., Dokkyo Univ. Sch. of Med., Mibu, Tochigi 321-02) ····167

60. Ca dependence of serum factor in the primary culture of oral epithelial cells.
Kasai, S., Ikeshima, K. and Terasawa, T. (Dept. Physiol., Tohoku Dental Univ., Koriyama 963) ····167

61. Role of plasmin inhibitors on attachment and spreading of adult rat hepatocytes in serum-free primary culture.
Watanabe, K., Hasegawa, K. and Koga, M. (Dept. Physiol., Dokkyo Univ. Sch. Med, Mibu, Tochigi 321-02) ····167

62. The effect of vigorous exercise training on cholesterol metabolism in rats.

Abe, T., Sakamoto, T*., Asami, T*., Atomi, Y., Hirota, K. and Higashi, T. (College of Arts and Sciences, University of Tokyo, Tokyo 153) ……168

63. Whole-cell conductance and single potassium channels in isolated mouse fibroblasts.
Hosoi, S. and Slayman, C. L*[1]. (Tsukuba Res. Instit., Hamamatsu Photonics, Tokodai, Tsukuba 300-26 ; Dept. Physiol., Yale Univ. Sch. Med., New Haven, CT 06510, U. S. A.[1]) ……168

65. Mechnism of potassium uptake induced by isoproterenol and acetylcholine in submaxillary gland of rat and mouse.
Takahashi, H., Katoh, K[1]., Hayashi, H[2]., Iwatsuki, N. and Nishiyama, A. (1st. Dept. of Physiol. Sch. Med., Dept. of Animal Physiol., Faculty of Agriculture[1], College of Med. Sci[2]., Tohoku Univ., Sendai 980) ……168

66. Ca^{2+}- and voltage-activated K^+ channel in apical cell membrane of gallbladder epithelium.
Matsunaga, H., Maruyama, Y. and Hoshi, T. (Dept. of Physiol, Fac. of Med., University of Tokyo, Tokyo 113) ……169

67. Role of Na^+-K^+ pump in secretion in hypertrophied pancreas of the rat.
Ishikawa, T. and Kanno, T. (Dept. Physiol., Fac. Vet. Med., Hokkaido Univ., Kita-ku Sapporo 060) ……169

68. Electron probe X-ray microanalysis of guinea pig colon epithelium.
Sasaki, S., Nakagaki, I., Tanaka, H., Imai, Y. and Suzuki, Y. (Dept. of Physiol., Osaka Med. Coll., Takatsuki, Osaka 569 and Dept. of Physiol., Yamagata Univ. Sch. of Med., Yamagata 990-23) ……169

69. Effects of DIDS on the secretion of posterior silk gland cells.
Nakagaki, I. and Sasaki, S. (Dept. of Physiol., Osaka Med. Coll., Takatsuki, Osaka 569) ……170

70. Dielectric dispersion of cultured epithelial monolayers formed on a tubular support.
Asami, K. and Irimajiri, A. (Dept. Physiol., Kochi Medical School, Nankoku Kochi 781-51) ……170

71. Regulation of glucagon secretion in glucagon-producing tumor cells (ITC-1).
Sakai, S., Hashiguchi, M., Saito, H., Kanazawa, M*[1]., Tosaka, T. and O'hata, S. (Dept. Physiol. and Int. Med[1]. Tokyo Med. Coll., Shinjuku-ku, Tokyo 160) ……170

4. Active Transport (72—103)

72. Effects of L-alanine on water transport across the seawater eel intestine.
Ando, M. (Lab. of Physiol. Fac. of Integrated Arts and Sci. Hiroshima Univ.) ……171

73. Inhibitory effects of captpril, a converting enzyme inhibitor, on vasopressin-stimulated water flow in the toad bladder.
Fumiaki, M. and Yoshihiro, N. (Department of Medicine, Kitasato University School of Medicine, Sagamihara, 228) ……171

74. Impedance analysis of fluid transport in salivary gland.
Nakahari, T., Yoshida, H*., Tanaka, H. and Imai, Y. (Dept. of Physiol. and Dept. of Biol. Osaka Medical College, Takatsuki, 569) ……171

75. Intercellular junctions and short circuit current in frog skin.
Katakura, T. and Hatakeyama, I. (Dept. Physiol., Kitasato Univ. Sch. Med., Sagamihara, Kanagawa, 228) ……172

76. Effect of tetorodotoxin on the response of short-circuit current across rat colonic

mucosa to propionate.
Yajima, T. and Hijikata, H*. (Physiology Group, Yakult Central Institute for Microbiological Research, Kunitachi, Tokyo 186) ····172

77. Cl^- channel in the secretory mechanism of gastric acid.
Asano, S*[1]. and Takeguchi, N. (Faculty of Pharmaceut. Sci., Toyama Med[1]. and Pharmaceu. University, Toyama, 930-01) ····172

78. Microelectrode study on pH gradient across gastric mucus gel and intracellular pH of surface epithelial cells.
Masaki, H., Morimoto, Y., Kotera, K., Fujimoto, M. and Satake, N. (Dept. of Physiol., Osaka Med. Coll., Takatsuki, Osaka 569) ····173

79. The effect of cyclic nucleotide on ion transport in tubular cells of bullfrog kidney.
Hagiwara, N., Fujimoto, M., Inoue, A., Abe, H. and Matsumura, Y. (Dept. Physiol., Osaka Med. College, Takatsuki, Osaka 569) ····173

80. Network-thermodynamic analysis of electro-kinetic phenomena in epithelia.
Miyamoto, M., Sohma, Y., Takeuchi, T. and Imai, Y. (Dept. of Physiol. Osaka Medical College, Takatsuki, 569) ····173

81. Cotransport of D-glucose and H^+ by intestinal brush border membrane sugar carriers under Na^+-free conditions.
Hoshi, T., Takuwa, N. and Tajima, A. (Dept. Physiol., Fac. Med., Univ. of Tokyo, Tokyo 113) ····174

82. Regulation of Ca-ATPase in basolateral membrane of rat kidney cortex.
Tsukamoto, Y. (Dept. Medicine, Kitasato Univ. Sch. Med., 1-15-1 Kitasato, Sagamihara, Kanagawa 228) ····174

83. Biosynthesis, processing and localization of (Na^+, K^+) ATPase in rat kidney.
Akayama, M., Yamamoto, A., Nakada, H., Masaki, R., Omori, K. and Tashiro, Y. (Dept. Physiol., Kansai Med. Univ. Moriguchi 570) ····174

84. Immunoelectron microscopic localization of (Na^+, K^+) ATPase in the rat parotid gland.
Iwano, T., Yamamoto, A., Akayama, M., Omori, K., Kumazawa, T. and Tashiro, Y. (Dept. of Physiol., and Otorhinolaryngol, Kansai Med. Univ. Moriguchi 570) ····175

85. Immunoelectron microscopic localization of (Na^+, K^+) ATPase in the rat exocrine pancreatic cells.
Tanaka, K., Yamamoto, A., Akayama, M., Omori, K. and Tashiro, Y. (Dept. Physiol. Kansai Med. Univ. Moriguchi 570) ····175

86. Relation of Na^+, K^+-ATPase activity to salivary secretion in rat submandibular gland.
Nemoto, A., Sugita, K. and Ueha, T. (Dept. Oral Physiol., Josai Dent. Univ., Sakado, Saitama 350-02) ····175

87. Effect of anti α-subunit antiserum and various inhibitors on Na^+, K^+-ATPase from different tissues.
Kurihara, K., Nemoto, A., Atsumi, T., Hoshi, K. and Ueha, T. (Dept. Oral Physiol., Josai Dent., Univ., Sakado, Saitama, 350-02) ····176

88. The dependence of insulin-stimulated Na efflux on the internal Na concentration.
Kitasato, H., Marunaka, Y. and Kanbe, M. (Dept. Physiol., Shiga Univ. of Med. Sci., Ohtsu 520-21) ····176

89. Effects of the external K concentration on the insulin-stimulated Na/K transport in

frog skeletal muscles.
Marunaka, Y., Kitasato, H. and Murayama, K. (Department of Physiology, Shiga University of Medical Science, Ohtsu, 520-21) ····176

90. Effect of cellular redox state on ouabain-sensitive Rb^+ infux into HeLa cells.
Ikehara, T., Yamaguchi, H., Hosokawa, K. and Miyamoto, H. (Dept. Physiol., Sch. Med., Univ. Tokushima, Tokushima 770) ····177

91. ^{31}P-NMR study in isolated perfused pancreas of rat.
Matsumoto, T., Murakami, M., Seo, Y., Watari, H. and Kanno, T. (Dept. Molecular Physiol., Natl. Inst. Physiol. Sci, Okazaki 444 and Dept. Physiol., Fac. Vet. Med., Hokkaido Univ., Sapporo 060) ····177

92. Ring muscle contractility of small intestine.
Ohsawa, K. (Dept. Physiol., Fac. Med., Univ. Tokyo, Bunkyo-ku Tokyo) ····177

93. ^{31}P-NMR study in isolated perfused salivary gland of rat.
Murakami, M., Seo, Y., Watari, H. and Matsumoto, T^1. (Dept. Molecular Physiol., Natl. Inst. Physiol. Sci., Okazaki 444 and Dept. Physiol., Fac. Vet. Med., Hokkaido Univ., Sapporo 060^1)····178

94. ^{23}Na-NMR study of intracellular Na in isolated perfused salivary gland of rat.
Seo, Y., Murakami, M., Matsumoto, T., Watari, H. and Nishikawa, H. (Dept. Molecular Physiol., Natl. Inst. Physiol. Sci., Okazaki 444 and Dept. Physiol. Kyoto Pref. Univ. Med., Kyoto 602) ····178

95. Prerequisite role of K^+ channel activation and Ca^{2+} mobilization in acid secretion by cultured gastric parietal cells.
Ueda, S. and Okada, Y. (Dept. Physiol., Kyoto Univ. Sch. Med., Kyoto 606) ····178

96. Circuit model of active transport system and membrane potential.
Imai, Y., Tanaka, H. and Miyamoto, M. (Dept. of Physiol. Osaka Medical College, Takatsuki, 569)····179

97. Intestinal Na/Sugar cotransport characterized using a voltage-sensitive dye : An assessment of contribution by intracellular pH changes.
Kinoshita, Y. and Irimajiri, A. (Dept. Physiol., Kochi Medical School, Nankoku, Kochi 781-51)····179

98. ATPase activities in guinea pig colonic mucosa.
Suzuki, Y. and Suzuki, T. (Department of Physiology, Yamagata University School of Medicine, Yamagata 990-23) ····179

99. H^+ secretion in guinea pig colonic mucosa : HCO_3^- exit across the basolateral membrane.
Kaneko, K. and Suzuki, Y. (Department of Physiology, Yamagata University School of Medicine, Yamagata 990-23) ····180

100. Vectrial incorporation of purified Na pump into organic solvent free phosholipid bilayers.
Kumazawa, N., Tsujimoto, T. and Fukushima, Y. (Wakayama Medical College, Wakayama 640, Nat. Inst. for Physiological Science, Okazaki 444) ····180

101. Substrate specificity of Na, K-dependent hydrolysis by plasma membrane fraction prepared from insulin-pretreated muscles.
Kanbe, M. and Kitasato, H. (Dept. Physiol. Shiga Univ. Med. Sci. Ohtsu 520-21) ····180

102. Respiratory acidosis blocks cell-to-cell communications in bullfrog proximal tubules.
Matsumura, Y., Kumode, O., Morimoto, Y., Kotera, K., and Fujimoto, M. (Dept.

Physiol., Osaka Medical College, Takatsuki City, Osaka, 569) ……181

103. The effects of carbon dioxide on intracellular potassium activity and extracellular space of frog sartorius muscle.
Otsuka, M., Fujimoto, M., Hagiwara, N., Matsumura, Y. and Kotera, K. (Dept. Physiol., Osaka Med. College, Takatsuki, Osaka, 569) ……181

5. Excitable Membrane (104—150)

104. Impedance loci of the squid at the A.C. transient and constant phenomena. And the equivalent circuit by the condenser with parallel and series resistances.
Saito, T. (Dept. Physiol. Nippon Dental College, Tokyo.) ……182

105. Immunocytochemical characteristics of primary cultured neurons from El mice cerebral cortex.
Itoh, K., Sekiguchi, K., Ishige, A., Iizuka, S., Sugimoto, A., Abrada, M., Hosoya, E., Sugaya, E[1]., Asou, H[2]., Hirano, S[2]. (Tsumura Res. Inst. for Pharmacol., Ibaraki, Dept. Physiol., Kanagawa Dental Coll., Yokosuka[1] and Dept. Physiol., Toho Univ., Tokyo[2]) ……182

106. Effects of PTZ on primary cultured neurons from the cerebral cortex ; (I) Intracellular ionic changes.
Sekiguchi, K., Ishige, A., Itoh, K., Iizuka, S., Sugimoto, A., Aburada, M., Hosoya, E., Tsuda, T[1]., Sugaya, A[1]., Takagi, T[2]., Sugaya, E[2]., Asou, H[3]., Hirano, S[3]. (Tsumura Res. Inst. for Pharmacology, Ibaraki, Fac. of Pharmaceutical Sci., Josai Univ., Saitama[1], Dep. Physiol., Kanagawa Dental Coll., Yokosuka[2] and Dep. Physiol., Toho Univ., Tokyo[3]) ……182

107. Effects of pentylenetetrazole on primary cultured neurons from the cerebral cortex ; (II) intracellular protein changes.
Takagi, T., Kajiwara, K., Komatsubara, J., Sugaya, E., Tsuda, T[1]., Yasuda, K[1]., Sugaya, A[1]., Itoh, K[2]., Asou, H[3]. and Hirano, S[3]. (Dept. of Physiol., Kanagawa Dental Coll., Yokosuka, Fac. of Pharmaceutical Sci., Josai Univ., Saitama[1], Tsumura Res. Inst. for Pharmacology, Ibaragi[2], and Dept. of Physiol., Toho Univ., Tokyo[3]) ……183

108. Effect of arachidonic acid on the membrane currents in the squid giant axon.
Hori, H., Horie, H., Kawakami, T. and Takenaka, T. (Dept. Physiol., Yokohama City Univ. Sch. Med., Yokohama 232) ……183

109. Characteristics of the sodium channel having no gating mechanism of squid giant axons.
Seyama, I., Yakehiro, M. and Kato, R. (Dept. Physiol., Hiroshima Univ. Sch. Med., Hiroshima 734) ……183

110. Neural type differentiation and Na-channels in the isolated and cultured blastomeres from a cleavage-arrested 4-cell *Halocynthia* embryo.
Okamura, Y., Okado, H[1]. and Takahashi, K. (Dept. Neurobiol., Inst. Brain Res[1]., Tokyo Univ., Sch. Med., Tokyo 113) ……184

111. Effect of sea anemone toxin on the slow inactivation in the crayfish giant axon.
Warashina, A. and Ogura, T. (Dept. Physiol., Niigata Univ. Sch. Med., Niigata 951) ……184

112. Nerve growth factor-induced differentiation of Na-channel in pheochromocytoma cells.
Kamei, K., Miyake, M. and Hatanaka, H[1]. (Fac. of Pharmaceu. Sci., Hokkaido Univ., Sapporo 060 and Mitsubishi-kasei Inst. of life Sci., Tokyo 194[1]) ……184

113. Calcium channels from frog skeletal traverse tubular membranes in planar lipid bilayers.
Sokabe, M., Kato, T*., Naruse, K*. and Ito, F. (Dept. Physiol., Nagoya Univ. Sch. Med., Nagoya 466) ····185

114. Analysis of the effects of X-irradiation on the Ca channel of mouse oocytes.
Yoshida, S. (Dept. Physiol., Nagasaki Univ. Sch. Med., Nagasaki 852) ····185

115. Effects of pentobarbital on the calcium channel current in Aplysia neurons.
Ikemoto, Y., Mitsuiye, T. and Ishizuka, S. (Department of Physiology, Faculties of Medicine and Dentistry, Kyushu University, Fukuoka 812) ····185

116. Block by HEPES buffer unveiled the polymeric structure of a chloride channel.
Yamamoto, D. and Suzuki, N[1]. (Mitsubishi-Kasei Inst. Life Sci., Tokyo 194, Dept. Physiol., Kitasato Univ. Sch. Med., Kanagawa 228[1]) ····186

117. The kinetic properties of two classes of Ach receptor channel current in cultured *xenopus* muscles.
Igusa, Y. and Kidokoro, Y[1]. (Dept. of Physiol., Jichi Med. Sch., Tochigi-ken, 329-04, Jerry Lewis Neuromuscler Reseach Center, Sch. of Med., UCLA.[1]) ····186

118. Reverse of the spike afterpotential by noradrenaline in sympathetic preganglionic neurons in vitro.
Yoshimura, M. and Nishi, S. (Dept. Physiol., Kurume Univ. Sch. Med., Kurume 830) ····186

119. Intracellular reaction mechanism of neurotensin response induced by rat brain mRNA in *Xenopus* oocytes.
Ito, I., Hirono, C. and Sugiyama, H. (Lab. Memb. Biol., Natl. Inst. Physiol. Sci., Okazaki 444) ····187

120. Muscarinic receptor and neurotensin receptor share intracellular reaction mechanism in *Xenopus* oocytes injected with rat brain mRNA.
Hirono, C., Ito, I. and Sugiyama, H. (Lab. Memb. Biol., Natl. Inst. Physiol. Sci., Okazaki 444) ····187

121. Membrane hyperpolarization by somatostatin (SRIF) in human GH-producing pituitary tumor cells.
Yamashita, N. and Ogata, E*. (Fourth Dept. Int. Med, Univ. Tokyo Sch. Med, Tokyo 112) ····187

122. Effects of Substance P on the inactivation of the inwardly rectifying K current in cultured nuc. basalis neuron.
Yamaguchi, K[1]., Nakajima, Y*., Nakajima, S*. and Stanfield, P. R*[2]. (Dept. Biol., Purdue Univ., W. Lafayette, IN 47907 U. S. A. National Inst. for Physiol. Sci., Okazaki 444[1], Dept. Physiol., Univ. of Leicester, Leicester LE17RH, U. K.[2]) ····188

123. Electrophysiological properties of testosterone-secreting cells in mammalian testes studied with patch-clamp techniques.
Kawa, K. (Dept. Pharmacol., Gunma Univ. Sch. Med., Maebashi 371) ····188

124. Ca^{2+}-mediated reduction of K^+ current is enhanced by injection of IP_3.
Sakakibara, M. and Alkon, D. L*. (Dept. of Aerospace Physiol., Res. Inst. Environ. Med., Nagoya Univ., Nagoya 464 and Lab. of Biophys., NiNCDS, NIH, at the Marine Biological Laboratory, Woods Hole, MA 02543, U. S. A.) ····188

125. Electrical characteristics of mouse taste cell membrane.
Tonosaki, K. and Funakoshi, M. (Dept. of Oral Physiol., Sch. Dentistry, Asahi

Univ., Gifu 501-02) ····189
126. Anesthetic enhancement by monocarboxylic anions in the crayfish claw nerve.
Ichikawa, O., Miyoshi, M. and Hiji, Y. (Dept. Physiol., Tottori Univ. Sch. Med., Yonago 683) ····189
127. Fluorescent properties of nerve cold membrane bound terbium by excitation for tryptophan.
Aizawa, K., Ohtani, T., O'hata, S., Yamao, M., Nishiye, S. and Yamagishi, S. (Dept. of Physiol. Tokyo Medical College Shinjiku-ku Tokyo 160 O'tsuma Women's Univ. Chiyoda-ku Tokyo Dept. of Physiol. Juntendo Univ. Bunkyo-ku Tokyo Lab. of Membrane bio., Nat. Inst. Physiol. Sci. Myodaiji, Okasaki) ····189
128. Action potentials of crustacean peptidergic neurosecretory terminals recorded by potentiometric dyes.
Nagano, M. and Terakawa, S. (Dept. Physiol., Univ. of the Ryukyu, Okinawa 903-01 and Dept. Cell Physiol., Nat. Inst. Physiol. Sci., Okazaki 444) ····190
129. Scattering change in the neurosecretory terminal.
Terakawa, S. and Nagano, M. (Dept. Cell Physiol., Nat. Inst. Physiol. Sci., Okazaki 444 and Dept. Physiol., Univ. of the Ryukyu, Okinawa 903-01) ····190
130. Analysis of the optical activity signal recorded from nerve fibers.
Watanabe, A. (Dept. Cell Physiol. Nat. Inst. Physiol. Sci. Okazaki 444) ····190
131. Single channel and whole cell currents in collagenase-dispersed smooth muscle cells of guinea-pig vas deferens.
Morimoto, K., Kukita, F*., and Yamagishi, S*. (Dept. Physiol. Med. School Kumamoto Univ., Kumamoto 860, *Dept. Cell Physiol. Natl. Inst. Physiol. Sci., Okazaki 444) ····191
132. Change in ionic selectivity of nerve membrane by intracellularly applied Ca ion.
Yamagishi, S., Furuya, K., Kukita, F. and Hirono, C. (Dept. Cell Physiol., Natl. Inst. Physiol. Sci., Okazaki 444) ····191
133. Voltage-gated Ca^{2+}-channels in zona glomerulosa cells from rat adrenocortical gland.
Maruyama, Y., Matsunaga, H. and Hoshi, T. (Dept. of Physiol., Fac. of Med. University of Tokyo, Tokyo 113) ····191
134. Characterization of the GABA-induced chloride current in the spinal ganglion cell of the cat.
Tanaka, E., Higashi, H. and Nishi, S. (Dept. Physiol. Kurume Univ. Sch. Med., Kurume 830) ····192
135. Activation of K^+ and Cl^- channels and changes in the intracellular ion concentrations during cell volume regulation in hypotonic solutions.
Hazama, A., Oiki, S. and Okada, Y. (Dept. Physiol., Kyoto Univ. Sch. Med., Kyoto 606) ····192
136. Modification of K conductance of the squid axon membrane by SITS.
Inoue, I. (Inst. Marine Biol. Sch. Medicine, Tokushima Univ. Naruto City, Tokushima 771-03) ····192
137. Blocking behavior of single sodium channels in artificial lipid bilayers.
Uehara, A. and Moczydlowski, E*. (Dept. of Physiol., Sch. of Med., Fukuoka Univ., Fukuoka 814-01, *Dept. of Physiol. and Biophys., Cincinnati Univ., U. S. A.) ····193
138. Maitotoxin-induced increases in Ca- and K-permeabilities of cell membrane in mouse neuroblastoma cells.
Miyake, M. Fac. of Phermaceu. Sci., Hokkaido Univ., Sapporo 060) ····193

139. Effects of inward water flow on ionic currents in squid giant axons.
Kukita, F. (Lab. Membrane Biol., Natl. Inst. for Physiol. Sci., Okazaki, 444) ····193

140. Single-channel currents in mouse pancreatic B cells.
Murayama, K., Marunaka, Y., Ohara, A*. and Kitasato, H. (Dept. Physiol. and *Dept. Biol., Shiga Univ. Med. Sci., Ohtsu 520-21) ····194

141. A Wave function on an axon hillock.
Oonuki, M. (Dept. Physiol., Kitasato Univ. Sch. Med., Sagamihara-shi 1-15-1, Kanagawa 228) ····194

142. Polyethylene glycol(PEG)- induced fusion of dissociated Drosophila neurons.
Suzuki, N. (Dept. Physiol., Kitasato Univ. Sch. Med., Kanagawa 228) ····194

143. Nitrendipine binding in cultured chick skeletal muscle cells.
Satoh, R. and Kano, M. (Dept. of Physiol., Kitasato Univ. Sch. of Med., Sagamihara, Kanagawa 228) ····195

144. Membrane properties and intracellular biochemical processes during vasopressin-induced bursting activity in snail neurons.
Kishii, K., Onozuka, M., Furuichi, H., Imai, S. and Sugaya, E. (Dept. Physiol., Kanagawa Dental College, Yokosuka 238) ····195

145. Effect of hypoxia on the hippocampal CA1 neurons in rat brain slices.
Higashi, H., Yoshimura, M., Fujiwara, N*. and Shimoji, K*. (Dept. Physiol., Kurume Univ. Sch. Med., Kurume 830 and *Dept. Anesth., Niigata Univ. Sch. Med., Niigata 951) ····195

146. Effects of inhibitory amino acids on pyramidal neurons in the guinea-pig hippocampus *in vitro*.
Inokuchi, H. and Nishi, S. (Dept. Physiol., Kurume Univ. Sch. Med., Kurume 830) ····196

147. Characterization of glutamate and kainate receptors induced in *Xenopus* oocytes by rat brain mRNA.
Hirono, C., Ito, I. and Sugiyama, H. (Lab. Memb. Biol., Natl. Inst. Physiol.Sci., Okazaki 444) ····196

148. Cyclic nucleotide in the El mouse and effects of anticonvulsants.
Ishige, A., Sekiguchi, K., Iizuka, S., Itoh, K., Sugimoto, A., Aburada, M., Hosoya, E. and Sugaya, E. (Tsumura Res. Inst. for Pharmacology, Ibaraki and Dept. of Physiol., Kanagawa Dental Coll., Yokosuka) ····196

149. Inhibition of Na channel by cell surface expansion caused by fatty acids.
Horie, H., Kawasaki, Y*. and Takenaka, T. (Dept. of Physiol., Yokohama City Univ., 232, Mitsubishi-Kasei Inst. Life Science 194) ····197

150. Gangliosides in the cerebral cortex, hippocampus and primary cultured neurons of El mice.
Kajiwara, K., Takagi, T., Komatsubara, J., Sugaya, E., Itoh, K[1]., Sekiguchi, K[1]., Asou, H[2]. and Hirano, S[2]. (Dept. of Physiol., Kanagawa Dental Coll., Yokosuka, [1]Tsumura Res. Inst. of Pharmacology, Ibaragi, and [2]Dept. of Physiol., Toho Univ., Tokyo) ····197

6. Neurochemistry (151—167)

151. Neurochemical studies on the denervated hippocampus in the rat in special reference to the neurotrophic factors in the CNS.

Kohsaka, S., Yoshida, K[1]., Inoue, H., Takamatsu, K., Fujishiro, M., Otani, M[1]., Toya, S[1]., Asou, H[2]., Hirano, S[2]. and Tsukada, Y. (Dept. Physiol., [1]Dept. Neurosurg., Keio Univ. Sch. Med., Dept. Physiol., [2]Toho Univ. Sch. Med.) ····198

152. Changes of cell marker protein levels in the retina caused by the administration of methylazoxymethanol during the fetal or neonatal period of rats.
Nagayoshi, M., Hirata, Y. and Matsutani, T. (Dept. of Develop. Physiol., Inst. for Comprehensive Med. Sci., Fujita-Gakuen Health Univ. Sch. of Med., Toyoake, Aichi 470-11)····198

153. Convulsive activity of 2-guanidinoethanol.
Edaki, A., Watanabe, Y., Katayama, Y. and Yokoi, I. (Dept. Neurochem., Inst. Neurobiol., Okayama Univ. Med. Sch., Okayama 700) ····198

154. Application of high resolution H-NMR spectroscopy to studies on rat brain ischemia.
Hasegawa, H., Yoshioka, Y., Tanaka, Y., Nakaya, S., Kurosawa, N. and Yagi, S. (Dept. of Physiol. 2, Sch. of Med., Iwate Med. Univ., Morioka 020)····199

155. Kininase in cerebrospinal fluid and central action of bradykinin and its metabolites.
Yoshida, T., Shimazu, T. and Nosaka, S. (Dept. Physiol., Mie Univ. Sch. Med., Mie 514) ····199

156. Changes in concentration of ganglioside fractions in the *dw* cerebrum.
Sugisaki, T., Noguchi, T. and Satoh, I. (Dept. of Physiol. and R. I. Res. Unit, Gen. Res. Center, Toho Univ. Sch. Med. Tokyo-143) ····199

157. A developmental change of ganglioside content in maternal hyperphenylalaninemia in rat.
Harada, Y., Asou, H. and Hirano, S. (2nd Dept. Physiol., Toho Univ. Sch. Med., 5-21-16, Ohmori-Nishi, Ohta-ku, Tokyo) ····200

158. Brain gangliosides of neurological mutant mouse.
Hirano, S., Asou, H., Harada, Y., Okano, H[1]., Mikoshiba, K[1]., Fujishiro, M[2]. and Tsukada, Y[3]. (Dept. Physiol., Toho Univ. Sch. Med., Tokyo 143[1], Inst. Protein Res., Osaka Univ., Osaka 565[2] and Dept. Physiol., KeioUniv. Sch. Med., Tokyo 160[3])····200

159. Relation between lipid composition of myelin-like membrane and conduction velocity of ventral nerves of shrimps and earthworms.
Yamaguchi, H. and Kishimoto, Y[1]. (Dept. Physiol., Sch. Med., Univ. Tokushima, Tokushima 770, [1]Dept. Neurol., Johns Hopkins Univ. Sch. Med., Baltimore, Maryland 21205, U. S. A.)····200

160. The structure of myelin membrane glycoprotein.
Sakamoto, Y., Yoshimura, K., Nishijima, T. and Uyemura, K. (Dept. Physiol., Saitama Med, Sch., Moroyama, Saitama 350-04) ····201

161. Immunohistochemical study of reactive astrocyte in the cold injured rat brain.
Takamiya, Y., Toya, S., Otani, M., Murakami, H., Imanishi, T., Kohsaka, S[1]., Mikoshiba, K[3]., Ogawa, Y[2]., and Tsukada, Y. (Dept. Neurosurg. [1]Dept. Physiol., Keio Univ. Sch. Med., [3]Protein Res. Ins. Osaka Univ., [2]Dept. Neuropathol. Tokyo Metro. Ins. for Neurosc.)····201

162. Aging effects on brain metabolism of serotonin and dopamine.
Hori, S. and Ohtani, S. (Dept. Neurochem., Tokyo Metropol. Inst. for Neurosci., Tokyo 183)····201

163. Neuropeptides and insulin release.
Yanaihara, C., Hashimoto, Y., Mochizuki, T., and Yanaihara, N. (Lab. Bioorg. Chem.,

Shizuoka Coll. Pharm., Shizuoka 422 and Lab. Cell. Metabol., Nat. Inst. Physiol. Sci., Okazaki 444) ····202

164. Intracellular co-existence and biosynthesis of neuropeptides, PHI and VIP.
Hoshino, M., Ogino, K., Suzuki, T., Yanaihara, C. and Yanaihara, N. (Lab. Cell. Metabol., Nat. Inst. Physiol. Sci., Okazaki 444 and Lab. Bioorg. Chem., Shizuoka Coll. Pharm., Shizuoka 422)····202

165. Function and morphology of identified histaminergic *Aplysia* neuron, C2.
Gotoh, H., and Schwartz, J. H. (Dept. Physiol., Iwate Med. Univ., Morioka 020) ····202

166. Myelination by bulk-separated oligodendrocytes transplanted into the shiverer mutant mouse brain.
Kohsaka, S., Inoue, H., Yoshida, K[1]., Shinozaki, T[1]., Takayama, H[1]., Otani, M[1]., Toya, S[1]., Mikoshiba, K[2]., Inoue, Y[2]. and Tsukada, Y. (Dept. Physiol., Dept. Neurosurg. Sch. Med. Keio Univ[1]., Osaka Univ[2]. Ookkaido Univ. Fac. Med[3].) ····203

167. Methionine metabolism in experimental hyperphenylalaninemic rat brain.
Hirano, K., Kanamatsu, T., Nakai, K[1]. and Hirano, S. (2nd Dept. Physiol., Amino acid research unit general research center[1], Toho Univ. Sch. Med. Tokyo 143) ····203

7. Synapse and End-plate (168—219)

168. Screening systems for monoclonal antibodies which affect synapse formation.
Ohguchi, Y., Kobayashi, K*. and Kuroda, Y. (Dept. Neurochem. Tokyo Metropolitan Inst. for Neurosciences, Fuchu-shi, Tokyo 183)····204

169. Monosynaptic connections beween cerebellar granule and Purkinje cells in dissociated cell culture studied by simultaneous intracellular recording.
Hirano, T., Kubo, Y. and Wu, M. M*. (Dept. Neurobiol., Inst. Brain Res., Sch. Med., Univ. Tokyo, Hongo 7-3-1, Bunkyo-ku, Tokyo 113)····204

170. Responses of cultured cerebellar neurons to excitatory amino acids and analogues.
Mori-Okamoto, J. and Tatsuno, J. (Dept. Physiol., National Defense Medical College, Tokorozawa, Saitama 359)····204

171. Glutamate-evoked intracellular Ca^{2+} elevation in single hippocampal neurons : Its development under culture.
Ogura, A., Kudo, Y. and Amano, T. (Dept. Neuroscience, Mitsubishi-Kasei Institute of Life Sciences, Machida, Tokyo 194)····205

172. Effects of synthetic derivatives of glycine having cyclopropane ring on molluscan giant neurons.
Watanabe, K. and Takeuchi, H. (Dept. Physiol., Gifu Univ. Sch. Med., Gifu 500) ····205

173. Amino acid response induced in *Xenopus* oocytes by mRNA from mouse brain.
Asanuma, A., Horikoshi, T. and Yanagisawa, K. (Dept. of Physiol., Tsurumi Univ., Sch. of Dent. Med., Tsurumi-ku, Yokohama)····205

174. Mechanism underlying uptake and release of ^{3}H-taurine in the bullfrog lumbar sympathetic chain.
Tosaka, T., Sakai, S., Hashiguchi, T. and Tasaka, J. (Dept. Physiol., Tokyo Med. Coll., Shinjuku-ku, Tokyo 160) ····206

175. Inhibitory action of taurine on synaptic transmission in sympathetic ganglia of the bullfrog.

Hashiguchi, T., Sakai, S., Tosaka, T. and Tasaka, J. (Dept. Physiol., Tokyo Med. Coll., Shinjuku-ku, Tokyo 160) ····206

176. Muscarinic effects on the action potential in cultured sympathetic neurons by the modulation of Ca entry.
Mochida, S., Kobayashi, H. and Deie, M*. (Department of Physiology, Tokyo Medical College, Shinjuku-ku, Tokyo 160) ····206

177. Excitatory muscarinic receptor and ion channels in bullfrog sympathetic ganglion cells.
Tsuji, S. and Kuba, K. (Dept. Physiol. Saga Med. Sch. Saga 840-01)····207

178. Effect of extracellular choline concentration on choline kinase and choline acetyltransferase activities in isolated superior cervical ganglia of rats.
Ando, M., Iwata, M., Takahama, K. and Nagata, Y. (Dept. of Physiol., Sch. of Med., Fujita-Gakuen Health Univ., Toyoake, Aichi 470-11) ····207

179. Choline acetyltransferase activity in muscles of the aged mice.
Washio, H., Imazato, C*., Kanda, K[1]. and Nomoto, S[1]. (Mitsubishi-Kasei Institute of Life Sciences, Machida, Tokyo 194, and Dept. Physiol., Tokyo Metropol. Inst. Gerontol., Itabashi-ku, Tokyo 173[1]) ····207

180. The afferent neurotransmitter in the acoustico-lateralis receptors : extraction of an active factor from sensory epithelia.
Okano, K., Umekita, S. and Obara, S. (Dept. Physiol., Teikyo Univ. Sch. Med., Tokyo 173)····208

181. Release of L-dopa from vocalization nuclei, robustus archistriatalis (RA) of zebra finch *in vitro*.
Sakaguchi, H. and Saito, N. (Dept. Physiol., Dokkyo Univ., Med. Sch., Mibu, Tochigi, 321-02) ····208

182. Intracellular injection of cAMP produces inward current similar to the Dopamine-induced response.
Sasaki, K., Matsumoto, M., Shozushima, M., Takashima, K. and Sato, M. (Dept. Physiol., Sch. Med., Iwate Med. Univ., Morioka, Iwate 020) ····208

183. Regulatory mechanism of adrenaline-induced l. t. p. in bullfrog sympathetic ganglia
Kumamoto, E. and Kuba, K. (Dept. Physiol., Saga Medical School, Saga 840-01) ····209

184. The effect of vasoactive intestinal polypeptide on the neurons in cat vesical pelvic ganglion.
Akasu, T. and Shinnick-Gallagher, P*[1]. (Dept. Physiol. Kurume Univ. Sch. Med., Kurume 830, Japan and Dept. Pharmacol. and Toxicol., Univ. Texas Med. Branch, at Galveston, Galveston, Texas 77550, U. S. A.[1]) ····209

185. VIP elicits ganglionoc depolarization and selectively facilitates muscarinic excitations in a sympathetic ganglion.
Kawatani, M., Rutogliano, M[1]. and De Groat, W. C[1]. (Dept. of Physiol., Med. Sch., Showa Univ., Shinagawa, Tokyo, 142 Japan, Dept. of Pharmacol., Med. Sch., Univ. of Pittsburgh, PA. 15261, U. S. A.[1]) ····209

186. The effect of Substance P on the neuromuscular junction in rat.
Nemoto, H., Uchida, H., Sasaki, K. and Kinoshita, M. (The Fourth Department of Internal Medcine, School of Medcine, Toho University, Tokyo, 153)····210

187. Substance P receptors expressed in *Xenopus* oocytes from rat brain mRNA.

Harada, Y., Takahashi, T., Kuno, M., Nakayama, K. and Nakanishi, S. (Dept. Physiol. and Inst. Immunol., Kyoto Univ. Fac. Med., Kyoto 606) ····210

188. Substance P augments a persistent slow inward calcium-sensitive current in voltage-clamped spinal dorsal horn neurons of the rat.
Murase, K. and Randic, M. (Info. Comput. Sci., Toyohashi Univ. Tech., Tempaku, Toyohashi 440 Japan, and Vet. Physiol. Pharmacol., Iowa State Univ., Ames, IA 50011 USA)····210

189. Effect of luteinizing hormone-releasing hormone (LH-RH) on the nicotinic transmission of bullfrog sympathetic ganglia.
Hasuo, H. and Akasu, T. (Dept. Physiol., Kurume Univ. Sch. Med., 67 Asahi-machi, Kurume 830, Japan)····211

190. The effect of TRH-T on the neuromuscular junction in rat.
Uchida, H., Nemoto, H., Sasaki, K. and Kinoshita, M. (The Fourth Department of Internal Medicine, school of Medicine, Toho University, Tokyo, 153) ····211

191. Effects of the agonist-induced currents on the removal of the receptor-bound agonists in molluscan and frog ganglion cells.
Maruhashi, J., Inoue, M[1]., Akaike, N[1]. and Oomura, Y[1]. (Dept. Biol., Daiichi Col. Pharm. Sci., Fukuoka 815 and Dept. Physiol., Fac. Med. Kyushu Univ.[1]) ····211

192. Response patterns of excitatory postsynaptic current (EPSC) in response to lateral column (LC) and dorsal root (DR) stimulation in frog spinal motoneuron.
Matsuura, S., Kuno, M. and Hirakawa, T. (Dept. Physiol. Osaka City Univ. Med Sch., Osaka, 545) ····212

193. Electrical activities and their structural relations in the neuropiles of the crayfish cerebral ganglion.
Chichibu, S., Chiba, A. and Yaginuma, S. (Dept. Physiol., Kinki Univ. Sch. Med., Sayama, Osaka 589)····212

194. Actions of adenosine and calcium ion concentration on the quantal transmitter release at the neuromuscular junction.
Takeuchi, N., Takikawa, Y., Wako, H. and Yana, K[1]. (Dept. Physiol., Sch. Med., Juntendo Univ., Hongo, Tokyo 113 and Dept. Electrical Eng., Coll. Eng., Housei Univ., Koganei, Tokyo 184[1])····212

195. Effects of divalent cations on frequency facilitation.
Shibuya, Y*. and Maeno, T. (Dept. of Physiol., Shimane Med. Univ., Izumo, Shimane 693)····213

196. Effects of a spider toxin (JSTX) on the hippocampal pyramidal neurons.
Saito, M., Kawai, N. and Miwa, A. (Dept. Neurobiol., Tokyo Metropolitan Inst. for Neurosci., 2-6 Musashidai, Fuchu-city, Tokyo 183)····213

197. On the sea urchin venom which blocks frog neuromuscular transmission.
Anraku, M., Kihars, H. and Hashimura, S. (Dept. Physiol., Kagoshima Univ. Fac. Med., Kagoshima 890)····213

198. Histological and pharmacological investigations of the two symmetrically situated giant neurones identified on the anterior surface of the pedal ganglia of an African giant snail (Achatina fulica Férussac).
Yongsiri, A. and Takeuchi, H. (Dept. Physiol., Gifu Univ. Sch. Med., Gifu 500)····214

199. Decreases of action potential amplitudes, in sodium-free and calcium-free conditions, of identifiable giant neurones of an African giant snail (Achatina fulica Férussac).
Sun, X. P., Funase, K. and Takeuchi, H. (Dept. Physiol., Gifu Univ. Sch. Med., Gifu 500)……214

200. Identification and pharmacological characteristics of the three giant neurones in the left buccal ganglion of an African giant snail (Achatina fulica Férussac).
Matsuoka, T. and Takeuchi, H. (Dept. Physiol., Gifu Univ. Sch. Med., Gifu 500) ……214

201. The channel characteristics of nicotinic receptorts on cardiac ganglion cells.
Ikeda, K. and Nishi, S. (Dept. Physiol., Kurume Univ. Sch. Med., Kurume 830)……215

202. Hyperpolarizing and depolarizing actions of dopamine on the nucleus accumbens neurons of the guinea-pig.
Uchimura, N., Higashi, H. and Nishi, S. (Dept. Physiol., Kurume Univ. Sch. Med., Kurume 830) ……215

203. Auto-regression power spectral analysis of GABA-induced noise currents in cat dorsal root ganglion cells.
Hijirikawa, K., Tanaka, E., Higashi, H. and Nishi, S. (Dept. Physiol., Kurume Univ. Sch. Med., Kurume 830)……215

204. Anion selectivities of GABA-controlled chloride channels.
Akaike, N., Oomura, Y. and Yakushiji, T. (Dept. Physiol., Fac. Med., Kyushu Univ. 60, Fukuoka 812) ……216

205. Intracellular Ca decreases affinity of GABA receptor in frog sensory neurons.
Inoue, M., Oomura, Y., Yakushiji, T. and Akaike, N. (Dept. Physiol., Fac. Med., Kyushu Univ. 60, Fukuoka 812) ……216

206. The electrical properties of pentobarbital-activated chloride current.
Maruyama, Y., Oomura, Y., Tokutomi, N. and Akaike, N. (Dept. Physiol., Fac. Med., Kyushu Univ. 60, Fukuoka 812) ……216

207. Effect of pentobarbital on the postsynaptic potentials in the hippocampal slices from the guinea pig.
Tanimoto, M., Yoneda, K. and Okada, Y. (Dept. Physiology, Sch. Med., Kobe Univ., Kusunokicho, Chuo-ku, Kobe 650) ……217

208. Chemosensitivity of the afferent nerve terminals and divalent cation effects in a tonic sensory receptor.
Obara, S., Nagai, T. and Sato, H. (Dept. Physiol., Teikyo Univ. Sch. Med., Tokyo 173)……217

209. Nature of the slow outward current in the C-neurons rabbit cervical nodose ganglion.
Miyazaki, T. and Kobayashi, H. (Department of Physiology, Tokyo Medical College, Shinjuku 6-1-1, Shinjuku-ku, Tokyo 160) ……217

210. Evidence for the coexistance of the monoamine and neuropeptide in the dorsal unpaired median neurons of the insect.
Tanaka, Y. and Washio, H. (Lab. Neurophysiol., Mitsubishi-Kasei Inst. Life Science, Machida 194) ……218

211. Effects of convulsants on calcium-dependent protein phosphorylation in rat cortical synaptosomes.
Imai, S., Onozuka, M., Furuichi, H., Kishii, K. and Sugaya, E. (Dept. Physiol.,

Kanagawa Dental Coll., Yokosuka 238)……218

212. Effect of histrionicotoxin on synaptic and non-synaptic ACh receptor channels in the bull frog sympathetic ganglion.
Ogura, T. and Warashina, A. (Dept. Physiol., Niigata Univ. Sch. Med., Niigata, 951)……218

213. Effects of hycanthone on the neuromuscular transmission.
Enomoto, K. (Dept. of Physiol., Shimane Med. Univ., Izumo, Shimane 693)……219

214. Effects of divalent cations on the post-tetanic decline in miniature end-plate potential frequency and in end-plate potential amplitude at the frog neuromuscular junction.
Narita, K., Kita, H. and Kawasaki, F. (Dept. of Physiol., Kawasaki Med. Sch., Okayama 701-01)……219

215. Long-term facilitation of CA1 pyramidal cell activity induced by association of two orthodromic inputs in hippocampal slices.
Miyakawa, H. and Kato, H. (Dept. Physiol., Yamagata Univ. Sch. Med., Yamagata 990-23)……219

216. Changes of the population spike and EPSP after repeated paired stimulation in guinea-pig hippocampal slice.
Ito, K. and Kato, H. (Dept. Physiol., Yamagata Univ. Sch. Med., Zao Iida Yamagata 990-23)……220

217. The block of the synaptic transmission induced by the increased temperature in CA1 neurons of guinea-pig hippocampus in vitro.
Fujii, S. and Kato, H. (Dept. Physiol., Yamagata Univ. Sch. Med., Yamagata 990-23)……220

218. Acute effects of lithium on synaptic transmission in hippocampal slice.
Higashitani, Y. and Kato, H. (Dept. Physiol., Yamagata Univ. Sch. Med., Yamagata 990-23)……220

219. Effects of the reduction and deprivation of glucose on the postsynaptic potentials in the hippocampal slices from the guinea pig.
Okada, Y., Tanimoto, M. and Yoneda, K. (Dept. Physiol. Sch. Med. Kobe Univ., Kusunokicho, Chuo-ku, Kobe, 650)……221

8. Autonomic Nervous System (220—261)

220. Heterogeneity of ganglia of the guinea pig myenteric plexus : An in vitro study of the origin of terminals within single ganglia using a covalently bound fluorescent retrograde tracer.
Takaki, M. and Gershon, M. D*[1]. (Dept. Physiol., Okayama Univ. Med. Sch., Okayama 700, Dept. Anat. and Cell Biol., Columbia Univ., College of P and S, New York[1])……222

221. Effect of ATP on calcium dependent potassium conductance of myenteric neurones.
Morita, K., Katayama, Y. and Tatsumi, H. (Dept. Autonom. Physiol., Med. Res. Inst., Tokyo Med. and Dent. Univ., Tokyo 101)……222

222. Effects of substance P on calcium-dependent potassium conductance of the myenteric neuron of the guinea-pig ileum.
Katayama, Y., Morita, K. and Tatsumi, H. (Dept. Autonom. Physiol., Med. Res. Inst., Tokyo Med. and Dent. Univ., Tokyo 101)……222

223. Effects of atropine, d-chlorpheniramine maleate and DG-5128 on postprandial movements of gastrointestinal tract.

Fujii, K. and Okajima, M. (Dept. Physiol., Hiroshima Univ. Sch. Med., Hiroshima 734)……223

224. Role of peptidergic neurons on intrinsic mucosal reflex of small intestine in dogs.
Neya, T., Mizutani, M. and Nakayama, S. (Dept. Physiol., Okayama Univ. Med. Sch., Okayama 700)……223

225. Opioid-induced hyperpolarization by δ receptor activation in the guinea-pig submucous neurones.
Mihara, S. and North, R. A. (Neuropharmacol. Lab. 56-245, M. I. T., Cambridge MA 02139, U. S. A.) ……223

226. Inhibitory neurotransmitters working at the regulatory regions for circulation and respiration in the nucleus tractus solitarii.
Miura, M. and Takayama, K. (Dept. Physiol. 1st Div., Gunma Univ. Sch. Med., Maebashi 371) ……224

227. Sensitivities of neurotransmitters in the nucleus tractus solitarii neurons derived from tissue cultures of neonatal rats.
Okada, J. and Miura, M. (Dept. Physiol. 1st Div., Gunma Univ. Sch. Med., Maebashi, 371) ……224

228. Projection to hypothalamus of neurons within solitary tract nucleus influenced by hepatic vagal afferents in rats.
Kobashi, M. and Adachi, A. (Dept. Physiol., Okayama Univ. Dent. Sch., Okayama 700) ……224

229. Adrenergic nerves in the hypothalamo-bulbar pathway of the vagal nerve.
Miyamoto, J. K., Ide, Ch., Okubo, T., Kurosawa, E., Maruyama, E. and Fujita, Y. (Dept. of Physiol., Saitama Kenritsu Eiseitandai, Urawa, 338)……225

230. Release of peptide histidine isoleucine (PHI) and vasoactive intestinal polypeptide (VIP) by electrical stimulation of the vagus.
Yasui, S., Naruse, S., Yanaihara, C. and Yanaihara, N. (National Institute for Physiological Sciences, Okazaki, 444 and Shizuoka College of Pharmacy, Shizuoka, 422)……225

231. Effects of hypothalamic stimulation on norepinephrine turnover in peripheral tissues.
Saito, M. and Minokoshi, Y. (Dept. Med. Biochem., Sch. Med., Ehime Univ., Ehime 791-02) ……225

232. Thyrotropin-releasing hormone-induced changes in electroencephalographic and vagal activity in the cross-circulated brain of the rat.
Tonoue, T. and Seino, K*. (Dept. Physiol. II, Azabu Univ. Sch. Vet. Med., Sagamihara 229) ……226

233. Effects of substance P antagonists on somato-adrenal sympathetic nerve reflexes in anesthetized rats.
Fujino, M*., Kurosawa, M., Saito, H*., Sato, A. and Swenson, R. S*. (Dept. Physiol., Tokyo Metropolitan Institute of Gerontology, Tokyo 173)……226

234. Changes in the autonomic nervous system produced by mechanical stimulation of the uterus in the rat.
Hotta, H*., Robbins, A*. and Sato, Y. (Dept. Physiol., Tokyo Metropolitan Institute of Gerontology, Tokyo 173) ……226

235. Proliferative activity of superior cervical ganglionic and adrenal medullary cells.
Ogawa, M., Ishikawa, T[1]. and Ohta, H[2]. (Dept. Physiol., Dept. Anat[1]. and Dept. Neuropsychiatry[2], Kochi Medical School, Nankoku Kochi 781-51) ……227

236. Effects of PTH and calcitonin on hypogastric nerve-mediated contraction of vas deferens of guinea pig in vitro.
Matsumoto, A., Yonemura, K. and Ishiko, N. (Dept. of Physiol., Miyazaki Medical College, Miyazaki 889-16)……227
237. Effects of pentobarbital, α-chloralose and urethane on renal sympathetic nerve activity in awake cats.
Matsukawa, K. and Ninomiya, I. (Dept. Cardiac Physiol., National Cardiovascular Center, Research Institute, Osaka 565)……227
238. Possible ganglionic reflex arc through pterygopalatine ganglion.
Koyano, H., Hoshino, T., Yoshizaki, K. and Sato, M. (Dept. Physiol., Akita Univ. Sch. Med., Akita 010)……228
239. Electrogenesis mechanism of slow IPSP in hamster submandibular ganglion cells.
Suzuki, T., Shiozaki, K. and Sakada, S. (Dept. Physiol., Tokyo Dent. Coll., Chiba 260) ……228
240. Electrophysiological properties of sympathetic postganglionic neurons innervating submandibular gland of hamster.
Morita, M., Suzuki, T., Saito, T. and Sakada, S. (Dept. Physiol., Tokyo Dent. Coll., Chiba 260) ……228
241. Relation between the fluctuation of parotid secretory potential and the changes in ion concentrations of parotid saliva.
Inomata, K., Takakuwa, M., Hoshi, M., Kurahashi, M., Yoshida, M. and Iwase, K. (Dept. of Oral Physiol., Sch. of Dent., Higashi-Nippon-Gakuen Univ., Ishikari-Tobetsu, Hokkaido 061-02) ……229
242. Culture of nodose ganglion neurons from new born rabbit.
Sato, M., Hoshino, T., Yoshizaki, K. and Koyano, H. (Dept. Physiol., Akita Univ. Sch. Med., Akita 010)……229
243. Neuronal control of lipid metabolism in brown adipose tissue.
Minokoshi, Y. and Saito, M. (Dept. Med. Biochem., Sch. Med., Ehime Univ., Ehime 791-02) ……229
244. Effect of taste stimulation on the rate of efferent discharges in the pancreatic branch of the vagus nerve in the normal and decerebrated rat.
Niijima, A. and Fukuda, A. (Dept. Physiol., Niigata Univ. Sch. Med., Niigata 951) ……230
245. Relationship between antigravity muscle contraction and muscle sympathetic nerve activity in man.
Mano, T., Saito, M., Iwase, S., Yamazaki, Y. and Inamura, K. (Dept. VI, Res. Inst. Environ. Med., Nagoya Univ., Nagoya 464)……230
246. Comparison of responses in muscle sympathetic nerve activity to sustained and rhythmic handgrip exercise.
Saito, M., Iwase, S[1]. and Mano, T[1]. (Toyota Technological Inst., Nagoya 468, Res. Inst. Environ. Med. Nagoya Univ. Nagoya 464[1]) ……230
247. Cholinergic modulation and effects of dynorphin on the non-adrenergic non-cholinergic inhibitory potentials in the duodenal smooth muscle of the guinea-pig.
Ohkawa, H. (Dept. Physiol., Yamaguchi Univ. Sch. Med., Ube 755)……231
248. Participation of substance P-ergic neurons on the control of the guinea-pig biliary tract motility.

Yamasato, T. and Nakayama, S. (Dept. Physiol. Okayama Univ. Med. Sch., Okayama 700) ····231

249. Excitatory effects of acetylcholine on the pre- and post-sites of neuromuscular junction in the guinea-pig vas deferens.
Wakui, M. and Fukushi, Y. (Dept. Appl. Physiol., Tohoku Univ. Sch. Med., Sendai 980)····231

250. A possible cholinergic-adrenergic mechanism in the longitudinal smooth muscle of the guinea-pig vas deferens.
Fukushi, Y. and Wakui, M. (Dept. of Applied Physiol., Tohoku Univ. Sch. Med., Sendai 980)····232

251. Reflex responses in pudendal branches innervating the external urethral and anal sphincters to the pelvic nerves stimulation in dogs.
Yamane, M. (Dept. Physiol., Kawasaki Med. Sch., Kurashiki 701-01) ····232

252. Cholecystokinin antagonist (proglumide) potentiate the inhibitory effect of morphine on micturition reflex in rats.
Hisamitsu, T. and Okada, M. (Dept. of Physiol., Sch. of Med., Showa Univ., Tokyo 142)····232

253. Behavior of the inferior mesenteric ganglion cells during defecation and micturition in the dog.
Fukai, K., Fukuda, H. and Okada, H. (Dept. Physiol., Kawasaki Med. Sch., Kurashiki 701-01)····233

254. Effects of methopyrapone on the uptake and distribution of [3H] dopamine in mouse adrenal medulla.
Hirano, T., Fukuda, A. and Niijima, A. (Dept. Physiol. Niigata Univ. Sch. Med., Niigata 951) ····233

255. Retrograde transport of nerve growth factor in superior cervical sympathetic ganglion of the rat.
Takahama, K., Iwata, M., Ando, M., Hori, S[1]., Kato, K[2]. and Nagata, Y. (Dept. Physiol., Sch. Med., Fujita-Gakuen Health Univ., Toyoake, Aichi 470-11, Dept. Neurochem., Tokyo Metropol. Inst. Neurosci., Fuchu, Tokyo 183[1], and Dept. Biochem., Inst. Develop. Res., Aichi Pref. Colony, Kasugai, Aichi 480-03[2])····233

256. Effects of calcium ion on the active response of rabbit otic ganglion cells.
Yoshizaki, K., Hoshino, T., Sato, M. and Koyano, H. (Dept., Physiol., Akita Univ. Sch. Med., Akita 010)····234

257. Influences of trigeminal stimulation on the dorsal nucleus neurons of the vagus nerve.
Komatsubara, J., Kajiwara, K., Takagi, T. and Sugaya, E. (Dept. of Physiology, Kanagawa Dental College, Yokosuka) ····234

258. Noradrenaline (NA) effects on the rat dorsal vagal motor nucleus (DMV) neurons in vitro.
Fukuda, A., Nabekura, J., Minami, T. and Oomura, Y. (Dept. Physiol., Fac. Med. Kyushu Univ. 60, Fukuoka 812) ····234

259. Effect of amygdala stimulation on the neuronal activity of the dorsal vagal complex.
Nishimura, H., Kai, Y., Shimizu, N. and Oomura, Y. (Dept. Physiol., Fac. Med., Kyushu Univ. 60, Fukuoka 812) ····235

260. Effects of centrally-acting muscle relaxants on muscle sympathetic activity in man.
Iwase, S., Mano, T., Saito, M., Inamura, K. and Tsukahara, R. (Department VI, Research Institute of Environmental Medicine, Nagoya University, Nagoya 464)……235

261. The effect of acupuncture stimulation on the activity of efferent sympathetic postganglionic fibers in man.
Moriyama, T., Hayashi, H. and Serizawa, K[1]. (Dept. Physiol., Saitama Med. Sch., Saitama 350-04. Inservice Training Center for Oriental Med. Scie. Tech. Tokyo[1]) ……235

9. Peripheral Nerve and Spinal Cord (262—282)

262. Distribution analysis of conduction velocity of peripheral nerves.
Isogai, Y. and Takanashi, Y. (Dept. Physiol. and Dept. Lab. Med., Kyoto Prefec. Univ. Med., Kyoto 602)……236

263. Peripheral neural messages participated in electroacupuncture effects on the rat tail flick reflex.
Matsui, A., Tsuruoka, M. and Matsui, Y. (Dept. Physiol., Showa Univ. Sch. Dent., Tokyo 142)……236

264. Effects of NGF on cell death of axotomized sensory neurons in neonatal rats.
Kashihara, Y., Miyata, Y. and Kuno, M. (National Institute for Physiological Sciences, Okazaki 444) ……236

265. Electroacupuncture suppression produced by Aβ afferent nerve impulses from different dermatomes.
Tsuruoka, M., Matsui, A. and Matsui, Y. (Dept. Physiol., Showa Univ. Sch. Dent., Tokyo 142)……237

266. Effects of peripheral stimulation on self-mutilation of the rat induced by nerve section of the hindpaw.
Miyagawa, H*., Yasumo, W., Asada, H., Nishigori, A. and Yamaguchi, Y. (Dept. Health Sci., College of Integrated Arts and Science, Osaka Pref. Univ., Sakai 591)……237

267. Prolonged activation of alpha-motoneurons following electrical and vibratory stimulation in anemically decerebrated cats.
Wada, N. and Homma, S. (Dept. Physiol., Chiba Univ. Sch. Med., Chiba 280)……237

268. Morphological and physiological properties in the external urethral and anal sphincter motoneurons and muscle types of external anal sphincter in the cat.
Sasaki, M. (Dept. Neurophysiol., Inst. Brain Res., Sch. Med., Univ. Tokyo, Tokyo 113)……238

269. Dendritic spikes in pigs, cats and rabbits.
Fujita, Y., Harada, H., Kitamura, T. and Sato, T. (Dept. of Physiol., Nippon Med. School, 1-1-5, Sendagi, Bunkyo-ku, Tokyo, 113) ……238

270. The analysis of skin reflex pathways.
Hongo, T., Kudo, N., Oguni, E. and Yoshida, K. (Dept. of Physiol., Inst. of Basic Med. Sci., Univ. of Tsukuba, Ibaraki 305) ……238

271. Fiber architecture of the spinal cord in rabbit. Part III. The spinovestibular tracts.
Ikawa, Y. and Ban, T. (Orthopedic Surgery, Hanwa-Senboku Hospital, Osaka) ……239

272. Time course of Ia inhibition at rest and on voluntary movement in man.
Kagamihara, Y. and Tanaka, R. (Dept. Neurobiol., Tokyo Metropolitan Institute for

Neurosciences, 2-6 Musashidai, Fuchu, Tokyo 183) ····239

273. Effect of fragment A-B of tetanus toxin on the transmission of the motoneurone in the spinal cord.
Takano, K., Kirchner, F., Gremmelt, A., Matsuda, M[1]., Ozutsumi, N[1]. and Sugimoto, N[1]. (Abt. Pathoneurophysiol., Univ. Göttingen, Humboldtallee 23, D-3400 Göttingen, Res. Inst. Microb. Dis., Osaka Univ., Osaka 565[1]) ····239

274. An identification of a nerve-contractor motoneuron in the abdominal ganglion of *Aplysia*.
Koike, H., Umitsu, Y. and Matsumoto, H. (Dept. Neurophysiol., Tokyo Metropolitan Institute for Neurosciences, Tokyo 183) ····240

275. Crayfish local non-spiking neurons form parallel pathways as premotor interneurons.
Hisada, M. and Nagayama, T. (Zool. Inst., Hokkaido Univ. Fac. Sci., Sapporo 060) ····240

276. Chronic stimulation of the dorsal root and dendritic spikes of motoneurones in infant pigs.
Fujita, Y., Harada, H., Kitamura, T. and Sato, T. (Dept. of Physiol., Nippon Med. School, 1-1-5, Sendagi, Bunkyo-ku, Tokyo 113) ····240

277. NMA-induced locomotor activity in hind limbs of new-born rats.
Kudo, N. and Yamada, T*. (Department of Physiology, Institute of Basic Medical Sciences, University of Tsukuba, Niihari-gun, Ibaraki 305, Japan) ····241

278. Intracellular recording from primary afferent fibers in the isolated spinal cord of the rat.
Hori, Y., Homma, S., Nakajima, Y. and Watanabe, S. (Dept. Physiol., Chiba Univ. Sch. Med., Chiba 280 and Dept. Physiol., Kyorin Univ. Sch. Med., Tokyo 181) ····241

279. Opiate receptor in the spinal cord of the acupuncture afferent pathway explored by naloxone reversible evoked potential caused by acupuncture stimulation of the tibial muscle.
Hishida, F., Sato, T. and Takeshige, C. (Dept. Physiol., Sch. Med., Showa Univ., Tokyo 142) ····241

280. Changes of some neurotransmitter candidate contents in rat spinal cord after laminectomy and sciatic nerve transections.
Fujita, K. and Nagata, Y. (Dept. of Physiol., Sch. of Med., Fujita-Gakuen Health Univ., Toyoake, Aichi 470-11) ····242

281. Pinna afferent impulses responsible for scratch reflex in spinal cats.
Kurosawa, Y. and Aoki, M. (Dept. Physiol., Sapporo Med. College, Chuo-ku, Sapporo 060) ····242

282. Slow potentials in the unexcitable cells of spinal cord.
Tsuruhara, H. and Takahashi, T. (Dept. Physiol., Kyoto Univ. Sch. Med., Kyoto 606) ····242

10. Brain Stem (283—310)

283. Interstitial vestibular interaction in the control of head posture. II. Activity of vestibular nuclei and head posture.
Fukushima, K., Fukushima, J. and Kato, M. (Dept. Physiol., Hokkaido Univ. Sch. Med., Sapporo 060) ····243

284. Excitatory actions of noradrenaline on electrical activity of rat locus coeruleus neurons.
Sakaguchi, T., Kimura, F*. and Nakamura, S. (Dept. Neurophysiol., Inst. Higher

Nervous Activity, Osaka Univ. Med. Sch. Osaka 530)……243

285. 2-deoxyglucose uptake in the brainstem of thalamic cats during PLRF elicited forelimb movements.
Shimamura, M., Edgerton, V. R*[1]., Kogure, I. and Fuwa, T. (Dept. Neurophysiol., Tokyo Metro. Inst. for Neurosci., Tokyo 183, Japan and Dept. of Kinesiol., UCLA, Los Angeles, CA 90024, U. S. A.[1])……243

286. The effects on initiation of spontaneous locomotion after lesioning subthalamic locomotor region.
Udo, M. and Shimada, T. (Div. Neuromuscular Skills, Fac. Health and Sport Sci., Osaka Univ., Osaka 560)……244

287. The center of rabbit animal hypnosis.
Okamoto, T., Hisamitsu, T., Luo, C. P. and Takeshige, C. (Dept. Physiol., Sch. Med., Showa Univ., Tokyo 142) ……244

288. Eye movements evoked by microinjection of GABA agonist into the rat substantia nigra.
Sakamoto, M. and Hikosaka, O. (Dept. Physiol., Toho Univ. Sch. Med., Ota-ku, Tokyo 143)……244

289. Adrenal medulla cells of newborn rat grow to neurons in the caudate nucleus, and alleviate motor imbalance in rat with unilateral lesion in nigrostriatal dopamine pathway.
Nishino, H., Ono, T., Shibata, R., Shiosaka, S[1]. and Tohyama, M[1]. (Dept. Physiol., Toyama Med. and Pharmaceu. Univ., Toyama 930-01 and Dept. Neuroanat., Osaka Univ., Osaka 530[1]) ……245

290. Dynamics of adaptive change in vestibuloocular reflex.
Isu, N., Baker, J. F[1]., Harrison, R. E. W[1]., Wickland, C. R[1]. and Peterson, B. W[1]. (Instrumentat. Contr. Div., National Aerospace Lab., Chofu, Tokyo 182, Dept. Physiol., Northwestern Univ. Sch. Med., Chicago, IL 60611, U. S. A.[1]) ……245

291. Facilitatory and inhibitory effects induced by cutaneous stimulation on jaw opening reflex of the rat.
Yasumo, W., Asada, H*., Nishigori, A. and Yamaguchi, Y. (Dept. Health Sci., Coll. Integ. Arts and Sci., Osaka Pref. Univ. Sakai 591 and Coll. Biomed. Tech., Osaka Univ., Osaka 560)……245

292. Synaptic activation of trigeminal afferents on axotomized facial motoneurons in the cat.
Tanaka, T., Asahara, T. and Nishimura, Y. (Dept. Physiol., Mie Univ. Sch. Med., Tsu, Mie 514) ……246

293. Intracellular responses of trigeminal sensory neurons to peripheral and central stimulations.
Sunada, T., Kurasawa, I., Hirose, Y[1]. and Nakamura, Y. (Depts. Physiol. and Dent. Anesthesiol[1]., Fac. Dent., Tokyo Med. Dent. Univ., Tokyo 113) ……246

294. Recurrent inhibition of bulbar reticular neurons and its role in cortical induction of masticatory rhythm in guinea pigs.
Nozaki, S., Iriki, A. and Nakamura, Y. (Dept. Physiol., Fac. Dent., Tokyo Med. Dent. Univ., Bunkyo-ku, Tokyo 113)……246

295. Synaptic basis of rhythmical trigeminal premotor neuron activity underlying cortically

induced masticatory rhythm.
Iriki, A., Nozaki, S. and Nakamura, Y. (Dept. Physiol., Fac. Dent., Tokyo Med. Dent. Univ., Bunkyo-ku, Tokyo 113)……247

296. Effect of destruction of trigeminal ascending pathways on the jaw movement pattern.
Inoue, T., Nagashima, T., Nakamura, T. and Morimoto, T. (Dept. Oral Physiol., Osaka Univ. Fac. Dent., 1-8 Yamadaoka, Suita, Osaka 565)……247

297. Input organization of reticulospinal neurons from the cerebral cortex and tectum in the cat.
Isa, T. and Sasaki, S. (Dent. Neurophysiol., Inst. of Brain Res., Sch. of Med., Tokyo 113)……247

298. Ascending and descending axon collaterales of the posterior canal-activated excitatory vestibular neurons in the cat.
Uchino, Y., Ichikawa, T., Nakajima, H[1]., Isu, N[2]. and Watanabe, S. (Dept. Physiol. Kyorin Univ. Tokyo 181, Dept. Oto-Laryngol. St. Marianna Univ. Kanagawa 213[1], Instrumentation and Control Div. National Aerospace Lab. Tokyo 182[2])……248

299. Functional differences between dorsal and ventral subdivision of y-group nucleus of vestibular nuclear complex in cats.
Sato, Y. and Kawasaki, T. (Dept. Physiol., Fac. Med., Toyama Medical and Pharmaceutical Univ., Toyama 930-01)……248

300. Effects of stimulation of raphe nucleus and locus coeruleus on lumbar monosynaptic reflex pathways in the cat.
Edamura, M., Ohtsuka, K. and Aoki, M. (Dept. Physiol., Sapporo Medical College, Chuoku, Sapporo 060)……248

301. Coronal cortically evoked responses on single superior salivatory neurons in the cats.
Ishizuka, K., Murakami, T. and Nakayama, K. (Dept. Oral Physiol., Nippon Dental Univ., Niigata, Niigata)……249

302. Adaptive plasticity in ocular following response of monkey.
Kawano, K. and Miles, F. A. (Bionics Section, Electrotechnical Lab., Sakuramura, Ibaraki 305)……249

303. Optimal stimulus conditions for auditory brainstem responses.
Miyazaki, H., Hurukawa, C., Sekiya, T. and Katoh, S. (Maharishi Research Institue, Higashi 1-3-1, Shibuyaku, Tokyo)……249

304. Changes in central nerve activity with destruction of the internal capsule.
Sakurai, H., Naito, H. and Yasuhara, M. (Dept. Physiol., Kansai Med. Univ., Osaka 570)……250

306. Afferent connections of the superior salivatory nucleus in the rat.
Matsuo, R. (Dept. Oral Physiol., Osaka Univ. Faculty of Dent., Suita, Osaka 565)……250

307. Catecholamine content in the brain of spontaneously hypertensive rat (SHR) under immobilized stress.
Okamura, K. and Nomura, M. (Dept. Physiol., Fujita-Gakuen Health Univ. Sch. Med., Toyoake, Aichi 470-11)……250

308. Brainstem and spinal neuronal structures in relation to micturition in cats.
Sugaya, K., Ohta, Y., Matsuyama, K. and Mori, S. (Dept. of Physiol., Asahikawa Med. Col., Asahikawa 078-11)……251

309. Ponto-medullary suppression of postural muscle tone in the decerebrate, reflex standing cat.
Ohta, Y., Takakusaki, K., Matsuyama, K. and Mori, S. (Dept. of Physiol., Asahikawa Med. Col., Asahikawa 078-11) ····251

310. Functional roles played by cells in the nucleus reticularis gigantocellularis during MLR-induced controlled locomotion ; with reference to postural support.
Matsuyama, K., Ohta, Y., Sugaya, K., Takakusaki, K. and Mori, S. (Dept. of Physiol. Asahikawa Med. Col., Asahikawa 078-11) ····251

11. Diencephalon and Lymbic System (311—331)

311. Projection of visceral afferent input onto nucleus ventralis posterolateralis.
Taguchi, H., Masuda, T., Koyama, N. and Yokota, T. (Dept. Physiol., Med. Coll. Shiga, Otsu 520-21)····252

312. Nociceptive neurons in ventrobasal complex of primate thalamus.
Koyama, N., Masuda, T. and Yokota, T., (Dept. Physiol., Med. Coll. Shiga, Otsu 520-21) ····252

313. Modulation of lateral hypothalamic neuronal activity by non-vagal afferents in rats.
Ohta, A*. and Shiraishi, T. (Dept. Physiol., Tokai Univ. Sch. Med., Isehara 259-11) ····252

314. Effects of repetitive stimuli on the neuronal activity in VB nuclei.
Akita, H., Noda, K., Hozumi, K., Ogata, M., Hamanaka, S., Kobayashi, S., Aikawa, S. (Dept. of Physiol., Sch. of Hygienic Sciences, Kitasato Univ., Sagamihara, Kanagawa and Dept. of ME, Seishin-Igaku Inst., Itabashi-ku, Tokyo) ····253

315. Hypothalamic regulation of Na-pump activity in rat skeletal muscle.
Katafuchi, T., Yoshimatsu, H., Oomura, Y. and Akaike, N. (Dept. Physiol., Fac. Med., Kyushu Univ. 60, Fukuoka 812) ····253

316. Transplantation of normal arcuate nucleus into the brain of rat treated with monosodium glutamate.
Inoue, H., Kohsaka, S., Shinozaki, T[1]., Takayama, H[1]., Yoshida, K[1]., Otani, M[1]., Toya, S[1]. and Tsukada, Y. (Dept. of Physiol. and Dept. of Neurosurg[1]., Sch. Med., Keio Univ., Tokyo 160)····253

317. Effects of electrical stimulation of hypothalamus on sexual behavior in the female monkey.
Koyama, Y., Fujita, I., Nishino, H. and Oomura, Y. (Natl. Inst. Physiol. Sci., Okazaki 444, Dept. Physiol., Fac. Med., Kyushu Univ., Fukuoka 812) ····254

318. Electrically evoked mounting and grooming in the male monkey.
Fujita, I., Koyama, Y., Nishino, H. and Oomura, Y. (Natl. Inst. Physiol. Sci., Okazaki 444, Dept. Physiol., Fac. Med., Kyushu Univ., Fukuoka 812) ····254

319. Visual information processing among the inferotemporal cortex, amygdala and lateral hypothalamus in monkey.
Ono, T., Fukuda, M. and Nishino, H. (Dept. Physiol., Fac. Med., Toyama Med. and Pharmaceu. Univ., Toyama 930-01)····254

320. The influence of the kindling effect on the electrophysiological phenomena(Part 4).
Okamoto, M., Ikeda, H., Naito, H. and Yasuhara, M. (Dept. Physiol., Kansai Med. Univ., Osaka 570)····255

321. Septo-hippocampal pathways identified with laminar field potential analysis and HPR-labeling method in rats.

Oka, H. and Yoshida, K. (Dept. of Physiol., Fukui Med. Sch., Fukui 910-11) ····255

322. Dendritic and axonal arborization pattern of GABAergic local circuit neurones in rat hippocampal CA1 region.
Kawaguchi, Y. (National Institute for Physiological Sciences, Okazaki 444)····255

323. Monkey amygdala neuron responses to positive and negative affective situations.
Nishijo, H., Ono, T., Nakamura, K. and Kawabata, M. (Dept. Physiol., Fac. Med., Toyama Med. and Pharmaceu. Univ., Toyama 930-01) ····256

324. Distribution pattern of learning related neurons in monkey prefrontal cortex.
Yamatani, K., Ono, T., Nishino, H. and Fukuda, M. (Dept. Physiol. and Neurosurg., Fac. Med., Toyama Med. and Pharmaceu. Univ., Toyama 930-01) ····256

325. The segregation between the VPM and the VPL in the rat thalamus : A mapping study by single neurons.
Sugitani, M., Ooyama, H., Yano, J. and Sugai, T. (Dept. Physiol., Kanazawa Medical Univ., Ishikawa 920-02) ····256

326. The role of limbic-hypothalamic system in metabolic adaptation of pyruvate to immobilization stress.
Ohri, A., Hamaguchi, K., Kinoshita, C., Edashige, N., Kitaoka, K. and Seto, K. (Dept. Physiol. Kochi Med. Sch., Kochi 781-51) ····257

327. The afferent auditory pathway to the lateral hypothalamic cue tone discrimination related neurons of the rat.
Nakamura, K., Ono, T., Kawabata, M. and Muramoto, K. (Dept. Physiol., Fac. Med. and Pharmaceu. Univ., Toyama 930-01) ····257

328. Kinetics of indolamines in the chronic rat hypothalamus : Voltammetry analysis.
Aoyagi, K., Shimizu, N. and Oomura, Y. (Dept. Physiol., Fac. Med., Kyushu Univ. 60, Fukuoka 812) ····257

329. Subfornical organ neurons with efferent projections to the rat hypothalamic paraventricular nucleus.
Saito, H., Tanaka, J., Kaba, H. and Seto, K. (Dept. Physiol., Kochi Med. Sch., Kochi 781-51)····258

330. Responses of neurons in the region of the subfornical organ to vasopressin.
Tanaka, J., Kaba, H., Saito, H. and Seto, K. (Dept. Physiol., Kochi Med. Sch., Kochi 781-51)····258

331. Simultaneous recordings from two types of hippocampal non-pyramidal cells and the electrically induced paroxysmal discharge.
Kogure, S. (Dept. of Physiol., Nippon Med. School, 1-1-5, Sendagi, Bunkyo-ku, Tokyo, 113)····258

12. Cerebellum (332—342)

332. Metabolic mapping of optokinetic pathways to the cerebellum by means of 2-deoxyglucose autoradiography in the rat.
Mori, K. and Miyashita, Y. (Dept. Physiol., Fac. Medicine, Univ. of Tokyo, Hongo, Bunkyo, Tokyo 113)····259

333. The visual neurons responding to optokinetic stimulation in the cerebellar fastigial nucleus of the cat.

Ohno, M., Ohhashi, T*. and Kato, M. (Dept. Physiol., Hokkaido Univ. Sch. Med., Sapporo 060) ····259

334. Direction of saccadic eye movement and effect of bicuculline on saccadic eye movement elicited by microstimulation of the pre- and postsynaptic components of fastigial neurons.
Murakami, S. and Noda, H[1]. (Colledge of Medical Tech. Hokkaido Univ., Sappro 060 Dep. Visual Science Sch. Optometry Indiana Univ[1]., Bloomington IN. 47405 U. S. A.) ····259

335. Simultaneous multiple unit recording from 32 Purkinje cells in rat cerebellar cortex.
Sasaki, K. and Llinás, R[1]. (Dept. Physiol., Fac. Med., Toyama Med. and Pharmaceu. Univ., Toyama 930-01 and Dept. Physiol. and Biophysics, New York Univ. Med. Ctr., New York, NY 10016[1])····260

336. Undescribed properties of Purkinje cell response observed in *in vivo* cat's cerebellum.
Takahira, H. (Dept. Physiol., Tokai Univ. Sch. Med., Isehara, 259-11) ····260

337. Projections from the prepositus hypoglossi nuclear complex to the vestibulocerebellum of the rabbit.
Maekawa, K. (Dept. Physiol., Jichi Med. Sch., Tochigi-ken 329-04) ····260

338. Long-term effects of 3-acetylpyridine-induced destruction of cerebellar climbing fibers of the rat.
Karachot, L*., Ito, M., and Kanai, Y*. (Dept. of Physiol., Fac. of Med., Univ. of Tokyo, Bunkyo-ku, Tokyo 113) ····261

340. Projection from the prefrontal cortex onto the cerebellar hemisphere in the monkey.
Sasaki, K. and Gemba, H. (Inst. for Brain Res., Fac. Med., Kyoto Univ., Kyoto 606) ····261

341. Functional role of cerebello-prepositus circuit in the control of gaze in the cat.
Ohtsuka, K., Edamura, M. and Aoki, M. (Dept. of Physiol. Sapporo Medical College, Chuo-ku, Sapporo 060) ····261

342. Visual projection to the cerebellum in carp—in association with dorsal light tilt reaction—.
Mori, S., Watanabe, S., Takabayashi, A., Sakakibara, M. and Takagi, S. (Dept. Aerospace Physiol., Res. Inst. Environ. Med., Nagoya Univ., Nagoya 464) ····262

13. Telencephalon (339, 343—361)

339. Reexamination of the ramp-generator hypothesis of the basal ganglia in pallidal neuron diacharges of awake monkeys.
Hamada, I., DeLong, M. R*., Mano, N. and Miyao, Y*. (Dept. Neurophysiol., Tokyo Metropo. Inst. for Neurosciences, 2-6 Musashidai, Fuchu-shi, Tokyo 183) ····263

343. Response properties of bradykinin sensitive tooth pulp driven neurons (BK-TPNs) in SI region of cat cerebral cortex.
Iwata, K., Itoga, H., Tamura, K., Toda, K. and Sumino, R. (Dept. Physiol., Nihon Univ. Sch. Dent., Chiyoda-ku, Tokyo 101) ····263

344. Neurons activated or inhibited by the contact of the hand with stabilized objects, found in the area 2 hand region of the monkey somatosensory cortex(SI).
Iwamura, Y., Tanaka, M. and Hikosaka, O. (Dept. Physiol., Toho Univ. Sch. Med., Omori-Nishi, Otaku, Tokyo 143)····263

345. Vestibral input to the fifth somatic sensory cortex(SV).
Mori, A., Matsuura, N., Naito, K. and Sumino, R. (Dept. Physiol., Nihon Univ. Sch. Dent., Chiyoda-ku, Tokyo 101) ····264

346. Effects of chronic ablation of the sensori-motor cortex and the superior colliculus on the head-turning induced by the stimulation of the caudate nucleus.
Ohno, T. and Tsubokawa, H. (Dept. Physiol., Institute of Basic Med. Sci., The Univ. Tsukuba, Sakura-mura, Niihari-gun, Ibaraki 305)……264
347. An analysis of recurrent EPSPs unitary produced in PT cells.
Kang, Y., Kayano, F., Endo, K. and Araki, T. (Dept. Physiol., Kyoto Univ. Fac. Med. Kyoto 606) ……264
348. Motor cortex neuronal activity related to a key press movement of ipsilateral, contralateral and bilateral hand.
Tanji, J. and Okano, K. (Dept. Physiol., Hokkaido Univ. Sch. Med., Sapporo 060)……265
349. Cyclic AMP system of polarized cerebral corebral cortex in the rat.
Moriwaki, A., Hattori, Y., Hayashi, Y., Sunami, T. and Hori, Y. (Dept. of Physiol., Okayama Univ. Med. Sch., Okayama 700) ……265
350. Electrophysiological and morphological studies on non-pyramidal tract neurons in the motor cortex of kittens.
Yamamoto, T., Samejima, A. and Oka, H. (Department of Physiology, Fukui Medical School, Fukui 910-11)……265
351. Reappearance of dense geniculocortical projection onto layer I after reverse suture in kittens.
Kato, N. and Kawaguchi, S. (Inst. Brain Res., Fac. Med., Kyoto Univ., Kyoto 606) ……266
352. Unit activities in cat cortical area 20 which correlated with pupillo-constriction responses.
Bando, T. (Dept. Physiol., Yamanashi Med. Sch., Tamaho, Nakakoma, Yamanashi 409-38, Japan) ……266
353. Corticocortical connections between the cortical areas related to eye movements in cats.
Nakai, M., Tamai, Y., Miyashita, E. and Tsujimoto, T. (Dept. of Physiology, Wakayama Medical College, Wakayama 640)……266
354. Suppression of visually triggered saccades by electrical stimulation of the monkey frontal eye field.
Azuma, M., Nakayama, H. and Suzuki, H. (Dept. Physiol., Hirosaki Univ. Sch. Med., Hirosaki 036)……267
355. GABA-ergic inhibition upon neuronal activities related to a visual reaction time task in the monkey prefrontal cortex.
Sawaguchi, T., Matsumura, M. and Kubota, K. (Dept. Neurophysiol., Primate Res. Inst., Kyoto Univ., Inuyama, Aichi 484) ……267
356. EEG changes of the monkey prefrontal cortex during learning of a visual discrimination task with GO/NO-GO performances.
Kubota, K. (Dept. Neurophysiol. Primate Res. Inst., Kyoto Univ., Aichi 484) ……267
357. Cortical field potentials associated with audio-initiated hand movements in the monkey.
Gemba, H. and Sakaki, K. (Inst. Brain Res., Fac. Med., Kyoto Univ., 606 Kyoto) ……268
358. A thalamo-cerebral connection in vocal center of song bird.
Okuhata, S., Saito, N. (Dept. of Physiol., Dokkyo Univ. Sch. Med., Mibu, Tochigi, 321-02)……268
359. Slow potentials of auditory neurons in cerebral vocalization nucleus of canary.

Maekawa, M. and Saito, N. (Dept. of Physiol., Dokkyo Univ. Med. Sch., Mibu, Tochigi, 321-02) ····268

360. Spatial property of inhibitory end-zones of simple and B-cells in cat striate cortex.
Yamane, S., Maske, R. and Bishop, P. O. (Bionics Section, Electrotechnical Laboratory, Umezono, Sakuramura, Niiharigun, Ibarakiken 305)····269

361. Interaction of two moving patterned stimuli on the responses of the complex neuron of the cat.
Kaji, S. and Kawabata, N*. (Bionics, Electrotech. Lab. Umezono, Sakura, Ibaraki 305)····269

14. EEG, EMG and Evoked Potential (362—375, 824)

362. Spectral sensitivity of the human visually evoked potentials to checkerboard pattern reversal stimulation.
Nakamura, T. and Morita, Y. (Grad. Sch. Electr. Sci. Technol., Shizuoka Univ., Hamamatsu 432 and 1. Dept. Physiol., Hamamatsu Univ. Sch. Med., Hamamatsu 431-31)····270

363. Basic studies on the EMG components of the photically evoked lid potential changes.
Hoshina, Y., Ozaki, T., Tanno, T. and Nikara, T. (Dept. Physiol., Hirosaki Univ. Sch. Med. and Lab. of Physiol., Sch. of Allied Med. Sci. Hirosaki Univ., Hirosaki 036) ····270

364. Changes in excitability of the brain stem reticular formation in the presence of flash stimulus.
Naito, H., Takemura, K., Hori, A., Yamamoto, T. and Yasuhara, M. (Dept. Physiol., Kansai Med. Univ., Osaka 570) ····270

365. Responses of EEG theta component to continuous light stimuli.
Katada, A., Koike, T., Fuzisawa, S., Suzuki, H[1]. and Ozaki, H[1]. (Lab. of Physiol-Psychol., Tokyo Gakugei Univ., Koganei, Tokyo 184, Lab. of Physiol. for the developmentally Handicapped Ibaraki Univ., Mito 310[1]) ····271

366. EEG topography of theta activity during mental calculation.
Tatsuno, J., Okamoto, J., Ashida, H., Maru, E. (Dept. of Physiol., Natl. Def. Med. Coll., Tokorozawa 359) ····271

367. Overall spatial and temporal characteristics of EEG components within alpha frequency band.
Suzuki, H., Ozaki, H., Katada, A[1]., Nagase, Y[1]. and Koike, T[1]. (Facult. Ed., Ibaraki Univ. Mito, 310, Tokyo Gakugei Univ., Koganei, 184[1]) ····271

369. Auditory Brain Stem Responses as Related to Symptoms of Schizophrenia.
Hayashida, Y., Tomita, S., Kubo, M., Abe, K*. and Egashira, K*. (Dept. Systems Physiol. and Dept. Neuropsychiat., Univ. Occup. Envirn. Hlth., Yahatanishi, Kitakyushu 807) ····272

370. Relationship between blood glucose levels and the occurrence of kindling in infant rat.
Lee, S., Kawawaki, H., Matsuura, S. (Dept. Physiol., Osaka City Univ. Med. Sch. Osaka 545) ····272

371. Changes in after-discharges of EEG waves by calcium antagonist in kindling seizures of suckling and adult rats.
Kawawaki, H., Lee, S. and Matsuura, S. (Dept. Physiol., Osaka City Univ. Med. Sch., Osaka 545) ····272

372. Frontal theta rhythms in the normal EEG of the waking adults.

Asada, H., Mizutani, M., Yasumo, W. and Yamaguchi, Y. (Labo. Clin. Physiol., Coll. Boimed. Tech., Osaka Univ., Toyonaka 560, Forensic Sci. Lab., Hyogo Pref., Police H. Q., Kobe 650 and Dept. Health Sci., Osaka Pref. Univ., Sakai 591)·····273

373. Localization and characteristics of rat cerebellar field potentials evoked by tooth pulp stimulation.
Shimizu, S. and Yoshino, H. (Dept. of Pharmacol., Kawashima Univ., Sch. of Dent., Kagoshima 890)·····273

374. Power spectral analysis of electroencephalographic activities in monoaminergic nuclei and prefrontal area of the cat brain.
Matsunari, S., Kuwahara, H*. and Nishi, S. (Dept. Physiol. and Computer Cen. Med. Res., Kurume Univ. Sch. Med., Kurume 830)·····273

375. Localization of an electric dipole and dipole tracing of human brain potentials - The inverse problem.
Nakajima, Y., Homma, S., Musha, T[1]., Okamoto, Y[1]. and He, B[1]. (Dept. Physiol., Sch. Med., Chiba Univ., Chiba 280 and Dept. appl. Electr., Tokyo Inst. Technol., Yokohama 227[1])·····274

824. The characteristics of the electrical responses during repetitively stimulated contraction of the human muscle.
Yamamoto, T. (Toyama-ken Takashi Reha. Hosptl., Toyama)·····274

15. Behavior (376—401)

376. Inhibition on the crayfish eye-cup withdrawal reflex.
Chiba, A., Yaginuma, S. and Chichibu, S. (Dept. Physiol., Kinki Univ. Sch. Med., Sayama, Osaka 589)·····275

377. Responsiveness to patterns in inferotemporal neurons in monkeys performing discrimination task.
Hikosaka, K., Watanabe, J., Sato, T., Suyama, H*. and Iwai, E. (Dept. Behav. Physiol., Tokyo Metropolitan Inst. for Neurosci., Fuchu, Tokyo 183)·····275

378. Principal component analysis of the images during thinking process II.
Kikuchi, M. and Shinagawa, Y. (Dept. of Physiol., Nippon Medical School, 1-1-5 Sendagi, Bunkyo-ku, Tokyo 113) ·····275

379. Electroencephalographic changes associated with shock-elicited ultrasonic vocalization in the rat.
Seino, K*., Oohashi, K*. and Tonoue, T. (Dept. Physiol. II, Azabu Univ. Sch. Vet. Med., Sagamihara 229) ·····276

380. Genetic improvement and behavior analysis on acallosal mouse in ddN strain.
Murakami, T. H. (Dept. Biol., Kagawa Med. Sch., Miki-cho, Kida-gun, Kagawa, 761-07)·····276

381. Effects of local lesions of cerebrum on maze learning in rats.
Abe, K., Kameda, K*., Yunoki, T*. and Obana, E*. (Dept. Physiol., Kumamoto Univ. Coll. Med. Sci., Kumamoto 862) ·····276

382. Interrelation between feeding related lateral hypothalamic (LHA) neurons and prefrontal cortex in the monkey.
Oomura, Y., Nishino, H., Fukuda, A., Kai, Y. and Karadi, Z. (Dept. Biol. Cont.

Syst., Natl. Inst. of Physiol. Sci., Okazaki 444)……277

383. Changes in brain multiple unit activity related to operant learning of eye movements in the cat.
Hanada, Y., Ikegami, S. and Kawamura, H. (Lab. of Physiol. Psychol., Mitsubishi-Kasei Institute of Life Sciences, Machida-shi, Tokyo 194) ……277

384. Orbitofrontal neuronal activity to accompany with operant conditioned error response.
Ishikawa, T., Tanaka, Y., Miyazawa, T., Fujita, I[1]., Nishino, H[1]. and Oomura, Y[1].
(Dept. Physiol., Nihon Univ. Sch. Med., Itabashi, Tokyo 173 and Dept. Siol. Control System, National Inst. Physiol. Sci., Okazaki 444[1]) ……277

385. The neuronal activities in the limbic system during postpartum parental behavior of female rats.
Shimura, T., Horio, T. and Shimokochi, M. (Dept. Behav. Physiol., Fac. Human Sciences, Osaka Univ., Suita 565) ……278

386. Plasma concentration of sugar-acid lactones in normal and food-deprived rats.
Nemoto, S., Fujita, I., Shimizu, N*., Nishini, H., and Oomura, Y*. (Natl. Inst. Physiol. Sci., Okazaki 444, Dept. Physiol., Fac. Med., Kyushu Univ., Fukuoka 812*)……278

387. Classification of nucleus raphe dorsalis neurons : their firing properties during sleep-waking cycle.
Shima, K., Nakahama, H., Yamamoto, M. (Div. Neurophysiol., Inst. Brain Diseases, Tohoku Univ. Sch. Med., Sendai 980) ……278

388. Arousal from sleep in cats (III) : A brain electrostimulation study.
Matsumoto, H., Morita, Y., Seno, H., Matsumoto, J[1]. and Sato, K[2]. (Dept. Physiol., Univ. Tokushima, Sch. Med., Tokushima 770, Dept. Human Culture, Naruto Univ. Teachers Education, Naruto 772[1] and Res. Foundation on Traffic Med., Tokyo 170[2]) ……279

389. Sleep-wake and temperature rhythm of cats under prolonged constant darkness.
Kuwabara, N., Aoki, K. and Seki, K[1]. (Life Sci. Inst., Sophia Univ. Tokyo., JAMSTEC., Yokosuka[1]) ……279

390. Regional cerebral blood flow and oxygen consumption in human sleep.
Okudaira, N., Kanemoto, H., Takahashi, K[1]., Uchida, K[1]., Iio, M[1]. and Torii, S.
(Dept. of Physiol., 2 nd Dept. of Int. Med., Toho Univ. Sch. of Med., Ohta-ku Tokyo 143[1] and Dept. of Radiology, Nakano National Chest Hospital, Nakano-ku Tokyo 165) ……279

391. Interacting sleep-modulatory effects of simultaneously administrated sleep substances in rats.
Kimura, M., Honda, K., Okano, Y., Komoda, Y*. and Inoué, S. (Inst. for Med. Dent. Eng., Tokyo Med. Dent. Univ., Kanda-Surugadai 2-3-10, Chiyoda-ku, Tokyo 101)……280

392. Delay of urination in aged animals.
Nagasaki, H. (Dept. Physiol. Yamanashi Univ. Sch. Med. Yamanashi 409-38) ……280

393. A study on the influence to the spirit and body by the adjustment of the posture.
Kozeki, K., Sakamoto, M. and Itow, H. (Body Reformatory School Tokyo 153) ……280

394. Cerebrophysiological study on the Kukai's "Shoji jisso gi".
Matsumoto, J. (Naruto University of Teacher Education, Naruto 772) ……281

395. Low frequency fluctuations of spontaneous activities of midbrain reticular neurons and their crosscorrelations.
Yamamoto, M., Nakahama, H., Shima, K., Aya, K. and Inase, M. (Div. Neurophysiol.

Inst. Brain Diseases, Tohoku Univ. Sch. Med., Sendai 980) ……281

396. Correlations among the activities of hippocampal theta cell, theta wave and PGO spikes.
Mushiake, H., Kodama, T., Nakahama, H., Yamamoto, M. and Shima, K. (Div. Neurophysiol., Inst. Brain Diseases, Tohoku Univ. Sch. Med., Sendai 980) ……281

397. The time series analyses of hippocampal neuronal activities during slow-wave sleep, paradoxical sleep and attentive state.
Kodama, T., Mushiake, H., Nakahama, H., Yamamoto, M. and Shima, K. (Div. Neurophysiol., Inst. Brain Diseases, Tohoku Univ. Sch. Med., Sendai 980) ……282

398. Spontaneous locomotor activity of the spontaneously hypertensive rats (SHR) using the running wheel.
Nomura, M. and Okamura, K. (Dept. Physiol., Fujita-Gakuen Health Univ. Sch. Med., Toyoake, Aichi 470-11) ……282

401. Effects of 2-deoxyglucose on sleep in the rat.
Uezu, E. and Terashima, S. (Dept. Physiol., Sch. Med., Univ. of the Ryukyus, Nishihara-cho, Okinawa 903-01)……282

16. Vision (402—457)

402. Laterality and optical rotation in organisms. 1) Effect of ingestion of optically rotatory compounds on visual acuity.
Tsukeda, K. (Dept. Physiol., Tokyo Univ. Sch. Med., Tokyo 113)……283

403. The influence of content of hepatic glycogen and of hepatic fat on that of choroidal riboflavin of a frog.
Fujishita, S. (Dept. of School Nurse, Fac. of Education, Osaka Kyoiku Univ., Osaka 547) ……283

404. Dynamics of second-order neurons in the cockroach ocellus.
Mizunami, M. and Tateda, H. (Dept. Biol., Fac. Sci., Kyushu Univ., Fukuoka 812) ……283

405. Functional role of the receptive field surround of the medulla neurons in the swallowtail butterfly larva.
Ichikawa, T. (Dept. Biol., Fac. Sci., Kyushu Univ., Fukuoka 812)……284

406. The direct effect of light on the rhodopsin metabolism during daily cycle in the compound eye of locust.
Hariyama, T., Harada, A. and Tsukahara, Y. (Research center for applied information sciences, Tohoku Univ., Katahira 2 chome, Sendai 980)……284

407. Mutations that affect bio-synthesis of the visual pigment in the fruitfly, *Drosophila melanogaster.*
Isono, K. and Tsukahara, Y. (Research Center for Applied Information Sciences, Tohoku Univ., Katahira, Sendai 980)……284

408. Analyses of phototransduction mechanisms using visual mutants of Drosophila.
Yoshioka, T., Inoue, H*. and Hotta, Y*[1]. (Dept. Physiol., Sch. Med., Yokohama City Univ. Yokohama 232 and Dept. Physics, Fac. Sci., Univ. of Tokyo, Tokyo 113[1]) ……285

409. Effects of Ca^{2+} and cyclic nucleotides on the photoresponse of an extraocular photoreceptor in *Onchidium* ganglia.
Gotow, T. and Hashimura, S. (Dept. Physiol., Kagoshima Univ. Sch. Med.,

Kagoshima 890)……285
410. Michaelis constant of the cGMP phosphodiesterase in frog rod outer segments.
Kawamura, S. and Murakami, M. (Dept. Physiol., Keio Univ. Sch. Med., Tokyo 160) ……285
411. Effects of L-glutamate and related amino acids on isolated turtle photoreceptors.
Kaneko, A. and Tachibana, M. (Natl. Inst. Physiol. Sci., Okazaki 444) ……286
412. The structure of cone terminals and the connectivity patterns of C-type horizontal cells in the dace retina.
Ueki, K. and Hashimoto, Y. (Dept. Physiol., Tokyo Women's Med. Coll., Tokyo 162) ……286
413. Morphology of skate outer retinal layer.
Sakai, H. M. (National Institute for Basic Biology, Okazaki 444)……286
414. On the question of whether rod-driven horizontal cells have axon and axon terminal.
Yamada, M., Tsukamoto, Y. and Kaneko, A. (Electrotech. Lab., Tsukuba Science City, Ibaraki, 305, Dept. Anatomy, Hyogo Coll. Med., Nisinomiya, 663 and Natl. Inst. for Physiological Sciences, Okazaki 444)……287
415. Membrane properties of the axon terminal of retinal horizontal cells.
Yagi, T. and Kaneko, A. (Natl. Inst. Physiol. Sci., Okazaki, Aichi 444)……287
416. Na-Ca exchange in horizontal cells isolated from the carp retina.
Yasui, S. and Kaneko, A[1]. (Natl. Inst. Basic Biol. and Natl. Inst. Physiol. Sci., Okazaki 444[1])……287
417. Calcium responses of *in situ* horizontal cells of the carp retina.
Takahashi, K. -I. and Murakami, M. (Dept. Physiol., Keio Univ. Sch. Med., Tokyo 160)……288
418. Responses of L-type external horizontal cells(LEHC)to green test light under the red background illumination.
Umino, O. and Watanabe, K. (Dept. of Physiol., Tokyo Women's Medical College, Tokyo 162)……288
419. Response latencies of horizontal cell subtypes in the carp retina.
Shigematsu, Y. and Yamada, M. (Electrotechnical Laboratory, Tsukuba Science City, Ibaraki, 305) ……288
420. Dynamics of skate horizontal cells.
Naka, K. -I. (National Institute for Basic Biology, Okazaki 444) ……289
421. Spatial properties of retinal cells in carp.
Takabayashi, A., Watanabe, S. and Mitarai, G. (Dept. Aerospace Physiol., Inst. Environ, Med., Nagoya Univ., Nagoya 464 and Dept. Physical Ed., Chukyo Univ., Toyota 470-03) ……289
422. Simulation study of the spatio-temporal mechanisms of the retinal horizontal cell layer.
Usui, S. (Physiol. Eng. Lab., Toyohashi Univ. of Technology, Toyohashi 440)……289
423. Electrical coupling between bipolar cells in carp retina.
Saito, T. and Kujiraoka, T. (Dept. Physiol., St. Marianna Univ. Sch. Med. Kawasaki 213) ……290
424. Dose-dependent effects of somatostatin-14 and -28 on the light response of ganglion cells in the isolated mouse retina.
Suzuki, H., Nakaye, T. and Tasaki, K. (Dept. of Physiol., Tohoku Univ. Sch. of Med., Sendai 980) ……290

425. Dendritic morphology of monoaminergic cells revealed by intracellular injection of Lucifer yellow in fixed carp retina.
Teranishi, T. and Negishi, K. (Dept. Neurophysiol., Neuroinformation Res. Inst., Kanazawa Univ. Sch. Med., Kanazawa 920) ····290

426. Immunohistochemical evidence for the existence of two subpopulations of putative serotonergic amacrine cells in fish retina.
Negishi, K. and Teranishi, T. (Dept. Neurophysiol., Neuroinformation Res. Inst., Kanazawa Univ. Sch. Med., Kanazawa 920) ····291

427. Neurotoxic effects of α-aminoadipic acid in the carp retina.
Sugawara, K. and Kato, S. (Dept. Neurophysiol., Neuroinformation Res. Inst., Kanazawa Univ. Sch. Med., Kanazawa 920) ····291

428. Voltage-dependent membrane currents in solitary retinal cells of chick embryo.
Yamashita, E. and Igari, T. (Dept. Blind Study, Sch. Ed. Tohoku Univ., Sendai, Miyagi 980) ····291

429. The Müller cell hypothesis of the origin of ERG b-wave and spreading depression potential(SDP).
Fujimoto, M. and Tomita, T. (Dept. Physiol., St. Marianna Univ. Sch. Med., Kawasaki 213) ····292

430. The off response of the electroretinogram.
Hanawa, I. and Katsuda, S. (Dept. Physiol., Kobe Univ. Sch. Med., Kobe 650) ····292

431. Effects of GABA and picrotoxin on c-wave and light peak of retinal potentials recorded in the chick.
Sato, T., Yoneyama, T[1]., Kim, H. K[1]., Matsumoto, N., Tochinai, A. and Suzuki, T. A. (Dept. Oral Physiol., Sch. Dent, Dept. Ophthal., Sch. Med[1]., Iwate Med. Univ., Morioka, Iwate 020) ····292

432. Synaptic mechanism of the generation of the spreading depression in the frog retina.
Shimoda, Y. (Dept. Physiol., Kyorin Univ. Sch. Med., Tokyo 181) ····293

433. Response properties of thalamic reticular and perigeniculate cells in the cat.
Hada, J., Haruta, R*., Uyama, J*., Sasaki, H. and Hayashi, Y. (Dept. Physiol. Hyogo Coll. Med., Nishinomiya 663) ····293

434. Topographical relationship between the superior colliculus and the ventral lateral geniculate nucleus in the rat.
Nagata, T., Morita, F., Sasaki, H. and Hayashi, Y. (Dept. Phisiol., Hyogo College of Medicine, Nishinomiya, Hyogo 663)····293

435. Intracortical connectivity studied in slice preparations of cat's striate cortex using trigger averaging technique.
Nakajima, S., Komatsu, Y., Hamasaki, T., Toyama, K. and Fetz, E. (Dept. Physiol., Psychiat. and Neurosurg., Kyoto Prefectural Sch. Med., Kyoto 602, Japan and Dept. Physiol. and Biophysics, Univ. Washington, Sch. Med., Seattle, WA 98195, USA) ····294

436. A functional role of cholinergic innervation in the cat visual cortex.
Sato, H., Tsumoto, T., Hata, Y*., Hagihara, K*., Masui, H*. and Nakamura, Y*[1].
(Dept. Neurophysiol., Inst. Higher Nervous Activity, Dept. Internal Med[1]., Osaka Univ. Med. Sch., Kitaku, Osaka 530)····294

437. Responses of cat's visual cortical neurons to muscimol and baclofen.

Ito, S., Katsuta, Y. and Ogawa, T. (Dept. Physiol., Akita Univ. Sch. Med., Akita 010) ····294

438. Analysis of contours in the cat's area 19.
Saito, H., Tanaka, K. and Fukada, Y. (NHK Sci. & Tech. Res. Labs., Setagaya-ku, Tokyo 157)····295

439. Functional characteristics of rotation-sensitive neurons of the posterior parietal association cortex of the monkey.
Sakata, H., Shibutani, H., Ito, Y., Turugai, K., Taira, M. and Mine, S. (Dept. Neurophysiol., Tokyo Metrop. Inst. Neurosci., Tokyo 183)····295

440. The characteristics of the change in neuronal activity relating to selective attention in monkey's inferior temporal cortex.
Sato, T. and Kawamura, T. (Dept. Behav. Physiol., Tokyo Metropol. Inst. for Neurosci., Fuchu, Tokyo 183) ····295

441. Positron emission tomographic measurements of human cerebral glucose metabolism and blood flow under sensory deprived and light illuminated states.
Tasaki, K., Tsukahara, Y., Tamai, M., Fukada, Y., Suzuki, H. and Sugita, Y. (Dept. of Physiol., Ophthal., Res. Ctr. Appl. Inf. Sci., Tohoku Univ., NHK) ····296

442. Motion stereopsis in normal and strabismic subjects.
Kitaoji, H., Umetani, K. and Toyama, K. (Depts. Physiol. and Ophthal., Kyoto Prefectural Sch. Med., Kawaramachi-Hirokohji, Kyoto, 602)····296

443. Pupillary contractions reflexes elicited by eletric magnetic fields.
Tsukahara, S. (Dept. Physiol., Fukushima Med. Coll., Fukushima 960) ····296

444. Ultrastructures and photoresponses in pineal organs of larval and adult cyclostomes.
Tamotsu, S. and Morita, Y. (Dept. Physiol., Hamamatsu Univ. Sch. Med., Hamamatsu 431-31)····297

445. Cell dissociation from the photosensory pineal organ.
Samejima, M. and Morita, Y. (Dept. Physiol., Hamamatsu Univ. Sch. Med., Hamamatsu 431-31)····297

446. Minute mechanical movements as the sign of the retinal photoreception.
Nakaye, T., Tasaki, I[1]. and Tasaki, K. (Dept. Physiol., Tohoku Univ. Sch. Med., Sendai 980 and National Institutes of Health, U. S. A.[1]) ····297

447. Rod-cone interaction in flash- and flicker detection.
Sugita, Y. and Tasaki, K. (Dept. Physiol., Tohoku Univ. Sch. Med., Sendai 980) ····298

448. Synaptic contacts between cones and horizontal cells in the turtle retina.
Ohtsuka, T. and Kouyama, N. (Dept. Inform. Physiol., Nat. Inst. Physiol. Sci., Okazaki 444 and Dept. Physiol., Tokyo Women's Med. College, Shinjuku, Tokyo 162) ····298

449. GABA-sensitivity of isolated bipolar cells dissociated from the goldfish retina.
Tachibana, M. and Kaneko, A. (Department of Information Physiology, National Institute for Physiological Sciences, Okazaki 444) ····298

450. Synaptic transmission from bipolar cells to amacrine cells in the carp retina.
Kujiraoka, T., Saito, T. and Toyoda, J-I. (Dept. Physiol. St. Marianna Univ. Sch. Med., Kanagawa 213)····299

451. The shape of the catecholaminergic neurons in the rabbit retina.

Tauchi, M. (National Institute for Physiological Sciences, Myodaiji, Okazaki 444) ……299

452. Effects of dopamine on ganglion cells in catfish retina.
Hida, E. and Naka, K. -I. (National Institute for Basic Biology, Okazaki 444)……299

453. Evoked potentials of the local retina of intact rats.
Kitagawa, K., Saito, H[1]. and Tamai, A. (Dept. Ophthalmol., Kochi Med. Sch., Okocho, Nankoku, Kochi 781-51 1st Dept. Physiol., Kochi Med. Sch[1].) ……300

454. Effects of barium on the ERG c-wave of isolated bullforg retina.
Matsuura, T. (Dept. Physiol., Kinki Univ. Sch. Med., Osaka 589)……300

455. Binocular function in visual cortical neurons in strabismic (siamese) cat.
Umetani, K., Kitaoji, H. and Toyama, K. (Depts. Physiol. and Ophthal., Kyoto Prefectural Sch. Med., Kawaramachi-Hirokohji, Kyoto, 602)……300

456. Central projections of retinal ganglion cells in Japanese monkeys(Macaca Fuscata).
Fukuda, Y. and Sawai, H*. (Dept. Neurophysiol., Osaka Univ. Med. Sch., Kita-ku, Osaka, 530)……301

457. Localization of calspectin (fodrin) in visual areas of the developing cortex.
Kimura, F., Tsumoto, T. and Sobue, K[1]. (Depts. Neurophysiol., and Neurochem. and Neuropharmacol[1]., Inst. Higher Nervous Activity, Osaka Univ. Med. Sch. Osaka 530) ……301

17. Audition and Equilibrium (458—471)

458. Endolymph calcium ion concentration in the guinea pig cochlea.
Ikeda, K., Kusakari, J., Takasaka, T., Saito, Y*. and Nishiyama, A*. (Depts. of Otolaryngol. & Physiol*., Tohoku Univ. Sch. of Med., Sendai 980) ……302

459. Cochlear microphonic potential and distortion product.
Hashimoto, T. and Taniguchi, I. (Inst. Med. Dent. Eng., Tokyo Med. Dent. Univ., Tokyo 101 ; Med. Res. Inst., Tokyo Med. Dent. Univ., Tokyo 113) ……302

460. Sensitivity to the mechanical displacement of the chick vestibular hair cell.
Ohmori, H. (National Institute for Physiological Sciences. Okazaki 444) ……302

461. Blockage of the Ca-dependent K channel with quinine in goldfish hair cells.
Sugihara, I. and Furukawa, T. (Dept. of Physiol., Tokyo Med. & Dent. Univ. Sch. of Med., Yushima, Bunkyo-ku, Tokyo 113) ……303

462. The mechanism of amplitude modulation in the cochlea of the guinea pig.
Moriyama, T., Hosokawa, Y., Murata, K. and Minami, S*. (Dept. Neurophysiol. Med. Res. Inst., Tokyo Med. & Dent. Univ., Tokyo 101) ……303

463. Efferent innervation to labyrinthine organs of the toad.
Sugai, T., Ooyama, H. Yano, J. and Sugitani, M. (Dept. Physiol., Kanazawa Med. Univ., Ishikawa 920-02)……303

464. Glutamate-induced inhibition and efferent transmission in frog auditory organ.
Yano, J., Ooyama, H., Sugai, T. and Sugitani, M. (Dept. of Physiol., Kanazawa Med. Univ., Ishikawa 920-02) ……304

465. Subdivisions of pure-tone units.
Maruyama, N., Kudoh, M., Furukawara, M. and Shinzawa, H. (Dept. of Neurophysiol., Brain Research Inst., Niigata Univ., Niigata 951)……304

466. Supplementary characteristics of the formant detector.

Maruyama, N., Kudoh, M., Furukawara, M. and Shinzawa, H. (Dept. of Neurophysiol., Brain Research Inst., Niigata Univ., Niigata 951)……304

467. Functional mapping of the brain of echolocating bats by the deoxyglucose method.
Taniguchi, I., Saito, N. and Arai, O. (Med. Res. Inst., Tokyo Med. and Dent. Univ., Tokyo 113, and Dept. Physiol., Dokkyo Univ. Med. Sch., Tochigi 321-02)……305

468. Effects of tilt stimulation on vestibular nerve discharges in carp.
Satow, Y., Takagi, S., Takabayashi, A. and Watanabe, S. (Gifu Coll. Med. Tech., Gifu 501-32, Res. Inst. Environmental Med., Nagoya Univ., Nagoya 464)……305

469. Contribution of ionic pumps to the DC potential and receptor activity of *Plotosus* electroreceptors.
Sugawara, Y. (Dept. Physiol., Teikyo Univ. Sch. Med., Tokyo 173)……305

470. Observations of eye movements evoked by microstimulation of the utricular macula of the cat.
Jijiwa, H., Motooka, T. and Watanabe, S*. (Dept. Physiol., Inst. Develop. Res., Aichi Pref. Colony, Kasugai 480-03, 5 th Dept., Inst. Environ. Med., Nagoya Univ., Nagoya 464) ……306

471. Intracellular recording of rat inferior collicular neurons to tone bursts.
Hosokawa, Y., Ito, S., Horikawa, J., Minami, S*. and Murata, K. (Dept. Neurophysiol. Med. Res. Inst., Tokyo Med. & Dent. Univ., Tokyo 101) ……306

18. Somatic and Chemical Sensation (472—495)

472. Comparison of effects of prostaglandin-E_2 and -I_2 on activities of the canine visceral polymodal receptor.
Mizumura, K., Sato, J. and Kumazawa, T. (Dept. Nervous & Sensory Functions, Res. Inst. Environ. Med., Nagoya Univ., Nagoya 464)……307

473. Identification of thalamic nuclei relaying pulpal information to somatosensory crtoex(SI).
Matsumoto, N., Sato, T., Ooe, M. and Suzuki, T. A. (Dept. Oral Physiol., Sch. Dent., Iwate Medical Univ., Morioka, Iwate 020)……307

474. Taste afferent system for some amino acids and 5′-nucleotides in mice.
Ninomiya, Y. and Funakoshi, M. (Dept. Oral Physiol., Asahi Univ. Sch. Dent., Gifu 501-02) ……307

475. Taste responses to amino acids in the Japanese sea catfish, *Plotosus anguillaris*.
Caprio, J*., Marui, T., Kasahara, Y. and Kiyohara, S. (Zool. Physiol., Louisiana State Univ., Baton Rouge 70803 USA* ; Dept. Oral Physiol., Kagoshima Univ. Dent. Sch. ; Biol. Inst., Coll. Lib. Arts, Kagoshima Univ., Kagoshima 890) ……308

476. Characteristics of the transepithelial potential change produced by water in the frog tongue.
Soeda, H., Sakudo, F., Kajiya, H. and Noda, K. (Dept. Physiol., Fukuoka Dent. Coll., Sawara-ku, Fukuoka 814-01)……308

477. Contribution of calcium channel in receptor membrane of frog taste cell to acid-induced receptor potential.
Okada, Y., Miyamoto, T. and Sato, T. (Dept. Physiol., Nagasaki Univ. Sch. Dent., Nagasaki 852) ……308

478. Thermal sensitivity of taste neurons in solitary tract nucleus of rats.
Ogawa, H., Hayama, T. and Yamashita, Y. (Dept. Physiol., Kumamoto Univ. Med. Sch., Honjo 2-2-1, Kumamoto 860)……309

479. Unit activities of primate fronto-operculum during eating and drinking.
Ito, S. and Oawa, H. (Dept. Physiol., Kumamoto Univ. Med. Sch., Kumamoto 860 and Dept. Neurophysiol., Primate Res. Inst., Kyoto Univ., Inuyama City, Aithi 484) ……309

481. Specific carbohydrate expressions by subsets of primary afferent fibers in somatosensory and olfactory systems.
Mori, K. (Dept. Physiol., Gunma Univ. Sch. Med., Maebashi, Gunma 371) ……309

482. Dual olfactory input to the orbitofrontal cortex.
Motokizawa, F. and Shimomura, F. (Dept. Physiol., Nara Med. Coll., Kashihara, Nara 634) ……310

483. Slow-adapting responses of Pacinian corpuscles of the cat urinary bladder.
Sakada, S., Aeba, A. and Hada, R. (Dept. Physiol., Tokyo Dent. Coll., Chiba 260)……310

484. Mammalian and amphibian muscle spindles stained immunohistochemically using anti-glial fibrillary acid protein.
Funahashi, A., Ito, F. and Sokabe, M. (Dept Physiol, Nagoya Univ Sch Med, Nagoya 466) ……310

485. Histochemical classification of the intrafusal muscle fibers in the frog muscle spindle
Yoshimura, A, Fujitsuka, N. and Ito, F. (Dept. Educ., Nagoya Inst. Technol., and Dept. Physiol., Nagoya Univ. Sch. Med)……311

486. Effects of cAMP on the encoding processes in frog muscle spindle.
Ito, F. and Sokabe, M. (Dept. Physiol., Nagoya Univ. Sch. Med. Nagoya 466)……311

487. Fusimotor innervation in the frog muscle spindle.
Fujitsuka, N. and Ito, F. (Dept. Educ., Nagoya Inst. Technol., Nagoya 466 and Dept. Physiol., Nagoya Univ. Sch. Med., Nagoya 466) ……311

488. Single unit response characteristics of mechanoreceptive afferents in the cats hairless skin to vibratory stimuli.
Aya, K., Nakahama, H., Shima, K., Yamamoto, M. (Div. Neurophysiol., Inst. Brain Diseases, Tohoku Univ. Sch. Med., Sendai 980) ……312

489. Changes in threshold of nociceptive withdrawal reaction(NWR)to pressure stimulus onto craniofacial areas after sodium urate(MSU)crystals injection into temporomandibular joint.
Okuda, K., Sato, T., Taira, K. and Suzuki, T. A. (Dept. Oral Physiol., Sch. Dent., Iwate Med. Univ., Morioka, Iwate 020) ……312

490. Response of neurons in rat A_1 and adjacent reticular region to acupuncture stimulation.
Toda, K. (Dept. Physiol., Fac. Dent., Tokyo Med. Dent. Univ., Tokyo 113)……312

491. Responses to electric stimuration of the mechanoreceptor afferent units innervating the frog skin.
Yamashita, Y. and Ogawa, H. (Dept. of Physiol., Kumamoto Univ. Sch. Med., Kumamoto 860)……313

492. Spectral analysis of instantaneous frequency response to sinusoidal stimulation in Mechanoreceptor afferent units of frog skin.
Taniguchi, K. and Ogawa, H. (Dept. of physiol., Kumamoto Univ. Sch. Med.,

Kumamoto 860)……313

493. Changes of the afferent responses of the snake muscle spindles to ramp-and-hold stretch in the diluted K^+ bathing solution.
Ichiki, M. (Dept. Physiol., Mie Univ., Sch. Med., Mie 514) ……313

494. Role of anions in salt taste reception of the frog.
Kitada, Y. (Dept. of Physiology, Okayama University Dental School, Shikata-cho, Okayama 700) ……314

495. Response characteristics of cortical taste area neurons in hamsters.
Yamamoto, T. and Kitamura, R. (Dept. Oral Physiol., Dept. of Oral Surg., Osaka Univ. Fac. Dent., Suita, Osaka 565) ……314

19. Smooth Muscle (496—517)

496. Comparison of electrical properties between human and guinea-pig tracheal smooth muscle.
Honda, K., Baba, K. and Tomita, T. (The 2 nd Dept. Int. Med., Depat. Physiol., Nagoya Univ., Nagoya 466) ……315

497. Beta-action on the guinea-pig tracheal muscle in the presence of barium ion.
Baba, K., Honda, K. and Tomita, T. (The 2 nd Dept. Int. Med. and Dept. Physiol., Nagoya Univ. Sch. Med. Nagoya 466)……315

498. Patch clamp study of single Ca channels in mammalian visceral smooth muscle cells.
Yoshino, M. and Yabu, H. (Dep. Physiol., Sapporo Med. College, Sapporo 060) ……315

499. Effects of catecholamines on ionic currents of guinea-pig vas deferens in Barium Krebs solution.
Inomata, H. (Dept. Applied Physiol., Tohoku Univ., Sch. Med., Sendai 980)……316

500. Contractile response of portal veins from chronic portal hypertensive rats to external potassium and calcium concentrations.
Yoshimura, T., Kiyosue, T. and Arita, M. (Dept. of Physiol. Medical College of Oita, Oita 879-56) ……316

501. Effects of hydrogen peroxide on the longitudinal muscle of rat myometrium.
Uno, Y. and Tomita, T. (Dept. Physiol., Nagoya Univ. Sch. Med., Nagoya 466)……316

502. Lipid composition related to Ca transport of plasma membrane isolated from stomach smooth muscle.
Sakai, Y., Isobe, A. and Ichikawa, S. (Dept. Physiol., Showa Univ. Sch. Med., Hatanodai, Tokyo 142) ……317

503. Actions of PGE_2 on the circular muscle of guinea-pig colon.
Ishizawa, M. (Physiol. Sch. of Allied Health Professions. Sapporo Medical College. Sapporo, 060)……317

504. Relationship between the frequency of spontaneous contractions and the acetylcholine content of the rabbit small intestine.
Yokoyama, S. (Dept. Physiol., Fukushima Med. Coll., Fukushima 960) ……317

505. Influence of cycloheximide on the changes in properties of the circular muscle of pregnant rat uterus.
Maruta, K., Ogasawara, T. and Osa, T. (Dept. of Physiol., Yamaguchi Univ. Sch. of Med., Ube 755) ……318

506. Comparison of phsphorous metabolites between stomach muscle and taenia of guinea-pig studied with NMR.
Nakayama, S., Takai, A., Tomita, T., Seo, Y. and Watari, H. (Dept. Physiol., Nagoya Univ. nagoya 466 ; Nat. Inst. Physiol. Sci., Okazaki 444) ····318

507. Characteristics of calcium-dependent potassium channels in the rat myometrium.
Kihara, M., Matsuzawa, K., Tokuno, H. and Tomita, T. (Dept. Gynaecol., Dept. Physiol. Nagoya Univ. Sch. Med., Nagoya 466)····318

508. Calcium-dependent potassium channels in the taenia of guinea-pig caecum studied by patch clamp method.
Tokuno, H., Kihira, M. and Tomita, T. (Dept. Physiol., Dept. Gynaecol., Nagoya Univ. Sch. Med., Nagoya 466)····319

509. Effects of glycogen-depletion in Na-pump activation in the taenia of guinea-pig caecum.
Tomita, T., Tokuno, H. and Takai, A. (Dept. Physiol. Sch. Med., Nagoya Univ. Nagoya 466) ····319

510. Properties of the mechanical response to rapid cooling in guinea-pig taenia coli.
Emura, A. and Sugi, H. (Dept. Physiol., Sch. Med., Teikyo Univ., Itabashi-ku, Tokyo 173)····319

511. Effect of ionic strength on the contraction in glycerinated smooth muscle of guinea-pig taenia coli.
Toride, M. and Sugi, H. (Dept. Physiol., Teikyo Univ. Sch. Med., Tokyo 173) ····320

512. Effects of nicorandil on single smooth muscle cells of guinea pig taenia caeci.
Ito, Y., Obara, K. and Yabu, H. (Dept. of Physiol., Sapporo Med. College, Sapporo 060) ····320

513. Characteristics of energy metabolism in the guinea-pig tracheal smooth muscle.
Itoh, M., Takai, A. and Tomita, T. (The 2 nd Dept. Int. Med., and Dept. Physiol., Nagoya Univ., Nagoya 466) ····320

514. Changes of the series elasticity during activation and relaxation in the anterior byssal retractor muscle of *Mytilus*.
Iwamoto, H. and Sugi, H. (Dept. Physiol., Sch. Med., Teikyo Univ., Tokyo 173) ····321

515, Electron microscopic studies on the structural changes in a molluscan smooth muscle during active and catch contractions.
Takahashi, I., Amakawa, Y*., Takama, M*. and Sugi, H. (Cent. Lab. Electron Microsc., and Dept. Phytiol., Sch. Med., Teikyo Univ., Itabashi-ku, Tokyo 173) ····321

516. Differences of mechanical properties of smooth muscle between a strip preparations and a whole tissue of guinea-pig vas deferens.
Mizobe, H., Tsuchiya, T. and Sugi, H. (Dept. Physiol., Teikyo Univ. Sch. Med., Tokyo 173)····321

517. Structural changes of individual cells during isotonic contraction of guinea pig smooth muscle strips.
Oota, I., Moriya, M. and Yabu, H. (Dept. Physiol., Sapporo Med. College, Sapporo 060) ····322

20. Skeletal Muscle (518—546)

518. The origin of the series elastic component in horseshoe crab skeletal muscle fibers.
Sugi, H., Gomi, S. and Tanaka, H. (Dept. Physiol., Sch. Med., Teikyo Univ., Itabashi-ku, Tokyo 173)……323

519. Studies on actin-linked regulation in scallop striated muscle.
Asada, N. and Yazawa, Y. (Division of Nutritional Physiol., Hokkaido Univ. of Education, Asahakawa 070) ……323

520. Variation of stiffness during and after ramp length change in frog single muscle fibers.
Tsuchiya, T. and Sugi, H. (Dept. Physiol., Teikyo Univ. Sch. Med., Tokyo 173) ……323

521. Lattice spacing in radially compressed skinned muscle fibers.
Umazume, Y., Higuchi, H. and Takemori, S. (Dept. Physiol., The Jikei Univ. Sch. Med., Tokyo 105)……324

522. An X-ray diffraction study of frog skeletal muscles using a two-dimensional X-ray detector.
Yagi, N. and Matsubara, I. (Dept. Pharmacol. Tohoku Univ. Sch. Med., Sendai 980) ……324

523. The effect of muscle length on energy utilization in frog skeletal muscles. A time-resolved ^{31}P NMR study.
Yamada, K., Tanokura, M. and Kawano, Y. (Department of Physiology, Medical College of Oita, Oita 879-56) ……324

524. Sarcomere length changes during contraction in mouse skeletal muscles examined by laser diffraction method.
Matsumura, M., Ochi, K., Toyota, H., Matsuki, Y. and Sato, Y. (Dept. Physiol., Kawasaki Med. Sch., Kurashiki 701-01) ……325

525. Role of the Ca-induced Ca release mechanism in cooling contracture of frog skeletal muscle fibres.
Horiuti, K. and Endo, M. (Dept. Pharmacol., Univ. Tokyo, Tokyo 113 and Dept. Physiol., The Jikei Univ. Sch. Med., Tokyo 105)……325

526. Effect of caffeine on calcium release from sarcoplasmic reticulum isolated from frog skeletal muscle.
Koshita, M. and Hotta, K. (Dept. Physiol., Nagoya City Univ. Med. Sch., Nagoya 467) ……325

527. Each effect of TN-C, TN-I and TN-T to the Ca^{2+} sensitivity of glycerinated skeletal muscle fiber.
Nakayama, Y., Yamaguchi, M*., Watanabe, Y. and Watanabe, K**. (Dept. of Physiol. & Anat. Kyoritsu Coll. of Pharm., Tokyo 105, Dept of Biochem and Nutri. Juntendo Univ., Chiba 275* and Dept. of Biol., Nihon Univ., Chiba 274**) ……326

528. Effects of external sodium on the excitation-contraction coupling in the skeletal muscle.
Kawata, H., Hatae, J. and Fujishiro, N. (Dept. Physiol., Fukuoka Univ. Sch. Med., Fukuoka 814-01) ……326

529. Activation and inactivation mechanisms of the potassium contracture in frog single twitch muscle fibers.
Takauji, M. and Tsutsu-ura, M. (Dept. Physiol., Sapporo Med. College, Sapporo 060)……326

530. Effect of some fluorogenic sulfhydryl (SH) reagents on excitation-contraction (E-C) coupling in single skeletal muscle fibers of frog, *R. Japonica.*
Fujino, M., Sato, Y. and Arita, T. (1 Dept. of Physiol., Natl. Def. Med. Coll., Tokorozawa) ····327
531. Site responsible for excitation-contraction (E-C) coupling on T-tubular membrane of skeletal muscle fibers of frog, *R. Japonica.*
Fujino, M., Arita, T. and Sato, Y. (1 Dept. of Physiol., Natl. Def. Med. Coll., Tokorozawa) ····327
532. On the mechanism of decoupling in skeletal muscle.
Isojima, C. (Dept. Physiol., St. Marianna Univ., Kawasaki 213)····327
533. Effects of SCN and Mn ions on the localized contracture in skeletal muscle fibers : Their antagonism.
Tameyasu, T. and Tanaka, M. (Dept. Physiol., St. Marianna Univ. Sch. Med., Kawasaki 213) ····328
534. Temperature-dependence of quinine contracture in rat skeletal muscle.
Yoshioka, T., Tamaki, T., Nagami, K., Nakahara, Y*. and Nakano, S. (Dept. Physiol., Tokai Univ. Sch. Med., Kanagawa 259-11, Mie Univ. Fac. Educ., Mie 514*) ····328
535. Biphasic contracture and ATP hydrolysis in glycerinated muscle, a spin label study.
Tsujimoto, T. and Nonaka, Y. (Dept. Physiol., Wakayama Med. Coll., Wakayama 640)····328
536. The role of alkaline protease in the development of myofibrillar necrosis in several murine muscular dystrophies.
Tsuji, S., Sawada, H., Kusumoto, S., Doi, Y. and Matsushita, H. (Dept. Physiol. Wakayama Medical College, Wakayama 640)····329
537. Properties of fragmemted sarcoplasmic reticulum(FSR)from the myogeneous strophic muscle.
Nishijima, H., Takahashi, A. and Sakai, T. (Dept. Physiol., Jikei Univ. Sch. Med., 3-25-8 Nishishinbashi. Minato-ku. Tokyo 105) ····329
538. Mechanical activation and inactivation induced by silver ion frog single muscle fiber.
Oba, T. and Hotta, K. (Dept. Physiol., Nagoya City Univ. Med. Sch., Nagoya 467) ····329
539. Mechanism of twitch potenaittion by caffeine in frog skeletal muscle fibers.
Kurihara, S., Konishi, M., Kawamura, T. and Sakai, T. (Dept. Physiol., Jikei Univ. Sch. Med., Tokyo 105) ····330
540. The effect of intracellular pH on the repriming of the labile maintenance heat of frog skeletal muscles.
Kitano, T., Kometani, K., Tanokura, M. and Yamada, K. (Dept. of Physiol., Medical College of Oita, Oita 879-56) ····330
541. A calorimetric study on calcium-binding by troponin C from bullfrog skeletal muscle.
Imaizumi, M., Tanokura, M. and Yamada, K. (Dept. of Physiol., Medical College of Oita, Oita 879-56) ····330
542. 31P-NMR study of the energy metabolism in poisoned frog skeletal muscles.
Yamada, T. and Sugi, H. (Dept. Physiol., Sch. Med., Teikyo Univ., Itabashi-ku, Tokyo 173)····331
543. Evidence for cooperative interactions of myosin heads in the force generation of vertebrate skeletal muscle fibers.

Chaen, S., Shimada, M. and Sugi, H. (Dept. Physiol. Sch. Med., Teikyo Univ, Itabashi-ku, Tokyo 173)……331

544. Changes in the X-ray diffraction pattern of tetanized frog skeletal muscle during sinusoidal length changes.
Tanaka, H., Kobayashi, T., Iwamoto, H. and Sugi, H. (Dept. Physiol., Sch. Med., Teikyo Univ., Itabashi-ku, Tokyo 173)……331

545. The changes of the protein components in disused atrophied muscle.
Atomi, Y. and Yamada, S. (Dept. Sports Sciences, College of Arts and Sciences, Univ. of Tokyo, Tokyo 153)……332

546. Compensatory muscle hypertrophy is not induced in albumin-deficient rat.
Yamada, S., Tomino, S. and Atomi, Y. (Dept. Sports Sciences, College of Arts and Sciences, Univ. of Tokyo, Tokyo 153) ……332

21. Muscle Movement and Its control (547—560)

547. Changes of evoked potentials on sural muscle in man by means of the monopolar lead.
Nikara, T., Ito, K. and Noda, M. (Lab. of Physiol., Sch. of Allied Med. Sci., Hirosaki Univ., Hirosaki 036) ……333

548. Contrast in the changing patterns of soleus muscle potentials to repetitive sciatic stimulation in young and old rats.
Uramoto, I., Watanabe, K. and Totsuka, T. (Dept. Physiol., Inst. Develop. Res., Kasugai, Aichi 480-03) ……333

549. Effect of sensory stimulation and nerve blockade on wrist flexor stretch reflex components.
Hayashi, R., Lee, R. G*. and Becker, W. J*. (Department of Clinical Neurosciences, Faculty of Medicine, University of Calgary, Calgary, Canada) ……333

550. Observations on F and S waves during muscular voluntary contractions of human.
Nagata, A. and Muro, M. (Dept. Bio-Dynamics., Niigata Univ. Fac. Ed., Niigata 950-21)……334

551. Efferent neural discharge patterns during nostril-closing reflex movements in the frog.
Nomura, H. and Suzuki, H. (Dept. Oral Physiol., Matsumoto Dental Coll., Shiojiri 399-07)……334

552. Activity of human single motor units during treadmill walking.
Ogawa, Y., Kurata, H. and Yonemoto, K. (Lab. Sports Med., Jikei Univ. Sch. Med., Chofu, Tokyo 182) ……334

553. Analysis of muscle spindle discharges during isometric voluntary contraction in man.
Toma, S., Nakajima, Y. and Homma, S. (Dept. Physiol., Sch. Med., Chiba Univ., Chiba 280) ……335

554. Movement pattern and reciprocal inhibition during rapid voluntary wrist flexion movements in man.
Sawada, Y., Miyamoto, S. and Aoki, M[1]. (Sch. of Allied Health Professions and Dept. of Physiol., Sapporo Med. College, Sapporo 060[1]) ……335

555. The factors responsible for the maximum tetanic force output of motor units in the rat medial gastrocnemius.
Kanda, K. and Hashizume, K. (Dept. of Physiol., Tokyo Metropol. Inst. of

Gerontol., Itabashi-ku, Tokyo 173)……335
556. Effects of stimulation of the upper brain centers on the spinal accessory motoneurones in the cat.
Higuchi, K[1]., Asahara, T., Nishimura, Y. and Tanaka, T. (Dept. Physiol. and Paediatr[1]., Sch. Med., Mie Univ., Tsu 514)……336
557. Eye movements examined by the corneal reflection image.
Sasaki, Y. and Suzuki, H. (Dept. Physiol., Hirosaki Univ. Sch. Med., Hirosaki 036) ……336
558. Characteristics of precise ballistic force exertion.
Kimura, M., Yoneda, T., Misato, E. and Ishida, A. (Dept. Physiol., Sch. Physical Edu. Juntendo Univ. Narashino 275)……336
559. Symmetry and asymmetry of ballistic force exertion.
Yoneda, T., Toshino, S., Kimura, M. and Ishida, A. (Dept. Physiol., Sch. Physical Edu. Juntendo Univ. Narashino 275)……337
560. Observations of filament structures and cross-bridge movement in the skeletal muscle fibers by the freeze-fracture method.
Suzuki, S., Oshimi, Y. and Sugi, H. (Dept., Physiol., Sch. Med., Teikyo Univ., Itabashi-ku, Tokyo 173)……337

22. Heart Musle (561—595)

561. Effect of isoproterenol and beta-adrenergic blocker on the slow rising phase of the action potential of canine ventricular muscle.
Hotta, M., Kojima, S. and Hirakawa, S. (2 nd Department of Internal Medicine, Gifu university School of Medicine, Tsukasamachi, Gifu)……338
562. Relationship between the maximum rate of rise of the action potential and the Na conductance in mammalian ventricular myocytes.
Watanabe, T., Toyama, J. and McDonald, T. F. (Res. Inst. of Environ. Med., Nagoya Univ., Nagoya 464, and Dalhousie Univ, Nova Scotia B3H 4H7, Canada)……338
563. Developmental change of fast inward current in cells isolated from chick embryonic ventricle at early stage.
Fujii, S., Ayer, Jr. R. K. and DeHaan, R. L. (Dept. Physics, Sch. Science, Science Univ. of Tokyo, 1-3 Kagurazaka Shinjuku Tokyo 162) ……338
564. Transient outward current in rabbit ventricular myocytes.
Hiraoka, M. and Kawano, S. (Dept. Cardiovasc. Dis., MRI, Tokyo Med. and Dent. Univ., Tokyo 113) ……339
565. Spontaneous oscillation potentials induced after an inhibition of Na-K pump on sinoatrial node cell.
Goto, K., Miyamae, S., Sudo, S., Nakano, S., Matsuda, T. and Nakano, M. (Dept. Physiol., Kanazawa Med. Univ., Uchinada, Ishikawa 920-02) ……339
566. Na-Ca exchange current in single guinea pig ventricular cells.
Kimura, J., Noma, A. and Irisawa, H. (Natl. Inst. Physiol. Sci. Okazaki 444) ……339
567. Outward currents through the inwardly rectifying K channels of single cells isolated from guinea-pig hearts.
Matsuda, H., Saigusa, A. and Irisawa, H. (National Institute for Physiological Sciences, Okazaki 444) ……340

568. Properties of single delayed rectifier K channels in pacemaker cells of rabbit heart.
Shibasaki, T., Noma, A. and Irisawa, H. (Natl. Inst. Physiol. Sci., Okazaki 444)……340
569. Mg^{2+} as a "fast blocker" of adenosine-5'-triphosphate(ATP)-regulated K-channel in guinea-pig ventricular cells.
Horie, M., Noma, A. and Irisawa, H. (Natl. Inst. Physiol. Sci., Okazaki, 444) ……340
570. Modulation of the cardiac Ca channel activity by protein phosphorylation.
Kameyama, M. (National Institute for Physiological Sciences, Myodaiji, Okazaki 444)……341
571. Voltage and time dependence of null modes of cardiac calcium channel gating.
Ochi, R. (Dept. Physiol., Sch. Med., Juntendo Univ., Tokyo 113)……341
572. The replacement of potasium by cesium in the rabbit sinoatrial node cells(2).
Sudo, S., Goto, K., Takahashi, T., Miyamae, S., Nakano, S., Matsuda, T. and Nakano, M. (Dept. Physiol., Kanazawa Med. Univ., Uchinada, Ishikawa 920-02)……341
573. Effect of acetylcholine on the intracellular potassium activity of frog atrial muscle.
Sawanobori, T. and Hirano, Y. (Dept. Cardiovasc. Dis., MRI, Tokyo Med. and Dent. Univ., Tokyo 113) ……342
574. Kinetics of sodium channel inactivation in isolated frog ventricular cells.
Yamaoka, K. and Seyama, I. (Dept. Physiol., Hiroshima Univ. Sch. Med., Hiroshima 734) ……342
575. Effect of coenzyme Q_{10} on action potentials and ionic currents of guinea pig ventricular cells.
Nakamura, S., Kiyosue, T. and Arita, M. (Dept. of Phisiol. Medical College of Oita, Oita 879-56) ……342
576. An X-ray diffraction study of chemically skinned cardiac muscle.
Matsubara, I. and Yagi, N. (Dept. Pharmacol., Tohoku Univ. Sch. Med., Sendai 980) ……343
577. Real-time optical mapping of spontaneous electrical activity in the early embryonic chick heart.
Komuro, H., Hirota, A., Sakai, T. and Kamino, K. (Dept. Physiol., Tokyo Ika-Shika Daigaku, Sch. Med., Tokyo 113)……343
578. Assessment of pacemaking area in the early embryonic chick heart using multiple-site optical recording of action potentials.
Sakai, T., Komuro, H., Hirota, A. and Kamino, K. (Dept. Physiol., Tokyo Ika-Shika Daigaku, Sch. Med., Tokyo 113)……343
579. Characteristics of twitch and aftercontration of depolarized ventricular muscle under the influence of catecholamine.
Ito, T. and Ehara, T. (Dept. Physiol., Fac. Med., Kyushu Univ., Fukuoka 812) ……344
580. Mechanical properties and ATPase activity in glycerinated myocardium of hyperthyroid rabbit.
Saeki, Y., Kato, C. and Yanagisawa, K. (Dept. Physiol., Tsurumi Univ. Sch. Dent. Med., Tsurumi, Yokohama 230) ……344
581. Development and recovery of anoxic contracture in rat ventricular muscle.
Okada, T. (Dept. Physiol., Sch. Med. Juntendo Univ., Tokyo 113) ……344
582. Contractile rebound after removal of Acetylcholine on canine atrial myocardium.
Inatomi, K. and Imanaga, I. (Dept. of Physiol., Sch. of Med., Fukuoka Univ., Fukuoka 814-01) ……345

583. Assessment of the mechanical efficiency of contractile machinery in dog left ventricle.
Suga, H., Goto, Y. and Igarashi, Y. (Dept. Cardiovasc. Dynamics, National Cardiovasc. Center Res. Inst., Osaka 565) ……345

584. Change of Na-Ca exchange transport and development of tetanic tension in frog ventricular muscles.
Nishiye, H. and Tanaka, S. (Dept. Physiol., Sch. Med., Juntendo Univ., Hongo, Tokyo 113)……345

585. Ba^{2+} -induced automaticity in guinea-pig ventricular myocytes.
Hirano, Y., Sawada, K. and Hiraoka, M. (Dept. Cardiovasc. Dis., MRI, Tokyo Med. and Dent. Univ., Tokyo 113) ……346

586. The voltage-dependent effect of 1, 4-dihydropyridine enantiomers on Ca channels in cardiac cells.
Kokubun, S. (Dept. Physiol. Jikei Univ. Sch. Med. Minato-ku Tokyo, 105)……346

587. Effects of beta receptor stimulation on intratellular calcium transients and tension in rat ventricular muscle.
Konishi, M., Kurihara, S. and Sakai, T. (Dept. Physiol., The Jikei Univ. Sch. Med., 3-25-8 Nishishinbashi, Minato-ku, Tokyo 105) ……346

588. Determination of slope of end-systolic pressure-volume lipe(Emax)by end-diastolic volume clamp in dog heart.
Igarashi, Y., Goto, Y, Yamada, O and Suga, H. (Department of Cardiovascular Dynamics, National Cardiovascular Center Research Institute, Osaka 565) ……347

589. Regulation of junctional conductance by H^+, Ca^{2+} and Mg^{2+} in cardiac paired cells of guinea-pig
Tsuboi, N., Noma, A. and Irisawa, H. (Nat. Inst. for Physiol. Sci., Okazaki)……347

590. Mapping of spread of spontaneous excitation in the frog atrium using multiple-site optical recording of action potentials.
Hirota, A., Sakai, T., Komuro, H. and Kamino, K. (Dept. Physiol., Tokyo Ika-Shika Daigaku, Sch. Med., Tokyo 113)……347

591. Comparison of epicardial activation maps of left ventricle between NR and SHR.
Miyazawa, T., Sato, S., Sekiya, S*[1]., Tsutsumi, T*[1]. and Osada, H*[1]. (Dept. of Clinical Physiol. Kanagawa Prefectural College, Yokohama 241. Div. of Cardiology, Showa Univ. Fujigaoka Hospital, Yokohama 227[1])……348

592. Two time-dependent plateau outward currents in guinea-pig Purkinje fibers.
Mitsuiye, T. and Ikemoto, Y. (Department of Physiology, Faculty of Medicine, Kyushu University, Fukuoka 812) ……348

593. Delayed outward current in isolated single ventricular myocytes of guinea-pig.
Matsuura, H., Imoto, Y., Gondo, H. and Ehara, T. (Dept. Physiol., Fac. Med., Kyushu Univ., Fukuoka 812) ……348

594. The effects of magnesium on the excitation-contraction coupling of ventricular muscle.
Ehara, T. and Ito, T. (Department of Physiology, Faculty of Medicine, Kyushu University, Fukuoka 812) ……349

595. Influence of the osmolarity on the spontaneous activity of the guinea-pig sinoatrial node.
Ohba, M. (Dept. Physiol., Sch. Med., Fukuoka Univ., Fukuoka 814-01)……349

23. Circulation (596—641)

596. Influences of -blocker upon cortex EEG and ECG in non-anesthetic SHR.
Ebisu, H., Koide, T[1]., Nomura, M[1]. and Nagata, U. (Research Laboratory of Fukuyuu Hospital, Department of Physiology, Fugita-Gakuen Health University School of Medicine[1]) ····350

597. Relationships between adrenergic innervation and pharmacological characteristics of alpha adrenergic receptors in canine major cerebral arteries.
Kawai, Y. and Ohhashi, T. (Dept. Physiol., Shinshu Univ. Sch. Med., Matsumoto 390) ····350

598. Integration of barosensory and non-barosensory inputs by neurons in the ventrolateral medulla.
Saeki, Y., Terui, N. and Kumada, M. (Institute of Basic Medical Sciences, The University of Tsukuba, Ibaraki-ken 305)····350

599. The transformation of the pressure wave traveling along the aorta.
Ichikawa, T., Nishimoto, Y., Taguchi, K., Morooka, N, Masuda, Y. and Inagaki, Y. (Third Dept. Int. Med., Chiba Univ. Sch. Med., Chiba 280) ····351

600. Haemodynamics and left ventricular wall motion changes with various heart rate in right ventricular pacing (VVI mode).
Shimizu, M*., Sekiya, T., Yamazaki, Y*., Iwata, J*., Tomiya, H*., Saito, T. Inagaki, Y. The 3rd Dept. of Internal Med. Chiba Univ. Sch. of Med. 1-8-1 Inohana Chiba 280)····351

601. Morphological and functional studies of vasa vasorum in canine thoracic aorta.
Ohhira, A. and Ohhashi, T. (Dept. of Physiol., Shinshu Univ. Sch. bf Med., Mataumoto 390) ····351

602. Nervous control of the portal vein during depressor reflexes in rabbits.
Takeuchi, T., Horiuchi, J. and Terada, N. (Dept. Physiol., Yamanashi Med. Col., Yamanashi 409-38) ····352

603. Renal nerve activity (RNA) during experimental hemorrhagic shock.
Koyama, S., Nishida, I., Morita, H., Tsuchiya, K., Nakamura, J., Kawata, M., Yoshida, H. and Hosomi, H. (Dept. of Physiol., Kagawa Medical School, Kagawa 761-07)····352

604. Effect of vagal stimulation on small pulmonary vessels in the rabbit.
Sada, K., Shirai, M. and Ninomiya, I. (Department of Cardiac Physiology, National Cardiovascular Center Research Institute, 5-7-1 Fujishiro-dai, Suita, Osaka 565)····352

605. Aortic baroreflex bradycardia in experimental hypercholesterolemia of rabbits.
Shimizu, T. (lst Dept. of Physiol., Fukushima Med. Coll., Fukushima 960) ····353

606. Interpretation of cardiac performance curve and venous return curve in the right heart bypass experiment.
Takeuchi, A., Sato, T., Shirataka, M. and Nara, Y. (Dept. Medicine, Physiol., Kitasato Univ. Sch. Med., Sagamihara, Kanagawa) ····353

607. Determinant of period of blood pressure oscillation.
Miyakawa, K. and Kaneko, M. (The 2nd Department of Physiology, Shinshu University School of Medicine, Matsumoto 390) ····353

608. Effects of CO_2 on circulating blood distribution.

Shigemi, K., Itoh, T., Natsuyama, T., Sohma, A., Tanaka, Y., Morimoto, T. and Miyazaki, M. (Depts. of Anesthesiol. and Physiol., Kyoto Pref. of Med., Kyoto 602)……354

609. Oxygen transfer process in capillary blood flow.
Niimi, H. and Yamakawa, H. (Dept. Vascular Physiology, National Cardiovascular Center Research Institute, Suita Osaka 565) ……354

610. Distribution of body fluid at early stage after rapid blood transfusion.
Hatakeyama, I., Katakura, T. and Nishida, S. (Dept. Physiol., Kitasato Univ. Sch. Med., sagamihara 228) ……354

611. Basic studies on arterial blood pressure changes caused by head-up tilt.
Takeo, T., Ozaki, T., Akitsu, H., Yoza, H., Suga, S. and Igarashi, K. (Dept. of Physiol., Hirosaki Univ. Sch. of Med., Hirosaki 036 and National Sanat. Iwaki Hosp., Namioka 038-13) ……355

612. Clinical studies on arterial blood pressure changes caused by tilting from horizontal to head-up position.
Igarashi, K., Suga, S. and Ozaki, T. (National Sanat. Iwaki Hosp., Namioka 038-13 and Dept. of Physiol., Hirosaki Univ. Sch. of Med., Hirosaki 036)……355

613. Radial distribution of some statistical characteristics of turbulence measured in the canine aorta.
Yamaguchi, T., Hanai, S., Yano, T[1]., Sawaguchi, H[1]., Tsuchihasi, K[1]. and Kikkawa, S[2]. (Nat'l. Cardiovasc. Center Osaka 560, Waseda Univ. Tokyo 160[1], Dept. Surg. Sci. Tokyo Women's Medical College Tokyo 162[2]) ……355

614. Noninvasive measurement of volume elastic modulus in finger arteries : comparison study with pulse wave velocity.
Shimazu, H., Seki, K., Kobayashi, H., Ito, H. and Yamakoshi, K[1]. (Dept. Physiol., Kyorin Univ. Sch. of Med., Mitaka-shi, Tokyo 181, Inst. of Appl. Elec., Hokkaido Univ. Sapporo-shi, Hokkaido 060[1])……356

615. Theoretical investigation on pulse wave propagating time.
Okai, O., Higuchi, Y. and Makino, K. (Dept. of Klinical Physiol., Kyorin Univ. Sch. of Health Sciences, Miyashita 476, Hachioji, Tokyo 192)……356

616. The differential digital plethysmogram during static finger exercise.
Satoh, T., Komiya, H., Ifuku, H., Hayashi, I. and Takemiya, T. (Div. of Physiol., Inst. of Health and Sports Sci., Tsukuba Univ. Sakura, Niihari, Ibaraki 305)……356

617. A camera-type planimeter gauge with a new monitoring system and its physiological applications.
Sakaguchi, M., Ohhashi, T[1]. and Azuma, T[2]. (Dept. Elect. Eng., Nagano 380 and Dept. Physiol., Shinshu Univ., Sch. Med., Matsumoto 390[1] and Juntendo Univ., Tokyo 113[2]) ……357

618. Analytical methods for respiratory arrhythmia.
Hayashi, H., Takayama, K. and Arita, A. (Dept. Physiol., Saitama Med. Sch., Saitama 350-04) ……357

619. Effects of sodium pentobarbital anesthesia on baroreflex control of renal sympathetic nerve activity and heart rate in the rabbit.
Morita, H., Koyama, S., Nishida, Y., Kawata, M., Yoshida, H., Tsuchiya, K., Nakamura, J. and Hosomi, H. (Dept. Physiol., Kagawa Med. Sch., Miki, Kagawa 761-07)……357

620. Neural modulation of secretion of atrial natriuretic peptide caused by volume expansion.
Tsuchiya, K., Nakamura, J., Morita, H., Nishida, Y., Kawata, M., Yoshida, H., Kaoyma, S., Hosomi, H., Miyata, A[1]. and Matsuo, H[1]. (Dept. Physiol., Kagawa Med. Sch., Kagawa 761-07. Dept. Biochem., Miyazaki Med. Coll., Miyazaki 889-16[1]) ……358

621. Effects of rapid sodium chloride injection on secretion of atrial natriuretic peptide.
Nishida, Y., Morita, H., Tsuchiya, K., Nakamura, J., Koyama, S., Hosomi, H., Miyata, A[1]. and Matsuo, H[1]. (Dept. Physiol., Kagawa Med. Sch., Kagawa 761-07 and Dept. Biochem., Miyazaki Med. Coll., Miyazaki 889-16[1]) ……358

622. Junctional adrenoceptor subtypes of cat's pial artery.
Nakai, M. (Dept. of Cardiovasc. Dynam. Natl. Cardiovasc. Ctr. Res. Inst., Suita, Osaka 565) ……358

623. Effect of Cardiac Sympathetic Nerve Activity on Coronary Catecholamine in Anesthetized Cats.
Honda, T. and Ninomiya, I. (Department of Cardiac Physiology, National Cardiovascular Center Research Institute, 5-7-1 Fujishiro-dai, Suita Osaka 565) ……359

624. Neural mechanisms responsible for arrythmia during coronary occlusion in conscious cats.
Ninomiya, I., Honda, T., Matsukawa, K. and Nishiura, N. (Dept. of Cardiac Physiol., Nat. Cardiovascular Center Res. Inst., Suita, Osaka 565) ……359

625. Spinal secending pathways mediating somatosensory inhbition on baroreflex vagal bradycardia.
Nosaka, S. and Murata, K*. (Dept. Physiol., Mie Univ. Sch. Med., Tsu, Mie 514)……359

626. Effect of phenylephrine on pressure transducer function of the carotid sinus baroreceptor.
Yoshida, H., Kawata, M., Nakamura, J., Tsuchiya, K., Nishida, Y., Morita, H., Koyama, S. and Hosomi, H. (Dept. Physiol., Kagawa Med. Sch., Kagawa 761-07) ……360

627. The role of baroreceptor reflexes in the hepatic circulatory regulation during rapid change of blood volume in the anesthetized dog.
Terada, N., Horiuchi, J. and Takeuchi, T. (Dept. Physiol., Yamanashi Med. Col., Tamaho, Yamanashi 409-38)……360

628. Increases in thyroid blood flow and vasoactive intestinal peptide (VIP) evoked by electrical stimulation of superior laryngeal nerves (SLN) in rats.
Ito, H*., Matsuda, K*., Sato, A., Shiraki, M*. and Tohgi, H*. (Dept. Physiol., Tokyo Metropolitan Institute of Gerontology, Tokyo 173) ……360

629. Response of intracranial pressure (ICP) induced by stimulating brainstem pressor area at different levels of perfusion pressure.
Yasunami, T., Maeda, M., Kuno, M. and Matsuura, S. (Dept. Physiol., Osaka City Univ. Med. Sch., Osaka 545) ……361

630. Identification and characterization of angiotensin II receptors in the fowl aorta.
Takei, Y. and Nishimura, H. (Dept. Physiol., Kitasato Univ. Sch. Med., Sagamihara, Kanagawa 228 and Dept. Physiol. Univ. Tennessee, Memphis, TN 38163, U. S. A.) ……361

631. Non-uniform elevation of vascular resistance in hypertensive rats.
Teranishi, Y. and Iriuchijima, J. (Dept. Physiol., School of Med., Univ. of Hiroshima, Hiroshima 234) ……361

632. The role of endothelial cells in acetylcholine and isoproterenol-induced vasodilations in canine renal artery.
Itoh, S. and Ohhashi, T. (Dept. of Physiol., Shinshu Univ. Sch. of Med., Matsumoto 390) ····362

633. Coronary blood flow rate determined oxygen consumption and uptake of catecholamine in isolated canine heart.
Azumi, T., Sada, K., Shirai, M. and Ninomiya, I. (Dept. Cardiac Physiol., Natl. Cardiovasc. Ctr. Res. Inst., Osaka 565)····362

634. Effects of regional alveolar hypoxia and hypercapnia on internal diameter of small pulmonary vessels in cats.
Shirai, M., Sada, K. and Ninomiya, I. (Department of Cardiac Physiology, National Cardiovascular Center Research Institute, Suita, Osaka 565)····362

635. Continuous measurement of blood volume and plasma sodium concentration and the analysis of drinking in dehydrated rats.
Sugimoto, E., Nose, H. and Morimoto, T. (Dept. Physiol., Kyoto Pref. Univ. of Med., Kyoto 602) ····363

636. Changes in plasma catecholamine levels in rat's transposition response.
Sakata, S. and Iriuchijima, J. (Dept. Physiol., School of Med., Univ. of Hiroshima, Hiroshima 734) ····363

637. Hemodynamic characteristics of the rabbit mesenteric small vascular beds during manipulation of the systemic blood pressure.
Hanai, S. and Minamiyama, M. (Dept. of Vascular Physiol., National Cardiovascular Center Research Institute, Suita, Osaka 565)····363

638. Numerical analysis of blood flow at the branch of vessel.
Tanifuji, S., Uyeda, M. and Inouye, A. (Dept. Applied Physics, Fac. Eng., Osaka City Univ., Osaka 558, Dept. Physiol., Sch. Med., Gifu Univ., 500 and Dept. Physiol., Hyogo Coll. Med., Nishinomiya 663)····364

639. The effect of local heat stimulation on the peripheral blood flow.
Hatamoto, H. (Dept. Physiol., Fac. Med., Kyoto Univ. Kyoto 606) ····364

640. The change of oxygen tension in the medulla during systemic arterial pressure oscillation in rabbits.
Kanai, K. and Miyakawa, K. (The 2nd Department of Physiology, Shinshu University School of Medicine, Matsumoto 390)····364

641. Recording system for the indirect measurements of blood pressure and Q-K time in rats.
Nojima, K., Otsuka, K., Saito, H. and Seto, K. (Dept. Physiol., Kochi Med. Sch., Kochi 781-51) ····365

24. Blood (642—665)

642. Mechanism of erythrocyte aggregation by macromolecules.
Maeda, N. and Shiga, T. (Dept. Physiol., Sch. Med., Ehime Univ., Ehime 791-02)····366

643. Effect of plasma protein on surface charge of red blood cells.
Kakiuchi, Y. and Arai, T. (Div. Physiol., Res. Inst. Applied Electricity, Hokkaido Univ., Sapporo 060)····366

644. The effect of Iohexol and other radiographic contrast media on the erythrocyte

membrane.
Tajima, N., Uyesaka, N., Okada, S., Kikuchi, H., Asahi, R. and Shinagawa, Y. (Dept. of Radio., Physiol., Nippon Medical School, Sendagi, Bunkyo-ku, Tokyo, Dept. of Radio., Nippon Medical School, First Hosp., Iidabashi, Chiyoda-ku, Tokyo) ……366

645. Ultrasonic measurements of red blood cell compressibility by a continuous pulse oscillation method.
Hasegawa, M., Sakanishi, A[1]., Terada, N[2]. and Dobashi, K[1]. (Dept. Vas. Physiol., Nat. Cardiovas. Center Res. Inst., Suita 565, Dept. Poly. Sci., Fac. Tech., Gunma Univ., Kiryu 376[1], Dept. Physiol., Yamanashi Med. Coll., Nakakoma-Gun 409-38[2]) ……367

646. The effect of red cell shape change upon pressure-flow relation of erythrocyte suspension in perfusion of bullflog's hind limb.
Uyesaka, N., Kikuchi, H. and Shinagawa, Y. (Dept. of Physiol., Nippon Medical School, Sendagi, Bunkyo-ku, Tokyo)……367

647. Analyses of the structute of t-PA (tissue plasminogen activator) with monoclonal antibodies.
Sugawara, Y., Makino, Y., Takada, Y. and Takada, A. (Dept. Physiol., Hamamatsu Univ., Sch. Med., Hamamatsu-shi, Shizuoka-ken 431-31) ……367

648. Effects of pH on secondary and tertiary structure of human plasminogen.
Makino, Y., Sugawara, Y., Takada, Y. and Takada, A. (Dept. Physiol., Hamamatsu Univ., Sch. Med., Hamamatsu-shi, Shizuoka-ken 431-31) ……368

649. Detection of a latent proteinase-like activity in the human plasma by SDS-PAGE containing a substrate.
Horie, N., Yamamoto, J. and Okamoto, U. (Fac. Nutr., Kobe-Gakuin Univ., Kobe 673)……368

650. Measurement of plasma erythropoietin by erythroid colony forming assay.
Sakata, S., Enoki, Y., Shimizu, S., Kawase, M., Kohzuki, H. and Ohga, Y. (Second Dept. Physiol., Nara Med. Univ., Kashihara, Nara 634) ……368

651. Plasminogen activator derived from tonsillar lymphocyte of rabbit.
Kosugi, T., Hamai, Y., Nakamura, M. and Kinjo, K. (Dept. Physiol., Sch. Med., Univ. Ryukyus, Okinawa, 903-01) ……369

652. Characterization of the erythroid precursor cells (BFU-E) in patients with paroxysmal nocturnal hemoglobinuria by the complement lysis sensitivity test.
Matsuda, M. and Terasawa, T. (Dept. Physiol., Tohoku Dent. Univ., Koriyama 963) ……369

653. Studies on the clearance mechanism for foreign substances by reticuloendothelial system (RES).
Oshiba, S., Takao, K., Imai, H. and Takaori, M. (Dept. Phsiol., Nihon Univ. Sch. Med., Tokyo)……369

654. Effects of local vibration on blood fibrinolytic activity.
Higashi, T., Watanabe, M[1]., Takashima, N[1]., Sagawa, S[1]., Isomoto, A[1]., Tyuma, I[1]. and Tsuji, K[2]. (Dept. Med. Tech. Lab., Col. Biomed. Tech., Osaka Univ., Toyomaka, Osaka 560, Dept. Physicochem. Physiol., Med. Sch., Osaka Univ.[1] and Dept. Cardiol., Hanwa Memor. Hosp.[2]) ……370

655. Plasma fibrinolysis in alcohol drinking : Increase of urokinase (UK)-type plasminogen activator in plasma.
Sumi, H., Yoshida, E., Yamamoto, T., Ikeda, R., Hamasuna, S., Morimoto, N., Tsushima,

H., Maruyama, M. and Mihara, H. (Dept. Physiol., Miyazaki Med. College, Kiyotake, Miyazaki-gun 889-16) ····370

656. Effects of standard and nicotineless cigarette smoke inhalation on changes in the adhesiveness of leukocytes during development of dietary-induced atherosclerosis in the rabbit.
Ohkubo, C. and Asano, M. (Dept. of Physiol. Hygiene, the Inst. of Publ. Health, Tokyo 108)····370

657. The deformation of red cells under shear flow. The effect of hematocrit on the deformation.
Kon, K., Maeda, N. and Shiga, T. (Dept. Physiol., Sch. Med., Ehime Univ. Ehime 791-02)····371

658. Empirical equations for the estimation of intraerythrocytic pH.
Ueda, Y. and Tyuma, I. (Dept. of Physicochem. Physiol. Osaka Univ. Med. Sch. Nakanoshima, Osaka, 530)····371

659. Binding of anti-human T lymphocytes monoclonal antibodies (OKT-3, -4, and -8) on quantitative flow cytometry.
Oonishi, T., Uyesaka, N, Sakashita, K and Shinagawa, Y. (Dept of Pathol., Dept. of Cancer Research, The Kanto Teishin Hosp., Hogashi-Gotanda, Shinagawa-ku, Tokyo, Dept. of Physiol., Nippon Medical School, Sendagi, Bunkyo-ku, Tokyo)····371

660. Populations of rabbit reticulocytes using scanning electron microscopy.
Kitahara, M., Saito, H. and O'hata, S. (Dept. Physiol. Tokyo Med. Coll., Shinjuku-ku, Tokyo 160) ····372

661. Studies on the fibrinolytic enzyme in the hepatobiliary system (XIV) the primary cultured rat hepatocytes and plasminogen activator release.
Oshiba, S., Yoshida, M., Imai, H., Sawai, H., Ogasawara, Y. and Endoh, E. (Dept. Physiol., Nihon Univ. Sch. Med., Tokyo)····372

662. The elevation of plasma thiol proteinase inhibitor in vitamin E deficient rat.
Watanabe, K., Ariga, T. and Oshiba, S[1]. (Dept. Agr. Chem., Sch. Agr. Vet. Med., Nihon Univ., Shimouma, Setagaya 3, Tokyo 154 and Dept. Physiol., Sch. Med., Nihon Univ., Oyaguchi-Kamimachi 30, Tokyo 173[1])····372

663. Mouse hemopoietic colony formation by pokeweed mitogen-stimulated spleen cell-conditioned medium.
Nagasawa, T., Okada, T. and Kinoshita, Y. (Dept. Physiol., Osaka City Univ. Med. Sch., Osaka 545) ····373

664. Patho-physiologycal importance of mechanical fragility of erythrocyte membrane.
Uyesaka, N., Hasegawa, S., Kikuchi, H. and Shinagawa, Y. (Dept. of Physiol., Nippon Medical School, Sendagi, Bunkyo-ku, Tokyo, Dept. of Hematol., The Kanto Teishin Hosp., Higashi-Gotanda, Shinagawa-ku, Tokyo)····373

665. Release of plasminogen activator by extracts by bovine anterior pituitary.
Sakai, J., Sanada, S., Ito, A., Nakashima, A., Sugishita, E. and Sugie, I. (Dept. of Physiol., Aichi Med. Univ., Nagakute, Aichi, 480-11)····373

25. Kidney and Body Fluid (666—672)

666. NMR behavior of the urine component creatinine.

Nakaya, S., Tanaka, Y., Yoshioka, Y., Hasegawa, H., Kurosawa, N. and Yagi, S. (Dept. of Physiol. 2, Schl. of Med., Iwate Med. Univ., Morioka 020) ····374

667. Acid stable trypsin inhibitor in the bile.
Yamamoto, T., Sumi, H., Maruyama, M., Tsushima, H., Ikeda, R., Hamasuna, S., Yoshida, E., Morimoto, N. and Mihara, H. (Dept. Physiol., Miyazaki Med. College, Kiyotake, Miyazaki-gun 889-16)····374

668. Effect of SITS on Na^+ and HCO_3^- appearing in plasma during passage of CO_2-rich gas throngh human whole blood.
Asano, K., Shimabukuro, S., Ogawa, A., Ohira, T., Minagawa, T. and Hirakawa, S. (2nd Dept. Intern. Med. Gifu Univ. Sch. Med.) ····374

669. Contribution of albumin and non-albumin fractions to protein osmotic pressure.
Yamada, S., Grady, M. K. and Staub, N. C. (Dept. Systems Physiol., Univ. Occu. Envirn. Hlth., Kitakyushu 807 and CVRI, Univ. California, San Francisco, U. S. A.)····375

670. Fluid shifts during head out water immersion (WI) in dogs.
Miki, K. and Krasney, J. A. (Dept. Physiol., Sch. Med. Univ. Occup. Environ. Hlth. Kitakyushu 807 ; Dept. Physiol., State Univ. of New York at Buffalo, 120 Sherman Hall, Buffalo NY, 14214 U. S. A.)····375

671. Angiotensin II (AII) and vasopressin (AVP) cause membrane depoloarization and contraction of cultured rat mesangial (M) cells.
Okuda, T*., Yamashita, N. and Kurokawa, K*. (Fourth Dept. Int. Med., Univ. Tokyo Sch. Med., Tokyo 112)····375

672. Analysis of intestinal water absorption with continuous monitoring of blood volume in rats.
Morita, M., Nose, H. and Morimoto, T. (Department of Physiology, kyoto Prefectural University of Medicine, Kamigyoku, Kyoto 602, Japan)····376

26. Respiration (673—707)

673. Factors affecting hypoxic ventilatory depression in the anesthetized rat.
Maruyama, R., Yoshida, A. and Fukuda, Y. (Dept. Physiol., Chiba Univ. Sch. Med., Chiba 280) ····377

674. Hypercapnic and hypoxic ventilatory responses during growth.
Honda, Y., Ohyabu, Y., Sato, M., Masuyama, H., Maruyama, R., Nishibayashi, Y. and Tanaka, Y. (Dept. Physiol., Chiba Univ. Sch. Med., Chiba 280) ····377

675. Effects of ceasing the blood flow to the upper part of the brain stem on the inspiratory activity during stimulation of the carotid sinus nerve in cats.
Natsui, T. and Kuwana, S. (Dept. of Physiol., Sch. of Med., Teikyo Univ., Itabashi-ku, Tokyo 173)····377

676. Influence of oxygen delivery on oxygen consumption ($\dot{V}O_2$) of the isolated perfused canine gracilis muscles.
Kohzuki, H., Enoki, Y., Sakata, S., Ohga, Y. and Shimizu, S. (Second Dept. Physiol., Nara Med. Univ., Kashihara, Nara 634) ····378

677. Regional inhomogeneity of convective and diffusive gas mixing in terminal air way.
Tanifuji, S. and Uyeda, M. (Dept. Applied Physics, Fac. Eng., Osaka City Univ., Osaka 558 and Dept. Physiol., Sch. Med., Gifu Univ., Gifu 500)····378

678. Microsteps in the oxygen diffusion process in the lung.
Koyama, T. and Araiso, T. (Div. of Physiol., Researth Institute of Applied Electricity, Hokkaido Univ., 060 Sapporo) ····378

679. Entrainment of breathing rhythm to locomotion rhythm.
Miyamoto, Y., Kawahara, K. and Nakazono, Y. (Dept. Information Eng., Fac. Eng., Yamagata Univ. Yonezawa 992)····379

680. Ventilatory responses to bicycle exercise at two pedalling rate in women.
Takano, N. (Dept. of School Health, Fac. of Education, Kanazawa, Univ., Kanazawa 920) ····379

681. Arterial blood pH during Hatha-YOGA and control breathing.
Miyamura, M. and Hiruta, S. (Lab. Work Physiol. Res. Cent. Hlth. Phys. Fit. Sports, Nagoya University, Chikusa-ku, Nagoya 464) ····379

682. Attenuation of hypoxic ventilatory depression by a synthetic progesterone.
Kimura, H., Kobayashi, T. and Fukuda, Y. (Dept. Chest Med. and Physiol., Chiba Univ. Sch. Med., Chiba 280)····380

683. The effect of synthetic progesterone on ventilation in normal man : comparison between Chlormadinone acetate (CMA) and Medroxyprogesterone acetate (MPA).
Morikawa, T., Tanaka, Y., Maruyama, R., Nishibayashi, Y. and Honda, Y. (Dept. Orthopaedic Surg., Chiba Univ. Sch. Med., Chiba 280) ····380

684. Ventilatory responses to stimulation of central chemosensitive area by injection of a high CO solution into the vertebral artery.
Kogo, N., Koshiya, N., Arita, H. and Kumada, M. (Inst. of Basic Med. Sci., Univ. of Tsukuba, Ibaraki 305)····380

685. Influences of morphine and proglumide on reflex respiratory suppression induced by thin-fiber muscular afferents.
Tadaki, E., Simbulan, D., Eguchi, K., Yasui, H*. and Kumazawa, T. (Dept. Nervous and Sensory Functions, Res. Inst. of Environ. Med., Nagoya Univ., Nagoya 464)····381

686. Correlation of inspiratory reticular unit activity in the brain stem to phrenic high frequency oscillations of rabbits.
Takano, K., Kato, F., Yamada, J*., Kimura, N. and Hukuhara, T., Jr. (Dept. Pharmacol. II., lst Dept. Surg*., Jikei Univ. Sch. Med., Minato-ku, Tokyo 105) ····381

687. Variation of high frequency oscillations in phrenic nerve activity in the course of one respiratory cycle.
Kato, F., Fujisaki, Y*., Kimura, N., Takano, K. and Hukuhara, T., Jr. (Dept. Pharmacol. II., lst Dept. Surg*., Jikei Univ. Sch. Med., Minato-ku, Tokyo 105) ····381

688. Pre-inspiration neuronal activity in ventral medulla of isolated brain stem-spinal cord of neonatal rat.
Onimaru, H., Arata, A., Homma, I and Ichikawa, S. (Dept. Physiol., Showa Univ. Sch. Med., Hatanodai, Tokyo 142)····382

689. The respiratory reflex induced by high frequency airway deflation (HFD) in rabbits.
Homma, I., Isobe, A., Onimaru, H., Oouchi, M. and Ichikawa, S. (Dept. Physiol., Showa Univ. Sch. Med., Hatanodai, Tokyo 142) ····382

690. Recovery of motor behabior following cross-reinnervation of forelimb muscles by the phrenic in cats.

Fujito, Y., Kawasaki, H. and Aoki, M. (Dept. Physiol., Sapporo Med. College, S. 1, W. 17, Chuo-ku, Sapporo 060)……382

691. Brainstem control of the cervical respiratory neurons in the cat.
Aoki, M., Fujito, Y., Kurosawa, Y. and Kawasaki, H. (Dept. Physiol., Sapporo Med. College, Chuo-ku, Sapporo 060) ……383

692. Respiratory neurons in the nucleus retroambigualis ; Electrophysiological and morphological analyses.
Koshiya, N., Kogo, N., Arita, H. and Kumada, M. (Inst. of Basic Med. Sci., Univ. of Tsukuba, Ibaraki 305)……383

693. Inhibition of respiration caused by microinjection of morphine or repetitive electrical stimulation in the region of the nucleus parabrachialis of cats.
Eguchi, K., Simbulan D., Tadaki, E. and Kumazawa, T. (Dept. Nervous and Sensory Function, Res. Inst. Fnviron. Med., Nagoya Univ., Nagaya 464)……383

694. Effect of high frequency ventilation on respiratory nerve discharges in the cat.
Kawasaki, H., Fujito, Y. and Aoki, M. (Dept. Physiol., Sapporo Medical College, Chuo-ku, Sapporo 060) ……384

695. An origin of inspiratory inhibition of expiratory neurons in the Bötzinger complex.
Ezure, K. and Manabe, M. (Dept. Neurobiol., Tokyo Metropolitan Institute for Neurosciences. Musashidai 2-6, Fuchu-shi, Tokyo 183) ……384

696. Activity of pulmonary vagal afferents innervating CO_2 sensitive receptors of the tortoise.
Ishii, K., Ishii, K*. and Dejours, P*. (LERP, CNRS, Strasbourg, Dept. of Physiol.*, Fukushima Med. Coll., Fukushima 960) ……384

697. Differences observed in phase response curve between the middle and the caudal external intercostal nerve stimulation in rabbits.
Kitano, S., Suzuki, H., Fujita, M*., Komatsu, A*. and Watanabe, K*. (Dept. Anesthe. and Physiol*., Tokyo Women's Medical College, Tokyo) ……385

698. Temporal relationships between both neural discharges relating to respiratory movements and straining in decerebrate dogs.
Fukuda, H. and Fukai, K. (Dept. Physiol., Kawasaki Med. Sch., Kurashiki 701-01) ……385

699. Respiratory reflexes from the upper airway of the rabbit.
Miyaoka, Y. and Shimada, K. (Dept. Oral Physiol, Niigata Univ Sch. Dent., Niigata 951) ……385

700. Relationships among panic-fear personality, aging, and ventilatory activity.
Tanaka, Y., Morikawa, T., Maruyama, R., Nishibayashi, Y. and Honda, Y. (Dept. Physiol., Chiba Univ. Sch. Med., Chiba 280) ……386

701. Effects of season on the metabolic rate in the bullfrog.
Sakakibara, Y. (Dept. Physiol., Chiba Univ Sch. Med., Chiba 280)……386

702. Effect of occlusion of arteries in the ventral surface of medulla on CO_2-phrenic nerve activity response in cats.
Kuwana, S. and Natsui, T. (Dept. of Physiol., Sch. of Med., Teikyo Univ., Itabashi-ku, Tokyo 173)……386

703. Characteristics of first and second stages of expiration in patients with transferred intercostal nerves.

Sibuya, M., Homma, I., Hara, T[1]. and Tsuyama, N[2]. (Dept. of Physiol., Showa Univ., Hiroo Hosp[1]., National Rehabilitation Center[2], Tokyo and Saitama, Japan)·····387

704. Flow pattern at the bifurcation of bronchial air way.
Uyeda, M., Tanifuji, S., Iwai, T. and Inouye, A. (Dept. Physiol., Sch. Med., Gifu Univ., Gifu 500, Dept. Applied Physics, Fac. Eng., Osaka City Univ., Osaka 558 and Dept. Physiol., Hyogo Coll. Med., Nishinomiya 663) ·····387

705. Vagal and nonvagal roles on the pattern of breathing induced by air airway occlusion (AO) in rabbits.
Sasaki, K., Uchida, H., Nemoto, H. and Kinoshita, M. (4 th Dept. of Internal Med., Toho Univ. School of Med., Meguro-ku, Tokyo 153) ·····387

706. Evaluation of uneven distribution of $\dot{V}A/\dot{Q}$ ratio from data on exchange of respiratory gases.
Doi, K., Niizeki, K., Kagawa, T. and Takahashi, K[1]. (Dept. Physiol. and Dept. Internal Med[1]., Yamagata Univ. Sch. Med., Yamagata 990-23)·····388

707. Analysis of pulmonary gas exchange during rebreathing by a simulation tethnique.
Shibuya, I., Niizeki, K., Uchida, K. and Mochizuki, M. (Dept. Physiol., Yamagata Univ. Sch. Med., Yamagata 990-23) ·····388

27. Digestion and Absorption (708—717)

708. Inhibitory effect of gymnemic acid on glucose absorption in the rat small intestine.
Yoshioka, S., Takeuchi, T*[1]., Imoto, T., Kasagi, T. and Hiji, Y. (Dept. Physiol., Int. Med[1]., Tottori Univ. Sch. Med., Yonago 683)·····389

709. Studies on phenomena through intestinal membrane and its disturbance (II).
Nakano, S., Terao, T., Miyoshi, M. and Yoshioka, T. (Dept. Physiol., Tokai Univ. Sch. Med., Kanagawa 259-11) ·····389

710. Permeability changes of tight junction in rat submandibular gland after sympathomimetical stimulations.
Uchihashi, K., Takai, N., Yoshida, Y. and Kakudo, Y. (Dept. Physiol., Osaka Dent. Univ. Osaka 540) ·····389

711. The effect of proglumide on luminal feedback regulation in the conscious rat.
Miyasaka, K. and Kitani, K. (The First Lab. Clin. Physiol. Tokyo Metropolitan Inst. of Gerontology, Toky1-173) ·····390

712. Effects of hypothalamic stimulation on the pancreatic exocrine secretion of dogs.
Okada, H. and Furukawa, N. (Dept. Physiol., Kawasaki Med. Sch., Kurashiki 701-01)·····390

713. Motile activity of isolated gastrointestinal tract of streptozotocin diabetic rats.
Karakida, T., Ito, S[1]. and Homma, S. (Dept. Physiol. and lst Dept. Internal Medicine[1], Niigata Univ. Sch. Med., Niigata 951) ·····390

714. The nutritional role of urea nitrogen in protein deficiency.
Tanaka, N., Kawasaki, I., Hori, S. and Yoshimura, H. (Dept. Physiol., Hyogo Coll. Med., Nishinomiya 663 and Dept. Home Economics, Kobe Women's Univ., Kobe 654) ·····391

715. The effect of brown rice diet on absorption of nutrients on low protein intake.
Miyoshi, H., Oi, Y., Yamamoto, Y*., Okuda, T. and Koishi, H. (Fac. of the Sci. of Living. Osaka City Univ.., Sumiyoshi-ku, Osaka 558)·····391

716. Effects of inhibitors on membrane digestion and absorption of sugars by everted

intestine of guinea pig.
Himukai, M. (Div. Bas. Nutr., Natl. Inst. Nutr., Tokyo 162) ····391

717. Secretion pattern of human parotid saliva.
Shimatani, Y., Katagiri, Y. and Abe, H[1]. (Dept. Physiol., Dept. Oral and Dental Surgey[1], Tokyo Women's Medical College, Tokyo 162) ····392

28. Internal Secretion and Reproduction (718—739)

718. The effects of Ca-agonist and -antagonist on electrical activity induced by glucose, quinine and tolbutamide in B-cells of pancreatic islets.
Sakamoto, Y., Matthews, E. K[1]. and Imanaga, I. (Dept. of Physiol., Sch. of Med., Fukuoka Univ., Fukuoka 814-01, Cambridge Univ., England[1]) ····393

719. Species difference in the secretory response of adrenocortical cells to platelet activating factor and histamine.
Shimada, T., Matsumoto, I., Hirose, T., Tanaka, Y. and Aikawa, T. (Dept. Physiol., Nagasaki Univ Sch Med., Nagasaki 852) ····393

720. Adrenal medullary secretory response to stimulation of the zona incerta, amygdala and hippocampus in the rat.
Matsui, H. (Dept. Physiol., Nagasaki Univ. Sch. Med., Nagasaki 852)····393

721. Effect of anti-allergic drug on the secretory response of the pituitary-adrenal axis to the intraventricular administration of comp. 48/80.
Matsumoto, I. and Aikawa, T. (Dept. Physiol., Nagasaki Univ. Sch. Med., Nagasaki 852) ····394

722. Stimulatory action of oxytocin on neurons in the supraoptic nucleus of rats *in vitro*.
Okuya, S[1]., Kannan, H. and Yamashita, H. (Dept. of Internal Medicine, Yamaguchi Univ., Sch. of Med., Ube 755[1] and Dept. of Physiol., Univ. of Occup. Environ. Health, Sch. of Med., Kitakyushu 807)····394

723. Paraventricular and periventricular nucleus neurons with projection to the median eminence.
Kannan, H., Kasai, M. and Yamashita, H. (Dept. Physiol., Univ. of Occup. Environ. Health Med., Kitakyushu 807)····394

724. Responses of paraventricular neurosecretory cells to osmotic stimuli applied locally to the anteroventral wall of the 3 rd ventricle.
Honda, K., Negoro, H., Higuchi, T. and Tadokoro, Y. (Dept. Physiol., Fukui Med. Sch., Fukui 910-11)····395

725. Growth hormone release induced by electrical stimulation of the basolateral amygdala, observed in pentobarbital anesthetized rats.
Koibuchi, N., Kato, M. and Suzuki, M. (Dept. Physiol., Institute of Endocrinology, Gunma Univ., Maebashi 371) ····395

726. Quantitative analyses of plasma vasopressin level after footshock : intensity effects and time course.
Onaka, T., Hamamura, M. and Yagi, K. (Dept. Physiol., Jichi Med. Sch., Tochigi 329-04)····395

727. Role of fetus expulsion reflex in parturition of the rat.
Higuchi, T., Tadokoro, Y., Honda, K. and Negoro, H. (Dept. Physiol., Fukui Med.

Sch., Fukui 910-11)……396

728. Age-related changes in amount of nuclear androgen binding in the murine submandibular salivary gland.
Katsukawa, H. and Funakoshi, M. (Dept. Oral Physiol., Asahi Univ., Sch. Dent. Gifu 501-02) ……396

729. Effects of anti-estrogen(tamoxifen)on the embryonic gonad of the japanese quail.
Ito, Y. and Yamamoto, N. (Dept. Physiol., Gifu Univ. Sch. Med., Gifu 500)……396

730. Influx of extracellular Ca^{2+} or mobilization of Ca^{2+} from intracellular store site-which is essential for human pancreatic growth hormone releasing factor(hpGRF)-induced growth hormone(GH)release from dispersed rat pituitary cells?
Kato, M. and Suzuki, M. (Dept. Physiol., Inst. Endocrinol., Gunma Univ. Maebashi 371) ……397

731. Roles of somatostatin neurons in the regulation of growth hormone in the rat.
Praputpittaya, C., Mitsugi, N., Arita, J. and Kimura, F. (Dept. Physiol., Yokohama City Univ. Sch. Med., Yokohama 232) ……397

732. Effects of newborn catecholaminergic tissue transplanted in the third ventricle on cyclic ovulation in rats.
Hashimoto, R. and Kimura, F. (Dept. Physiol., Yokohama City Univ. Sch. Med., Yokohama 232) ……397

733. Turnover of biogenic amine in the ventromedial, hypothalamic, paraventricular, and supracyiasmatic nucleus in rats subjected to restricted daily feeding.
Nagasaka, T[1]., Honma, K., Katsuno, Y. and Hiroshige, T. (Dept. Physiol., Sch. Med., Dept. Pediat. Dent., Sch. Dent., Hokkaido Univ., Sapporo, 060[1])……398

734. Release of oxytocin estimated with push-pull cannulae from the paraventricular nucleus of lactating rats.
Tadokoro, Y., Negoro, H., Honda, K. and Higuchi, T. (Dept. Physiol., Fukui Med. Sch., Fukui 910-11)……398

735. cAMP stimulates dopamine synthesis in the median eminence of rat hypothalamic slices.
Arita, J. and Kimura, F. (Dep . Physiol., Yokohama Ci y Univ. Sch. Med., Yokohama 232) ……398

736. Inhibition of pulsatile luteinizing hormone secretion and hypothalamic unit activities by intravenous estrogen administration in freely-moving ovariectomized rats.
Akema, T. and Kimura, F. (Dept. Physiol., Yokohama City Univ. Sch. Med., Yokohama 232) ……399

737. Effects of estrogen on the chemosensitivity of the rat paraventricular neurons in vitro.
Akaishi, T. and Sakuma, Y. (Dept. Physiol., Niigata Unv. Sch. Med., Niigata 951) ……399

738. Changes in sympatho-adrenal medullary functions during aging.
Ito, K., Sato, A., Sato, Y. and Suzuki, H. (Dept. Physiol., Tokyo Metropolitan Institute of Gerontology, Tokyo 173) ……399

739. Selective responses in plasma ACTH, prolactin and TSH levels after noxious and hypovolemic stimuli.
Hamamura, M., Onaka, T. and Yagi, K. (Dept. Physiol., Jichi Med. Sch., Tochigi 329-04) ……400

29. Body Temperature and Sweating (740—781)

740. Pattern differences in the experimental fever.
Watanabe, T., Nakamori, T*., Morimoto, A. and Murakami, N. (Dept. Physiol., Yamaguchi Univ. Sch. Med., Ube, Yamaguchi 755)……401

741. The involvement of biogenic amines on PGE_1-induced fever in the rabbit.
Iwamoto, J., Fujiwara, M., Ohwatari, N. and Kosaka, M. (Dept. of Environment. Physiol., Inst. for Trop. Med., Nagasaki Univ., Nagasaki 852)……401

742. The mechanism of biphasic fever induction.
Morimoto, A., Nakamori, T*. and Murakami, N. (Dept. Physiol., Yamaguchi Univ. Sch. Med., Ube, Yamaguchi 755) ……401

743. Responsiveness of hypothalamic neurons to interleukin-1, salicylate and mepacrine.
Nakashima, T., Hori, T., Shibata, M., Kiyohara, T., Asami, A. and Asami, T. (Dept. Physiol., Saga Medical College, Saga 840-01) ……402

744. Activity of preoptic thermosensitive neurons during thermoregulatory and feeding behaviors in the monkey.
Hori, T., Kiyohara, T., Oomura, Y[1]., Nishino, H[1]., Aou, S[1]. and Fujita, I[1]. (Dept. Physiol., Saga Medical College, Saga 840-01 and Dept. Higher Humoral Control, National Institute of Physiol. Sci., Okazaki 444[1])……402

745. Effect of changes in midbrain temperature on fusimotor activity in rats.
Sato, H. (Dept. Physiol., Nagoya City Univ. Sch. Med., Nagoya 467) ……402

746. Neurotensin modulation of metabolic thermoregulation.
Tsuzuki, S., Kubo, K. and Sasaki, T. (Dept. of Bioregulation, Inst. for Med. Gen., Kumamoto Univ. Med. Sch., Kumamoto 862)……403

747. Interrelation among temperatures of brain, abdominal cavity and skin in rabbits.
Fujitani, Y. Hosogai, M. and Oikawa, T. (Dept. Physiol., Tottori Univ. Sch. Med., Yonago 683) ……403

748. Studies of thermoregulation and thermal acclimatization on pika(An old-fashioned rabbit).
Kosaka, M., Ohwatari, N., Iwamoto, J., Tsuchiya, K., Fujiwara, M. and Fan, Yu-Jen. (Dept. of Environment. Physiol., Inst. for Trop. Med., Nagasaki Univ., Nagasaki 852) ……403

749. Human oral and tympanic membrane temperature.
Uchino, K., Masuda, M[1]. and Hattori, M[2]. (Dep. Student Health Center, Yokohama Nat. Univ., Yokohama 240. Jikei Univ. Sch. Med., Tokyo 105[1]. Dep. Physical Education, Tokai Univ., Hiratsuka. 254[2])……404

750. Heat Exchange during exercise in water of different temperatures.
Konda, N., Sagawa, S., Yousef, M. K., Yoshino, H. and Shiraki, K. (Dept. Physiol., Sch. Med., Univ. Occup. Environ. Hlth, Kitakyushu 807 ; Des Biol. Res. Cent., Univ. Nevada, Las Vegas, U. S. A.)……404

751. Effects of local cooling on electrical activity of supraoptic cells in vivo and in vitro.
Matsumura, K. and Nakayama, T. (Dept. Physiol., Osaka Univ. Med. Sch., Kita-ku, Osaka 530, Japan) ……404

752. Effects of thermal stimulation on salivary secretion in anesthetized rats.

Tanaka, H., Kanosue, K., Matsuo, R[1]. and Nakayama, T. (Dept. of Physiol., Osaka Univ. Med. Sch., Kita-ku, Osaka 530 and Dept. of Oral Physiol., Osaka Univ. Faculty of Dentistry, Suita, Osaka 565[1]) ····405

753. Facial fanning and exercise performance during hyperthermia in a hot and humid environment.
Hirata, K., Nagasaka, T. and Nunomura, T. (Dept. Physiol., Kanazawa Univ. Sch. Med., Kanazawa 920)····405

754. Vasoconstriction in the skin heated locally to above core temperature.
Nagasaka, T., Cabanac, M[1]., Hirata, K. and Nunomura, T. (Dept. Physiol., Kanazawa Univ. Sch. Med., Kanazawa 920 and Dept. Physiol., Claude Bernard Univ. Sch. Med. Lyon-Sud, Oullins, France[1]) ····405

755. The mechanism of heat-induced vasoconstriction in the finger.
Nunomura, T., Nagasaka, T. and Hirata, K. (Dept. Physiol., Kanazawa Univ. Sch. Med., Kanazawa 920)····406

756. Effects of repetitive immobilization stress(RIS)and cold acclimation(CA)on the adrenocortical hormone secretion.
Yahata, T., Murazumi, K. and Kuroshima, A. (Dept. of Physiol., Asahikawa Medical College, Asahikawa 078-11)····406

757. Effects of noradrenaline on dynamic property of the thermoregulatory system in spinal rats.
Asaki, Y., Iriki, M[1]. (Dept. Physiol., Tokyo Metropol. Inst. Gerontol., Tokyo 173, Dept. Physiol., Med. Univ. Yamanashi, Yamanashi 409-38[1]) ····406

758. Characteristics of cardiovascular responses of the bullfrog(*Rana catesbeiana*)to thermal stimulation of the spinal cord.
Nagai, M. and Iriki, M. (Dept. Physiol., Med. Univ. Yamanashi, 409-38 Yamanashi)····407

759. Effects of sports wear on thermoregulatory response during exercise.
Ohnuki, Y. and Niwa, K. (Dept. Health and Phys. Ed., Yamagata Univ. Fac. Ed., Yamagata 990) ····407

760. Effects of Qi-gong practice on sweating.
Ogawa, T., Shen, Z., Yamashita, Y., Ohnishi, N., Asayama, M. and Sugenoya, J. (Dept. Physiol., Aichi Medical Univ. Aichi 480-11) ····407

761. Increase of sweating capacity by various types of heat acclimation.
Ohnishi, N., Sugenoya, J., Ogawa, T., Asayama, M. and Yamashita, Y. (Dept. Physiol., Aichi Med. Univ. Nagakute 480-11) ····408

762. Effects of local Ca^{++} on the excitability of eccrine sweat glands in man.
Ohara, K., Hashitani, T. and Kumazaki, M*. (2 nd Dept. Physiol., Nagoya City Univ. Med. Sch., Nagoya 467)····408

763. Effect of lesions in raphe dorsalis or locus coeruleus on response of thalamic neurons in rats to skin warming and cooling.
Sakata, Y. and Murakami, N. (Dept. Physiol., Yamaguchi Univ. Sch. Med., Ube, Yamaguchi 755) ····408

764. Effects of endogenous pyrogen and prostaglandin E_2 on hypothalamic neurons of guinea pig brain slice.
Ono, T., Watanabe, T. and Murakami, N. (Dept. Physiol., Yamaguchi Univ. Sch

Med, Ube, Yamaguchi 755)……409

765. Effect of thyrotropin releasing hormone(TRH)and Cyclo-(His-Pro)on preoptic thermosensitive neurons in the rat.
Kiyohara, T., Hori, T., Yamasaki, M., Asami, T., Nakashima, T. and Shibata, M. (Dept. Physiol., Saga Med. Coll., Saga 840-01)……409

766. Preoptic and anterior hypothalamic neurons responding to changes in local temperature and blood pressure.
Koga, H., Hori, T., Kiyohara, T., Nakashima, T. and Shibata, M. (Dept. Physiol., Saga Medical College, Saga 840-01)……409

767. Responses of thermoresponsive neurons in guinea-pig preoptic-hypothalamic area and thalamus to serotonin and noradrenaline.
Ishikawa, Y. and Hinckel, P. (Dept. Physiol., Osaka Univ. Med. Sch., Kita-ku Osaka, 530. Physiol. Institut, Univ. Giessen, F. R. G.)……410

768. Effects of hypercapnia and hypoxia on the thermosensitivities of preoptic neurons to preoptic temperature.
Tamaki, Y., Matsumura, K., and Nakayama, T. (Dept. of Physiol., Osaka Univ. Med. Sch., Kita-ku Osaka 530)……410

769. Thermosensitivity of preoptic neurons in pigeon hypothalamic tissue slices.
Nomoto, S. (Dept. Physiol., Tokyo Metropol. Inst. Gerontol., Itabashi-ku, Tokyo 173)……410

770. Involvement of ventromedial and anterior hypothalamus in the control of brown adipose tissue thermogensis induced by preoptic cooling.
Imai-Matsumura, K. and Nakayama, T. (Dept. Physiol., Osaka Univ. Med. Sch., Kita-ku, Osaka 530)……411

771. Effect of cold acclimation and repetitive stress on plasma and tissue cAMP levels.
Habara, Y. and Kuroshima, A. (Dept. of Physiol., Asahikawa Med. Coll., Asahikawa 078-11)……411

772. Strain difference in thermal salivation and body water economics among 10 Wistar rat strains exposed to heat.
Furuyama, F., Ohara, K. and Yoshida, T[1]. (Dent. Physiol., Nagoya City Univ. Med. Sch., Nagoya 467 and Dept. Cell Genet., Nat. Inst. Gent., Mishima 411[1])……411

773. Changes in heart rate during thermal stimulation of the thoracic cord of chronic spinal rats with and without anesthesia.
Tsuchiya, K. (Dept. of Environment. Physiol., Inst. for Trop. Med., Nagasaki Univ., Nagasaki 852)……412

774. Suppression of nonshivering thermogenesis by development of heatseeking behavior.
Nakamori, T*., Morimoto, A. and Murakami, N. (Dept. Physiol., Yamaguchi Univ. Sch. Med., Ube, Yamaguchi 755)……412

775. Changes in metabolic activity of rat brain regions during heatseeking behavior in the cold environment.
Murakami, N., Morimoto, A. and Ono, T. (Dept. Physiol., Yamaguchi Univ. Sch. Med., Ube, Yamaguchi 755)……412

776. Change in salt intake during the recovery from thermal dehydration in rats.
Yawata, T., Okuno, T., Nose, H. and Morimoto, T. (Department of Physiology, Kyoto Prefectural University of Medicine, Kyoto 602)……413

777. The role of prostaglandins in the dissociation of thermoregulatory responses during LPS fever.
Iriki, M. (Dept. Physiol., Yamanashi Medical College, Tamaho Nakakoma Yamanashi 409-39) ····413

778. Endorphin effects on thermal adaptation to emotional stress.
Kubo, K., Tsuzuki, S. and Sasaki, T. (Dept. of Bioregulation, Inst. for Med. Gen., Kumamoto Univ. Med. Sch., Kumamoto 862)····413

779. Seasonal variations in local sweat rate of men.
Tsujita, J., Hori, S., Mayuzumi, M. and Meren, J[1]. (Dept. of Physiol. Hyogo Coll. of Med. Nishinomiya 663, Dept. of Physical Education, Mukogawa Women's Univ. Nishinomiya 663[1])····414

780. Thermal insulation in man at a simulated depth of 10 m.
Sagawa, S., Yoshino, H., Konda, N., Shiraki, K. and Yousef, M. K. (Dept. Physiol. Sch. Med., Univ. Occup. Environ. Hlth., Kitakyushu 807 ; Des. Biol. Res. Cent., Univ. Nevada, Lasvegas, U. S. A.) ····414

781. Cold induced vasodilatation in the rats.
Azuma, T. (Dept. Physiol., Mie Univ. Sch. Med., Tsu 514) ····414

30. Biorhythm (782—791)

782. Retarded growth of the suprachiasmatic nucleus and pineal body in *dw* and *lit* dwarf mice.
Noguchi, T., Sugisaki, T., Kudo, M. and Satoh, I. (Depts. of Physiol. and Path. and R. I. Res. Unit, Gen. Res. Center, Toho Univ. Sch. Med. Tokyo-143) ····415

783. Circadian locomotor rhythm in SCN lesioned rats ; Effects of methamphetamine.
Honma, S., Honma, K. and Hiroshige, T. (Dept. Physiol., Hokkaido Univ. Sch. Med., Sapporo 060) ····415

784. Ontogenesis of PHI-containing neurons in the rat SCN.
Ishikawa, K. and Frohman, L. A. (Div. Endo. and Meta., Univ. Cincinnati, Cincinnati Ohio USA)····415

785. Phase-dependent response of human circadian rhythms to a bright pulse : experiments in a temporal isolation unit.
Honma, K., Honma, S. and Wada, T[1]. (Dept. Physiol., Sch. Med., Coll. Med. Technol., Hokkaido Univ., Sappor, 060[1]) ····416

786. Phase response curves, free-running period, and activity time in circadian locomotor rhythms of rats.
Isobe, Y. and Ohara, K. (Dept. Physiol., Nagoya City Univ. Sch. Med., Nagoya 467) ····416

787. Effects of peptide hormones on circadian sleep rhythm in Brattleboro rats.
Yamaoka, S. (Dept. Physiol., Saitama Medical School, Moroyama, Saitama, 350-04) ····416

788. Entrainment of Circadian Behavioral Rhythms of Rats to the Periodic Avoidance-Task.
Abe, H., Kida, M. and Mano, T. (Dept. VI, Res. Inst. Environ. Med., Nagoya Univ., Nagoya 464) ····417

789. Complex phase-locked responses of molluscan neuron.
Ishizuka, S. and Hayashi, H*. (Dept. Physiol., Fac. Dent., Kyushu Univ., Fukuoka 812 Dept. Electronics, Fac. Engineering, Kyushu Univ., Fukuoka 812*) ····417

790. Effects of photoperiod and ambient temperature on circadian rhythms of preferred ambient temperature self-controlled by the Djungarian hamster, Phodopus sungorus.
Tokura, H. (Lab. Physiol., Dept. Clothing Sci., and Div. Human Life and Environ. Sci., Graduate Div. Human Culture, Nara Women's Univ., Nara 630) ····417

791. Circadian cellular mechanism of non-parametric and parametric entrainment.
Hasegawa, K. and Tanakadate, A. (Dept. Physiol., Kitasato Univ. Sch. Med., Sagamihara 228) ····418

31. Exercise, Physical Fitness and Fatigue (792—806)

792. Relationship between ventilatory responses and tetanic stimulation during voluntary contractions of the triceps surae.
Shimoshikiryo, K., Nagata, A., Muro, M. and Yona, M. (Dept. Bio-Dynamics, Toho Univ. Sch. Med., Tokyo 143) ····419

793. Effects of laterality and immobilization of arm on walking pattern.
Yamasaki, M., Tsuzuki, S. and Sasaki, T. (Dept. Bioregulation, Inst. for Med. Genetics, Kumamoto Univ. Med. Sch., Kumamoto 862) ····419

794. The effects of vibratory stimulation and weight loading on the error magnitude in forearm position sense.
Miyamoto, S., Sawada, Y. and Aoki, M. (Sch. Allied Health Professions and Dept. Physiol., Sapporo Med. Col., Sapporo 060*)····419

795. Electromyographic analysis of delayed muscle soreness after muscle fatigue.
Muro, M., Nagata, A., Yona, M. and Shimoshikiryo, K. (Dept. Physical Education, Tokyo College of Pharmacy, Hachioji 192-03) ····420

796. Effect of exercise training on zinc metabolism in human blood.
Ohno, H. and Yahata, T. (Dept. Physiol., Asahikawa Medical College, Asahikawa 078-11) ····420

797. Investigation of optimum amount of exercise from view point of mobilization characteristics of serum free fatty acids.
Iwagaki, S. and Kazami, M. (Dept. physiol. Tokai Univ. Sch. physical education. Hiratsuka-city, 259-12) ····420

798. Personal apace perception in human extremities.
Kurata, H., Uchida, H*., Ogawa, Y. and Yonemoto, K. (Lab. Sports Med., Jikei Univ. Sch. Med., Chofu, Tokyo 182)····421

799. Is EMG activity constant during at various kinds of constant speeds?
Harada, K., Ogawa, Y*., Kurata, H*. and Yonemoto, K*. (Lab. of Physical Edu., Jikei Univ. Sch. Med., Kokryo-cho, Chofu-shi, Tokyo 182 and Lab. Sports Med., Jikei Univ. Sch. Med., Kokuryo-cho, Chofu-shi, Tokyo 182*) ····421

800. Effect of training on creatine kinase isoenzymes of heart and skeletal muscle.
Watanabe, M. (Dept. Exercise Physiol., Sch. Educa., Tokyo Gakugei Univ., Tokyo 184)····421

801. Uric acid metabolism at exercise(5 th report)-effect of exercise on presecretory reabsorption, secretion and postsecretory reabsorption of urate in real tubule.
Mikami, T., Murakami, H., Saito, A., Hadano, S., Kanai, C., Goto, K., Ono, T. and Ito, A. (Institute of Health and Sports Science, Tsukuba Univ., Sakuramura,

Niiharigun, Ibaragi 305)……422
802. Effect of exercise training on the coupling conditions between β-receptors and guanine nucleotide regulatory proteins.
Izawa, T., Komabayashi, T., Tsuboi, M. and Koshimizu, E. (Lab. Exercise Physiol., and Dept. Pharmacol., Tokyo Coll. Pharma., Tokyo 192-03) ……422
803. Visual stabilization of posture-reference to size of visual fields.
Watanabe, S., Takagi, S., Takabayashi, A., Hashiba, M., Mori, S. and Sakakibara, M. (Dept. Aerospace Physiol., Res. Inst. Environ. Med. Nagoya Univ. Nagoya 464 and Dept. Otorhinolaryngol. Nagoya City Univ. Sch. of Med. Nagoya 467) ……422
804. Swimming exercise-induced changes of the ethanol metabolism and administered ethanol levels rats.
Tachiyashiki, K., Imaizumi, K., Takamata, A., Toda, N*. and Ogita, Z-I*. (Dept. Living and Health Sci., Joetsu Univ. of Educ., Joetsu, Niigata 943 and Dept. Pathol. Biochem., Res. Inst. for Oriental Med., Toyama Med. and Pharmaceu. Univ., Toyama 930-01*)……423
805. A trial for measuring oxygen uptake using wireless telemeter.
Ikegami, Y. and Miyamura, M. (Resaerch Center of Health, Physical Fitness and sports, Nagoya University, Chikusa-ku, Nagoya 464) ……423
806. Ventilatory and heart rate responses to hypoxia in track and field athletes.
Ohyabu, Y., Usami, A., Ishida, Y., Miyagawa, C., Arai, T., Ohyabu, I., Sato, M. and Honda, Y. (Dept. Physiol., Chiba Univ. Sch. Med., Chiba 280, Dept. Physical Education, Tokai Univ., Kanagawa 259-12)……423

32. Enviroment and Metabolism (807—823)

807. Temperature acclimation and fatty acid(FA)composition of skeletal muscles.
Ogawa, K., Ohno, T[1]. and Kuroshima, A[2]. (Lab. of Physical Educat., Hokkaido Tokai Univ., Lab. of Nutrition Physiol., Hokkaido Univ. of Educat[1]. and Dept. of Physiol., Asahikawa Medical Coll., Asahikawa[2])……424
808. Myoglobin (MB) determination by polyacylamide gel electrophoresis and effect of thermal acclimation on skeletal muscle MB.
Ohno, T. and Kuroshima, A[1]. (Lab. of Nutrition Physiol., Hokkaido Univ. of Education and Dept. of Physiol., Asahikawa Med. Coll., Asahikawa[1]) ……424
809. Seasonal changes in plasma and aortic lipids in domestic rats.
Hashimoto, H., Furui, H., Hara, T. and Masumura, S. (Dept. Physiol., Shimane Medical Univ., Izumo, Shimane 693)……424
810. Sex differences in the effect of uric acid administration to fasting animals.
Kawaguchi, T., Shimode, M., Matsushita, H. and Nagase, S[1]. (Dept. of Physiol. Wakayama Medical College, Wakayama 640 and Dept. of Chemistry, Sasaki Institute, Tokyo[1])……425
811. Enhancement of metabolic and cardiovastular responses to feeding activity in freely moving spontaneously hyertensive rats.
Shido, O. and Nagasaka, T. (Dept. Physiol., Kanazawa Univ. Sch. Med., Kanazawa 920) ……425
812. Brown adipose tissue characteristics in wild rodents.

Yanagidaira, Y. and Ueda, G. (Dept. of Environ. Physiol., Shinshu Univ. Sch. Med., Mtsumoto, 390)……425

813. Role of the hippocampus on the stressful hormone secretion and thermoregulation under the immobilization stress.
Mohri, M., Negoro, H. and Higuchi, T. (Japan Marine Science and Tecnology Center 237 and Dept. Physiol., Fukui Med. Sch. Matsuoka 910-11) ……426

814. Counter-current response of ear vessels to cold.
Ueda, G., Yanagidaira, Y., Takeoka, M. and Lashimura, O. (Dept. Environmental Physiol. Shinshu Univ. Sch. Medicine, Matsumoto, 390) ……426

815. Effects of centrifugal acceleration exposing to Z axis of the hamsters' body upon cardiopulmonary functions.
Satake, H., Mizuno, Y[1]., Matsunami, K. and Watanabe, S[2]. (Inst. Equilibrium Res., Gifu Univ. Sch. Med., Gifu 500, Daido Inst. Tech., Nagoya 457[1], Res. Inst. Environ. Med., Nagoya Univ., Nagoya 464[2]) ……426

816. Effect of acute exposure to simulated high altitude on water and electrolyte metabolism in man-influence of spironolactone-.
Miyamoto, N., Tamura, Y. Seo, H., Murata, Y., Kanda, K. and Matsui, N. (2 nd Dep. Res. Inst. Environ. Med., Nagoya Univ., Chikusa-ku, Nagoya 464) ……427

817. Effects on red cell deformability of exercise under acute and chronic exposure to a low atmospheric pressure.
Kikuchi, Y., Asano, K*. and Ohshima, N. (Dept. Bioeng., Inst. Basic Med. Sci. and Dept. Work Physiol., Inst. Health and Sport Sci., University of Tsukuba, Ibaraki 305)……427

818. Cardiac function at supine rest and during submaximal exercise in acute severe hypoxia.
Kikuchi, K. and Asano, K. (Lab. for Work Physiol. Inst. of Sports Sciences, Univ. of Tsukuba Sakura, Niihari, Ibaraki 305)……427

819. Modification of rhysus monkey under high gas density hyperbaric environment (51 bar, He-N -O, 4 days).
Seki, K., Taya, Y., Mizushima, Y., Shidara, F., Nakano, M. and Nakayama, H. (Laboratory of Hyperbaric Physiology, JAMSTEC, Yokosuka-shi, 237-Japan) ……428

820. Hormone changes in renin-angiotensin system under hyperbaric heliox environment.
Tamura, Y., Seo, H., Murata, Y., Kanda, K., Matsui, N. and Takeuchi, H. (2 nd Dep., Res. Inst. Environ. Med., Nagoya Univ., Nagoya 464, Japan Marine Sci. and Technol. Center, Yokosuka 237) ……428

821. Changes of cardiopulmonary response during centrifugal acceleration.
Sudoh, M., Ikawa, S., Kawakami, K[1]., Fuse, M[2]. and Saiki, H[3]. (Space Med. Lab. The Jikei Univ. Sch. Med., Minato-ku, Tokyo 105, Radiology, The Jikei Univ. Sch. Med., Minato-ku, Tokyo 105[1], Nihon Kohden, Shinjuku-ku, Tokyo 161[2], St. Marianna Univ. Sch. Med., Kawasaki 213[3])……428

822. Single unit activity of the hypothalamus under hyperbaric environments in rats.
Osaka, T., Kannan, H. and Yamashita, H. (Dept. of Physiol., Univ. of Occup. Environ. Health, Sch. of Med., Kitskyushu 807) ……429

823. In vivo kinetics of ethanol administered orally to rat.
Imaizumi, K., Tachiyashiki, K. and Shiga, T[1]. (Dept. Living and Health Sci., Joetsu Univ. of Educ., Joetsu, Niigata 943 and 2-nd Dept. Physiol., Sch. Med., Ehime Univ., Ehime 791-02[1]) ……429

1, ⅢP(1)0900

A PROGRAM TO ANALYZE BLACK-AND-WHITE AUTORADIOGRAPHIC IMAGES

KAWASHIMA,T., UEKI,S., SATAKE,H., MATSUNAMI,K. AND NAKANISHI,Y.* Inst. Equilibrium Res. Gifu Univ. Sch. Med., Gifu 500, *Mitani shoji Co.

Graphic analyzing program ASPECT for microcomputer has the following main characteristics. First dot images (512 x 512) are sampled by a video camera, and are transformed into 64 grades according to each bright intensity. Three main procedures to analyse the images are prepared. 1) Smoothing filter treatments to reduce noises 2) Emphasizing treatments to enhance contrast of images. 3) Differentiation treatment to sharpen edge or line of boundaries. By using these treatments, unclear objects could be made distinguishable, and brightness-area histogram can be calculated. Another main function is to make the images intotwo grades, and enable to measure the relative area of a specific region. We made use of this program to analyze the autoradiogram of brain tissues of monkeys performing a learning task of a delay response with visual tracking movements. Each autoradiogram were divided into eight grades and displayed in eight colors according to the total absorbed amount of 2-DG. With the aid of this program, further knowledge about the active part in the brain in quantitative way more precisely.

2, ⅢP(2)0900

CIRCUITRY CHANGES OF A PCM CONVERTER FOR APPLICATIONS AS A DC-DATA RECORDER.

ITO,Y.,OHMORI,H. National Institute for Physiological Sciences. Okazaki 444.

A commercially available PCM converter was modified in circuitry to use as a two-channel DC-data recorder in experiments. The PCM converter has such nice features as a high resolution of the analogue data(14/16 bits), a high frequency responsibility(apx.20 kHz), and a very long recording time(5-8 hrs/cassette). However, the commercially available converter is made for audio-frequency(5Hz-20kHz) range and is not good for physiology experiments. Modifications were made as follows to one model of a PCM converter(SONY,PCM 501ES). 1)The frequency response was extended to the D.C. range.Capacitors labeled C103, C104,C203,C204,and C130,C131,C230,C231 were shunted. C102,C202 were removed.C129,C229 were replaced with apx.1000pF. 2)Filter modules(LPF101,LPF201,LPF102,LPF202) were replaced with a Bessel type low pass filter. The cut-off frequency was set at about 15 kHz. 3)The input and output signal ranges were increased to ±10V. Resistors, R105,R205 were replaced with 10kohm. R142,R242 were replaced with 20-30 kohm. R144,R244 were removed.4) Attenuators were disconnected and the input signals were attenuated by 10t 50kohm trimmer resistors of which outputs were connected to nodes formed by R103/R104 and by R203/R204. Offset adjustments were made by RV102,RV202 and by RV104,RV204. RV103,RV203 are for adjusting skewness of the A/D converter. A Hi-Fi VCR is recommended for a combined usage with the PCM converter to use 2 DC channels and 2 AC channels simultaneously.

3, ⅢP(3)0900

L-BAND ESR FOR IN VIVO MEASUREMENT.

NISHIKAWA, H. Dept. Physiol. Kyoto Pref. Univ. Med., Kyoto 602

We have developed an L-band ESR system. The system was equipped with a single-turn, flat loop surface coil and modulation coils, but without cavity for in vivo measurement of biological system. This system has been used as an ESR imaging system constructed with field gradient coils in addition to the ESR system. The single turn surface coil of 0.7 cm diameter, 4.1 cm lenght, and 0.8 mm gap at 1.86 GHz was most sensitive. Its S/N ratio was equal to or better than that of an X-band cavity in an aqueous flat cell. The signal intensity decreased exponentially with the distance from the flat coil plane. An L-band ESR imaging system was constructed with the L-band ESR, magnetic field gradient coils and desk top computer. The peak to peak splitting of two-capillary sample containing aqueous nitroxide was induced by magnetic field gradient, and was directly proportional to the object separation. The ESR gradient projection spectra for a two-capillary sample placed in an x-z field gradient were measured at 30° interval. The sample image was reconstructed by using the filtered back projection method. The in vivo image of the rat tumor was also abtained by the same method.

5, ⅢP(5)0900

TELEMETERING INJECTION SYSTEM DEVELOPED FOR CONSCIOUS SMALL ANIMALS.

NISHIURA,N., NINOMIYA,I. AND YONEZAWA,Y* Dept. of Cardiac Physiology National Cardiovascular Center Research Institute, 5-7-1 Fujishiro-dai, Suita Osaka 565, and*Dept. of Electrical Engineering Hiroshima Institute of Technology, Itukaichi, Hiroshima, 738 Japan

We developed a small (H20×W50×D45mm) and lightweight (45gr) telemetering injection system which can be applied in freely moving small animals. The system was constructed by electrical and mechanical parts fixed togather with acrylic resin. Electrical parts were made by a receiving stage and a motor control circuit. To reduce the size & weight and to avoid the interference, the recieving unit was made only with one packaged operational amplifier using a photo optical technique. Mechanical parts consisted with a micro DC motor, gear trains and a acrylic syringe (0.75ml). Injection speed was 0.025ml/s and a solution of 0.75 ml was injected in a period of 30 s. However, with ON-OFF control technique, the injection period can be prolonged up to 24 hours. Power of this telemetering injection system was supplied with four button type small batteries (LR44).The transmitted range was about 3m within a air-conditional cage.

6, ID 0915

INTERFACE BETWEEN PHYSIOLOGY AND QUANTUM DYNAMICS.

O'HATA,S., AIZAWA,K., KITAHARA,M., SAKAI,S., IMAGAWA,M., SAITO,H. and YAMAO,M. Dept. of Physiol., Tokyo Medical college, Shinjuku-ku, Tokyo 160

In the last general meeting, the author explained the relation between the probability density of beta-distribution (Leonhard Euler) and Weiss' formula,Tasaki's minimal gradient, and Hill's alternating current stimulation theory.

In succession, a sense of physiology relating to beta-distribution will be explained.

The probability density of beta-distribution is transformed into Schrödinger's picture of a simple harmonic oscillator by the transformation of space and time, and this result will make clear the mechanism of the exchange of Na and K based upon quantum dynamics.

7, ID 0930

A MODEL OF DIFFERENTIAL EQUATIONS FOR MEMBRANE TRANSPORT OF NON-ELECTROLYTE.

MATSUDA,H. AND SHINAGAWA,Y. Information Processing Center of Medical Sciences & Department of Physiology, Nippon Medical School, Sendagi, Bunkyo-ku, Tokyo 113

The overshoot uptake of D-glucose into human erythrocytes induces a large fluctuation of concentrations of the internal- and external non-electrolyte solute. They are at least initially far from the equilibrium concentrations. To elucidate such a dynamical behavior of solute concentrations and time change of the osmotic volume flux into erythrocytes (J_v), a mathematical model for membrane transport is presented, which is derived from a biased diffusion equation incorporating a nonlinear term of the solute flux and the carrier mediated transport ($J_{s,cmt}$) as follows;

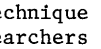
$$J_s = (1-\sigma)J_v\Delta\pi/\{1-\exp[(1-\sigma)J_v/\omega]\}+c_{s,out} + J_{s,cmt}.$$

This equation actually coincides with the Kedem-Katchalasky equation for membrane transport which is written as $J_s=(1-\sigma)J_v(c_{s,in}+c_{s,out})/2+\omega\Delta\pi+J_{s,cmt}$ when $(1-\sigma)J_v<<\omega$ and $\Delta\pi=c_{s,in}-c_{s,out}<<c_{s,out}$. The effect of the carrier mediated transport on the concentration of the solute inside the membrane and the solute flux at a state far from the equilibrium is investigated. Conditions for occurrence of the overshoot uptake is discussed.

8, ID 0945

MEANING OF THE MICROVISCOSITY IN BIOMEMBRANES MEASURED FROM FLUORESCENCE DEPOLARIZATION TECHNIQUE.

ARAISO, T. AND KOYAMA, T. Division of Physiology, Res.Inst. Appl. Electr., Hokkaido University, Sapporo 060

Fluorescence depolarization technique is widely utilized for evaluation of fluidity of biomembranes. Though many researchers have reported the microviscosity of biomembranes, the results varied depending upon the variations of the methods and the fluorophores used. Does the microviscosity have general meaning as the usual macroscopic viscosity has ? In order to answer the question, we compared fluorescence anisotropy decay of two different fluorophores, diphenylhexatriene (DPH,) and diphenylbutadiene (DPB, ) in DPPC vesicles and erythrocyte membranes in the pico-nano second time region. If the interior of lipid bilayer has usual viscous property as found in normal liquid, the two fluorophores offer the same microviscosity. In the DPPC vesicles , those two probes gave almost the same values of microviscosity indicating that we can consider the normal viscous property in the hydrocarbon chain area of lipid bilayers. In the erythrocyte membranes, however, the small probe (DPB) gave a smaller value than that obtained from DPH (0.4 poise from DPB and 0.75 poise from DPH at 37°C). This may be caused by the differance of location of DPH and DPB. It is concluded that the microviscosity has general meaning, but it has to be considered with the location of fluorescent probes.

9, I D 1000

SPIN-LABELED ORIENTED MULTIBILAYER AS REVEALED BY VECTOR ELECTRON PARAMAGNETIC RESONANCE. WATARI, H., KWAN, C-Y., MURAKAMI, M., & SEO, Y. Dept. Molecular Physiol., Natl. Inst. Physiol. Sci., Okazaki 444.

The phase variation in respective to Zeeman field modulation in electron paramagnetic resonance (EPR) of the spin label in glycerol-water solution at an intense microwave field was reported and this phenomenon led to vector concept EPR. This was applied to spin labeled oriented multibilayer to explore the anisotropic fluctuation in the membrane. Dimyristoylphosphatidylcholine (DMPC) was dissolved in chloroform:ethanol with 3-spiro-doxyl-5-cholestane. An oriented twenty bilayer membrane was prepared on a quartz plate at a temperature above the gel-liquid crystalline transition point. The eighteen spectra of second harmonic absorption EPR were measured at 10 degrees interval of instrumental phases, with the magnetic field perpendicular ($\perp$) and parallel to the membrane surface. By the vector integration of these spectra, a highly anisotropic feature was found in the gel phase of DMPC multibilayers containing 10 M% of cholesterol at a temperatures of the gel phase just below the phase transition region where the value of $\perp$ is two times larger than the parallel one. Since the integration of these spectra correlates the total magnitude of the spectral diffusion, a single averaged correlation time can be evaluated. The wobbling motion of the DMPC oriented multibilayer is found to be 10^{-3} to 10^{-6} s and the axial rotation to be 10^{-6} to 10^{-9} s.

10, I D 1015

NMR RELAXATION STUDY ON THE MOBILITIES OF WATER AND Na^+ IONS IN THE NUCLEUS OF INTERVERTEBRAL DISC. MIFUNE,T., KUSAKA,Y., SEO,Y., NISHIKAWA,H., YAMASHITA,F. AND SAKAKIDA,K. Dept. Orthop. Surg. and Dept. Physiol., Kyoto Pref. Univ. Med., Kyoto 602

The matrix of crtilage contains a large amount of water, Na^+ions in high concentration of fibrous component such as collagen and glycosaminoglycan(GAG). The fibrous components interact with water and Na^+ions in the matrix. In this study, the effect of the content of collagen or GAG on the mobilities of water and Na^+ions in the matrix were analyzed by ^1H- and ^{23}Na-NMR relaxation times (T_1 and T_2). The nuclei of intervertebral disc of cow as the materials were treated by hyaluronidase to obtain the various ratios of collagen to GAG. The NMR relaxation times of water and Na^+ ions in the nuclei were measured by a pulsed FT NMR at 100 Mz (^1H) and 24 Mz (^{23}Na).

T_1 and T_2 of water increased as the content of GAG decreased. The degree of the increase in T_2 was significantly larger than in T_1. The decrease in collagen content increased remarkably T_1 of water. Both T_1 and T_2 of Na^+ ions increased as the content of GAG decreased. These facts suggest that the mobilities of Na^+ions are restricted by GAG more than by collagen, and that both GAG and collagen have much bound water.

11, I D 1030

On the complex formation of the reduced D-amino acid oxidase with ligands. **NISHINA, Y. AND SHIGA, K. Department of Physiology, Kumamoto University Medical School, Kumamoto, 860**

D-Amino acid oxidase (DAO) purple intermediate appearing in the catalytic cycle consists of reduced enzyme and the 2-imino acid derived from the substrate. The 2-imino acid has a C=N double bond and a carboxyl group binding to the imino carbon. Picolinate, which has a structure similar to a 2-imino acid, became a good ligand for complex formation with the reduced DAO. Thus picolinate-reduced enzyme complex supplies a good model for the purple intermediate of DAO plus substrate. Resonance Raman spectra of the complex indicate that picolinate in the complex is a cationic form protonated at the N atom. Quantitative analysis (according to the competitive binding method) of the spectrophotometric titration curve of picolinate with the reduced enzyme made it possible to some extent to estimate the dissociation constant and the binding mode. A compound like benzoate, which does not have a cationic group on an aromatic ring, or a compound like pyridine, which does not have a carboxylate group, cannot bind to the reduced enzyme. A compound in which a carboxyl group is attached to an aromatic ring is generally a good ligand for complex formation with the oxidized DAO. On the other hand, a compound which can bind to the reduced DAO needs a cation group in addition to a carboxyl group.

12, I D1045

^{1}H-NMR STUDIES ON THE STRUCTURAL TRANSITIONS OF BOVINE MERCAPTALBUMIN (BMA).
SOGAMI, M., ERA, S., KUWATA, K., SUZUKI, E. AND WATARI, H$^+$. Dept. Physiol., Sch. Med., Gifu Univ., Gifu 500 and $^+$Dept. Mol. Physiol., Natl. Inst. Physiol. Sci., Okazaki 444

The N-F transition (pH 4.40-3.75, 0.10 M NaCl) of BMA and sodium dodecul sulfate (SDS)-BMA complex (AD_m ; m, molar ratio of added SDS to BMA ; $0 \leq m \leq 12$) were studied by measuring CD-resolved secondary structure, acid-titration, ^{1}H-NMR spectra and cross relaxation time (T_{IS}) between irradiated and observed protons. The acid-titration analysis of AD_{12} showed non salt-bonding between carboxylate groups and cationic side chains in the F-form as in the case of BMA, that is, AD_0, indicating charged side chains being presumably mobile. ^{1}H-NMR spectra and T_{IS} values in the F-forms of AD_0, AD_4 and AD_{10} indicated the increase in the local motion. On the other hand, AD_{10} and AD_{12} did not show any significant changes in CD-resolved secondary structure in the N-F transition. The F-form of AD_{10} or AD_{12} may therefore be the molten-globule state which has secondary structure similar to the N-form of the complexes with fluctuating tertiary structure. The F-form of AD_0 may be similar to the molten-glovule-like state, except for slight increase of molecular volume and slight decrease in helical content.

13, I D1100

COMPARATIVE STUDIES ON THE CONFORMATION OF THE NATIVE (N-) AND AGED (A-) FORMS OF BOVINE MERCAPTALBUMIN.
KUWATA, K., ERA, S., SOGAMI, M. AND WATARI$^+$, H. Dept. Physiol., Sch. Med., Gifu Univ., Gifu 500 and $^+$Dept. Mol. Physiol., Natl. Inst. Physiol. Sci., Okazaki 444

The N-A isomerization (the intramolecular SH/S-S exchange reaction) of bovine mercaptalbumin (BMA) in alkaline region was studied by using ion-exchange HPLC, CD-resolved secondary structure, ^{1}H-NMR spectra (360 MHz) and cross relaxation time (T_{IS}) between irradiated and observed protons. k_+ and k_- of the N-A isomerization reaction

$$N \underset{k_-}{\overset{k_+}{\rightleftharpoons}} A$$

of BMA at pH 8.6 without added salts at 25° obtained by ion-exchange HPLC, were 5.7×10^{-5}sec^{-1} and 6.4×10^{-5} sec^{-1}, respectively. On the other hand, k_+ and k_- in 0.10 M KCl were 2.53×10^{-6}sec^{-1} and 2.50×10^{-5}sec^{-1}, respectively, indicating the N-form being stabilized in salt solution. Helical content (f_α) of the A-form, fractionated by S-SepharoseFF at pH 5.0, was 0.62 at isoionic pH, indicating the secondary structure being similar to the F-form. ^{1}H-NMR spectra and T_{IS} values obtained by f_2-irradiation at 7.14 ppm at $\gamma H_2/2\pi \sim 69$ Hz indicated that the A- and iodoacetamide-blocked A-forms seem to be in a conformational state which has the secondary structure similar to the F-form of BMA with fluctuating tertiary structure and slightly large molecular volume ($\sim$10 % increase).

14, I D1115

HETEROTROPIC EFFECTS OF THE N-TERMINAL CARBAMYLATED HEMOGLOBINS.
IMAIZUMI, K., IMAI#, K. AND TYUMA#, I. Lab. Physiol., Dept. Living & Health Sci., Joetsu Univ. of Educ., Joetsu, Niigata 943 and #Dept. Physicochem. Physiol., Med. Sch., Osaka Univ., Osaka 530.

The heterotropic effects of chemically modified hemoglobins($\alpha_2\beta_2$, $\alpha_2^c\beta_2$, $\alpha_2\beta_2^c$ and $\alpha_2^c\beta_2^c$: c denotes carbamylation of α amino groups) in which the N-terminal α amino groups of the α and/or β chains were specifically carbamylated by cyanate, were investigated by measuring accurate oxygen equilibrium curves under different concentrations of CO_2 in the presence and absence of Cl^-, 2,3-diphosphoglycerate, and/or inositol hexaphosphate. Each oxygen equilibrium curve was analyzed according to the Adair equation to evaluate the four-step oxygenation constants and the median oxygen pressure(P_m). The overall oxygen affinity of $\alpha_2^c\beta_2^c$ was lowered on the addition of CO_2 and this lowering in affinity was attributed to a direct effect of HCO_3^-, not to that of CO_2, since all the binding sites for CO_2 were blocked in $\alpha_2^c\beta_2^c$. The magnitude of the effect of HCO_3^- suggested that HCO_3^- interacts with hemoglobin in a way similar to that for Cl^-. The order of the number of Cl^- released upon oxygenation was $\alpha_2\beta_2^c > \alpha_2\beta_2 > \alpha_2^c\beta_2$. The effect of CO_2 on oxygen affinity was compared in terms of log P_m(+4mM CO_2) − log P_m(CO_2-free). In the presence of 0.1M Cl^- and at pH 7.4, those values were 0.39, 0.32, 0.14 and 0.03 for $\alpha_2^c\beta_2$, $\alpha_2\beta_2$, $\alpha_2\beta_2^c$ and $\alpha_2^c\beta_2^c$, respectively. Therefore, the α amino groups of the β chains make a greater contribution to the CO_2 effect than those of the α chain.

15, I D1130

EFFECTS OF PH AND TEMPERATURE ON MEMBRANE POTENTIAL OF NEWT ERYTHROCYTES.
KAWANO,K. AND SHINAGAWA,Y. Inf.Processing Center of Med.Sciences & Dept. of Physiol., Nippon Med. School, Sendagi, Bunkyo-ku, Tokyo 113

The erythrocyte membrane represents the more hyperpolarized potential at low temperature(previous data on newt:23.0±1.0mV at 0°C;while 16.2±0.4mV at 18°C,pH7.4). The membrane potentials of newt red cells were measured by microelectrodes at 0°C, changing pH of the external medium. In the alkaline solution, the potentials hyperpolarized more(26.4±1.2mV at pH 8.0), similarly at the room temperature. By the change in external potassium ions at 0°C, the membrane potential changed more evidently than the potential at 18°C. From these observations the following equation was proposed,

$$E = \frac{RT}{F} \ln \frac{P_{Cl}[Cl]_i + P_K[K]_o + P_H[H]_o}{P_{Cl}[Cl]_o + P_K[K]_i + P_H[H]_i}$$

The hyperpolarization at low temperature is explained as the flux of potassium, and the potential difference from the Nernst equation of chloride at low external Cl^- concentration(previously reported), as the flux of proton. The permeability ratio, P_{Cl}/P_K, is a function of temperature.

16, I D1145

INFLUENCE OF MAGNETIC FIELD ON ERYTHROCYTE FLOW.
OKAZAKI, M., MAEDA, N. and SHIGA, T. Dept. Physiol., Sch. Med., Ehime Univ., Ehime 791-02.

A narrow erythrocyte stream in a wide laminar buffer flow was drifted in parallel to the applied inhomogeneous magnetic field. The degree of the drift depended on the electronic state of hemoglobin inside the erythrocytes: i.e., no drift for oxy-Hb, a little for low spin CN-MetHb, and distinct for both deoxy-Hb and high spin MetHb, and was proportional to the square of the magnetic moment of erythrocytes. Also, the drift was proportional to the product, [magnetic flux density] x [magnetic field gradient], and to the reciprocal of the flow velocity. The above relations were quantitatively explained by considering the force working on a paramagnetic material in a magnetic field and the resistant force obeying the Stokes law.

The calculated drift for a single erythrocyte was, however, far smaller than the observed drift. Moreover, the drift increased when the hematocrit was increased. Therefore, the drift of "a volume" of erythrocyte mass with a larger diameter but with a smaller susceptibility, rather than that for a single erythrocyte, should be taken into account for the theoretical calculation.

The above phenomena suggest that the magnetic field might influence the venous blood flow of low velocity, if the inhomogeneous magnetic field is strong enough.

17, II P (47) 1330

^{1}H-NMR AND HIGH-PERFORMANCE LIQUID CHROMATOGRAPHIC (HPLC) STUDIES ON MODIFIED BOVINE PLASMA ALBUMIN (BPA*) FORMATION IN ACIDIC REGION.
FUJII, H., KUWATA, K., ERA, S., SUZUKI, E., SOGAMI, M. AND WATARI, H+. Dept. Physiol., Sch. Med., Gifu Univ., Gifu 500 and +Dept. Mol. Physiol., Natl. Inst. Physiol. Sci., Okazaki 444

Plasma albumin showed the N-F transition (pH 4.40-3.75) in acidic region. Bovine plasma albumin Fr. V (BPA) has been known to contain small amount of proteolytic enzyme. It was reported by Wilson & Foster (1971) that the enzyme catalyzes a very limited and specific cleavage of BPA between Gln-392 and Cys-435 in one or two portions, when BPA exists in the F-form near pH 3.8 and that the primary and secondary proteolytic products, BPA* and BPA**, have molecular weights of 66K and 63K, respectively. ^{1}H-NMR spectra of the mixture of BPA* and BPA** at pD 7.30 (0.87 %, 0.10 M Na^+) were quite similar to those of the F-form of proteolytic enzyme-free BPA (BMA) at pD 4.0. Though moving-boundary electrophoretic mobility of BMA in 0.03 M Na acetate, pH 4.8 was almost zero (the N-form), those of BPA* and BPA** were positive. Ion-exchange HPLC studies of the mixture of BPA or BMA, BPA* and BPA** on TSK SP-5PW at pH 5.0 showed the clear resolution of three components, indicating BPA* or BPA** being more positive than BPA or BMA at pH 5.0. ^{1}H-NMR spectra, moving-boundary electrophoretic mobility and ion-exchange HPLC profile might support that BPA* and BPA** seem to be in a conformational state quite similar to the F-form of BPA or BMA even at pH 4.8 ~ 7.5.

18, II P (48) 1330

HIGH-PERFORMANCE LIQUID CHROMATOGRAPHIC (HPLC) STUDIES ON MERCAPT – NONMERCAPT CONVERSION OF HUMAN SERUM ALBUMIN. SUZUKI, E+., ERA, S., KUWATA, K., KIDA, K., SHIGEMI, J., SOGAMI, M., MIURA, K+. AND SAWADA, S++. Dept. Physiol., +Dept. Int. Med., Sch. Med., Gifu Univ., Gifu 500 and ++Sawada Hospit., Gifu 500

Human serum albumin (HSA) is the mixture of mercaptalbumin (HMA) and nonmercaptalbumin (HNA). During HPLC studied on HSA using various kinds of HPLC columns, we found a covenient HPLC column, Asahipak GS-520, for the analysis of fractions of HMA and HNA. Resolution of HMA and HNA on GS-520 was not affected by bound lipid impurities, such as fatty acid. The mean value of HMA fraction ± standard deviation, $\bar{f}_{HMA}$ ± S.D., for 28 healthy male adults was 0.75 ± 0.028. $\bar{f}_{HMA}$ ± S.D. for 28 patients with chronic renal failure was 0.51 ± 0.096, indicating a significant increase in HNA content. In chronic hemodialysis (H.D.) patients, $\bar{f}_{HMA}$ ± S.D. before H.D. for 122 patients was 0.40 ± 0.093. After H.D. for 5 hours, mean value of [(f_{HMA} after H.D.) - (f_{HMA} before H.D.)] for 110 patients was 0.17 ± 0.054, indicating HNA → HMA conversion during H.D.. When increasing cystine concentration after H.D., HMA → HNA conversion might be accerelated. Values of $\bar{f}_{HMA}$ for various liver diseases, chronic rheumatoid arthritis and nephrotic syndrom were significantly lower than $\bar{f}_{HMA}$ of 0.75 for healthy male adults.

19, II P (49) 1130

COMPARATIVE ^{1}H-NMR STUDIES ON WATER STRUCTURE IN HEPATIC TISSUE AND PROTEIN SOL OR GEL STATES. ERA, S., KATO+, K., SUZUKI, E., KUWATA, K., TAKAHASHI+, M., SOGAMI, M. AND WATARI++, H. Dept. Physiol., +Dept. Pathol., Sch. Med., Gifu Univ., Gifu 500 and ++Dept. Mol. Physiol., Natl. Inst. Physiol. Sci., Okazaki 444

Cross relaxation times (T_{IS}) and longitudinal relaxation times (T_1) of water were obtained by f_2-irradiation at 7.13 ppm from TSP at $\gamma H_2/2\pi$ of 39 ~ 69 Hz, according to Akasaka's method (1981) and by the inversion recovery method, respectively, using 360 MHz ^{1}H-NMR spectrometer. Contaminated proteolytic enzyme in bovine plasma albumin Fr. V (BPA) catalyzes a very limited cleavage of BPA, when BPA exists in the F-form near pD 4.1. The primary and secondary proteolytic products, BPA* (MW ~ 66K) and BPA** (MW ~ 63K) have a tendency to form transparent gel (BPA*-gel) at pD 4.1 above 7 %, though enzyme-free BPA, that is, bovine mercaptalbumin (BMA) is transparent solution even at 12 %. T_1 and T_{IS} values of HDO in BPA*-gel (7.0 ~ 12.0 %) were far shorter than those in corresponding BMA solutions. T_1 and T_{IS} values of H_2O in normal rat liver were shorter than those in hepatocellular tumor (HEP-84) and regenerating rat liver, indicating the hydration of normal liver being strong and rapidly exchangeable with free water, that is, "gel-like".

20, II P (50) 1330

THE "FINE" AND "COARSE" FIBRIN GELS OBSERVED FROM H-NMR T_1 AND T_2 OF WATER PROTONS. TANAKA, Y., NAKAYA, S., YOSHIOKA, Y., HASEGAWA, H., KUROSAWA, N. and YAGI, S. Dept. Physiol. II, Schl. Med., Iwate Med. Univ., Morioka, Iwate, 020

According to Edsall et al. (1947), the fibrin gel formed from the fibrinogen solution under various conditions results in the transparent "fine" and the opaque "coarse" type. In this report using 10 g/l fibrinogen solution, these two types were examined on the relaxation time T_1 and T_2 of water protons using H-NMR spectroscope (Bruker's WP80SY-WG).

From the values of T_1 and T_2 after Kumosinski and Pessen's calculation, the "fine" made at higher pH near to 8.8 was much more hydrated by about 0.4 g of H_2O/g of fibrinogen than the "coarse" made at lower pH near to 6.8 was hydrated by about 0.3 g/g.

The gel made at constant pH=7.75 was the "fine" at higher concentration of NaCl near to 0.1 M and, on the other hand, the "coarse" at lower concentration near to 0.03 M. On these gels too, the H-NMR relaxation time T_1 and T_2 were examined.

21, II P (51) 1330

WATER PROPERTIES IN NARROW SPACE. YOSHIDA, A., ERA, S.+ AND SOGAMI, M.+ SANNO Inst. Busin. Adminst., Tokyo 158 and +Dept. Physiol., Sch. Med., Gifu Univ., Gifu 500

The water properties in narrow space are very different from those in bulk phase. Water in the fused glass plates narrower than 1 μm does not freeze even at -80°C and not evaporate rapidly in a vaccum. The water in small dimension, such as a fine neural fiber, will have more stable ordered structure than that in bulk phase. The important ions, being in the biological system, can be divided into two groups which have opposite effect to water structure. Na^+, Ca^{2+} and Mg^{2+} in one group are water structure-ordering ions, and K^+ and Cl^- in the other group are water structure-disordering ions. So, it can be speculated that all living cells exclude water structure-ordering ions and take up water structure-disordering ions in order to avoid to be formed water structure in the cell.

22, II P (52) 1330

CONFORMATION OF BRADYKININ. UYEDA,M.*,TANIFUJI,S. AND IWAI,T. *Dept. of Physiol., Sch. of Med.,Gifu Univ.,Gifu 500 and Dept. of Applied Physics,Fac. of Eng., Osaka City Univ.,Osaka 558

Bradykinin in solution are thought to exist in ordered structure at least in some parts from CD spectroscopy (Cann,1979; London,1979; Linter,1979). NMR spectroscopy deduced,however,unordered structure from the 'random coil' parameter of Wuethrich (Bundi & Wuethrich,1979) and relaxation parameters. We calculated conformation energy of random coil model compounds of Wuethrich (Gly-Gly-X-Ala) by empirical force field method and optomized main chain ϕ,ψdihedral angles by automatic grid search under restricted degree of freedom and deduced that the conformation of the compounds may be random for X=Gly but probably in ordered structure for X=Ile,Ser, Arg,Phe and Tyr. For the bradykinin we got sixteen different conformations within 4 kcal/mol from minimum energy and almost all conformation had a bend structure. The calculated CD spectra for obtained conformation by exciton approximation were agreed very well with experimental one. The calculated vicinal coupling constants $J_{NH\alpha}$ and $J_{\alpha\beta}$ from both obtained dihedral angles using Karplus type equation and self-consistent perterbation method (Pople,1968) agreed well with the experiment.

23, II P (53) 1330

AMOUNT OF SINGLET OXYGEN GENERATED FROM PORPHYRINS WITH DIFFERENT SIDE CHAINS. OHTANI, T., AIZAWA, K., SAKAI, H., O'HATA, S., UCHIMOTO, Y*., FUKUDA, Y*., YAMADA, M*. AND SAWADA, H*. Dept. of Physiol. Tokyo Medical College Shinjuku-ku Tokyo 160 * Hamari Chemicals LTD. Higashi yodogawa-ku Osaka-shi Osaka 533

Hematoporphyrin derivative (HpD) has become widely used as a tumor-specific photosensitizer in photodynamic therapy. This method is based on the accumulation of HpD in tumor and its photodynamic action which may be caused by generation of singlet oxygen. HpD is a mixture of porphyrins. We have already reported that HpD generated the singlet oxygen using luminol reaction. In this study, we measured the quantity of singlet oxygen from porphyrins by photoradiation. In result, we found that porphyrins with different side chains genarated the different amount of singlet oxygen by photoradiation and that a compound (HPDG) genarated 3 times amount of singlet oxygen. HPDG had diethylenglycol residue. Then we synthesized porphyrins which had mono, tri, tetra ethylenglycol residue. Amount of singlet oxygen summarized by following ordering : di > mono > tri > tetra ethylenglycol.

24, II P (54) 1330

TEMPERATURE DEPENDENCE ON THE AGGREGATION-DISAGGREGATION OF PHOSPHOLIPID LIPOSOMES

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Dept. of Physiol., Fac. of Hygienic Tech., Azabu Univ., Sagamihara, Kanagawa 229
*Dept. of Physics, Jikei Univ. Sch. of Med., Chofu, Tokyo 182
**Dept. of Physics, Showa Univ., Fujiyoshida, Yamanashi 403

We investigated the aggregation-disaggregation phenomena of synthetic phospholipid liposomes as a model of a cell aggregation. We observed the aggregation-disaggregation of synthetic dipalmitoyl phosphatidylcholine (DPPC) liposomes by means of optical microscopy.

The liposomes aggregated above the main phase transition temperature (the melting point of hydrocarbon chain ; Tc). Keeping the temperature above Tc, the assemblies of the aggregated liposomes increased in size. Decreasing the temperature, the assemblies suddenly disaggregated at Tc.

The transition temperature increases gradually with increasing Ca^{2+} concentration. The aggregation was also observed above Tc. However the disaggregation was not observed at high Ca^{2+} concentration.

The aggregation was not observed at low pH values. We also investigated the density dependence on aggregation

25, II P (55) 1330

DETERMINATION OF THE DIFFUSION RATE OF OXYGEN IN A HEMOGLOBIN SOLUTION.

HASHIMOTO, M., ISOMOTO, A., AND TYUMA, I. Dept. Physico-chemical Physiol., Osaka univ. Sch. Med., Osaka 530

We developed a system for determination of hemoglobin oxgen saturation.

The system was composed of microscope, TV camera, and microcomputer-aided color image processor. The image processing system represented the color image of objects by the values of R(red), G(green), and B(blue) brightness, and displayed their characteristic positions in the pattern space in which the coordinate axes were defined in terms of R, G, B brightness. The colors of hemoglobin solutions of various oxygen saturations were discriminated and analyzed by using this system.

The system was applied to estimating the diffusion rate of oxygen in a hemoglobin solution, and the kinetic behavior was investigated.

26, I C1345

INTRACELLULAR Na ACTIVITY AND Na TRANSPORT MECHANISMS OF THE MOUSE LACRIMAL GLAND ACINAR CELLS. SAITO, Y., OZAWA, T. and NISHIYAMA, A. Dept. of Physiol., Tohoku Univ. Sch. of Med., Sendai 980.

Intracellular Na activity (aNa_i) of the mouse lacrimal gland acini measured by double-barreled Na-selective microelectrode was 7 ± 1 mM in the resting state. Addition of ouabain (1 mM) immediately depolarized the membrane and gradually increased aNa_i. K-free Ringer also increased aNa_i level indicating that aNa_i is regulated by electrogenic Na/K pump. Acetylcholine (1 μM) increased aNa_i to 15 ± 1 mM in 5 min. The ACh-induced aNa_i increase was slightly inhibited by Cl-free Ringer, furosemide (1 mM) or bumetanide (0.5 mM) and inhibited by about 50 % with amiloride (0.1 mM) or harmaline (0.1 mM). Based on the present data we suggest that there are fractions of Na influx mediated by loop diuretics-sensitive Cl transport and Na-H exchange mechanisms across the basolateral membrane of the acinar cells.

27, I C1400

Na- AND K-DEPENDENT Cl ACCUMULATION BY THE LACRIMAL GLAND ACINAR CELLS AND EFFECTS OF FUROSEMIDE. OZAWA, T., SAITO, Y. and NISHIYAMA, A. 1st. Dept. of Physiol., Tohoku Univ. Sch. of Med., Sendai 980.

Using double-barreled Cl-selective microelectrodes, we have shown that the mouse lacrimal gland acinar cells accumulate Cl against the electrochemical potential gradient and addition of secretagogues decrease the intracellular Cl activity aCl_i (Pflügers Arch., 405 108, 1985). In the present study, we explored the mechanism responsible for the uphill Cl accumulation. Either K-free or Na-free Ringer perfusion decreased aCl_i toward the equilibrium activity and readmission of normal Ringer increased aCl_i toward the normal level. In the presence of 1 mM ouabain alternating application of K-free and high-K Ringer caused a decrease and an increase in aCl_i respectively. Furosemide (1 mM) hyperpolarized the membrane by a few mV, decreased aCl_i toward the level predicted for the passive distribution and inhibited the aCl_i changes induced by Na or K concentration changes of the perfusate. Present results suggested the participation of NaKCl cotransport mechanism at the basolateral membrane for uphill Cl accumulation by the mouse lacrimal gland acini.

28, I C1415

EFFECT OF PILOCARPINE ON THE Na,K-ATPase IN DOG SUBMANDIBULAR GLANDS. KOMABAYASHI, T., TSUBOI, M., IZAWA, T. AND KOSHIMIZU, E. Dept. Pharmacol., Tokyo Coll. Pharma., Tokyo 192-03

The Na,K-ATPase activity was dose-dependently increased by pilocarpine. The pilocarpine-stimulated Na,K-ATPase activity was inhibited by ouabain or the metabolic inhibitors. When Na in the medium was replaced with Li, the Na,K-ATPase activity was not increased by pilocarpine. Monensine, the Na ionophore, stimulated the Na,K-ATPase activity in a dose-dependent manner in the presence of extracellular Na. The dose required for the maximal response was 50 μM. The Monensine -induced Na,K-ATPase activity was enhanced in the presence of pilocarpine. NaF, which activates the accumulation of cyclic AMP, did not stimulate Na,K-ATPase activity. The effect of NaF was unchanged in the presence of IMX. In addition, dibutyryl cyclic AMP had little stimulant effect. A23187, the Ca ionophore, slightly stimulated the activity. These results suggest that the Na,K-ATPase activity in submandibular glands is related to the Na influx, but not to the cyclic AMP level in the cells.

29, I C1430

POTENTIATION OF α-ADRENERGIC AGONIST- OR CHOLINERGIC AGONIST-INDUCED KALLIKREIN RELEASE IN RAT SUBMANDIBULAR GLAND BY ISOPROTERENOL.
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Effect of α- and β-adrenergic agonists and muscarinic cholinergic agonists on kallikrein release was studied in the rat submandibular gland slices. The stimulation of kallikrein release by isoproterenol, phenylephrine and carbamylcholine was dose-dependent and the significant stimulation was observed at 1 μM isoproterenol, 10 μM phenylephrine and 10 μM carbamylcholine. The amount of kallikrein release by high dose of phenylephrine and carbamylcholine was much larger than that of isoproterenol. Synergism of the amount of kallikrein release was observed between isoproterenol and phenylephrine or carbamylcholine, whereas additive effect was obtained between phenylephrine and carbamylcholine.

Certain evidences exist that β-adrenergic agonist acts through an increase in intracellular cyclic AMP level, while α-adrenergic and cholinergic agonist operate through an increase in calcium level. Therefore, these results suggest that the two intracellular messengers, cyclic AMP and calcium, regulate kallikrein release by acting in concert.

30, I C1445

MODULATION OF ISOPROTERENOL-INDUCED TISSUE CYCLIC AMP ACCUMULATION IN RAT PAROTID SLICES BY α-ADRENERGIC AGONISTS.
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Previously we reported that α-adrenergic agonists such as phenylephrine and methoxamine augment the effect of isoproterenol on tissue cyclic AMP accumulation in the rat parotid slices (Yoshimura et al., J. Physiol. Soc. Japan. 46 ; 339 (1984). Methoxamine did not augment the forskolin- or isobutylmethylxanthine-induced tissue cyclic AMP accumulation. Omission of Ca^{++} in the medium almost completely abolished the effect of α-adrenergic agonists. These results suggest that the augmentation is caused by regulating the process leading to the activation of adenylate cyclase by β-adrenergic agonist and that it is mediated by an increased influx of Ca^{++} into the cell. In the presence of bicarbonate in the medium, on the other hand, α-adrenergic agonists inhibited the effect of 1 μM isoproterenol on tissue cyclic AMP accumulation. The significant inhibition was observed by 10 μM phenylephrine or 50 μM methoxamine and the complete inhibition was obtained by 100 μM phenylephrine or 500 μM methoxamine. Omission of Ca^{++} in the medium did not abolish the effect of phenylephrine. The inhibition was partly overcome by increasing the concentration of isoproterenol to 100 μM.

31, I C1500

IMPEDANCE ANALYSIS IN SALIVARY GRAND
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The impedance of salivalry gland was measured with YHP-4192A(5 Hz - 15M Hz) and YHP-4193A(400 KHz - 110 MHz). The salivary gland at rest or after stimulation without blood supply was isolated from a living body. And the measurement was performed with the probe which was decreased residual inductance in terminal leads. The conductance was differrent between resting and stimulated state among all frequencies (5 Hz - 110 MHz) and the limiting value at high-frequncy was not determind in the used frequencies. On the other hand, the permittivity was slightly differrent between both states and the limiting value of both states at high-frequncy(>100 M Hz) was almost same as that of water. In the present study we analyze these data based on dielectric theory of disperse systems.

32, I C1515

RELEASE OF SECRETIN - IMMUNOREACTIVITY FROM THE VASCULARLY PERFUSED SMALL INTESTINE OF GUINEA-PIG.

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Previous studies in anesthetized pig suggested that secretin - immunoreactivity (S-IR) is released by H^+ dependent and non-dependent process from S-cells (J.Physiol. Soc.Japan 47:374,1985). The present study was performed to examine if the release of S-IR could be demonstrated in an in vitro model. The experiments were performed on an isolated and vascularly perfused guinea-pig small intestine. S-IR into the venous effluate was measured. The small intestine rapidly absorbed luminally administered glucose. The intestine secreted S-IR rapidly in response to NaCl (150 mM, pH 1.5), tripsin inhibitor (100 mM, pH 6.2) and taurocholate (100 mM, pH 6.2), but not to K solution (60 mM). These results indicate that this model offers an unique oppotunity to study the stimulus-secretion coupling process of the S-cells.

33, I C1530

THE ROLE OF Na^+-K^+ PUMP ON SECRETORY AND REDOX RESPONSE IN THE ISOLATED PERFUSED RAT PANCREAS.

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The role of Na^+-K^+ pump on the stimulus-secretion coupling in the pancreatic acinar cell was studied by estimating influences of ouabain and low K^+ environment on both secretory and redox responses to continuous stimulation with CCK-8 in the isolated perfused rat pancreas. The secretory response to CCK-8 was abolished by 1mM ouabain or by K^+ removal. The redox response was not affected by ouabain but was inhibited by K^+ removal. Tissue [ATP]/[ADP] ratio was increasd after stimulation with CCK-8. On these results, it is concluded that Na^+-K^+ pump may play a role in the stimulus-secretion coupling in the pancreatic acinar cell and that CCK-8 induced cytochrome reduction may closely correlate with Na^+-K^+ pump activity, but may not be the direct indication of the activation of Na^+-K^+ pump. It is supposed that the pancreatic secretagogues act on the acinar cells to increase cytosolic Ca^{2+} concentration, and the increase in cytosolic Ca^{2+} concentration accerelates frequency of exocytosis and activates energy production in the mitochondria.

34, I C1545

INTRACELLULAR pH AND ITS REGULATION BY THE Na^+/H^+ ANTIPORT IN ISOLATED ENTEROCYTES FROM RABBIT.

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The Na^+/H^+ antiport is found in the plasma membranes of many cell types, and there is accumulating evidence for its presence in the brush border membrane of small intestine. However, most studies of intestinal brush border membrane Na^+/H^+ antiport have been performed in isolated membrane vesicles, and little is known about its mode of operation and role in intracellular pH regulation in intact enterocytes. In this study, by using a pH-sensitive fluolescence probe, 9-aminoacridine, we estimated intracellular pH (pHi) of isolated enterocytes from rabbit and examined the role of the Na^+/H^+ antiport in pH_i regulation. By the null-point method with digitonin, pH_i of the enterocytes was estimated to be 7.1-7.2 in the presence of extracellular Na^+, while in the absence of Na^+, it was in the range of 6.6-6.7. Pulse injection of Na^+ into a Na^+-free cell suspension induced a gradual intracellular alkalinization of which rate was found to be a saturable function of Na^+ concentration (Km 17 mM). Li^+ had the same effect as that of Na^+ while choline did not. Amiloride inhibited the effects of Na^+ dose-dependently. These results indicate that the Na^+/H^+ antiport is normally functioning in the intact enterocytes and playing a crucial role in the regulation of pH_i.

35, I C1600

EFFECT OF URSODEOXYCHOLATE (U) AND TAUROURSODEOXYCHOLATE (TU) ON THE TRANSPORT MAXIMUM (TM) OF SULFOBROMOPHTHALEIN IN THE RAT. KITANI, K. AND KANAI S. First Lab. Clin. Physiol. Tokyo Metropolitan Institute of Gerontology, 35-2, Sakaecho, Itabashiku, Tokyo

Intravenous infusion of various bile salts is known to increase the BSP Tm in various animal species. A recent report, however, has shown no effect of TU or U infusion but a dignificant enhancing effect of taurocholate infusion on the BSP Tm in hamsters (Delage et al. 1983). From these observations, they suggested that there exists a difference in the excretory mechanism between taurocholate and TU (or U). We examined effects of U and TU infusion on the BSP Tm in rats and found that both U and TU can significantly enhance a BSP Tm in the rat, suggesting that the proposal of Delage et al. cannot be generalized. In rats infused with U, the BSP Tm began to decline more rapidly than in rats infused with TU, while the bile flow remained at a higher level or even further increased. These results do not positively support the hypothesis proposed by Hofmann on the urso-induced choleresis (chole-hepatic recycling hypothesis).

36, I C1615

DISTRIBUTION OF THE INCREASE IN INTRACELLULAR Ca IONS AT FERTILIZATION OF HAMSTER EGGS: APPLICATION OF IMAGE INTENSIFICATION METHOD. [1)]MIYAZAKI, S., [2,3)]HASHIMOTO, N*, [4)]YOSHIMOTO, Y*, [2)]KISHIMOTO, T*, [1)]IGUSA, Y. AND [4,5)]HIRAMOTO, Y. [1)]Dept. Physiol., Jichi Med. Sch., Tochigi-ken, 329-04; Lab. [2)]Reprod. Biol. and [4)]Cell Prolif., Natl. Inst. for Basic Biol., Okazaki, 444; [3)]Dept. Zool., Fuc. Sci., Univ. of Tokyo, Tokyo, 113; [5)]Biol. Lab., Tokyo Inst. Technol., Tokyo, 152.

In golden hamster eggs the intracellular Ca ion concentration has been shown to increase periodically during fertilization, by means of the Ca-sensitive microelectrode. We examined the temporal and spatial distribution of the periodic Ca rise in a single egg, using a super-sensitive TV camera based on the image intensification method that enables the record of photon-limitted events. The Ca-dependent luminescent protein, aequorin, was injected into an unfertilized egg and a single sperm was applied on the certain point of the egg surface. The luminescence generated by intracellular Ca-aequorin reaction produced light spots on the TV scleen, which were processed in the attached computer. The analysis of the light spots revealed that, in the first 2 Ca-transients after insemination, the Ca rise starts near the site of sperm-egg fusion and spreads to the entire egg in several sec. The Ca transient ceases in 14-18 sec without any special distribution pattern. In the succeeding responses the Ca rise occurs synchronously in the entire egg within a second.

37, I C1630

NONSELECTIVE CATION CHANNEL IN SEA URCHIN EGGS (II). OBATA, S., KURODA, H. Sugashima Marine Biological Laboratory, Nagoya Univ., Toba, Mie 517

The fertilization potential of a sea urchin egg consists of two transient depolarizations, that is, a quick depolarization and the following slow depolarization. The peak value of the slow one depends on the permeabilities both of Na^+ and K^+. Ca^{++} ionophore, A23187, can induce a membrane potential change that is similar to the fertilization potential.

We examined the ionic mechanism of the slow depolarization in the membrane potential change induced by A23187. When $[Na^+]_o$ was reduced ($[K^+]_o$=10mM, $[Ca^{++}]_o$=10mM), the peak value of the slow one decreased with $[Na^+]_o$. In zero calcium sea waters (containing 2mM EGTA), the similar result was obtained. When $[K^+]_o$ was increased ($[Na^+]_o$=100mM), the peak value changed with $[K^+]_o$.

A23187 has been reported to transiently increase $[Ca^{++}]_i$ of sea urchin eggs (R. Steinhardt et al., Dev. Biol., 58, 185-196 (1977)). Consequently, our results suggest that the increase in $[Ca^{++}]_i$ induces the slow depolarization that depends on the permeabilities both of Na^+ and K^+ in the fertilization potential of a sea urchin egg.

38, I C1645

VOLTAGE CLAMP STUDY IN CYNOPS BLASTOMERE —— MEASUREMENT OF Na/K PUMP CURRENT.
OHARA, A., DOIDA, Y., MURAYAMA, K., MARUNAKA, Y. & KITASATO, H. Dept. Biol. and Dept. Physiol., Shiga Univ. Med. Sci., Ohtsu 520-21, Japan.

Membrane currents of eggs of Japanese newt, Cynops pyrrhogaster, were measured under voltage clamp. Eggs naked of jelly coat and vitelline membrane were impaled with two glass microelectrodes (resistance: about 5 MΩ) in a solution containing (in mM): 80 NaCl, 2 KCl, 1.4 $CaCl_2$, 20 choline-Cl, 2.4 HEPES (pH 8). Na/K pump current was estimated by subtracting the current recorded in the above solution added with 0.1 mM ouabain from the current under the same conditions but omitting ouabain. (1) I-V relationships were obtained from currents at 3 s after sudden potential displacement of various magnitudes from the holding potential of resting level (-70 ∿ -100 mV). Membrane resistance was 2 ∿ 4 MΩ in the absence of ouabain and 3 ∿ 6 MΩ in its presence. The difference of currents between in the absence and presence of ouabain was zero at -150 ∿ -160 mV, about 10 nA (outward) at holding potential and 12 ∿ 20 nA (outward) at 0 mV. (2) The effect of change in $[K^+]_o$ on membrane current recorded at the holding potential of resting level was studied. Osmolarity of solution was compensated by changing $choline^+$, other constituents being kept unchanged. In the absence of ouabain, currents were outwardly increased by a rise of $[K^+]_o$. The addition of ouabain to the solution brought about an inward flow of current in the presence of K^+.

39, II C0915

CYTOPLASMIC FREE Ca^{2+} IN EXOCYTOSIS OF MAST CELL GRANULES.
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In mast cells, treatment with sendai virus (HVJ) or bridging of IgE receptor molecules due to the reaction with antigen are reported to increase membrane permeability of Ca2+. More than 98 % pure rat mast cells were separated with a modified coil planet centrifuge. Mast cells were passively sensitized with rat reaginic sera or mouse monoclonal IgE antibody and stimulated with antigen, or they were stimulated with HVJ. Dynamic records with a time-lapse cinematography showed granule extrusion within two minutes, followed by the morphological recovery. Intracellular free Ca2+ of resting mast cells were measured with quin-2, and it ranged from 46 to 135 nM (mean, 87.5 nM). In stimulated cells, fluorescence intensity of quin-2(FQ) reached a maximum after 10 to 20 min, and then gradually declined to the resting level. While A23187 caused biphasic increase of FQ without decline, and morphologically induced the irreversible mast cell disruption. As a result, HVJ and antigen induce the simillar reversible responses due to transient opening of calcium gate, different from that induced by the ionophore.

40, II C 0930

MECHANISMS OF HISTAMINE RELEASE FROM RAT MAST CELLS BY CALCIUM REINTRODUCTION,
SORIMACHI, M., NISHIMURA, S. AND YAMAGAMI, K., Dept. physiol. Kagoshima Univ. Sch. Med. Kagoshima 890.

Introduction of Ca with simultaneous removal of Na caused histamine secretion from mast cells treated with Ca-free(EGTA) medium. This response was markedly diminished when the concentration of Na in the treatment medium was lowered in which Tris, choline or sucrose was substited for Na. Conversely, treatment with K-deprived medium or ouabain in the absence of Ca markedly potentiated the response. The extent of potentiation also depended on the concentration of Na involved in the treatment medium. These results suggest the existence of the reversed Na-Ca exchange mechanism. On the other hand, introduction of Ca with or without removal of Na caused secretion when Ca-free, Na-deficient medium was made with KCl, which concentration is higher than 50 mM. The concentration of Ca producing the maximal secretion was 1 and 0.1 mM, respectively, with and without the conventional concentration of Na, and increasing their concentrations caused the smaller responses. The inhibitory effect of 10 mM Ca was reversed by further treatment with a Na-containing medium, but not with Na-free medium, indicating that the secretion by the reversed Na-Ca exchange mechanism reappeared. These results indicate two different mechanisms for secretion by Ca.

41, II C 0945

Non-linear current-voltage relation in cultured mouse macrophage cell line (P388D1).
Takeo Maruyama. Dept. of Applied Physiol., Tohoku Univ., Sch. Med., Sendai 980.

The electrophysiological properties of cultured macrophage cell line (P388D1) were studied by intracellular recordings. By impalying the cell with a glass microelectrode, the membrane potential rapidly hyperpolarized at -67.6 mV in 4 mM Ca^{2+} solution. After the peak of hyperpolarization, the membrane potential quickly depolarized and stabilized at the steady state membrane potential of -19.7 mV. The membrane hyperpolarizing responses were suppressed by the Ca^{2+}-free 0.1 mM EGTA or 4 mM Co^{2+} solution. The membrane hyperpolarizing responses were evoked by iontophoretic injection of Ca^{2+} into the cell in Ca^{2+}-free 0.1 mM EGTA solution and were inhibited by 0.1 mM quinine solution. Intracellular applied current at the steady state membrane potential caused action potentials, followed by hyperpolarizing after-potentials in TTX solution. The current-voltage relations of cell membrane showed non-linear, S-shaped curves: in the range of -10 to 10 mM, and delayed rectification were seen; in the range of -100 to -130 mV, anomalus rectifications. The results indicate that P388D1 show the membrane hyperpolarizing responses which involve Ca^{2+}-dependent K^+ channels, and are capable of generating action potentials as results of permeability increase to Ca^{2+}.

42, II C 1000

HYPERPOLARIZING MEMBRANE POTENTIAL CHANGES IN A CLONED MONKEY KIDNEY CELL LINE (JTC-12). Hangil Chang, Naohide Yamashita and Kiyoshi Kurokawa*. Fourth Dept Int Med, Univ Tokyo Sch Med, Tokyo 112

JTC-12 cells are derived from normal monkey kidney which possess various properties characteristic to proximal tubule. The resting potential of JTC-12 cells was -17±5.0 mV and input resistance was 57±40 MΩ. Spontaneous hyperpolarization was observed in 18.8% of the cells. Mechanical stimulation to adjacent cells by another electrode evoked a large hyperpolarization. The input resistance was decreased during hyperpolarization and the obtained reversal potential fitted K electrode potential. Hyperpolarization could be elicited by intracellular injection of Ca or Sr ions. Intracellular injection of EGTA suppressed hyperpolarizations. Application of quinidine inhibited spontaneous and mechanically evoked hyperpolarizations. Therefore it was concluded that membrane hyperpolarization was caused by an increase in Ca-activated K cunductance. In Ca-free medium spontaneous hyperpolarization was abolished while mechanically evoked hyperpolarization was not. This result indicated that extracellular Ca ions are required for spontaneous hyperpolarizations. Under whole cell clamp spontaneous hyperpolarization was observed. Therefore it was concluded that membrane hyperpolarization in JTC-12 cells was not caused by a leak of Ca ions at the impalement of the electrode.

43, II C 1015

FIBROBLAST RESPONSES TO Clq-RECEPTOR STIMULATION. OIKI, S., OHNO-SHOSAKU, T., AND OKADA, Y. Dept. Physiol., Kyoto Univ. Sch. Med., Kyoto 606

In response to inflammation and tissue injury, the fibroblasts migrate to the site and proliferate therein. Studies by an agarose-well method showed that fibroblastic L cells migrated predominantly toward the concentration gradient of Clq. During the chemotaxis, the cells exhibited typical polarity in the cell shape. To examine whether the cells exhibit electrical polarity as well, the extracellular field around the migrating fibroblasts was measured using a vibrating probe. Appreciable currents were found to flow from the rear to the front of the migrating cells. Application of Clq to the cell vicinity induced a hyperpolarization associated with a significant decrease in input resistance. Desensitization of the responses after repeated Clq applications and abolishment of the responses by a proteolytic enzyme indicate an involvement of the receptors. Upon the stimulation of Clq-receptors, the intracellular free Ca^{2+} concentration (0.1-0.2 μM) was found to increase twice to threefold by means of Ca^{2+}-selective microelectrodes. The reversal potential of hyperpolarizing responses was close to the equilibrium potential to K^+. The response was inhibited by blockers of Ca^{2+} channels (nifedipine) and Ca^{2+}-activated K^+ channels (quinine). Therefore, it is concluded that the stimulation of Clq-receptors induces Ca^{2+} influxes and Ca^{2+}-activated K^+ currents by which the extracellular field is presumably brought about.

44, IIC 1030

CONTROL OF HOMEOSTASIS BY THE IMMUNOMODULATIVE AND TISSUE REGENERATION PROMOTING EFFECTS OF CAR AND HCAR. NAGAI, K. Dept. Physiol., Dent. Res. Center, Nihon Univ. Tokyo 101

Since substances that can influence immunomodulation and tissue regeneration have not be identified, homeostasis described by Cannon still remains a physiologic concept and the belief that acceleration of spontaneous healing is impossible is held as a major premise of medicine. We demonstrated that carnosine (CAR) and homocarnosine (HCAR) promote tissue regeneration and modulate immunological activities, and that these agents can consolidate homeostasis, which is an integrated process of these physiological functions. The effects of these agents on tissue regeneration was evaluated by examining granulation, and those on immunological activities by studying PFC. CAR and HCAR enhance the immunopotential. They increase the intensity of reaction to small amounts of SRBC but decrease it in the presence of excess amounts; they suppress hypersensitive reaction in immature mice but the enhance reaction diminished with age in those over 30 weeks old. The agents also increase immunological activities suppressed by γ-irradiation, 5-FU, MMC, cortisone, or the development of cancer, suggesting that they can be effective in the treatment of cancer and even AIDS. Our findings that CAR and HCAR regulate homeostasis suggest that inflammation is a relative condition mutually variable with the homeostatic potential.

45, IIC 1045

EFFECT OF PHORBOL ESTER TUMOR PROMOTER ON DYE-COUPLING BETWEEN MOUSE EPIDERMAL CELLS. KANNO, Y., SHIBA, Y. AND ENOMOTO, T. Dept. Physiol., Hiroshima Univ. Sch. Dent., Hiroshima 734

Phorbol ester tumor promoters, as represented by 12-O-tetradecanoylphorbol-13-acetate (TPA) have been demonstrated to promote the induction of tumor on mouse skin. However, the precise mechanism is not yet clear. In order to study possible involvement of altered cell communication in the process of tumor promotion on mouse skin, we investigated the effect of TPA on cell communication between primary cultured epidermal cells of mouse skin, using dye transfer method. Epidermal cells actively proliferated in low Ca^{2+} (0.08 mM) medium, whereas they differentiated into keratinized cells in normal Ca^{2+} (1.5mM) medium. When Lucifer Yellow CH dye was micro-injected into a cell, it was transferred to many proliferating or differentiating cells within a few minutes. When 10-100 ng/ml of TPA was added onto cells which were cultured in low Ca^{2+} medium, dye-coupling was completely inhibited 30 minute later and this inhibition was continued for at least 24 hours. Similarly, TPA induced the inhibition of dye-coupling between cells which were cultured for 2 to 12 hrs in normal Ca^{2+} medium. In contrast, TPA did not inhibit Ca^{2+}-induced differentiation of epidermal cells. These results seem to indicate that phorbol ester tumor promoter inhibits gap junctional cell communication of proliferating and presumably differentiating epidermal cells of mouse skin.

46, IIC 1100

EFFECTS OF COLLAGEN AND TUMOR PROMOTERS ON COLONY SHAPE AND GROWTH OF CULTURED EPITHELIAL CELLS. SHIBA, Y., SASTRODIHARDJO, S.*, SASAKI, Y. AND KANNO, Y. Dept. Physiol., Hiroshima Univ. Sch. Dent., Hiroshima, 734

The interaction between cells and extracellular matrix plays an important role in the regulation of cell shape and growth. Cytoskeletal organization is also a crucial factor for their control. Since collagen and tumor promoters are known to induce morphological change of cultured epithelial cells, their effects on cell shape, growth and actin organization have been investigated to clarify their action mode. Tumor promoting phorbol esters caused colony shape change, growth enhancement and actin disappearance in FL and MDCK cells, but not in KB cells. Type 1 collagen changed the colony shape and actin organization from filamentous to aggregation form in FL, MDCK and KB cells, but did not enhance cell growth. Actin organization of cultured fibroblastic cells, 3T3-A31, was altered by phorbol esters but not by type 1 collagen. These results indicate that type 1 collagen and tumor promoting phorbol esters act on colony shape through different mechanisms, resulting in different growth behavior.

47, II C 1115

INVOLVEMENT OF CYTOSKELETONS IN PROLIFERATION OF ADULT RAT HEPATOCYTES IN PRIMARY CULTURE. HASEGAWA, K., WATANABE, K. AND KOGA, M., Dept. Physiol., Dokkyo Univ. Sch. Med., Mibu, Tochigi 321-02.

Hepatocytes and other anchorage-dependent cells in cultures respond to hormones and growth factors by changing their cell shape prior to DNA synthesis and cell division. Such morphological alteration is caused in part by cytoskeletal changes. Therefore, we examined whether cytoskeletal changes are related to the induction of hepatocyte DNA synthesis in primary culture.

Colchicine and vinblastine inhibited DNA synthesis by 50 to 90% when added to the culture medium at 10^{-7} to 10^{-6} M. Lumicolchicine (a colchicine derivative that does not bind to microtubules), however, did not inhibit DNA synthesis at the same concentration as colchicine, indicating that colchicine inhibited DNA synthesis by disturbing microtubule polymerization. Cytochalasin B showed a similar inhibitory effect as colchicine in DNA synthesis. The most sensitive period to colchicine and vinblastine treatment was between 10 and 30 hours after plating. This period corresponds to middle to late prereplicative period, since the lag time before the onset of DNA synthesis is about 30 hours. These results suggest that polymerization of microtubules and microfilaments during the middle to late prereplicative period is necessary for the induction of DNA synthesis.

48, II C 1130

INTRACELLULAR DISTRIBUTION OF TISSUE-TYPE PLASMINOGEN ACTIVATOR IN A HUMAN MELANOMA CELL LINE (Bowes). SAKAI, T., OKADA, K., FUKAO, H., BANDO, H., UESHIMA, S., KIKUCHI, H. AND MATSUO, O. Dept. Physiol., Kinki. Univ. Sch. Med., Sayama, Osaka 589

The human melanoma cell line (Bowes) secretes tissue-type plasminogen activator (t-PA). However, the precise mechanism of t-PA secretion remains unclear. In the present study, the mechanism of t-PA secretion was investigated by methods involving subcellular fractionation and plasminogen acitvator (PA) activity assay. The cell homogenate was adjusted to a concentration of 1.4 M sucrose and centrifuged (100,000 x g, 3 h) as a layer of discontinuous sucrose gradient (2.0, 1.6, 1.4, 1.2 and 0.8 M). Subcellular membranous organelles were separated into four bands. The PA activity of the fractions was assayed using chromogenic substances (S-2251 and S-2288) and fibrin plate methods. A strong PA activity was observed in the lower two bands (rER and transitional region to Golgi complex), and a weaker PA activity in the lightest band (trans face of Golgi complex). Bioimmunological assay of PA revealed that such PA activity was related to antigenicity to anti-t-PA antibody. Electrophoretic enzymography also showed that the major PA activity band was observed at 72 kDa, and the minor band at 50 kDa. The present results suggest that t-PA has PA activity from a very early stage in the intracellular pathway, and t-PA is transported in the course of the Golgi complex as reported for other asparagine-linked glycoproteins.

49, II C 1145

ANALYSIS OF PLASMINOGEN ACTIVATOR IN SYNOVIAL FLUID. KIKUCHI,H.,UESHIMA,S.,FUKAO,H., OKADA,K.,BANDO,H.,SAKAI,T.,MATSUO,O. AND TANAKA,S.* Dept. Physiol. and Orthop.* Kinki Univ. Sch. Med., Sayama, Osaka 589

Plasminogen activator (PA) is one of the neutral protease which activates plasminogen and latent collagenase. In the present study, PA in the synovial fluid was extensively investigated as one of the possible enzymes involved in the pathogenesis of RA. Using enzymography for assaying the PA activity as well as its molecular basis, and the effect of urinary trypsin inhibitor (UTI) and β-methasone were also studied basically. Synovial fluid (SF) was obtained from patients with RA or osteoarthritis (OA). Modified euglobulin fraction of SF was used for the experiments. PA was measured by fibrin plate method and electrophoretic enzymography. The 19 out of 20 cases of RA showed a lysis area. On the other hand, only 2 out of 16 cases of OA. The difference in incidence of demonstrating PA between RA and OA was significant (R.A.Fisher:α=4.3 x 10^{-7}). The SF in RA contained PAs of three molecular weights: 90 K, 55 K and 33 K. In order to examine the immunological charactor of PA, antibodies of urokinase (UK) type PA and tissue type PA (t-PA) were reacted with the PA in RASF. The 90 K PA was t-PA and 55 K and 33 K PAs of the UK type. β-methasone suppressed the t-PA type PA, while UTI suppressed the UK type PAs. Since t-PA type PA has a high affinity for fibrin and digests fibrin effectively, UTI may provides a agent for the treatment of RA.

50, II C 1300

IN VITRO MORPHOGENESIS OF NORMAL AND NEOPLASTIC MAMMARY EPITHELIAL CELLS OF THE MOUSE.
ENAMI, J. and KOGA, M. Dept. of Physiol., Dokkyo Univ. Sch. of Med., Mibu, Tochigi 321-02

We have previously reported that collagen gel matrix culture was superior to conventional monolayer culture in inducing differentiation and long-term growth of mammary epithelial cells. The present study was undertaken to further establish a culture system which allows the in vitro morphogenesis of normal and neoplastic mammary epithelial cells. Freshly isolated mammary epithelial cells from SHN mice were embedded in collagen gels reconstituted from a 0.3% collagen solution (Cellmatrix I, Nitta Gelatine) and cultured in Dulbecco's modified Eagle's medium supplemented with 10% fetal bovine serum and insulin. Normal epithelial cells from young adult mice (10-12 weeks) initially grew rapidly to form outgrowths of thin strands. However, these cells died in 2-3 weeks and the structures disappeared. In contrast, epithelial cells from old mice (about one year) formed thick bundles and hollow ductal structures were occasionally seen. These structures were stable for longer than one month in culture. Mammary tumor cells grew as even thicker bundles or aggregates. These structures were stable and easily distinguishable from the above described structures. Thus, by using collagen gel matrix culture, it was possible to distinguish normal, neoplastic and probably pre-neoplastic mammary epithelial cells of the mouse.

51, II C 1315

STUDY ON DIFFERENTIATION AND MATURATION SYSTEM OF THYMIC LYMPHOCYTES IN STREPTOZOTOCIN -INDUCED DIABETIC RATS (2nd report).
OKIMOTO,T., HATO,F., TABATA,T*., TOYOKAWA,T., KIMURA,S., AND KINOSHITA,Y. Dept. of Physiol., and Dept. of Internal Med*., Osaka City Univ. Sch. Med., 1-4-54, Asahi-machi Abeno-ku Osaka 545.

The anomalous changes [reduction of thymus weight and the number of cortical lymphocytes, decrease in percentage of rosette forming cells (RFC), and increment of soybean lectin (SBL) responding cells] were detected in the thymus of streptozotocin (STZ) -induced diabetic rats. Pretreatment of the thymocytes with thymosin fraction 5 (TF5) significantly enhanced both RFC percentage and SBL response. Further, the response to SBL stimulation in the three subsets of thymus small lymphocytes was examined. The SBL response was higher in the least dense and intermediate subsets. TF5 treatment to the subsets induced the enhancement of the former and the reduction of the latter. The data presented here suggested that maturational impairment of thymocytes was induced by possible disorder of hormonal secretion from thymus epithelial cells and that the immigration of undifferentiated lymphoid cells and precursor T cells into the thymus abnormally increased in the STZ rats. To scrutinize the disorder, we examined the insulin reseptor which appeared to exist in the cortical lymphocytes. The study on the insulin receptor in the diabetic rat thymocytes would be useful to analyze those disorders.

52, II C 1330

SEPARATION OF THE THYMIC HORMONES FROM RAT THYMUS EPITHELIAL CELL CULTURE SUPERNATANT AND ASSAY OF THE BIOLOGICAL ACTIVITIES OF THE THYMIC HORMONES.
TOYOKAWA, T., OSHITANI, N., HATO, F., OKIMOTO, T., KIMURA, S., AND KINOSHITA, Y. Dept. Physiol., Osaka City Univ. Sch. Med., 1-4-54, Asahi-machi, Abeno-ku, Osaka, 545.

It is presumed that the thymic hormones (TH), secreted from the thymus epithelial cells (TEC) take part in the differentiation and maturation of T cell series. Several groups extracted the thymic hormonal products from whole thymus. In considering that the rate of TEC is only less than 1 % among whole nucleated cells in normal thymus, it will be very important to establish in vitro culture system of TEC. Several investigators tried to culture TEC and to assay the biological activities of the culture supernatant, however, few data were presented concerning with molecular properties of TH. Then, by culturing TEC of rats, the authors separated biologically active polypeptides ("X" and "C") from the culture-supernatant by high-performance liquid chromatography. And the observations were obtained that "X" (M.W.≒10,000) possessed a capacity to induce non -specific proliferation of early stage of precursor T cells (PTC) and "C" (M.W.≒3,000) had an activities to endow late stage of PTC with Con A-responsiveness and rosette -forming capacity. From these results, it was assumed that the polypeptides participated in the proliferation, differentiation and maturation of T cells in normal thymus.

53, II C 1345

The generation of field potentials recorded from the guinea pig olfactory cortical slice incubated under anoxia. Fujii, T. Kyoto Municipal Jr. College of Nursing, Higashi-takada, Mibu, Kyoto 604

The amplitude of field potentials evoked by electrical stimulation of lateral olfactory tract in guinea pig olfactory cortical slice (ca 400 μm thick) maintained in vitro at 37°C, began to decrease when the incubation gas of 95% O_2 was replaced with 95% N_2. But, the slice began to gain resistance to an anoxic condition (5-8 min), and then the potentials also tended not to decrease in amplitude after the repetition of anoxic condition two or three times. When the slice, gained the resistance against the anoxia, was incubated with the 95% N_2 at 28 C, the potentials decreased slightly in amplitude and kept their heights for more than 10 min. But, they diminished in amplitude and disappeared with the superfusion of medium containing no glucose and recovered with that of control solution. On the other hand, the redox-state of cytochromes (a, b and c) in mitochondria shifted to a reductive state level during the incubation period of anoxia. These findings led to the following results. 1. The anoxia-resistant potential was generated in the brain slice after the repetitive incubation of anoxia. 2. This potential was prominent when the slice was incubated at 28°C. 3. The generation of the potential was associated with the use of not oxygen, but glucose.

54, II C 1400

EFFECT OF CELL SURFACE IRREGULARITIES ON THE 'APPARENT' MEMBRANE CAPACITY AS DEDUCED FROM THE IMPEDANCE OF SPHERICAL CELL SUSPENSIONS.

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The capacity of cell membranes (C_m) has been claimed rather unequivocally to be of ~1 μF/cm². Indeed, C_m is believed to be one of the most readily accessible parameters among the cell-associated electrical properties such as relative permittivity and conductivity for the cell structural components. Based on a dielectric model for the suspension of spherical shells (shell diameter, D; volume fraction, ϕ), permittivity increment ($\Delta\varepsilon$) for a given suspension can be described as a function of C_m, D and ϕ, thereby enabling calculation of C_m from pertinent dielectric measurements. However, the calculation of C_m almost exclusively assumes a smooth membrane to cover the entire cell surface, taking little account of the effect of areal increases due to microvilli or rufflings. By applying a dielectric shell model we analyzed the impedance behavior of cultured spherical cells (RBL-1) whose volume was varied by osmotic perturbation. The cells exposed to 650 mosM had an apparent C_m(calculated from $\Delta\varepsilon$, ϕ and D) of 4-5 μF/cm² corresponding to their highly microvillous appearance; C_m decreased with decreasing osmolality down to 1.07 μF/cm² at 150 mosM where the cell surface appeared nearly smooth. These results suggest that the 'apparent' C_m may be utilized to assess the degree of plasma membrane infoldings.

55, II C 1415

EFFECT OF INTRACEREBROVENTRICULAR INFUSION OF THYROTROPIN RELEASING HORMONE ON REDOX CHANGE OF CYTOCHROMES AND ELECTRICAL ACTIVITY IN PERFUSED BULLFROG BRAIN.

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Redox state of cytochromes in the perfused bullfrog brain was continously measured with the aid of a scanning organ spectrophotometer and electrical activity was simultaneously recorded in the vicinity of the tip of light guide of the spectrophotometer. Intracerebroventricular (i.c.v.) infusion of thyrotropin releasing hormone(TRH) caused burst electrical activity in the optic tectum and cerebral hemisphere ranging over 1-1000pmol/100g body weight in a dose-related manner. I.c.v. infusion of TRH (1000pmol/100g body weight) induced parallel reduction of cytochrome a(a_3), b and c+c_1 with concomitant burst potential, but i.c.v. infusion of lower doses of ^{3}TRH (10,100 pmol/100g body weight) did not cause reduction of cytochromes in spite of evoking electrical activity in the optic tectum. I.c.v. infusion of all doses of TRH used at the present experiment induced no reduction response of cytochromes in the cerebral hemisphere. Parallel reduction of cytochromes induced by higher dose of TRH may be due to relative hypoxia during elevated activity of neuron and/or neuroglia.

56, II C 1430

The roles of calmodulin-binding proteins in rat brain development. Matsui, H., Itano, T., Doi, A., Hatase, O., Dept. of Physiol., Kagawa Med. Sch., Miki, Kagawa, 761-07

Calcium ion has important physiological roles in differentiation and development of nervous system. The roles of calcium ion is most, but not all, attributed to its intracellular receptor protein (calmodulin) and calmodulin-binding proteins.

Rat brain is not fully developed at birth, and the majority of synaptogenesis takes place postnatally. In rat cerebrum, the number of synapses markedly increases between 1 and 4 weeks postnatally, and so rat brain is a good model to study brain development.

We investigated the changes of calmodulin and calmodulin-binding proteins in rat brain development.

The calmodulin-binding proteins were purified from new born and adult rat forebrain with ultracentrifugation, DEAE (Diethylaminoethyl)-sephacel and calmodulin affinity column.

Three novel calmodulin-binding proteins were found, which increased in amount during rat brain development. Their molecular weight was 94K, 80K, and 32K on SDS-polyacrylamide gel electrophoresis,respectively. These proteins were phosphorylated by intrinsic kinases. The proteins were purified to their apparent homogeneity. We will discuss on the properties of these proteins.

57, II C 1445

Purification of calcium binding proteins from rat liver mitochondria and its physiological roles. Itano,T., Matsui,H., Doi,A., and Hatase,O. Dept. of Physiol. Kagawa Med. Sch., Kagawa, 761-07

It is well-accepted that Ca ion and Ca binding protein (CBP) mediate the hormonal and neuronal informations into cells. However, it is still not so clear which organelle regulate the intracellular Ca concentration. We have focused on one of the possible organelle, mitochondria (Mt), that transport Ca ion actively. In the present study, we identified and purified three CBPs in rat liver Mt which would have an important role to regulate Ca concentration.

Rat liver Mt was purified by Percoll gradient centrifugation method. Mt was lysed in hypotonic buffer and sonicated to prepare the matrix fraction(MX). Purification procedures were ammonium sulfate precipitation , DEAE-sephacel-, and high performance liquid- chromatography with TSK-gel 3000SW. The CBP from MX were purified as a single band on SDS-polyacrylamide gel electrophoresis(PAGE). Each CBP has molecular weight of 50K, 30K, and 20K on SDS-PAGE. CBPs were detected by special dye named stains-all and 45-Ca binding method. Rabbit Ig G against each CBP were prepared and used for immunohistochemical studies. These proteins were localized on the MX side of inner membrane. The observations were suggested that CBP had some physiological roles for the transport or storage of calcium ions in mitochondria.

58, II C 1500

NMR STUDIES ON CREATINE KINASE REACTION IN MUSCLE.

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^{31}P NMR spectra of resting smooth muscle of bullfrog stomach showed the signals of phosphocreatine (PCr, 4.8 $\mu mol \cdot g^{-1}$ wet weight), ATP (3.6) inorganic phosphate, phosphomonoesters, and phosphodiesters. Intracellular pH was 7.3. ^{1}H NMR spectra showed the signals of lactate, total creatine (6.6), methyl protons of cholines. PCr and ATP decreased together under anaerobic conditions, and intracellular acidification was observed with the increase in lactate.

^{31}P saturation transfer study showed that saturation of γ-ATP resonance reduced the PCr intensity to 62 % of its control value, and the measured T_1 values of PCr was 2.4 s in the presence of the saturation. The calculated forward flux of the creatine kinase reaction (the direction of PCr hydrolysis) was 770 $nmol \cdot g^{-1} \cdot s^{-1}$. Oxygen consumption rate was 65.4 $nmol \cdot g^{-1} \cdot min^{-1}$. From this value, the ATP synthesis rate was calculated to be 6.54 $nmol \cdot g^{-1} \cdot s^{-1}$ with the assumption of P/O = 3. The creatine kinase flux was 100 times larger than the ATP turnover rate. In conclusion, the creatine kinase reaction is at equilibrium in resting smooth muscle of bullfrog stomach.

59, ⅢP(6)0900

AMINO ACID REQUIREMENT FOR PROLIFERATION OF RAT HEPATOCYTES IN PRIMARY CULTURE.
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We have previously reported that the serum-free Koga's medium L (Biochem. Biophys. Res. Commun. 1982, 104, 259-265) and HEM (3rd Inter. Cell Cult. Congress, 1985, p. 49) supplemented with fibronectin, EGF, insulin, corticosterone and T_3 stimulated the proliferation of adult rat hepatocytes in primary culture. The cell number increased to more than twice the initial number in 3 days.

Because of the central role of the liver in amino acid metabolism, we decided to investigate the effect of amino acids on growth of rat hepatocytes. Medium containing 8 essential amino acids was sufficient to allow survival of hepatocytes. With the addition of arg (or orn), his and pro to this medium, the cells were able to proliferate. When any one of these amino acids was omitted or the concentrations of all the amino acid were lowered, the cells did not proliferate. Moreover, addition of asn and gly further promoted the proliferation of the cells. This combination of 13 amino acids stimulated the growth nearly the same as Koga's medium L. Hepatocytes consumed asn, gly and pro remarkablly. But comsumption of branched-chain amino acids were very little. It is concluded that availability of certain amino acids plays an important role in the control of hepatocytes proliferation.

60, ⅢP(7)0900

Ca DEPENDENCE OF SERUM FACTOR IN THE PRIMARY CULTURE OF ORAL EPITHELIAL CELLS.
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Rabbit's oral epithelial cells were cultured in modified MCDB 152 with various Ca concentrations. Falcon's 24-well type "Primaria" dishes were used without any feeder layers. After 5 to 8 days of culture, the materials on the bottom surface of the wells were fixed and stained with May Grünwald and Giemsa solution, and the numbers of colony were counted by invert microscope. Some serum fractions were obtained by the mixing with Chelex 100 resin(Bio-Rad Lab.) at several pH. The result of preliminary experiment indicated that the colony numbers were markedly down in culture containing dialysed or chelated serum as comparing with original FBS.

This suggested a growth factor(s) might be lost in the treated sera.

Then, we tried to extract this from FBS using Chelex and gained an acid fraction as F2 which promoted the colony formation. Correlation between colony numbers and Ca contents in the medium with F2 or FBS was compared.

Here-by, colony numbers were increased by Ca with dose dependence in the F2 containing culture, but not in FBS, and F2 at 2-4mg/ml was significantly enhanced the colony numbers than that of FBS at the same Ca contents.

61, ⅢP(8)0900

ROLE OF PLASMIN INHIBITORS ON ATTACHMENT AND SPREADING OF ADULT RAT HEPATOCYTES IN SERUM-FREE PRIMARY CULTURE.
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We have previously reported that fibronectin was necessary for attachment and spreading of hepatocytes in serum-free culture. We have also reported that plasmin inhibitors were necessary because hepatocytes produced plasmin which inhibited continued spreading of themselves. In this study, we examined the possibility that plasmin inhibits continued spreading by degrading the following three materials; 1) fibronectin, 2) materials originally present on the surface of freshly isolated hepatocytes, 3) materials synthesized after the cells are placed in culture. Treatment of fibronectin with plasmin did not affect attachment and spreading of hepatocytes. Treatment of freshly isolated hepatocytes with plasmin also did not affect attachment and spreading. In our preliminary experiments, addition of cycloheximide (1 uM) to the medium inhibited spreading after 10 hours of plating even in the presence of plasmin inhibitors, although it did not inhibit initial attachment and spreading. It is suggested that newly synthesized materials may not be required for initial attachment and spreading, but may be important for continued spreading. Further studies concerning this are currently under investigation

62, III P (9) 0900

THE EFFECT OF VIGOROUS EXERCISE TRAINING ON CHOLESTEROL METABOLISM IN RATS.

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Twenty-eight male Wistar rats, aged 7 weeks, were subjected to a vigorous exercise regimen of running for 5 weeks and 35 rats acted as their control. After 5 weeks both exercised and control rats were injected 2μCi of ^{14}C-mevalonate per 100g body weight into peritoneal cavities and sequentially sacrificed at 20, 40, 60, 80, 100, 120, and 180 min after the injection. The exercised rats showed a significantly lower level of liver, serum, and aorta total cholesterol than the control rats. The incorporation of mevalonate into liver cholesterol and serum lipoprotein cholesterol (especially HDL fraction) in the exercised rats were significantly higher compared with these of the control. Furthermore, the exercised rats showed a higher rate of cholesterol biosynthesis activity in liver. From these results it was concluded that the hepatic lipoprotein cholesterol production was elevated by exercise compared with that of control.

63, III P (10) 0900

WHOLE-CELL CONDUCTANCE AND SINGLE POTASSIUM CHANNELS IN ISOLATED MOUSE FIBROBLASTS

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The whole-cell patch-electrode technique can offer not only a better method of recording from small cells, thanks to tight glass-to-membrane seals, but also a direct way of evaluating the current leakage through the seals (Hosoi & Slayman, 1985, J.Physiol. 367;267-290). Steady-state current voltage curves were generated before and after rupture of the membrane patch; the difference between these gave leak-corrected current-voltage relationships of isolated mouse fibroblast membrane. Single channel recordings in cell-attached and excised-patch modes revealed two classes of channels. Small channels have conductance of 20-30 pS, K^+ selectivity and inward rectification. Detailed analysis indicates that the present channels show striking similarites to the K^+ inward rectifier of cardiac cells (Sakman & Trube, 1984, J. Physiol. 347:641-657; Kameyama et al., 1983, Jap. J. Physiol. 33:1039-1056). This suggests that a common (genetically?) category of channels is the main component responsible for maintaining resting potential in animal cells. Conspicuous large channels have conductances up to 300 pS, which probably corresponds to the Ca^{2+}-activated K^+ conductance observed in the whole-cell recordings.

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65, III P (12) 0900

MECHANISM OF POTASSIUM UPTAKE INDUCED BY ISOPROTERENOL AND ACETYLCHOLINE IN SUBMAXILLARY GLAND OF RAT AND MOUSE.

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In previous studies on superfused submaxillary gland(SMG), acetylcholine(ACh) induced a K^+ release followed by a K^+ re-uptake, while isoproterenol(Iso) evoked only K^+ uptake. This K^+ uptake was blocked by ouabain. The present study was undertaken to provide further evidence for the mechanism of K^+ uptake evoked by Iso and ACh stimulation. 1) Replacement of Cl^- by NO_3^- or SO_4^{--}, but not Br^-, markedly reduced Iso-evoked K^+ uptake. Additionally, furosemide(Furo) severely suppressed the K^+ uptake. The K^+ uptake was blocked by a low Na^+. 2) In mouse, ACh-evoked re-uptake, but not release, of K^+ was blocked by a low Na^+ and a Cl^--free NO_3^-, SO_4^{--}, isethionate but not Br^-. Furo inhibited K^+ uptake. 3) In rat, ACh-evoked K^+ re-uptake was blocked by Cl^--free SO_4^{--}. But replacement of Cl^- by NO_3^-, isethionate or Br^- caused little effect on K^+ re-uptake. The K^+ re-uptake was markedly reduced by amiloride and by a low Na^+. The evidence presented above indicates that a Na-K-Cl cotransporter operates in SMG acinar cells and has an important role to play in Iso- and ACh-evoked K^+ uptake. In rat, however, other Na^+ influx mechanisms in addition to a Na-K-Cl cotransporter may link ACh-evoked K^+re-uptake.

66, III P (13) 0900

Ca^{2+}- AND VOLTAGE- ACTIVATED K^+ CHANNEL IN APICAL CELL MEMBRANE OF GALLBLADDER EPITHELIUM.

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The presence of Ca^{2+}- and voltage-activated K^+-channels was demonstrated in the apical cell membrane of gallbladder epithelium by patch-clamp single-channel current recording. The patch-clamp technique was directly applied to the apical membrane of untreated epithelia. In K^+-depolarized epithelial cells, stepwise depolarization of the membrane induced voltage-dependent outward current steps when the patch pipette was filled with a Na^+-rich solution. The current steps were not affected by the presence or absence of Cl^-. When a K^+-rich solution was in the pipette and K^+-depolarized cells were examined, the i/v-relations were linear against membrane potential and the reversal potential was 0 mV. Under such conditions, the single-channel conductance was 140 pS. In excised inside-out patch-membranes, raising free Ca^{2+} concentration of the medium (inner side of the membrane) from 10^{-7} to 10^{-6} M caused a marked increase in open probability of the channels. This suggests that intracellular Ca^{2+} plays, as a second messenger, a crucial role in regulation of the membrane potential by modulating the high-conductance apical K^+-channels in gallbladder epithelial cells.

67, III P (14) 0900

ROLE OF Na^+-K^+ PUMP IN SECRETION IN HYPERTROPHIED PANCREAS OF THE RAT.

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A synthetic protease inhibitor(FOY-305) was administered orally once a day for 21 days.This procedure caused a significant hypertrophy of rat pancreas.Basal level of fluid secretion in isolated perfused preparation of hypertrophied pancreas was about ten times as high as that in the preparation of normal pancreas.Maximum fluid secretion was evoked by stimulation with 100pM CCK-8,whereas maximum protein output was induced by stimulation with 300pM CCK-8.Either basal level of fluid secretion or fluid secretion and protein output induced by 100pM CCK-8 were reduced by lowering Na^+or K^+concentration and by addition of 1mM ouabain to the solution perfusing the hypertrophied pancreas. When the hypertrophied pancreas was perfused with a solution containing 2.8mM K^+or 1mM ouabain,parallelism between fluid secretion and protein output induced by 100pM CCK-8 was lost.These results show that Na^+-K^+ pump activity plays an important role in maintaining basal level of fluid secretion and in both fluid secretion and protein output induced by CCK-8 in perfused preparation of hypertrophied pancreas,the mechanism of fluid secretion can be dissociated from that of protein output.

68, III P (15) 0900

ELECTRON PROBE X-RAY MICROANALYSIS OF GUINEA PIG COLON EPITHELIUM.

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It has been reported that there are four ion transport systems in guinea pig colon epithelial cells:1--- Cl^-ion secreting system, 2--- K^+ ion secreting system, 3--- H^+ion secreting system, 4--Na^+ion absorbing system. Electron microscope studies showed that the distal colon epithelial cells were divided into two parts: one was the crypt part and the other was the surface part. Many Goblet cells were found in the crypt part and it was suggested that the cells secreted mucin, ions and water into the crypt lumen by the exocytotic mechanisms of secretory granules in the apical portion of the cells. The surface cells had much prosperous microvilli which were positive for ATPase cytochemistry. The epithelium dissected out from guinea pig colon was set up in Ussing type chamber and short circuit currents were measured in various conditions(Forskolin, Bumetanide, Oubain treated). After that, the specimens were frozen and X-ray microanalysis of frozen sections was performed.

69, III P (16) 0900

EFFECTS OF DIDS ON THE SECRETION OF POSTERIOR SILK GLAND CELLS. NAKAGAKI, I. AND SASAKI, S. Dept. of Physiol., Osaka Med. Coll., Takatsuki, Osaka 569, Japan.

The effects of DIDS on the membrane potential and elemental distribution of posterior silk gland cells were investigated using microelectrode technique and X-ray microanalysis of freshly frozen ultra thin sections.

The average basolateral membrane potential was -47 mV and the glands exhibited lumen negative voltage in normal glands. Flimsy cocoon mutant silkworms missed the function of fibroin secretion and revealed a large accumulation of fibroin globules in the apical cytoplasm, and the voltage of the lumen was more positive than that of normal glands. The X-ray spectra over the cytoplasm and glandular lumen of normal glands showed the higher Ca and Cl peaks, and lower K peak than those of flimsy cocoon mutant.

Application of DIDS (2×10^{-3} M) caused the depolarization of the luminal membrane potential of normal glands. However, there was no effects on membrane potential of flimsy cocoon mutant.

With DIDS treatment, Cl concentrations increased in the cytoplasm and decreased in the lumen.

These results suggest that anion blockers such as DIDS inhibit the Cl transport from the cytoplasm into the lumen of silk gland.

70, III P (17) 0900

DIELECTRIC DISPERSION OF CULTURED EPITHELIAL MONOLAYERS FORMED ON A TUBULAR SUPPORT. ASAMI, K. and IRIMAJIRI, A. Dept. Physiol., Kochi Medical School, Nankoku, Kochi 781-51

The Madin-Darby canine kidney (MDCK) cells were monolayer-cultured on a cross-linked gelatin substrate of a thin, tubular form of 1-2 mm in diameter and 0.1-0.3 mm in thickness. By plating the cells either on one side of the tubing or on both sides, the selective formation of the following three types of tubular epithelial systems was feasible: (1) external monolayer, (2) lumenal monolayer and (3) external/lumenal double-monolayers. All these types are expected to serve as an in vitro macro-model of the tubular epithelial tissues. For the purpose of elucidating their electrical anatomy we subjected these models to a rapid impedance analysis covering a frequency range 10Hz-10MHz. The single-monolayers (i.e. types 1 and 2) perfused with a physiological saline showed dielectric dispersions having a dielectric increment ($\Delta\varepsilon$) of 10^5-10^6 and a characteristic frequency (f_c) of 10 kHz, when the impedance was measured with the monolayered tubing interposed between a pair of parallel-plate electrodes. With the double-monolayer system (i.e. type 3), on the other hand, the overall impedance characteristics were simulated by a superposition of two sub-dispersions in which $\Delta\varepsilon_1 = 10^5$-$10^6$, $f_{c1} = 1$-5 kHz, $\Delta\varepsilon_2 = 10^4$-$10^5$ and $f_{c2} =$ 30-50 kHz. These dispersions were analyzed by a theory of cylindrical cell-layers.

71, III P (18) 0900

REGULATION OF GLUCAGON SECRETION IN GLUCAGON-PRODUCING TUMOR CELLS (ITC-1). SAKAI, S., HASHIGUCHI, M., SAITO, H., KANAZAWA, M.[1], TOSAKA, T. AND O'HATA, S. Dept. Physiol. and Int. Med.[1], Tokyo Med. Coll., Shinjuku-ku, Tokyo 160

We have established a glucagon-producing tumor cell line (ITC-1) by subcutaneous inoculation of insulinoma (In 111) cells to Syrian hamsters. ITC-1 cells were grown as monolayers in RPMI-1640 medium. To investigate the regulation mechanism of glucagon secretion in ITC-1 cells, the several factors known to affect glucagon secretion of A cells were examined. ITC-1 cells were incubated with the substances to be tested in RPMI-1640 medium or Hanks solution at 37°C for 5 hrs. Immunoreactive glucagon (IRG) in the medium was assayed with C-terminal antibody (OAL 123). Insulin (20 mU/ml) and somatostatin (SS 14, 1 nM) induced 50% and 60% decrease in IRG secretion, respectively. Veratridine (1-100 μM) increased significantly IRG secretion. This increase was inhibited by 100 nM tetrodotoxin. High K Hanks solution (40 mM, 60 mM KCl) induced 191% increase in IRG secretion. This increase was abolished by 1 μM verapamil or OCa. IRG secretion appeared to require both extracellular Ca ion and inward Ca transport. Arginine (1.2 mM-20 mM) stimulated the IRG secretion, however, glucose (0-400 mg/dl) did not suppress it. Adrenaline and acetylcholine (10 nM-100 μM) exhibited relatively poor response. These results suggested that endocrine regulation was predominant compared with nervous control in ITC-1 cells.

72, II C 1630

EFFECTS OF L-ALANINE ON WATER TRANSPORT ACROSS THE SEAWATER EEL INTESTINE. ANDO, M. Lab. of Physiol., Fac. Integrated Arts & Sci., Hiroshima Univ., Hiroshima 730

By using a newly-developed perfusion system, effects of L-alanine on net water flux and transepithelial potential difference (PD) across the seawater eel intestine were examined. Addition of 5 mM L-alanine into the mucosal fluid increased both the net water flux from mucosa to serosa and the serosa-negative PD, after latent periods of 20 -30 min for net water flux and about 10 min for PD, whereas the effects of serosal alanine were not so pronounced as those of mucosal alanine. During the latent period, however, a slight depolarization of PD was observed immediately after application of alanine to the mucosal fluid, indicating existence of Na^+-alanine cotransport system. Similar depolarization was also evoked by D-glucose, L-valine or L-glycine. Since the net water flux does not increase during these depolarizing phases, it is unlikely that water transport links directly to Na^+-alanine cotransport. After inhibiting Na^+-K^+-Cl^- transport by application of 0.01 mM furosemide to the mucosal fluid, 5 mM L-alanine induced the initial depolarization of PD but no enhancement in the serosa-negative PD and net water flux, indicating closely-linked relationship between Na^+-K^+-Cl^- and water transport. After removing furosemide by rinsing with alanine-free Ringer solution, the serosa-negative PD and net water flux increased in proportion to the duration of pre-treatment with 5 mM L-alanine.

73, II C 1645

INHIBITORY EFFECTS OF CAPTPRIL, A CONVERTING ENZYME INHIBITOR, ON VASOPRESSIN-STIMULATED WATER FLOW IN THE TOAD BLADDER. Fumiaki Marumo and Yoshihiro Nara, Department of Medicine, Kitasato University, Sagamihara 228

Interactions between captpril, which is a converting enzyme inhibitor as same as a kininase II inhibitor, and vasopressin(Vp), a hormone which induces osmotic water flow in bladder of the toad, Bufo bufo japonicus, were examined. In addition, enhancing effects of angiotensin I(A-I) on Vp-stimulated water flow were studied. Captpril inhibited Vp-stimulated water flow. Bradykinin from a mucosal solution, inhibited the water flow. Captpril enhanced the inhibitory effects of bradykinin. It is thus evident that captpril inhibits the water flow by suppressing the kininase II activity of the toad bladder, and PGE_2 inhibits Vp action in case of captpril. However, captpril still inhibited the water flow after pre-treatment with indomethacin. Thus captpril has a direct effect on the adenylate cyclase cyclic AMP system in the toad bladder.

A-I enhanced the Vp-stimulated water flow, but A-II did not. After being preincubated with A-II, A-I failed to have any stimulatory effect on the water flow. A-I significantly enhanced Vp-stimulated cyclic AMP content in bladder mucosal cells. These results indicate that A-I enhances Vp-stimulated water flow by increasing cyclic AMP production in bladder cells and that A-II may possibly interfere with A-I in a competitive manner.

74, II C 1700

IMPEDANCE ANALYSIS OF FLUID TRANSPORT IN SALIVARY GLAND

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The salivary gland secretes massive amount of fluid with nervous stimulation. During secretion, the decrease in extracellular fluid (ECF) has been observed. Impedance method is useful for monitoring the changes in ECF, because the tissue conductances at low frequency were related to ECF volume.

In present study, the impedances of dog submandibular gland was measured continuously using YHP 4192A LF Impedance Analyzer. The measured frequencies were 5kHz, 500kHz, 5MHz and the measured period was 10 sec. The measurement was performed during the resting and stimulated state with or without blood supply. During stimulation with blood supply, the conductances decreased rapidly and stayed at low level in contrast to the resting level. When the stimulation was stopped, the conductance was recovered to the resting level. Furthermore, during stimulation without blood supply, the conductances of submandibular gland were lower than those with blood supply. The changes of submandibular gland conductance and the salivary secretion rate were comparable.

75, IIIC 0915

INTERCELLULAR JUNCTIONS AND SHORT CIRCUIT CURRENT IN FROG SKIN.
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Abdominal skins of Rana japonica were punctured successively with fine tip microelectrodes from the epithelial side and measured epithelial cell potentials ($PD_{o,sc}$) in addition to transepithelial potential difference (PD_{tr}) in open circuit condition (o.c.c.) or short circuit current (I_{sc}) in short circuit condition (s.c.c.) in chloride Ringer. In o.c.c., PD_o became negative with respect to the outer bathing solution after penetration of the first high resistance barrier, but varied from -20 to -65 mV even in the same skin despite relative high voltage divider ratio (0.5-0.7). Occasional breakdown of punctured cell led PD_o to less negative value (about -10 mV), which seemed to be intercellular space potential (PD_j), not equal to PD_{tr}. After second high resistance barrier penetration, recorded potential jumped to nearly equal value of PD_{tr}. In s.c.c., PD_{sc} values became some tens of mV more negative than in o.c.c., varied within 5 mV in the cells between two high resistance barriers with relative high fractional resistance (fR_o=0.5-0.7), but PD_j remained unchanged (about -10 to -20 mV). The results coincide with our previous dye coupling method data and suggest that I_{sc} lets epithelial cells more negative and gives favorable conditions in cell coupling.

76, IIIC 0930

EFFECT OF TETRODOTOXIN ON THE RESPONSE OF SHORT-CIRCUIT CURRENT ACROSS RAT COLONIC MUCOSA TO PROPIONATE. TAKAJI YAJIMA and HIROMI HIJIKATA.* Physiology Group, Yakult Central Institute for Microbiological Research, 1796 Yaho, Kunitachi, Tokyo.

The mucosal Na-propionate (ED50=0.06mM) induced biphasic responses of short-circuit current (s.c.c.), transmural potential difference and Cl transport across rat colonic mucosa (Yajima & Hijikata, J. Physiol. Soc. Japan 47, 391, 1985). In the present study, we examined the contribution of the enteric nerve system in the s.c.c. response to propionate by the comparison of responses in (a) MC preparation consisting of the mucosa, muscularis mucosae, the submucosa tissue and the circular muscle and (b) M preparation consisting of the mucosa and muscularis mucosae. The MC preparation responded to the serosal 1,1-dimethyl-4-phenylpiperazinium (DMPP) to increase the s.c.c., that was abolished by serosal tetorodotoxin (TTX). The M preparation did not respond to serosal DMPP, indicating the absence of submucosa nerve plexus.

Mucosal propionate produced the biphasic s.c.c. responses in both the preparations. The serosal TTX reduced the increase in s.c.c. by propionate by about 60% in the MC preparation, but not in the M preparation. On the other hand, mucosal lidocaine reduced the s.c.c. response of both the preparations by about 80%. These results suggest that both neural and non neural mechanisms are involved in the response of s.c.c. across rat colonic mucosa to the mucosal propionate.

77, IIIC 0945

Cl^- CHANNEL IN THE SECRETORY MECHANISM OF GASTRIC ACID ASANO, S.* AND TAKEGUCHI, N. Faculty of Pharmaceut. Sci., Toyama Med. & Pharmaceu. University, Toyama, 930-01

H,K-ATPase is a gastric H^+ pump and resides in tubulovesicles in resting parietal cells. Recently, we have shown that S-S cross-linking of H,K-ATPase increases Cl^- conductance of tubulovesicles, suggesting that the vesicles have closed Cl^- conductance. Here, S-S cross-linking by CuP, a S-S cross-linking agent, increased $^{36}Cl/Cl$ exchange, but did not affect $^{86}Rb/Rb$ exchange across hog gastric vesicles. Gastric vesicles with opened Cl^- conductance could take up H^+ upon addition of MgATP without prolonged preincubation in a solution containing K^+. Preincubation of gastric vesicles with picoprazole, which is a specific inhibitor of H,K-ATPase and binds to 100 k Da polypeptides of the enzyme, dose-dependently inhibited opening of the Cl^- conductance by CuP, indicating that the Cl^- conductance is part of the function of the H,K-ATPase. Another H,K-ATPase inhibitor, SCH 28080 also inhibited the opening of the Cl^- conductance by CuP. Our recent findings suggest that anion conductance is due to the presence of a specific channel and that inhibitory sites of H,K-ATPase activity, Cl^- channel and K^+ conductance by substituted benzimidazoles have similar "triplet" structures.

78, ⅢC 1000

MICROELECTRODE STUDY ON pH GRADIENT ACROSS GASTRIC MUCUS GEL AND INTRACELLULAR pH OF SURFACE EPITHELIAL CELLS. MASAKI,H., MORIMOTO,Y., KOTERA,K., FUJIMOTO,M. AND SATAKE,N., Dept. of Physiol., Osaka Med. Coll., Takatsuki, Osaka 569

Using double-barreled pH microelectrode, intracellular pH (pH_i) and apical cell membrane potential (E_M) were simultaneously and continuously monitored in surface epithelial cells of the bullfrog gastric mucosa mounted on a modified Ussing chamber. At luminal pH 6.0, pH_i was 7.41, E_M was -30.4 mV, cell negative to mucosal solution, and transepithelial potential (E_t) was -49.3 mV, serosal reference. Decrease of luminal pH from 6.01 to 1.80 produced a pH_i fall from 7.50 to 7.01, E_M hyperpolarization from -27.0 to -34.9 mV and E_t depolarization from 52.8 to 48.0 mV. Pretreatment of amiloride (10^{-4}M) in luminal solution did not inhibit pH_i fall when HCl (20mM) was added to luminal soultion. After adding amiloride to serosal solution at luminal pH 1.8, pH_i was gradually decreased. Normal interfacial pH of luminal bulk solution and mucus gel (LMI) was 6.46, whereas that of mucus gel and epithelium (MEI) was 6.02. LMI and MEI fell to 5.90 and 4.41, respectively, after histamine administration, and to 4.74 and 5.63 by luminal acidification with 0.5 mM HCl. We concluded that 1) pH_i was affected by the pH of luminal fluid, 2) Na^+-H^+ exchange mechanism sensitive to amiloride might exist in the basolateral membrane, 3) the luminal pH can affect the mucus gel pH gradient and histamine also alters it.

79, ⅢC 1015

THE EFFECT OF CYCLIC NUCLEOTIDE ON ION TRANSPORT IN TUBULAR CELLS OF BULLFROG KIDNEY. HAGIWARA,N., FUJIMOTO,M., INOUE,A., ABE,H. AND MATSUMURA,Y. Dept. Physiol., Osaka Med. College, Takatsuki, Osaka 569

Double-barrel K^+ selective microelectrodes were used to study the effect of dibutyryl-cyclic AMP (dbcAMP) on tubular ion transport mechanism in doubly-perfused bullfrog proximal tubules. The peritubular membrane potential (E_M) and intracellular K^+ activity ($(K)_i$) were monitored continuously after peritubular application of dbcAMP (10^{-3}M). 1) In control, dbcAMP hyperpolarized E_M by about 8 mV with an increase of $(K)_i$ by 4 mEq/L. 2) In low Na (0.5 mM) luminal perfusion, the hyperpolarization was immediately suppressed to about 3 mV, followed by a depolarization by several mV later. 3) Addition of 10^{-3}M amiloride to the luminal fluid, E_M was hyperpolarized by a few mV without appreciable changes of $(K)_i$. 4) With 10^{-5}M ouabain in the peritubular perfusate, dbcAMP-induced hyperpolarization was gradually abolished.

Thus, it was demonstrated that hyperpolarization was diminished by the procedures reducing the cellular entry of Na from the lumen and the blockade of Na extrusion to the interstitium. Amiloride could partially offset the dbcAMP-induced hyperpolarization, indicating that hyperpolarization after dbcAMP and amiloride would be common in effect.

80, ⅢC 1030

NETWORK-THERMODYNAMIC ANALYSIS OF ELECTRO-KINETIC PHENOMENA IN EPITHELIA MIYAMOTO,M., SOHMA,Y., TAKEUCHI,T. AND IMAI,Y. Dept. of Physiol. Osaka Medical College, Takatsuki, 569

Electro-kinetic phenomena in the membrane transport system are assumed to be the power coupling processes from the network-thermodynamics. Streaming potential is a power transducing process from hydraulic to electric powers. Electro-osmosis is a power transducing process from electric to hydraulic powers via ionic transport processes.

Using the modified Ussing chamber without any chemical potential, osmotic pressure and hydrostatic pressure differences, we observed the synchronous volume flow oscillation due to the menbrane potential oscillation. The phase relations of electro-kinetic phenomena on the frog skin and tongue mucosa were the same as the cation exchange membrane, but that of the gastric mucosa was reversed and was the same as that of the anion exchange membrane. But these behaviours could be changed by the pH of solution, ionic contents and drugs. This dependency may be explained by the electric charge and pore size in aqueous channels. We can estimate the role of electro-kinetic phenomena in epithelial transport.

81, ⅢC 1045

COTRANSPORT OF D-GLUCOSE AND H^+ BY INTESTINAL BRUSH BORDER MEMBRANE SUGAR CARRIERS UNDER Na^+-FREE CONDITIONS. HOSHI, T., TAKUWA, N. AND TAJIMA, A. Dept. of Physiol., Faculty of Med., Univ. of Tokyo, Tokyo 113

Phlorisin-sensitive Na^+-dependent D-glucose transport across intestinal and renal brush border membranes is almost completely suppressed by Na^+-replacement. In the absence of Na^+, however, D-glucose transport is stimulated by imposing or increasing transmembrane potential (Hilden and Sacktor, 1982). To clarify the mechanism of Na^+-independent voltage-dependent glucose transport, the role of H^+ was examined in both brush border membrane vesicles from rabbit intestine and isolated everted toad intestine. Vesicular uptake of D-glucose under Na^+-free conditions was found to be stimulated by imposing a pH gradient across the membranes (inside pH > outside pH), and the stimulation was abolished by 10 μM FCCP. No stimulation was observed for L-glucose under similar experimental conditions. In isolated toad intestine, the glucose-evoked potential (ΔV_G) was trivial in Na^+-free media of pH 7.4, while lowering medium pH resulted in a marked increase of amplitude of ΔV_G. Such Na^+-independent ΔV_G's were saturable, conforming to Michaelis-Menten kinetics, and sensitive to phlorizin. Dipeptides, which are cotransported only with H^+, induced similar pH-sensitive evoked potentials, indicating that D-glucose is cotransported with H^+ under Na^+-free conditions.

82, ⅢC 1100

REGULATION OF CA-ATPase IN BASOLATERAL MEMBRANE OF RAT KIDNEY CORTEX. TSUKAMOTO, T. Dept. Medicine, Kitasato Univ. Sch. Med, 1-15-1 Kitasato, Sagamihara, Kanagawa 228

In the kidney, more than 60% of the filtered Ca is reabsorbed in the prexysmal tubules. Ca enters into the tubular cell through the brushborder membrane by the passive process. However, Ca is driven out of the cell against electrochemical gradient through the basolateral membrane (BLM). ATP dependent Ca transport has been reported as one of the mechanisms of this Ca transport. In order to elucidate the cellular mechanism of this transport, Ca dependent ATPase activity was characterized in the BLM of rat kidney cortex and the regulation of this enzyme activities were studied. As a result, both high (Km = 172 nM free Ca) and low (25 μM free Ca) affinity Ca dependent ATPase activities were found in the BLM. Maximum activities were achieved when the assay mixture did not contain Mg. The enzyme activities were stimulated by the $1,25(OH)_2D_3$ repletion in the BLM of vitamin D deficient rats. The enzyme activities were also found depressed in the thyroparathyroidectomized rats on 2nd and 7th day of the surgery. In conclusion, PTH and $1,25(OH)_2D_3$ has a stimulatory effect on the Ca-dependent ATPase activities in the BLM of rat kidney cortex.

83, ⅢC 1115

BIOSYNTHESIS, PROCESSING AND LOCALIZATION OF (NA^+, K^+)ATPASE IN RAT KIDNEY. AKAYAMA, M., YAMAMOTO, A., NAKADA, H., MASAKI, R., OMORI, K. AND TASHIRO, Y. Dept. Physiol., Kansai Med. Univ. Moriguchi 570

Holo(Na^+, K^+)ATPase was purified from rat renal outer medulla and the antiserum was raised in rabbits. The monospecificity was tested by Ouchterlony's double immunodiffusion, inhibition assay and Western blotting analysis. Rat kidney microsomes were fractionated by sucrose density gradient centrifugation (0.8-1.4 M) to the ER and Golgi rich fractions. On SDS-PAGE blot, the molecular masses of α-subunits in both fractions were the same (95 Kd), while those of β-subunits were 50 Kd (ER) and 54 Kd (Golgi), respectively. By endo H treatment, the 50 Kd component was converted to 37 Kd, while the 54 Kd component did not change. These results suggest that the β-subunit 37 Kd in polypeptide chain, is cotranslationally glycosylated in ER (50 Kd), and then is converted to the mature complex type (54 Kd) in Golgi. Immunoelectron microscopic analyses indicated that the ATPase was distributed at high concentration over the basolateral plasma membranes but at a lower concentration over the luminal surface of the renal convoluted tubules, in agreement with the results of Kyte.

84, ⅢC 1130

IMMUNOELECTRON MICROSCOPIC LOCALIZATION OF (NA^+, K^+)ATPASE IN THE RAT PAROTID GLAND. IWANO, T., YAMAMOTO, A., AKAYAMA, M., OMORI, K., KUMAZAWA, T. AND TASHIRO, Y. Dept. of Physiol., and Otorhinolaryngol, Kansai Med. Univ. Moriguchi 570

Rat parotid glands were fixed by perfusion with 4% paraformaldehyde and embedded in Lowicryl K4M or LR Gold. The ultrathin sections were incubated with the antibody against the holo(Na^+, K^+)ATPase purified from rat kidney (Akayama et al. 1986), subsequently with protein A gold complex and observed under an electron microscope. In the acinar cells, the gold particles were found not only over the basolateral plasme membrane surface but also over the luminal counterpart. The particle density on the former, however, was much higher than on the latter. In the striated duct cells the ATPase was more numerous than in the acinar cells and more predominantly distributed over the basolateral membranes than over the luminal ones. In the parotid glandular cells (Na^+, K^+)ATPase thus exists bilaterally as in canine hepatocytes (Takemura et al. J. Cell Biol., 99,1502 (1984).

85, ⅢC 1145

IMMUNOELECTRON MICROSCOPIC LOCALIZATION OF (NA^+, K^+)ATPASE IN THE RAT EXOCRINE PANCREATIC CELLS. TANAKA, K., YAMAMOTO, A., AKAYAMA, M., OMORI, K., AND TASHIRO, Y. Dept. Physiol. Kansai Med. Univ. Moriguchi 570

Rat pancreases were fixed by perfusion with 4% paraformaldehyde and embedded in Lowicryl K4M or LR Gold. The ultrathin sections were incubated with the antibody against the holo(Na^+, K^+)ATPase purified from rat kidney (Akayama et al. 1986), subsequently with protein A gold complex and observed under an electron microscope. In the acinar cells, the gold particles were found both over the luminal and basolateral surfaces. Surprisingly, however, the particle density over the luminal plasma membrane surface was higher than that over the basolateral counterpart. In the duct cells similar results were obtained. Thus bilateral distribution of the ATPase was also found in the exocrine pancreatic cells as well as in the parotide gladular cells and hepatocytes. The ATPase on the luminal surface may be responsible for the water flow accompanied with the pancreatic secretion.

86, ⅢC 1300

RELATION OF Na^+,K^+-ATPase ACTIVITY TO SALIVARY SECRETION IN RAT SUBMANDIBULAR GLAND. NEMOTO, A., SUGITA, K. AND UEHA, T. Dept. Oral Physiol., Josai Dent. Univ., Sakado, Saitama 350-02

We have investigated the relation of Na^+,K^+-ATPase activity to salivary secretion in rat submandibular gland by means of the measurement of salivary flow rates and concentrations of electrolytes in the saliva. The Na^+,K^+-ATPase activities in the submandibular glands were also examined biochemically and histochemically. The methods of partial perfusion and intraductal injection were used to administer the three inhibitors (ouabain, ethacrynic acid and furosemide) to the gland. The following results were obtained. 1. Na^+,K^+-ATPase enzyme systems of the rat submandibular gland were inhibited by ouabain, ethactynic acid and furosemide respectively. Particularly, the inhibitory effect of ouabain was remarkable among these inhibitors. 2. It was assumed that there were inward sodium transport mechanisms inhibited by ethacrynic acid and furosemide at the basal portion of the acinar cells, this mechanisms were not concerned with Na^+,K^+-ATPase enzyme systems. 3. The functional mechanisms of the Na^+,K^+-ATPase enzyme systems at the luminal membranes were significantly weak as compared with the systems of basal portion.

87, ⅢC 1315

EFFECTS OF ANTI α-SUBUNIT ANTISERUM AND VARIOUS INHIBITORS ON Na^+,K^+-ATPase FROM DIFFERENT TISSUES.
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It is well accepted that Na^+,K^+-ATPase is classified into two isoforms; the kidney type which plays a role of ion transport, and the brain type which maintains the membrane potential of the excitable membranes.

In the present study, we investigated the effect of various inhibitors (ouabain, vanadate (V) and several diuretic drugs) on the three Na^+,K^+-ATPase purified from the submandibular gland (SMG), kidney and brain. Although the molecular weights of catalitic subunits of Na^+,K^+-ATPases from the three tissues were all similar, there observed some difference in their kinetic parameters. The Ki values of ouabain for the SMG and kidney enzymes were similar (approximately 10^{-4}M) but were different from the brain value (3.00×10^{-6}M). We will also report the effects of the antibody rised for α-subunit of the SMG Na^+,K^+-ATPase on the enzymes from other two origins.

88, ⅢC 1330

THE DEPENDENCE OF INSULIN-STIMULATED Na EFFLUX ON THE INTERNAL Na CONCENTRATION
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Insulin(250mu/ml) causes a shift of the Na efflux vs. Na_i curve toward the region of lower Na_i concentrations in frog sartorius muscles. To determine whether the shift of the Na efflux vs. Na_i curve is due to a rise in the affinity to Na_i of Na/K transport systems already functioning, the dependency of Na efflux newly developed by insulin on the internal Na concentration in ouabain-pretreated muscles was examined, taking advantage of the property that in a ouabain-free solution insulin stimulates Na efflux even from muscles whoes K_o-sensitive Na efflux has been completely suppressed by ouabain. The insulin-stimulated Na efflux vs. Na_i curve in ouabain-pretreated muscles was located on the left of the ouabain-sensitive Na efflux vs. Na_i curve in intact control muscles. The magnitude of the insulin-stimulated Na efflux from ouabain-pretreated muscles coincided with the difference in magnitude between insulin-stimulated and control Na effluxes in ouabain-nontreated muscles at any concentrations of Na_i. The stimulating effect of insulin was completely blocked by Monensin(10^{-6}M), whereas both Actinomycin D (10^{-6}M) and chloroquine(5×10^{-5}M) had no effect on the effect of insulin. These findings support the view that insulin stimulates an incorporation of Na/K transport systems, whoes affinity to Na_i is high, to plasma membrane from intracellular stores.

89, ⅢC 1345

EFFECTS OF THE EXTERNAL K CONCENTRATION ON THE INSULIN-STIMULATED Na/K TRANSPORT IN FROG SKELETAL MUSCLES.
MARUNAKA, Y., KITASATO, H. AND MURAYAMA, K. Department of Physiology, Shiga University of Medical Science, Ohtsu, 520-21 Japan.

Insulin hyperpolarizes the membrane of frog skeletal muscles by activating the Na,K-pump, which is stimulated by the external K. The purpose of this study is to observe the insulin-induced hyperpolarization at various concentrations of external K.

Insulin hyperpolarized the membrane by 5, 4, 1 and 1 mV at the external K concentrations of 1, 2, 5 and 10 mM, respectively. On the one hand, the insulin-induced increase in the Na efflux was stimulated about 2-fold by a rise of the external K concentration (1-10 mM). Though the rise of the external K concentration stimulated the insulin-induced increase in the Na efflux about 2-fold, the rise of the external K concentration decreased the magnitude of the insulin-induced hyperpolarization 1/5-fold. One of the reasons for this phenomenon was a decrease in the specific membrane resistance (3/5-fold) with the rise of the external K concentration. However, the decrease in the magnitude of the insulin-induced hyperpolarization could not be explained only by the decrease in the specific membrane resistance. The observations in this study indicate that the rise of the external K concentration decreases the electrogenicity of the insulin-stimulated Na,K-pump. This is the main reason for the decrease in the magnitude of the insulin-induced hyperpolarization.

90, ⅢC 1400

EFFECT OF CELLULAR REDOX STATE ON OUABAIN-SENSITIVE RB^+ INFLUX INTO HELA CELLS. IKEHARA,T.,YAMAGUCHI,H.,HOSOKAWA,K.AND MIYAMOTO,H. Dept. Physiol., Sch. Med., Univ. Tokushima, Tokushima 770

Ouabain-sensitive Rb^+ influx into HeLa cells was measured in the presence of an artificial electron mediator, phenazine methosulfate (PMS), to examin the effect of cellular redox state on Na^+,K^+-pump activity. PMS stimulated the active Rb^+ influx and this stimulation was independent of the intracellular ATP or Na^+ contents. Cellular respiration was stimulated but glycolysis was inhibited by the dye, resulting in an extreme reduction in the NADH content even when certain respiratory inhibitor such as rotenone or NaCN was present. Ouabain-sensitive Rb^+ influx increased in the presence of 50 μM PMS was decreased to the control level on addition of 10 mM ascorbate. Also, the influx increased maximally in the presence of 5 mM ascorbate plus 10 μM PMS was decreased to the normal level when the PMS concentration increased to 100 μM. These results are discussed as relating to changes in the cellular redox state, which were brought about by PMS-mediated flux of reducing equivalents.

91, ⅢC 1415

^{31}P-NMR STUDY IN ISOLATED PERFUSED PANCREAS OF RAT. MATSUMOTO, T.+, MURAKAMI, M., SEO, Y., WATARI, H. & KANNO, T.+ Dept. Molecular Physiol., Natl. Inst. Pysiol. Sci., Okazaki 444 and +Dept. Physiol., Fac. Vet. Med., Hokkaido Univ., Sapporo 060

The present study was undertaken using phosphorus nuclear magnetic resonance (^{31}P-NMR) to investigate the kinetics of phosphorus energy metabolites in the isolated perfused pancreas of rat. The gland was perfused with a modified Krebs-Henseleit solution (25°C). The resonance peaks from creatine phosphate, ATP, inorganic phosphate, sugar phosphates were identified. At resting, the resonance peak of creatine phosphate (PCr) was detected in 6 perfused gland out of 21. The resonance of ATP was observed in all glands, kept unchanged for two hours. By cessation of perfusion, the levels of ATP and PCr decreased, while ADP and inorganic phosphate (Pi) increased. The resonance peak of Pi was shifted to the higher magnetic field, indicating a tissue acidification. Thereafter reopening the perfusion, the tissue contents of phosphorus compounds and pH recovered to their resting levels. A continuous stimulation by 0.1 umol/l acetylcholine caused marked increases in pancreatic juice flow and protein output and the levels sustained. The tissue levels of phosphorus energy metabolites kept unchanged during stimulation. The tissue pH was slightly decreased (0.05 pH unit) during secretion.

92, ⅢC 1430

RING MUSCLE CONTRACTILITY OF SMALL INTESTINE.
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A role of small intestine that its function is digestive,absorbent,osmotic and contractile still alive is an old one. Potential difference of the transmural membrane which was removed from small intestine,conductivity from the incubated solution for records of the absorbtion and movement of longitudinal-circular muscle for observation of the contraction were recorded simultaneously in this study. Two types of normal tube and everted sac from small intestine and simulated membrane of visking tube were prepared in the experiment. The PD of the normal tube was changed gradually during 20 min or more and less than 1 mV of amplitude. The PD patterns were different from that of an everted sac. The contractile mechanogram was divided into 6 patterns from the normal condition at a root of mesentery. All of the motilities from an everted sac were always shown forming with a rectangular wave having spike bursts for a curvature of the everted circular muscle and the PD from the everted sac was changed transiently and unstable electrically for a dose response. Because the PD activated together when the simulated tube and normal tube were broken open with pin-cett. What did we catch in a PD of small intestinal everted sac? The PD was not more than 10mV and can be estimated by formula of streaming potential dependent on the Zeta potential of mucoscal side and osmotic pressure. The surface negative charges of about 1000 were measured from purified brush border membrane of small intestine in our previous paper.

93, I P (45) 1330

^{31}P-NMR STUDY IN ISOLATED PERFUSED SALIVARY GLAND OF RAT. MURAKAMI, M., SEO, Y., WATARI, H. & MATSUMOTO, T.+, Dept. Molecular Physiol., Natl. Inst. Physiol. Sci., Okazaki 444 and +Dept. Physiol., Fac. Vet. Med., Hokkaido Univ., Sapporo, 060

The present study was undertaken using phosphorus nuclear magnetic resonance (^{31}P-NMR) to investigate the kinetics of phosphorus energy metabolites in the isolated perfused mandibular gland of rat. At resting, 7 resonance peaks were identified to; 1) sugar phosphates (SP) and AMP, 2) inorganic phosphate (Pi), 3) creatine phosphate (PCr), 4) ATP and ADP, 5) ATP, ADP, NAD and NADH, 6) unknown peak, and 7) ATP. By reopening of the perfusion, the phosphorus compounds and pH recovered to their resting levels. The secretory flow rate was dependent on concentration of acetylcholine (ACh; 1 umol/l was optimal). By 1 umol/l of ACh, PCr and ATP decreased hand in hand, and Pi increased, but SP unchanged. The high dose (1 mmol/l) of ACh decreased PCr strongly at the initial phase, following with a moderate recovery of PCr. By this dose, ATP kept decreasing during stimulation. The Pi showed a drastic increase to 2-3 times, and also SP increased. The present results proved a Lohmann reaction system in the mandibular gland of the rat and suggests a barrier between the ATP utilizing system (ATPase) and the Lohmann reaction system (creatine phosphokinase) in the acinar cell of the mandibular gland.

94, I P (46) 1330

^{23}NA-NMR STUDY OF INTRACELLULAR NA IN ISOLATED PERFUSED SALIVARY GLAND OF RAT. SEO, Y., MURAKAMI,M., MATSUMOTO, T., WATARI, H. & NISHIKAWA, H.+ Dept. Molecular Physiol., Natl. Inst. Physiol. Sci., Okazaki 444, and +Dept. Physiol., Kyoto Pref. Univ. Med., Kyoto 602.

With the onset of secretion by acetylcholine (ACh) in salivary gland, it is believed that Na-Cl entry across basolateral membrane increased thus secretion and that the Na gradient across the basolateral membrane is maintained by the increased activity of the Na/K ATPase. In vivo NMR methods have enabled us to measure phosphorus energy metabolites. The present study was undertaken using sodium nuclear magnetic resonance (^{23}Na-NMR) to measure intra- and extra-cellular Na in the isolated perfused mandibular of rat. The intra- and extra-cellular Na were discriminated by use of the chemical shift reagent, Dy(TTHA)^{3}Na (dysprosium triethylenetetramine-N,N,N',N'',N''',N'''-hexaacetic acid). During control perfusion, the intracellular Na was estimated as 3-5 mmol/l ICF. During secretion by 1 mmol/l of acetylcholine (ACh) for 30 min, intracellular Na increased up to about 15 mmol/l ICF. During perfusion only with ouabain (0.1 mmol/l), Na_{in} almost unchanged, but the Na_{in} increased drastically during perfusion with ouabain and ACh.

95, I P (47) 1330

PREREQUISITE ROLE OF K^+ CHANNEL ACTIVATION AND Ca^{2+} MOBILIZATION IN ACID SECRETION BY CULTURED GASTRIC PARIETAL CELLS. UEDA, S. AND OKADA, Y. Dept. Physiol. Kyoto Univ. Sch. Med., Kyoto 606

Stimulation-secretion coupling in the parietal cells was studied using the monolayer epithelial cells in the organ culture of fragmented gastric fundus of newborn rats. Microelectrode studies showed that the cells exhibit hyperpolarizations upon the receptor-mediated stimulation by carbachol, gastrin or histamine (plus isobutylmethylxanthine). The hyperpolarizing responses were inhibited by inhibitors of Ca^{2+}-activated K^+ channel (quinine and TEA). By photometric fluorescence microscopy, changes in the intracellular Ca^{2+} concentration were monitored in the quin 2-loaded cells. The quin 2 fluorescence was found to increase in response to these secretagogues. Electrophysiological studies with EGTA, caffeine and mitochondrial inhibitors suggested that the receptor stimulation mobilizes Ca^{2+} from both extracellular and intracellular pools. Acridine Orange (AO), an optical probe of H^+ accumulation, was taken up preferentially by the parietal cells, exhibiting orange fluorescence within the cells, in the presence of secretagogues. The AO fluorescence was markedly diminished by removal of extracellular Ca^{2+} or by the application of quinine. Thus, it is concluded that not only Ca^{2+} mobilization but the operation of Ca^{2+} activated K^+ channels play prerequisite roles in acid secretion by parietal cells in response to gastric acid secretagogues.

96, I P (48) 1330

CIRCUIT MODEL OF ACTIVE TRANSPORT SYSTEM AND MEMBRANE POTENTIAL.
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Circuit model of membrane transport system deduced from the network thermodynamics gives us not only an explanation of membrane transport phenomena but also new foresights on their beheivior. We had reported last year that the model of electro-kinetic phenomena gave us a forsights of experimental studies on the electro-osmosis and streaming potential. In this meeting, we report the circuit model of membrane transport system including active transport, which explaines the electrogenisity due to active ion pump. We also report experimental results of membrane potential on the epithelia.

97, I P (49) 1330

INTESTINAL Na/SUGAR COTRANSPORT CHARACTERIZED USING A VOLTAGE-SENSITIVE DYE: AN ASSESSMENT OF CONTRIBUTION BY INTRACELLULAR pH CHANGES.
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The fluoroprobe method using a voltage-sensitive dye, diS-$C_3(5)$, is useful for characterizing the Na^+/sugar cotransport in isolated chicken enterocytes. Kinetic analyses of membrane potential changes as represented by sugar-evoked fluorescence increases (ΔF) favor a 2:1 (Na^+: sugar) coupling stoichiometry at the whole cell level. However, the validity of such analyses could be undermined in case the transport-associated ΔF were predominantly affected by alterations in the intracellular parameters such as pH_i. Therefore, we employed an acridine orange method to determine whether or not the pH_i of the enterocytes changes in response to the cotransport-mediated solute entry. The addition of glucose or mannose (10 mM) to the cell suspensions caused a substantial decrease in pH_i when a Cl^- medium was employed. Replacement of Cl^- by SO_4^{2-}, by contrast, markedly suppressed the solute-evoked changes in pH_i. Moreover, under the condition that the standard media used in our kinetic studies contained SO_4^{2-} but no Cl^- and were basically supplemented with 10 mM mannose, a further addition of 10 mM mannose resulted in virtually no changes in ΔF or pH_i, while glucose induced a sizeable ΔF with no appreciable change in pH_i. Thus, the possibility that the major portion of ΔF reflects the pH_i changes can be excluded.

98, I P (50) 1330

ATPase ACTIVITIES IN GUINEA PIG COLONIC MUCOSA.
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The isolated guinea pig colon showed the ability to secrete acid into the mucosal bathing solution. The mucosal membrane step of the mucosal acidification has previously been suggested to be mediated by $(H^+ + K^+)$ATPase. To characterize this process more precisely, Mg^{2+}-dependent ATPase activities were measured in a homogenate obtained from colonic mucosa. In one typical experiment, Na^+ or K^+ dependency of ATPase activities was examined and the results were as follows (μmoles Pi/mg protein/hr): 50mM Na^+, 14.7; 50mM K^+, 15.2; 50 mM Na^+ and 50 mM K^+, 21.0. Thus, it was suggested that the activity of K^+-dependent Na^+-independent ATPase was small, if not negligible, compared with that of $(Na^+ + K^+)$-dependent ATPase in guinea pig colonic mucosa.

99, I P (51) 1330

H^+ SECRETION IN GUINEA PIG COLONIC MUCOSA:HCO_3^- EXIT ACROSS THE BASOLATERAL MEMBRANE. KANEKO, K. AND SUZUKI, Y. Department of Physiology, Yamagata University School of Medicine, Yamagata 990-23

In isolated guinea pig colon, mucosal acidification has been shown to be associated with serosal alkalinization, which is presumably due to HCO_3^- exit from the cell into the serosal bathing solution. To investigate the mechanism involved in HCO_3^- exit across the basolateral membrane, effects of removal of Cl^- from or addition of 4,4'-diisothiocyano-2,2'-stilbene-disulfonic acid (DIDS) into the bathing solution on serosal alkalinization rate (J^{OH}) were examined. J^{OH}, determined with a pH stat device, was 1.09±0.06μmoles/cm^2/hr under control conditions. The serosal alkalinization was completely abolished when the tissues were bathed with Cl^--free, gluconate solution. Addition of DIDS (3x 10^{-4}M) into the serosal bathing solution resulted in the reduction of J^{OH}. The percentage of reduction by DIDS was increased when Cl^- concentration in the bathing solution was lowered. These results suggested that HCO_3^- exit across the basolateral membrane might be mediated by DIDS-sensitive Cl^--HCO_3^- exchange mechanism.

100, I P (52) 1330

VECTORIAL INCORPORATION OF PURIFIED Na PUMP INTO ORGANIC SOLVENT FREE PHOSPHOLIPID BILAYERS. KUMAZAWA, N., TSUJIMOTO, T., and FUKUSHIMA, Y.* Dept. of Physiol., Wakayama Medical College, Wakayam 640, * Nat. Inst. for Physiological Science, Okazaki 444

Purified (Na,K)ATPase was incorporated into solvent free phospholipid bilayers according to Coronado & Latorre's method (1983) with modifications. The incorporated bilayer was found to contain an ion channel which underwent opening and closing (switching) upon application of a transmembrane potential gradient of more than 40 mV. The minimum conductance was about 40 pS. It was inhibited by ouabain from one side. ATP added to the opposite side shifted the threshold potential for switching of the channel to 80 mV. Furthermore the magnitude of minimum conductance decreased to 6-10 pS. These results showed that the enzyme was incorporated vectorially into the planar bilayers. Although it is not yet clear whether the binding of ATP to the enzyme or phosphorylation of the enzyme by ATP raised the threshold potential for initiation of the channel-switching, this action of ATP may operate to some extent in cells to suppress leakage of ion through the Na pump itself in the presence of the physiological membrane potential.

101, I P (53) 1330

SUBSTRATE SPECIFICITY OF Na,K-DEPENDENT HYDROLYSIS BY PLASMA MEMBRANE FRACTION PREPARED FROM INSULIN-PRETREATED MUSCLES. KANBE,M. and KITASATO,H. Dept. Physiol., Shiga Univ. Med. Sci., Ohtsu 520-21

The Na,K-ATPase activity of an isolated plasma membrane fraction obtained from frog skeletal muscles was increased approximately 2-fold by pretreating muscles with insulin. To characterize the Na,K-ATPase of the plasma membrane prepared from insulin-pretreated muscles, hydrolyses of various nucleotide phosphates by the preparation described above was studied. ATP was Na,K-dependently hydrolyzed maximally at the concentration of 1.0 mM by both intact and insulin-pretreated plasma membrane. Na,K-dependent hydrolyses of ADP, CTP, ITP and UTP (1.0mM) by plasma membrane prepared from intact muscles were 5-10% of that of ATP. GTP was hydrolyzed Na,K-dependently 65% of ATP. Na,K-dependent hydrolyses by plasma membrane prepared from insulin-pretreated muscles of ADP, CTP, ITP and UTP (1.0mM) increased approximately 9-, 4-, 6- and 10-fold of corresponding hydrolyses by intact plasma membrane, respectively; whereas, the hydrolysis of GTP was nearly equal to that by intact plasma membrane. Moreover, the affinity to these substrates was increased by pretreating with insulin. These results suggests that the Na/K transport protein which is somewhat different in property is incorporated to the plasma membrane by insulin.

102, I P (54) 1330

RESPIRATORY ACIDOSIS BLOCKS CELL-TO-CELL COMMUNICATIONS IN BULLFROG PROXIMAL TUBULES.

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In our previous report, we have demonstrated electrophysiologically that cell-to-cell communications in bullfrog proximal tubules close in respiratory acidosis (J. Physiol. Soc. Japan 47:p.392, 1985). To examine this finding further, we observed the spread of a dye, Lucifer Yellow CH, in sliced kidney preparation after its iontophoresis into a cell of the epithelium. Hyperpolarizing current (60 nA) was employed for the microinjection. Depolarizing current was also employed for holding the dye. In the first series of experiments, we used the separate procedures for microinjecting and observing the dye coupling. Three min after changing the bath CO_2 from 1.5% to 5%, microinjection of the dye was performed for 2 min. Five min after that, the preparation was fixed by a neutral phosphate formaldehyde solution. The dye couplings were examined by the use of an incident fluorescent microscopy. In the second series of experiments, microinjection of the dye was performed on the stage of the microscope. The dye was injected for 3 min just after changing the bath CO_2. The spread of the dye was photographed at the time of 0, 2, 3, and 5 min after the microinjection.

Both series of fluorescent photographs revealed that the dye coupling was effectively blocked in respiratory acidosis.

103, I P (55) 1330

THE EFFECTS OF CARBON DIOXIDE ON INTRACELLULAR POTASSIUM ACTIVITY AND EXTRACELLULAR SPACE OF FROG SARTORIUS MUSCLE.

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Resting potential (E_M) and intracellular K^+ activity ($(K^+)_i$) of isolated frog sartorius muscles under various CO_2 tensions were determined with double-barreled K^+-selective microelectrodes.

CO_2 caused a depolarization with a decrease of $(K^+)_i$ and an increase of extracellular K^+ activity ($(K^+)_e$), the latter change being CO_2-load dependent. These effects were almost completely blocked by Ouabain. Mannitol depolarized the E_M and increased $(K^+)_i$, and addition of CO_2 produced further depolarization and a decrease of $(K^+)_i$ conversely. To estimate changes in the extracellular spaces (ECF), a computer-aided image analysis was employed on the sections of frozen and dried muscle preparations loaded with CO_2 or mannitol. ECF was increased by mannitol, and decreased by CO_2.

Thus, we conclude that the effects of CO_2 would come from: 1) the leak of cell K^+, 2) the involvement of Na^+-K^+ pump, 3) the change of ion conductance across the membrane, 4) the shift of water into the cell, diluting the cell K^+, and 5) a sequestration of K^+ to other tissues.

104, I B 0915

IMPEDANCE LOCI OF THE SQUID AT THE A.C. TRANSIENT AND CONSTANT PHENOMENA. AND THE EQUIVALENT CIRCUIT BY THE CONDENSER WITH PARALLEL AND SERIES RESISTANCES. SAITO, T. Dept. Physiolog. Nippon Dental College, Tokyo.

Formerly the living body impedance was measured by alternating current bridge, but this method made clear only the constant phenomenon and the transient was unknown. The finit alternating potential ($E_m \sin\omega t$, $\omega t \geq 0$) is invented by the author for solving this problem. The circuit of the condensor c and the series resistance R produces the passing potential v by it.

$$v = V_m\left\{\sin(\omega t+\phi) - \sin\phi\,\varepsilon^{-\frac{t}{(W+R)c}}\right\} \qquad V_m = \frac{WE_m}{W+R}, \qquad \tan\phi = \frac{1}{\omega(W+R)c}$$

Here W is the input resistance of the measuring apparatus. By R and c the loci in the transient and constant condition can be gotten.

When the circuit is the condenser c with the parallel resistant r and series R, the passing current i is following,

$$i = I_m\left\{\sin(\omega t+\phi) - \sin\phi\,\varepsilon^{-\frac{t}{c}\left(\frac{1}{R}+\frac{1}{r}\right)}\right\} \qquad I_m = \frac{E_m\sqrt{1+\omega^2R^2c^2}}{\sqrt{(R+r)^2+(\omega Rrc)^2}} \qquad \tan\phi = \frac{\omega R^2c}{R+r+\omega^2R^2rc^2}$$

This circuit is analized by this. The sepioteuthis is used in this experiment.

105, I B 0930

IMMUNOCYTOCHEMICAL CHARACTERISTICS OF PRIMARY CULTURED NEURONS FROM El MICE CEREBRAL CORTEX. ITOH,K., SEKIGUCHI,K., ISHIGE,A., IIZUKA,S., SUGIMOTO,A., ABURADA,M.,HOSOYA,E., SUGAYA,E.*, ASOU,H.**, HIRANO,S.** Tsumura Res. Inst. for Pharmacology, Ibaraki, *Dept. Physiol., Kanagawa Dental Coll., Yokosuka and ** Dept. Physiol., Toho Univ., Tokyo.

To elucidate the differences between an epileptogenic neuron and a normal neuron, cellular characteristics of neurons of mutant strain El mice which are highly susceptible to seizures were investigated using immunocytochemical techniques.

In neurons of 3-day primary cultures, the control ddy mouse neurons showed dividing stages in 2-4% neurofilament (NF)-positive neurons whereas no dividing neurons were observed in the NF-positive El mouse neurons. In 7-day cultures, localization of GD3 ganglioside in the membrane of proliferating control ddy mouse neurons was observed , but there was no GD3 ganglioside in the mutant El mouse neurons. In 7-day cultures, the neurofilament of El mice formed a bundle-type proliferation whereas those of ddy mice formed well- balanced spreading networks.

These findings suggest that neurons of the El mouse are differentiated earlier and are characterized by postmitotic cells compared with those of the control ddy mouse.

106, I B 0945

EFFECTS OF PENTYLENETETRAZOLE ON PRIMARY CULTURED NEURONS FROM THE CEREBRAL CORTEX; (I) INTRACELLULAR IONIC CHANGES. SEKIGUCHI,K., ISHIGE,A., ITOH,K., IIZUKA,S., SUGIMOTO,A., ABURADA,M., HOSOYA,E., TSUDA,T.*, SUGAYA,A.*, TAKAGI,T.**, SUGAYA,E.**, ASOU,H.*** and HIRANO,S.*** Tsumura Res. Inst. for Pharmacology, Ibaraki, *Fac. of Pharmaceutical Sci., Josai Univ., Saitama, **Dept. of Physiol., Kanagawa Dental Coll., Yokosuka and ***Dept. of Physiol., Toho Univ., Tokyo.

To elucidate the mechanism of initiation of seizure discharge in a single mammalian neuron, effects of a convulsant drug, pentylenetetrazole (PTZ), on the intracellular ionic behavior in culutured neurons were investigated.

Primary cultured neurons of cerebral cortex were used. Some of the primary cultured neurons showed burst-like repetitive firing with current passage after application of PTZ in cultured medium. The calcium distribution map of the neuronal cell surface was observed using a computer controlled electron probe X-ray microanalyzer (JOEL, CCM-733). Calcium distribution near the cell surface of the primary cultured neurons was increased with PTZ application.

The above findings suggest that in the mammalian primary cultured neuron, intracellular calcium shift was induced during PTZ-induced bursting activity which is similar to our previous observation in the snail neurons.

107, I B 1000

EFFECTS OF PENTYLENETETRAZOLE ON PRIMARY CULTURED NEURONS FROM THE CEREBRAL CORTEX; (II) INTRACELLULAR PROTEIN CHANGES.

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To clarify the mechanism of the initiation of seizure discharges in a single isolated mammalian neuron, effects of a convulsant drug, pentylenetetrazole (PTZ), on the intracellular protein in primary cultured neurons were investigated.

SDS-gel electrophoresis as well as two dimensional electrophoresis was used. The PTZ treated primary cultured neurons showed an enhanced band at ca. 15 kdaltons and other slight changes in higher molecular weight bands in disk electrophoresis patterns.

Together with our previous report that PTZ-induced protein changes during bursting activity in snail neurons, the above-mentioned findings suggest that the intracellular processes during bursting activity induced by PTZ in mammalian cultured neurons were similar to those in snail neurons and the intracellular protein changes are one step in evoking seizure phenomena.

108, I B 1015

EFFECT OF ARACHIDONIC ACID ON THE MEMBRANE CURRENTS IN THE SQUID GIANT AXON.

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The effects of arachidonic acid on the ionic currents of the voltage-clamped squid giant axon were investigated using intracellular and extracellular application of the test substance. Na and K currents were recorded in intracellularly perfused giant axons before,during and after exposure the test solution. Arachidonic acid mainly suppress the Na current but have little effect on the K current. These effects are completely reversed after washing with control solution. The effects of this fatty acid on the membrane currents were also examined by computer simulation. The time constant for activation τ_m were shifted 20 mV in a depolarizing direction and increased about twice value by the application of the test solution. The time constant for inactivation τ_h was also shifted 20 mV in a hyperpolarizing direction by application of arachidonic acid.

109, I B 1030

CHARACTERISTICS OF THE SODIUM CHANNEL HAVING NO GATING MECHANISM OF SQUID GIANT AXONS.

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It has been shown that squid giant axons in which the gating mechanisms of both Na- and K-channels were eliminated by intracellular digestion with α-chymotrypsin retain the sensitivity to specific Na channel opener, grayanotoxin(GTX). This finding suggests that the property of the filter section of the Na channel which is closely interrelated with the gating mechanism in the physiological condition could be directly examined. This experiment was designed to characterize the filter section of the Na channel with the use of voltage clamp and internal perfusion methods. In the enzyme-treated axon, GTX began to generate inward current at a membrane potential far below the normal resting potential. TTX suppressed this inward current. Batrachotoxin, another potent Na channel opener, induced inward current qualitatively similar to that produced by GTX. In order to further characterize the enzyme-treated Na channel, the interaction of specific Na channel blockers from the internal surface such as trypargine and guanidyl-side armed cyclam was examined. The blocking mode of Na channel in the enzyme-treated axon was compared with that in the normal axon. From these observations, molecular moiety of the filter section of Na channel will be discussed.

110, I B 1045

NEURAL TYPE DIFFERENTIATION AND Na-CHANNELS IN THE ISOLATED AND CULTURED BLASTOMERES FROM A CLEAVAGE-ARRESTED 4-CELL HALOCYNTHIA EMBRYO. OKAMURA, Y., OKADO, H.* AND TAKAHASHI, K. Dept. Neurobiol., Inst. Brain Res., Tokyo Univ., Sch. Med., Tokyo 113

The 4-cell embryo of the Halocynthia whose cleavage was arrested differentiated to the epidermal type, as previously reported, but the other cell types may appear when each blastomere was cultured separately. In the present experiment, the cleavage-arrested blastomeres which were isolated from the dechorionated 4-cell embryo and identified by the vital staining patterns of mitochondria were continuously cultured at 10°C in Jamarine artificial sea water containig extra 20 mM $CaCl_2$. Voltage-clamp measurements were performed more than twice for each blastomere. Changes in Na, Ca, delayed K and anomalous K channels were examined during development and compared between anterior A3 and posterior B3 blastomeres. At the final stage of the development the recorded blastomeres were fixed and sectioned in order to determine the differentiation types with immunocytochemical markers. Both anterior A3 and posterior B3 showed an increase in egg type Na channels with a shift of the critical level to hyperpolarized direction after 20 hours development. After 50 hours the increased Na channels in A3 which includes presumptive neural region were altered into the differentiated type with the depolarized critical level, while B3 blastomeres showed an increase in differentiated Ca or differentiated Ca plus delayed K channels.

111, I B 1100

EFFECT OF A SEA ANEMONE TOXIN ON THE SLOW INACTIVATION IN THE CRAYFISH GIANT AXON. WARASHINA, A. AND OGURA, T. Dept. of Physiol., Niigata Univ. Sch. of Med., Niigata,

When the crayfish giant axon is depolarized, at least two different types of Na inactivations take place. One is the normal, fast inactivation. The other develops slowly so that its occurrence in intact axons is obvious only in the potential range where the normal inactivation is insignificant. Excepting minor components that changed very slowly, time courses of the slow inactivation can be described by the function erfc (t/τ), in which τ values fall in a few sec range for the onset process and in several hundreds of msec for the offset process. The steady-state slow inactivation has a potential dependence similar to that of the normal inactivation but occurs in about 20 mV hyperpolarized region relative to the latter. The slow inactivation remains in the axons of which normal inactivation has been completely removed by treating axons with a toxin (PaTX) extracted from the sea anemone, Parasicyonis actinostoloides. However, the potential dependence of steady-state slow inactivation in PaTX-treated axons is less sharp as compared with that in intact axons. Furthermore, the recovery rate from the slow inactivation delays by more than one order of magnitude as compared with that in intact axons. These results suggest that mechanisms involved in the normal and slow inactivations are basically different although some coupling between them occurs.

112, I B 1115

NERVE GROWTH FACTOR-INDUCED DIFFERENTIATION OF Na-CHANNEL IN PHEOCHROMOCYTOMA CELLS. Kamei, K., Miyake M. and *Hatanaka, H. Fac. of Pharmaceu. Sci., Hokkaido Univ., Sapporo 060 and *Mitsubishi-Kasei Inst. of Life Sci., Tokyo 194

A PC-12 cell line derived from pheochromocytoma elicits various neuronal properties in response to nerve growth factor(NGF). We observed here changes in the properties of Na-channel during the NGF-induced neuronal differentiation of PC-12h cells.

The application of both 100 μM veratridine (Ver) and 500 ng/ml scorpion toxin (ScTX) to the NGF(-) cells induced appreciable TTX-sensitive ^{22}Na-influx (30-40 nmole/min/mg), but Ver (up to 200 μM) alone stimulated little influx (2-4 nmole/min/mg). After 9-12 days in culture with NGF(50 ng/ml), the rate of the Ver-induced ^{22}Na-influx was increased to 30-40 nmole/min/mg, which was almost 30% of that (90-110 nmole/min/mg) of the influx induced by Ver and ScTX. Note that the effective doses of both toxins are almost the same between the NGF(-) and the NGF(+) cells. These results suggest that the inactivation gates of Na-channel in undifferentiated cells are almost in closed state at rest but some of these gates in differentiated cells are open state at rest, since Ver and ScTX are known to open specifically the activation and the inactivation gates respectively. Thus, inactive Na-channels in undifferentiated PC-12h cells came to operate well in the ordinary range of membrane potential(-70~+40 mV) in association with the NGF-induced neuronal differentiation.

113, I B 1130

CALCIUM CHANNELS FROM FROG SKELETAL TRAVERSE TUBULAR MEMBRANES IN PLANAR LIPID BILAYERS,
SOKABE, M., KATO, T., NARUSE, K. AND ITO, F.
Dept. Physiol. Nagoya Univ. Sch. Med., Nagoya 466

Skeletal traverse tubular(T-tubles) system is equipped with calcium channels and plays an important role in excitation-contracion coupling. The direct study of the T-tuble membranes, however, is made difficult by the geometry of the T-sysytem. The aim of the present study is to investigate single channel properties of the putative calcium channels by incorporating biochemically isolated T-tuble membranes into planar lipid bilayers formed on the tip of patch-clamp pipettes. The T-tuble preparation was obtained from the hind-limb skeletal muscles of frogs(Rana Castebeiana) and planar bilayers were made from asolectin. 50mM Ba-HEPES(pH 7.2) was used to avoid the contribution from other monovalent ion channels. Single channel currents were measured by using current to voltage converter under voltage clamp conditions. Several types of voltage-dependent and-independent channels(10 - 60pS) with open times of 10 to 1000msec. could be observed. Some of these channels were selective for divalent cations over monovalent ions.

114, I B 1145

ANALYSIS OF THE EFFECTS OF X-IRRADIATION ON THE Ca CHANNEL OF MOUSE OOCYTES.
YOSHIDA,S. Dept. Physiol., Nagasaki Univ. Sch. Med., Nagasaki 852

Effects of radiation on electrophysiological properties of Ca channels were studied to speculate X-ray induced changes in the structure of the mouse oocyte. The lower abdomen of adult female mice was exposed to a single dose of 10-100 Gy X-rays, and oocytes were collected from the oviducts for the study between 0 and 80 hours after X-irradiation. Membrane currents of oocytes were measured by two-electrode voltage-clamp techniques. At higher doses of X-rays, the oocyte membrane became leaky, and the magnitude of membrane currents was decreased. Furthermore, activation and inactivation time courses became slower, and the steady-state inactivation curve shifted to more positive values of membrane potential and increased its slope. In control oocytes, the magnitude of Ca currents was larger than that of Ba currents, while it was smaller than that of Sr currents. However, the selectivity ratios among these alkali earth cations were close to 1.0 in some irradiated oocytes. The fact that a part of irradiated oocytes showed radioresistance suggests that the "target theory" can be applied to the present experiments. The X-ray induced changes in mouse oocytes are supposed to be destruction and/or modification of 1) lipid bilayers of the oocyte membranes, 2) amino groups buried in or on the surface of the membrane, 3) selectivity filters, 4) channel proteins, 5) DNAs, etc.

115, I B 1300

EFFECTS OF PENTOBARBITAL ON THE CALCIUM CHANNEL CURRENT IN APLYSIA NEURONS.
IKEMOTO, Y., MITSUIYE, T. AND ISHIZUKA, S. Department of Physiology, Faculties of Medicine and Dentistry, Kyushu University, Fukuoka 812

Effects of pentobarbital on the calcium channel current in Aplysia neurons were examined with the two microelectrode voltage clamp technique, in order to assess the presynaptic actions of the agent. Barium current was elicited in Ba-sea water, where neither Na, Ca nor K ions carried the transmembrane current. The current was reduced by the anesthetic (0.1 to 3mM) in a dose-dependent manner. The maximal available conductance was decreased without shifting the activation nor inactivation curve along the voltage axis. Inactivation at -10mV was facilitated and recovery from inactivation at -50mV was retarded by the agent, resulting in a use-dependent depression of the current. The current was reduced in a greater extent in lower pH solutions (pH=7.0 to 9.0), indicating that the uncharged form of the drug was responsible. The current was reduced in a greater extent with the holding potential more positive (-30mV, where the steady state inactivation was about 0.5 instead of 1.0 at -50mV), showing that the drug has higher affinity to the inactivated state of the channel. These findings suggest that pentobarbital depresses the transmitter release from the nerve terminal by reducing the calcium current. The drug may be more effectve when the nerve impulses reach the terminal at a high frequency, where the use-dependent depression takes place.

116, I B 1315

BLOCK BY HEPES BUFFER UNVEILED THE POLYMERIC STRUCTURE OF A CHLORIDE CHANNEL. YAMAMOTO, D., SUZUKI, N.* Mitsubishi-Kasei Inst. Life Sci., Tokyo 194, *Dept. Physiol., Kitasato Univ. Sch. Med., Kanagawa 228.

By patch clamping primary cultured Drosophila neurones, we have found a novel type of Cl channel. The channel has a unitary conductance of 35pS, and stays at open states for tens of minutes with occasional interruptions by short closing transitions. When HEPES or MOPS ($\geq$1mM) was applied to the cytoplasmic face of membrane, it caused flickering within single openings of the Cl channel. A close inspection of records in HEPES has revealed that the open Cl channel has several subconductance levels, some of which are hardly detectable in the absence of HEPES. We interpret for this result as follows: i) The Cl channel is a complex of multiple protochannels which are gated simultaneously, ii) HEPES and MOPS act as an open-channel blocker, and iii) a blocker molecule randomly hits any one of the open pore, producing a plenty of subconductance levels.

117, I B 1330

THE KINETIC PROPERTIES OF TWO CLASSES OF ACh RECEPTOR CHANNEL CURRENT IN CULTURED XENOPUS MUSCLES. [1)]IGUSA, Y. AND[2)]KIDOKORO, Y* [1)]Dept. Physiol., Jichi Med. Sch., Tochigi-ken, 329-04. [2)]Jerry Lewis Neuromusclar Research Center, Sch. Med., UCLA.

A gradual shortening of the "apparent" open time of the ACh receptor channel has been shown during early developmental stage in cultured Xenopus muscles without innervation. Using a single channel recording, two distinct ACh currents are observed; the one is with long open time, low conductance (Low-γ events) and the other with short open time, high conductance (High-γ events). The purpose of this study is to further investigate the kinetic properties of both currents on cultured Xenopus muscles at low ACh concentration (0.2 μM) using the cell-attached patch clamp technique and to determine the rate constants α and β according to the four-state current model. To obtain the "corrected" open time of both events, we calculated the brief closed time included in an open state (burst) and the number of brief closures. Each closed time in a burst ranged in 0.1-0.5 msec. The number of closure per burst and β in Low-γ event were about 1.5-2 fold higher than those in High-γ event. The corrected mean open time and α of both events, however, were substantialy the same. There was no difference of corrected open time in each channel in 1-6 days cultures. These results suggest that the longer apparent open time of Low-γ event is mainly due to the more frequent re-opening.

118, I B 1345

REVERSE OF THE SPIKE AFTERPOTENTIAL BY NORADRENALINE IN SYMPATHETIC PREGANGLIONIC NEURONS IN VITRO. YOSHIMURA, M. & NISHI, S., Dept. Physiol., Kurume Univ. Sch. Med., Kurume

The effect of noradrenaline (NA) on the spike afterhyperpolarization (AHP) of sympathetic preganglionic neurons was studied with intracellular recording using cat spinal cord slice preparation. The neurons identified by their antidromic responses to stimulation of the white ramus or the ventral root had a long lasting spike AHP. Superfusion of the slice with NA (10-50 μM) resulted in depression of the AHP and an appearance of a depolarizing afterpotential (DAP) which was absent in control conditions. The DAP was associated with a decrease in input resistance and was voltage-dependent, being depressed in nonlinear fashion by membrane hyperpolarization. In a solution containing cobalt or low calcium the DAP was depressed markedly in amplitude. Substitution of choline or tris for Na suppressed the DAP while tetrodotoxin (TTX) was without effect. Ionophoretic injection of EGTA into the cell abolished the DAP. While intracellular injection of Cs resulted in marked prolongation of the spike duration, a decrease in amplitude of the AHP and appearance of the DAP which resembled the NA-induced DAP in duration. The Cs-induced DAP was associated with a decrease in membrane resistance, resistant to TTX and depressed by cobalt. The Cs-induced DAP, however, was voltage-independent and was not abolished in Na-free solution. It is concluded that NA activate Ca-dependent Na channel and the appearance of NA-induced DAP are not in consequence of depression of the AHP.

119, I B 1400

INTRACELLULAR REACTION MECHANISM OF NEUROTENSIN RESPONSE INDUCED BY RAT BRAIN mRNA IN XENOPUS OOCYTES. ITO, I., HIRONO, C. AND SUGIYAMA, H. Lab. Memb. Biol., Natl. Inst. Physiol. Sci., Okazaki 444

Poly(A)$^+$ mRNA isolated from adult rat brains was fractionated into several fractions by sucrose gradient centrifugation. Microinjection of mRNA, coresponding to 30S-50S RNA, into Xenopus oocytes induced an electrophysiological response to neurotensin(NT). Under voltage clamp condition(-60mV), application of NT to mRNA-injected oocytes produced transient and oscillatory inward current which appeared after a delay of several tens of second. These inward currents were accompanied by an increase in membrane conductence. NT response of mRNA-injected cells had a strong tendency of desensitization. NT receptor on mRNA-injected oocytes showed essentially the same pharmacological properties as those of native NT receptors. Intracellular injection of inositol 1,4,5-triphosphate(IP_3) induced a NT like current response and a large dose of IP_3 desensitised the NT response as well as the response to the second IP_3 injection. NT response and IP_3 response were completely inhibited by intracellular injection of EGTA. Treatment with islet-activating protein(IAP) resulted in a loss of responsiveness to NT. These results suggest that the NT receptors interact with inhibitory GTP-binding regulatory proteins and evoke electrophysiological response mediated by Ca^{++} mobilization triggered by IP_3.

120, I B 1415

MUSCARINIC RECEPTOR AND NEUROTENSIN RECEPTOR SHARE INTRACELLULAR REACTION MECHANISM IN XENOPUS OOCYTES INJECTED WITH RAT BRAIN mRNA. HIRONO, C., ITO, I. AND SUGIYAMA, H. Lab. Memb. Biol., Natl. Inst. Physiol. Sci., Okazaki 444

Microinjection of mRNA isolated from rat brains induced muscarinic acetylcholine (ACh) response and neurotensin (NT) response in Xenopus oocytes. When the ACh response was desensitized by application of a large dose of ACh, NT response was also suppressed, suggesting a close relationship between the two types of responses. In fact, ACh response and NT response showed similar patterns and time courses, and in addition, the two responses exhibited common features in the following aspects: (1) Islet-activating protein (2 μmg/ml, 20 h treatment) reduced the responses to both ACh and NT. (2) Intracellular injection of inositol 1,4,5-triphosphate (IP_3) caused electrophysiological responses similar in shape to ACh or NT responses. Injection of a large dose of IP_3 suppressed the responses to both ACh and NT as well as the response to the second injection of IP_3. (3) EGTA injected into oocytes inhibited all of the responses to ACh, NT and IP_3. These results suggest that muscarinic receptor and NT receptor share a common target (inhibitory guanine nucleotide-binding regulatory protein) and generate electrophysiological responses mediated by intracellular Ca^{++} ions mobilized by IP_3.

121, I B 1430

MEMBRANE HYPERPOLARIZATION BY SOMATOSTATIN (SRIF) IN HUMAN GH-PRODUCING PITUITARY TUMOR CELLS. Naohide Yamashita and Etsuro Ogata*. Fourth Dept Int Med, Univ Tokyo Sch Med, Tokyo 112

SRIF is a potent inhibitory hormone of GH secretion. We examined the membrane potential response to SRIF in human GH-producing pituitary cells under whole cell variation of patch electrode voltage clamp techniques. Under current clamp with patch electrode, the resting potential was -52.4±8.0 mV and spontaneous or evoked action potentials were observed. Under voltage clamp, the outward current carried through K^+ channels, tetrodotoxin-sensitive Na^+ channels and Ca^{++} channels were recognized. The threshold of Ca^{++} channels was about -60 mV. SRIF caused membrane hyperpolarization with an increased membrane permeability. The reversal potential of membrane hyperpolarization was -78.4±4.3 mV in 6mM K^+ medium and -97.2±6.4 mV in 3 mM K^+ medium, which indicated that hyperpolarization was caused by an increased permeability to K^+ ions. When the patch electrode contained 20 mM EGTA, SRIF induced hyperpolarization was still observed. Therefore the permeability increase to K^+ ions by SRIF was considered not to be due to Ca^{++}-activated K^+ conductane. The level of hyperpolarized membrane potential by SRIF was -63.6±5.9 mV, which was sufficient to deactivate Ca^{++} channels. Hormone secretion was significantly suppressed by SRIF, and cobalt ions which inhibited Ca^{++} channels.

122, I B 1445

EFFECTS OF SUBSTANCE P ON THE INACTIVATION OF THE INWARDLY RECTIFYING K CURRENT IN CULTURED NUC. BASALIS NEURON. YAMAGUCHI, K.+, NAKAJIMA, Y.*, NAKAJIMA, S.* AND STANFIELD, P.R.*# Dept. Biol., Purdue Univ., W.Lafayette, IN 47907 U.S.A. +National Inst. for Physiol. Sci., Okazaki 444 #Dept. Physiol., Univ. of Leicester, Leicester LE17RH, U.K.

Substance P (SP) elicited a long-lasting depolarization concomitant with an increase in input resistance in cultured cholinergic neurons from the rat basal forebrain (1). Using the whole cell voltage clamp technique, we have revealed that SP suppressed the inwardly rectifying K channel (2): The I-V relation of the SP-sensitive current showed inward rectification; the chord conductance depended on external K concentration as well as voltage; replacement of K by Rb blocked the action of SP completely. Furthermore, a low concentration (0.5 mM) of Cs caused a voltage-dependent blockade of the SP sensitive current. At large negative potentials, a voltage- and time-dependent inactivation of the rectification channel was observed. SP enhanced this inactivation, but did not shorten the inactivating time constant. This inactivation does not seem to be a blockade by Na in the bath solution.

(1) Nakajima, Y. et al., (1985) Proc. Natl. Acad. Sci. USA. 82: 6325-6329
(2) Stanfield, P.R. et al., (1985) Nature 315: 498-501

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123, I B 1500

ELECTROPHYSIOLOGICAL PROPERTIES OF TESTOSTERONE-SECRETING CELLS IN MAMMALIAN TESTES STUDIED WITH PATCH-CLAMP TECHNIQUES. KAWA, K. Dept. Pharmacol., Gunma Univ. Sch. Med., Maebashi 371.

The testosterone-secreting cells (Leydig cells) in adult mice were isolated mechanically by perfusing intertubular spaces of testes with physiological saline. Perfusates were collected in recording chamber and the Leydig cells were identified by their morphological characteristics (diameter 13-20 μm, bright cell-border, occasionally clustered). Identification was confirmed reliable by the specific staining of 3β-hydroxysteroid dehydrogenase.

The whole-cell membranes of Leydig cells were voltage-clamped with patch-electrodes. The holding potential was -80∼-95 mV and the external saline contained 126 mM NaCl, 5 mM KCl and 10 mM CaCl . Depolarization over -40 mV evoked inward currents which decayed completely during 150 msec stimuli. The inward currents were identified as Ca^{2+} -carried current, since replacement of external Ca^{2+} with Mn^{2+} reversibly diminished the current whereas Ba^{2+} or Sr^{2+} substituted for Ca^{2+} . No measurable outward currents were evoked by the depolarization up to +40 mV.

124, I B 1515

Ca^{2+}-MEDIATED REDUCTION OF K^+ CURRENT IS ENHANCED BY INJECTION OF IP_3. SAKAKIBARA, M. and ALKON, D. L.* Department of Aerospace Physiology, Research Institute of Environmental Medicine, Nagoya University, Nagoya 464 and Laboratory of Biophysics, NINCDS, NIH, at the Marine Biological Laboratory, Woods Hole, MA 02543, U.S.A.

Elevation of intracellular Ca^{2+}, $[Ca^{2+}]_i$, in the isolated soma of the Hermissenda type B photoreceptor cell has been shown to cause prolonged reduction of voltage-dependent K^+ current, I_A and $I_{Ca^{2+}\text{-}K^+}$. This reduction (for 1-5 min.) suggested that biochemical steps may be responsible for reduction which may outlast $[Ca^{2+}]_i$ elevation itself and could lead to the I_A and $I_{Ca^{2+}\text{-}K^+}$ reduction (lasting days) which encodes associative memory. Iontophoretic injection of inositol trisphosphate (IP_3), but not IP_1, caused prolonged reduction of I_A and $I_{Ca^{2+}\text{-}K^+}$ but did not affect the voltage-dependent Ca^{2+} current, nor the light-induced inward current, I_{Na^+}, of the type B cell. IP_3 injection caused similar effects on the K^+ currents of the type A photoreceptor cell. I_{Na^+} of the type A cell, unlike that of the type B cell was, however, increased following IP_3 injection. The difference in IP_3 effects on type B and A of I_{Na^+} may reflect differences in endogenous IP_3 levels which, in turn might explain differences in receptor sensitivity during light and dark adaptations.

125, I B 1530

ELECTRICAL CHARACTERISTICS OF MOUSE TASTE CELL MEMBRANE. TONOSAKI, K. AND FUNAKOSHI, M. Dept. Oral Physiol., Sch. Dentistry, Asahi Univ. Gifu 501-02

The responses in mouse taste cells were investigated further using intracellular recording and dye marking techniques. Taste cells could be grossly classified into two types; H- and D-type, according to their sucrose responses. The H-type taste cell responded to sucrose with depolarization and was accompanied by membrane resistance increase and had negative reversal potential. Current-voltage (I-V) relationship was linear in the narrow range of the membrane voltage and showed the inward and outward rectification. While, D-type taste cell responded with depolarization and was accompanied by no visible resistance change to sucrose and had positive reversal potential. I-V relationship was linear in the wide range and did not show the rectification. From these phenomena, we speculated as follows; 1) the sucrose depolarization response is not simply generated by the membrane depolarization and/or the response does not depend entirely on the membrane resistance change, 2) the H-type taste cell response is due to a decrease of gK and/or gCl, 3) the D-type taste cell response is due to an increase in gNa.

126, I B 1545

ANESTHETIC ENHANCEMENT BY MONOCARBOXYLIC ANIONS IN THE CRAYFISH CLAW NERVE. ICHIKAWA, O., MIYOSHI, M. AND HIJI, Y. Dept. Physiol., Tottori Univ. Sch. Med., Yonago 683

The block time in the nerve excitation was studied electrophysiologically by adding several kinds of organic anions to the procaine solution. The anesthesia was enhanced only when monocarboxylic anions were added, i.e. monocarboxylates significantly lowered the minimum blocking concentration of procaine and shortened the block onset time. All these data were simulated by the adsorption model. Anesthetization was treated as the adsorption of local anesthetic molecules to the nerve membrane exceeding more than the critical adsorption ratio. The recovery from anesthesia was also explainable by such a simple model. Parameters such as adsorption and desorption rates of procaine were determined by using a ultraviolet absorption technique. From the adsorption model, two following estimations were predicted: (1) Monocarboxylates enhance anesthesia both by increasing the adsorption rate and by lowering the critical adsorption ratio. (2) Procaine is absorbable to phospholipid in the membrane as much as 1:1 in molecular ratio, though the anesthesia takes place at less than half of this ratio.

127, I B 1600

FLUORESCENT PROPERTIES OF NERVE CORD MEMBRANE BOUND TERBIUM BY EXCITATION FOR TRYPTOPHAN AIZAWA, K., OHTANI, T., O'HATA, S., YAMAO, M.,* NISHIYE, S** AND YAMAGISHI, S. Dept. of Physiol. Tokyo Medical College Shinjuku-ku Tokyo 160 *O'tsuma Women's Univ. Chiyoda-ku Tokyo **Dept. of Physiol. Juntendo Univ. Bukyo-ku Tokyo ***Lab. of Membrane Bio., Nat. Inst. Physiol. Sci. Myodaiji, Okazaki

The replacement of calcium ion by terbium ion (Tb^3) has been observed in a number of protein (e.g. transferrin, and troponin-c). The fluorescent properties of Tb^3 were used to study the calcium binding sites on native nerve cord membrane. The maximum excitation wave length of Tb^3 was 225nm in the aqueous solution. The emission spectrum of Tb^3 revealed the characteristic fluorescence quartet at 490,545,585 and 620nm in aqueous solution by 225nm excitation. The wave length of maximum fluorescence emission for native squid giant axon nerve cord membrane was similar to that of tryptophan by 290nm excitation. As a matter of course, the emission peak of Tb^3 was not detected for the native membrane by 290nm excitation. With the addition of 0.02mM $TbCl_3$, the membrane appeared the emission peak of Tb^3 by 290nm excitation. At that time, maximum excitation wave length for the 545nm emission shifted from 225nm to 235nm. The membrane efficiently enhanced the Tb^3 emission by 290nm excitation. The enhanced emission of the bound Tb^3 was sensitized by resonant energy transfer from nearby aromatic residues in membrane which were directly excited by 290 nm The shift of maximum excitation occured with a imidazole-Tb^3 complex in the membrane.

128, I B 1615

ACTION POTENTIALS OF CRUSTACEAN PEPTIDERGIC NEUROSECRETORY TERMINALS RECORDED BY POTENTIOMETRIC DYES. NAGANO, M. AND TERAKAWA, S. Dept. Physiol., Univ. of the Ryukyu, Okinawa 903-01 and Dept. Cell Physiol., Nat. Inst. Physiol. Sci., Okazaki 444

In order to elucidate the excitation-secretion coupling in peptidergic neurosecretory terminals, evoked changes in absorption were measured in the isolated X-organ-sinus gland system of lobster (Panulirus japonicus) and crayfish (Procambarus clarkii) stained with voltage sensitive dyes (NK 2367, NK 2761). In the terminals (sinus gland), the optical signal was very large (signal/DC,~0.1%) and rapid (about 20 ms in duration at ½ amplitude). The signal was wavelength-dependent, and showed different action spectra not only between two dyes used but also between two species. When no dye was used, the absorption response was wavelength-independent and had much slower time course (more than seconds). Thus, the absorption signals obtained by staining with the dye represent action potentials in the terminal. In Na-reduced (< ½) medium, this action potential became small and slow. The slow response was reversibly blocked by addition of 0.2 mM Cd to the medium, suggesting the presence of Ca spike. The dependece of the peak amplitude of rapid response on the Na concentration was consistently observed with both dyes. Differently from these signals, absorption signals of somata and axons were relatively small and short, indicating regional differences in excitability.

129, I B 1630

SCATTERING CHANGE IN THE NEUROSECRETORY TERMINAL. TERAKAWA, S. AND NAGANO, M. Dept. Cell Physiol., Nat. Inst. Physiol. Sci., Okazaki 444 and Dept. Physiol., Univ. of the Ryukyu, Okinawa 903-01

Changes in light scattering were examined in the secretory terminal of neurons in the crustacean X-organ-sinus gland system (lobster, crayfish, and crab) using a bright field light microscope. A brief electrical stimulus to the axon induced a large decrease in turbidity of the terminal area. This response was 5 - 15 sec in duration and as large as 0.1% of the background light intensity. The time course was totally different from that of the action potential in the same area measured with potentiometric dyes. Repetitive stimulation induced responses summated one after another. In this case, the second or the third response was always larger than the first, indicating a facilitative effect of repetitive stimulation. This scattering response was variable depending on recording sites but independent on the wavelength of illuminating light. Axons and somata produced no change in light scattering. Reduction of the Na or Ca concentration in the medium suppressed the response. Addition of tetrodotoxin or Cd to the medium also suppressed, whereas addition of Ba, 4-aminopyridine, or tetraethylammonium enhanced the response. These results suggest that the large scattering response found in the terminal reflects an excitation-coupled and Ca-dependent neurosecretory process in this tissue.

130, I B 1645

ANALYSIS OF THE OPTICAL ACTIVITY SIGNAL RECORDED FROM NERVE FIBERS. WATANABE, A. Dept. Cell Physiol. Nat. Inst. Physiol. Sci. Okazaki 444.

An apparatus was constructed which could detect optical signals produced by a rapid change of the optical activity of the sample. The high frequency response of the apparatus was limited by the time constant of the low pass filter at the output of the lock-in amplifier employed. The time constant of about 0.4 ms was usually selected. The nerve was dissected from the walking leg of the spiny lobster and mounted on the sample stage of the apparatus. When the nerve was stimulated the output of the apparatus gave an optical signal which became evident after averaging for about 50-500 times. The signal was analyzed mathematically assuming that the nerve could be regarded as a substance which was both birefringent and optically active. With the aid of the resultant equation, an attempt was made to separate the optical signal into two components. The first of them was originated from the birefringence change of the nerve and the second from the optical activity change. The time course of the first component resembled closely with the birefringence signal recorded with the classical method in which the analyzer and polarizer were crossed and the azimuth of the nerve was set at 45° with the azimuths of the analyzer and polarizer. The second component mainly consisted of a spike-like brief response and was constant when the nerve azimuth was changed by rotating the chamber for the preparation.

131, II P (1) 0900

SINGLE CHANNEL AND WHOLE CELL CURRENTS IN COLLAGENASE-DISPERSED SMOOTH MUSCLE CELLS OF GUINEA-PIG VAS DEFERENS. MORIMOTO, K., *KUKITA, F., and *YAMAGISHI, S. Dept. Physiol. Med. School Kumamoto Univ., Kumamoto 860, *Dept. Cell Physiol. Natl. Inst. Physiol. Sci., Okazaki 444

Isolated vas deferenses are subjected to three successive 10-min incubations in a calcium-free Tyrode's solution containing collagenase (0.5 %) and bovine serum albumin (2 %). Following mild agitation by pipetting in calcium-free Tyrode's solution, separated relaxed smooth muscle cells were obtained in considerable numbers. The cell membrane of single cells easily form "gigaseal" with a patch-clamp pipette given slight negative pressure inside. After formation of "gigaseal", the inner membrane was broken without damaging the seal and then, the membrane currents were examined (whole cell currents). Thereafter, the outside-out patches were formed to study the single channel currents. Current recordings were collected on magnetic tape and subsequently analyzed by computer (Nicolet 1280). To date, two types of outward currents and one type of inward current activated by membrane potential jump, and one type of inward current activated by application of ATP to outer membrane have been identified.

132, II P (2) 0900

CHANGE IN IONIC SELECTIVITY OF NERVE MEMBRANE BY INTRACELLULARLY APPLIED Ca ION. YAMAGISHI, S., FURUYA, K., KUKITA, F. AND HIRONO, C. Dept. Cell Physiol., National Inst. for Physiol. Sci., Myodaiji, Okazaki 444.

Effect of intracellularly applied Ca or EGTA on ionic selectivity of nerve membrane was examined using squid giant axons. The axon immersed in artificial sea water was intracellularly perfused with a K-salt solution as a control. When Ca ion was applied internally, the action potential was depressed with increase in Ca concentration. Under voltage clamp experiment, an inward Na current (I_{Na}) and an outward K current (I_K) were depressed by internal addition of Ca ion. I_{Na} was completely inhibited by 30 mM Ca addition to 100 mM K^+ solution. The apparent K_D's of I_{Na} and I_K inhitition were 2.8 mM and 5.8 mM respectively.

Concerning the resting membrane, the resting potential slowly depolarized with time by continuous perfusion of Ca ion. At this condition, K selectivity, tested by external K concentration change, decreased to one sixth of the control. While Na selectivity somewhat increased. When the axon was previously perfused with a K-EDTA solution for 5 minutes aiming to remove internally bound Ca, the membrane had changed to anion selective. Namely, the membrane potential changed for 28 mV by 10 fold increase in external Cl concentration which was 9 times lager than that of the control.

133, II P (3) 0900

VOLTAGE-GATED Ca^{2+}-CHANNELS IN ZONA GLOMERULOSA CELLS FROM RAT ADRENOCORTICAL GLAND. MARUYAMA, Y., MATSUNAGA, H. AND HOSHI, T. Dept. of Physiol., Faculty of Med., Tokyo University, Tokyo 113

Zona glomerulosa cells of adrenal cortex respond to various stimuli such as Angiotensin II, ACTH and serum K^+ and consequently secrete Aldosterone which regulate circulating blood volume by acting renal distal tubules to uptake and retaine Na^+. The secretory process of Aldosterone is totally depend on internal Ca^{2+} and/or external Ca^{2+}. This suggests that the specific pathways for Ca^{2+} (channels) is present in the plasma membrane of zona glomerulosa cells. With the help of giga-seal whole-cell clamp technique, we demonstrated the presence of voltage-gated Ca^{2+}-channels in the cells from rat. The Ca^{2+}-current was present only if cells were clamped at negative potentials (about -80mV), was most prominent for relatively small depolarization (at about -20 mV), and inactivated within tens of milliseconds. Ba^{2+} could be replaced as a charge carrier for the Ca^{2+}-channels and Nitrendipine (1 μM) reduced the size of inward current. Extreme sensitivity for K^+ of the cells could be explained by that this Ca^{2+}-channel has a low threshold voltage of -60 mV.

134, II P (4) 0900

CHARACTERIZATION OF THE GABA-INDUCED CHLORIDE CURRENT IN THE SPINAL GANGLION CELL OF THE CAT. TANAKA, E., HIGASHI, H. AND NISHI, S. Dept. Physiol., Kurume Univ. Sch. Med., Kurume 830

GABA induces in cat spinal ganglion cells an inward current which is carried by chloride ions moving through the GABA receptor membrane. The noise analysis of the GABA-induced current showed that the activated chloride channels have the mean life time of 10.8 ms, single channel conductance of 50 pS and single channel current of 4 pA. Double reciplocal plots for the mean life time and GABA concentration yielded the values of the forward (β) and backward (α) rate constants of the GABA receptor-ionophore complex to be 63 $s^{-1}(\beta)$ and 50 $s^{-1}(\alpha)$, respectively. On the assumption that the chloride channel opens according to the two-step model, GABA-induced current was reconstructed by a computer-aided simulation using these kinetic parameters. It was revealed that the theoretically obtained GABA-current matched very well with those of the experimentally observed membrane current, while the concentration of GABA calculated for the theoretical GABA-current appeared to be 5 to 10 times greater than that actually needed for the GABA-induced current.

135, II P (5) 0900

ACTIVATION OF K^+ AND Cl^- CHANNELS AND CHANGES IN THE INTRACELLULAR ION CONCENTRATIONS DURING CELL VOLUME REGULATION IN HYPOTONIC SOLUTIONS. HAZAMA, A., OIKI, S. AND OKADA, Y. Dept. Physiol., Kyoto Univ. Sch. Med., Kyoto 606

Cells can regulate their volumes in hypotonic solutions: Initial swelling due to passive water influxes is followed by a regulatory volume decrease (RVD) due to KCl effluxes. To examine the RVD mechanism in cultured epithelial Intestine 407 cells, electrophysiological studies were carried out. The cells exhibited transient hyperpolarizations in response to the application of hypotonic media. This hyperpolarizing response was inhibited by quinine or Ba^{2+}, and prolonged by SITS under control conditions. In a low Cl^- solution, the hyperpolarization was followed by a depolarization which was suppressed by SITS. Voltage clamp studies indicated that biphasic membrane currents consisting of a quinine-sensitive K^+ current and a SITS-sensitive Cl^- current are associated with the membrane potential changes upon the RVD. By means of ion-selective microelectrodes, it was found that the intracellular K^+ and Cl^- concentrations temporarily decreased (from about 100 and 37 mM to about 50 and 7 mM, respectively) and then gradually resumed during the RVD. Taken together, it is concluded that quinine-sensitive K^+ and SITS-sensitive Cl^- channels are serially activated upon hypotonic stimulation, and the K^+ and Cl^- effluxes thus produced drive the extrusion of water which resets cell volume.

136, II P (6) 0900

MODIFICATION OF K CONDUCTANCE OF THE SQUID AXON MEMBRANE BY SITS. INOUE, I., Inst. Marine Biol. Sch. Medicine, Tokushima Univ. Seto-cho, Naruto City, Tokushima, 771-03

Effects on g_K of 4-acetamido-4'-isothiocyanostilbene-2,2'-disulfonic acid (SITS) which is known as a blocker of anion transport as well as that of voltage dependent Cl conductance of the squid axon membrane were studied on internally perfused axons of squid, Doryteuthis bleekeli. 3-200 μM of SITS was applied internally. The SITS effects are summarized as follows: (1) Slowing-down of the open-close rates of K channels in the whole voltage region. (2) Appearance of steady g_K at a voltage below -100 mV, and as a consequence the steady g_K at a level of normal resting potential (∿-60 mV) increased to a level of approximately 30% of the maximum g_K after the maximal drug effect attained (<30 μM). (3) Disappearance of the g_K inactivation which was found to become distinct at relatively high temperature (>10°C). These SITS effects proceeded depending solely on the drug concentration, and were almost irreversible.

These effects of SITS on g_K were somewhat similar to those on g_{Na} of one family of reagents, such as veratridine, batorachotoxin, and grayanotoxin, which are used as Na channel openers.

137, II P (7) 0900

BLOCKING BEHAVIOR OF SINGLE SODIUM CHANNELS IN ARTIFICIAL LIPID BILAYERS. UEHARA, A. AND MOCZYDLOWSKI, E.* Dept. of Physiol., Sch. of Med., Fukuoka Univ., Fukuoka 814-01, *Dept. of Physiol. and Biophys., Cincinnati Univ., U. S. A.

Effects of various pharmacological agents that block single sodium channels from mammalian skeletal muscle, heart muscle and brain in lipid bilayers could be described in terms of three modes of action that correspond to at least three different binding sites. Guanidinium toxins such as tetrodotoxin and saxitoxin act only from the extracellular side and induced discrete blocked states that correspond to residence times of individual toxin molecules. Such toxins apparently do not deeply penetrate the channel pore since the voltage dependence of block is insensitive to toxin charge and block is not relieved by internal Na^+. Many non-specific organic cations including charged local anesthetics exhibit a voltage-dependent block that is enhanced by depolarization when present on the inside of the channel. This site is probably within the pore, but binding to this site is weak, as indicated by fast blockade that often appears as lowered channel conductance. A separate class of neutral local anesthetics such as benzocaine and procaine induced discrete closed states when added to either side of the membrane. This blocking effect could be explained by preferential binding to closed states of the channel.

138, II P (8) 0900

MAITOTOXIN-INDUCED INCREASES IN Ca- AND K-PERMEABILITIES OF CELL MEMBRANE IN MOUSE NEUROBLASTOMA CELLS

MIYAKE, M., Fac. of Phermaceu. Sci., Hokkaido Univ., Sapporo 060

The marine dinoflagellate toxin mitotoxin (MTX) has been suggested to be an activator of voltage-sensitive Ca-channels. We will report here that MTX produces also a marked increase in K(Rb)-permeability of cell membrane in mouse neuroblastoma N-18 cells. Then, the mode of this MTX effect on N-18 cells will be discussed.

When N-18 cells were depolarized in 50 mM $[K^+]_o$, ^{45}Ca-uptake was immediately increased and reached to a steady new level within 8-12 min. MTX also stimulated ^{45}Ca-uptake in N-18 cells; e.g., $5x10^{-10}$ g/ml MTX produced, at the incubation time of 12-16 min, ^{45}Ca-uptake as large as that in 50 mM K^+, while it then increased to 5-8 times larger level at 30 min. In contrast, the same concentration of MTX exerted the maximum effect on ^{86}Rb-efflux within 12-16 min. The MTX($5x10^{-10}$ g/ml)-stimulated maximum rate of the ^{86}Rb-efflux was 10-15 %/min, whereas under the toxin-free conditions the rates were less than 1.5 %/min in the high K^+(50 mM)-solutions and less than 0.3 %/min in the physiological solutions. These results indicate that the MTX-induced marked increase in K(Rb)-permeability is independent of increasing cytosolic free Ca^{2+} which is due to the MTX-induced increase in Ca-permeability of the membrane. MTX may thus open a (non-specific?) monovalent cation-channel in the surface membrane of N-18 cells apart from its effect as an activator of voltage-sensitive Ca-channels. This notion is confirmed by the pharmacological properties of the MTX-induced increase in K-permeability.

139, II P (9) 0900

EFFECTS OF INWARD WATER FLOW ON IONIC CURRENTS IN SQUID GIANT AXONS. KUKITA, F. Lab. Membrane Biol., Natl. Inst. for Physiol. Sci., Okazaki, 444 JAPAN

It is well known that accumulated K^+ in the periaxonal space affects the properties of K-channel in the squid axolemma. In the previous report, I demonstrated that the outward osmotic water flow removed accumulated K^+ practically and uncovered the real properties of K channel, i.e. the Goldman-type rectification and the n^4 kinetics, which could not be observed under the normal condition because of the unexpectedly large amount of K^+ accumulated in the periaxonal space. In this report, I represent the effects of the inward osmotic water flow which could be expected to cause the opposite effects on ionic currents. The typical properties of the K-channel which could be explained by the increase in the accummulated K^+ are as follows: 1) the linear I-V curve, 2) the slower closing kinetics and 3) the smaller K conductance. In addition to the effect above-memtioned, the inward water flow decreased the inward Na current without any large change in its voltage-dependence. I tried to explain all these effects on both K and Na channels by the change in K^+ at the outside surface of the axolemma but could not reject the possibility of some additional mechnical effects of the water flow on the axolemma.

140, II P (10) 0900

SINGLE-CHANNEL CURRENTS IN MOUSE PANCREATIC B CELLS. MURAYAMA, K., MARUNAKA, Y., OHARA, A.† AND KITASATO, H. Dept. Physiol. and †Dept. Biol., Shiga Univ. Med. Sci., Ohtsu 520-21

To clarify the mechanism controlling ionic permeability during the resting and active states in pancreatic B cells, we surveyed ionic channels in the freshly isolated mouse pancreatic B cells that were adhered on the cover slip coated with protamine (1 mg/ml) using single-channel recording techniques. To date we have identified K^+, Cl^- and non-specific (presumably $Na^+ + K^+$) channels. They all but one are regarded primarily as voltage-independent channels, although the opening rate changed a little at different membrane potentials. Most frequently encountered were K^+ channels. From single-channel conductances, those K^+ channels could be grouped to two classes, 36-pS and 55-pS channels. The higher conductance K^+ channels appeared to be Ca^{2+}-dependent, but the lower ones were insensitive to inside Ca^{2+}. The I-V relationship for both K^+ channels was linear on the cell-attached patch, but after formation of the cell-free, inside-out patch, they showed a tendency to become non-linear. In both Cl^- and non-specific channels observed, there were high- and low-conductance channels. We suppose that these Cl^- and non-specific channels may be activated by some chemical substances like transmitters. A voltage-dependent (presumably K^+) channel was also found.

141, II P (11) 0900

A WAVE FUNCTION ON AN AXON HILLOCK. Oonuki, M. Dept.Physiol., Kitasato Univ. Sch.Med., Sagamihara-shi.1-15-1, Kanagawa 228.

The spatial-time figure of a deporalized potential on a membrane of an axon hillock, generalized by activation of synapses, is given as the solution Ψ_i of the following wave-equation.

$$\frac{\partial}{\partial t}\Psi_i = -i\frac{\eta_i}{2\pi\rho}\frac{\partial^2}{\partial x^2}\Psi_i + \frac{m_i\alpha_i}{\theta}\cdot L\cdot\frac{\partial}{\partial x}\Psi_i$$

γ_i : time constant of a psp of the i-th synapse
η_i = 1-exp-d/γ_i
d : absolute refractory period
ρ : density of channels on an axon hillock
L : length of an axon hillock
m_i = $a_i(\gamma_i/d)\eta_i$
a_i : amplitude of a psp of the i-th synapse
α_i : frequency of activation of the i-th synapse
θ : threshold-deporalized potential

The above equation shows that both a quantum-mechanical wave and a clasical one work.

142, II P (12) 0900

POLYETHYLENE GLYCOL(PEG)-INDUCED FUSION OF DISSOCIATED DROSOPHILA NEURONS. SUZUKI, N. Dept. Physiol., Kitasato Univ. Sch. Med., Kanagawa 228.

I report fusion of normal Drosophila neurons dissociated from the larval central nervous system (CNS). A primary culture system of dissociated CNS neurons of both the wild type and mutants have been recently established. These dissociated Drosophila neurons can be fused to yield multinucleated cells by PEG treatment. The best fusion efficiency and survival rate of fused cells were produced by 50% solution of PEG of about 6000 mol. wt. Under this condition, the fusion index was about 30% and more than 60% of fused cells were viable. The fused cells could be grown in culture for more than a week and showed characteristic neuronal morphology. Since neurophysiological analysis of Drosophila neurons has been hindered by the small cell size, the large fused cells may facilitate the studies of the primary defects in various neurological mutants of Drosophila.

143, II P (13) 0900

NITRENDIPINE BINDING IN CULTURED CHICK SKELETAL MUSCLE CELLS. SATOH, R. and KANO, M. Dept. of Physiol., Kitasato Univ. Sch. of Med., Sagamihara, Kanagawa 228

We examined the binding of ^{3}H-nitrendipine, a potent Ca channel antagonist, to chick skeletal muscle cells differentiating in cell culture. Two types of saturable binding sites for the ^{3}H-nitrendipine were observed. The high and low dissociation constants (Kd) obtained from Eadie-Hofstee analysis were approximately 8.5 nM and 1.2 nM, respectively. These Kd values were not significantly altered throughout the culture period examined. There were significant increases in the maximum binding capacities (Bmax) for both binding sites between third and ninth days in culture. Since nitrendipine was a putative ligand for voltage-sensitive Ca channeles, these results suggest the development of the voltage-sensitive Ca channels in differentiating skeletal muscle cells. The role of these two types of nitrendipine binding sites on diffentiating chick skeletal muscle cells remained to elucidate.

144, II P (14) 0900

MEMBRANE PROPERTIES AND INTRACELLULAR BIOCHEMICAL PROCESSES DURING VASOPRESSIN-INDUCED BURSTING ACTIVITY IN SNAIL NEURONS. KISHII, K., ONOZUKA, M., FURUICHI, H., IMAI, S. AND SUGAYA, E. Dept. of physiol. Kanagawa Dental College, Yokosuka 238

To elucidate the mechanism of generation of bursting activity, effects of arginine vasopressin (AVP) were studied electrophysiologically and biochemically in neurons of the snail, Euhadra peliomphala. AVP caused bursting activity as well as the development of a negative resistance characteristics (NRC) in the current voltage (I-V) curve of the identified neurons. Similar effects were observed by application of veratridine, dibutyryl cyclic AMP and isobutylmethylxanthine. Both the electrical activity and the I-V relation induced by AVP were markedly inhibited by reduction of extracellular sodium but not by cobalt-substituted calcium-free saline. This hormone also brought about elevation in the intracellular cyclic AMP level, and increases in adenylate cyclase and protein kinase activities. AVP caused also promotion of calcium release from the intracellular reservoir, lysosome-like granules. These results suggest the possibility that AVP-induced bursting activity is mediated not by its direct ionic influx action, but through the intracellular biochemical processes.

145, II P (15) 0900

EFFECT OF HYPOXIA ON THE HIPPOCAMPAL CA1 NEURONS IN RAT BRAIN SLICES. HIGASHI, H., YOSHIMURA, M., #FUJIWARA, N. AND #SHIMOJI, K. Dept. Physiol., Kurume Univ. Sch. Med., Kurume 830 and #Dept. Anesth., Niigata Univ. Sch. Med., Niigata 951

In response to 40 min superfusion of a hypoxic medium equilibrated with 95%N_2/5%CO_2, a majority of the neurons showed a transient slow hyperpolarization of 5-10 mV. It was, in turn, followed by a slow depolarization which reached within 20 min a plateau level of about 25 mV from resting potential. The changes induced hypoxia were fully reversible when the slice was reoxygenated, i.e., the neuron immediately began to repolarize and showed a transient hyperpolarization of about 5 mV, and the membrane potential returned to pre-hypoxic levels after 20 min of reoxygenation. Analysis revealed that the initial hyperpolarization is due to an increase in voltage-independent K^+ conductances, presumably such as ATP-sensitive and Na^+-activated K^+ conductances, and that the subsequent depolarization is brought about by accumulation of extracellular K^+ due to reduction in the Na pump activity, and that the reoxygenation-induced hyperpolarization is produced by reactivation of the Na pump. In a minority of neurons, the plateau phase of the slow hypoxic depolarization was followed by a phase characterized by a faster depolarization which may be due to Ca^{++} influx, and resting potential was subsequently abolished after 20-30 min of hypoxic superfusion. These results indicate that low O_2 tension per se may not be the major cause of neuron damage due to asphyxia.

146, II P (16) 0900

EFFECTS OF INHIBITORY AMINO ACIDS ON PYRAMIDAL NEURONS IN THE GUINEA-PIG HIPPOCAMPUS IN VITRO. INOKUCHI,H. AND NISHI,S. Dept. Physiol., Kurume Univ.Sch.Med.,Kurume 830

GABA and taurine are inhibitory amino acids which are contained in hippocampal neurons with short axons. Intracellular recordings from CA1 neurons in hippocampal slices were made to examine the action of taurine and to compare it with those of GABA and baclofen. Drugs were applied by superfusion. Taurine (1 mM) produced a hyperpolarization associated with a decrease in membrane resistance. The hyperpolarization persisted as long as taurine was present, while it was suppressed by strychnine (10 μM), but unaffected by bicuculline (30 μM). At higher concentrations of taurine, the decay of hyperpolarizing response was intervened by a phase which showed a much lower resistance than that during the peak of hyperpolarization. Bicuculline (30 μM) selectively eliminated the intervening low risistance phase. The taurine-hyperpolarization was reversed at approximately -70 mV at which the GABA response was also inverted, while the baclofen-produced hyperpolarization was not reversed. These findings point to that taurine increases the chloride conductance across the cell membrane and that it activates the receptor which is sensitive to blocking action of strychnine. Taurine, at higher concentrations, activates $GABA_A$ receptor, while it is without effect on $GABA_B$ recptor.

147, II P (17) 0900

CHARACTERIZATION OF GLUTAMATE AND KAINATE RECEPTORS INDUCED IN XENOPUS OOCYTES BY RAT BRAIN mRNA. HIRONO, C., ITO, I. AND SUGIYAMA, H. Lab. Memb. Biol., Natl. Inst. Physiol. Sci., Okazaki 444.

When Xenopus oocytes were microinjected with poly(A)$^+$ mRNA isolated from rat brains, the oocytes were found to acquire electrophysiological responsiveness to excitatory acidic amino acids. Under voltage clamp conditions at -60 mV, kainic acid (KA) caused sustained inward current responses, whereas quisqualic acid (QA) caused transient, oscillatory inward current responses. Glutamate at lower concentrations caused responses very similar to QA responses, while at higher doses it also induced responses of KA type. Although QA and KA responses were accompanied by increases in membrane conductance, the reaction mechanisms of the two responses appeared to be completely different because: (1)Response patterns were different (oscillatory or sustained). (2)Reversal potentials were different (-40 mV for QA, 0 mV for KA). (3)Intracellularly applied EGTA blocked QA responses but not KA responses. (4)QA responses were abolished when ACh responses of the same cell, which we have reported previously, were desensitized by ACh, and the reverse was also the case, whereas no interactions were observed between KA responses and ACh responses. These results suggested that rat brain mRNA induced at least two types of amino acid receptors which appeared to be activated both by glutamate but had totally different reaction mechanisms.

148, II P (18) 0900

CYCLIC NUCLEOTIDE IN THE EL MOUSE AND EFFECTS OF ANTICONVULSATS. ISHIGE,A., SEKIGUCHI,K., IIZUKA,S., ITOH,K., SUGIMOTO,A., ABURADA,M., HOSOYA,E. AND SUGAYA,E.* Tsumura Res. Inst. for Pharmacology, Ibaraki and *Dept. of Physiol., Kanagawa Dental Coll., Yokosuka.

The El mouse is well known as a seizur model animal. To elucidate the mechanism of seizure discharge in the El mouse, cyclic nucleotide changes in the brain during PTZ-induced seizure were investigated; and the effects of aticovulsants were also examined.

Cyclic nucleotide was measured using the whole brain. El mice showed a higher latent level of cyclic AMP compared with ddY mice. El mice showed increases in cyclic AMP values during seizure induced by tossing-up procedures and in PTZ-induced convulsions in El mice.

The above findings suggest that the latent cyclic AMP level in El mice is higher than that in ddY mice and cyclic AMP content in the brain increases during seizure induced by PTZ or tossing-up procedures; and also suggest that anticonvulsant drugs inhibit cyclic AMP elevation during seizure.

149, II P (19) 0900

INHIBITION OF Na CHANNEL BY CELL SURFACE EXPANSION CAUSED by FATTY ACIDS.
HORIE,H.,KAWASAKI,Y.* AND TAKENAKA,T., Dept. of Physiol.,Yokohama City Univ.232, Mitsubishi-Kasei Inst. of Life Science 194.

2-Decenoic acid reversibly inhibit the Na channels of squid giant axons. In this work we have studied effets of 2-Decenoic acid on two aspects of tissue cultured dorsal root ganglion neurons dissected from adult mice. (1) the intensity in a round area, dia 4um, of fluorescent probe F18, 5(octadecylthiocarbamoylamino)fluorescein, labeled to the neurons (2) size of the neurons measured under Nomarski optics equipped with a computerized video system. When 2.1mM 2-Decenoic acid was externally applied to the labeled neurons, the relative value of the intensity of F18 decreased 0.82 and after washing it out the intensity recovered to the same level as before the treatment. From the analysis of the video picture a relative value of the diameter of the neurons increased 1.07 and that of the height of neurons increase 1.12 when 2.1mM 2-Decenoic acid was applied to the neurons. From calculation with these two values, a relative value of the cell surface area increased about 1.20 which is almost equal to that calculated from the change of the fluorescent intensity. It is thought that the surface membrane expansion might accompany with increase of pressure in the membrane and this pressure might reduce the opening ability of the Na channels.

150, II P (20) 0900

GANGLIOSIDES IN THE CEREBRAL CORTEX, HIPPOCAMPUS AND PRIMARY CULTURED NEURONS OF EL MICE.
KAJIWARA,K., TAKAGI,T., KOMATSUBARA,J., SUGAYA,E., ITOH,K.*, SEKIGUCHI,K.*, ASOU,H.** and HIRANO,S.** Dept. of Physiol., Kanagawa Dental Coll., Yokosuka, *Tsumura Res. Inst. for Pharmacology and **Dept. of Physiol., Toho Univ., Tokyo.

To determine the differences between epileptogenic neurons and normal nerons, behavior of various gangliosides in neuronal tissues in mutant inbred strain El mice and control ddY mice were investigated.

El mice were trained once a week by tossing-up procedures. The cerebral cortex and the hippocampus of 3-week-old and the 6-week-old El mice as well as ddY mice were removed and gangliosides were measured. Gangliosides of primary cultured neurons of both the El mice and ddY mice were also measured.

The total content of gangliosides in El mice was less than that in ddY mice. The contents of the GQ_{1b}, GT_{1b} and GD_{1b} gangliosides in El mice were less than those in ddY mice. The distribution and concentration of GD_3 gangliosides showed different patterns between El mice and ddY mice. GM_3 and GM_2 gangliosides were increased in the El mice compared with those in ddY mice.

These findings indicate that there are clear differences in the distribution and maturation patterns of gangliosides between El mice and ddY mice.

151, I C 0915

NEUROCHEMICAL STUDIES ON THE DENERVATED HIPPOCAMPUS IN THE RAT IN SPECIAL REFERENCE TO THE NEUROTROPHIC FACTORS IN THE CNS. KOHSAKA, S., #YOSHIDA, K., INOUE, H., TAKAMATSU, K., FUJISHIRO, M., #OTANI, M., #TOYA, S., @ASOU, H., @HIRANO, S., AND TSUKADA, Y. Dept. Physiol., #Dept. Neurosurg., Keio Univ. Sch. Med., @Dept. Physiol., Toho Univ. Sch. Med., Tokyo.

Our previous studies have demonstrated the existence of neurotrophic factors in rat hippocampal extract (HNTFs) for the cultured neural cells from rat brain. The activity of HNTFs was found to be increased by 14 days after the septo-hippocampal deafferentation. The hippocampal sections were immunohistochemically stained with antisera to glial fibrillary acidic protein (GFAP), S-100 and myelin basic protein (MBP). The staining patterns of GFAP and S-100 in the hippocampus showed practically no difference between the operated and the control rats. In contrast, MBP-positive fibers were hardly detected in the operated hippocampus.

Although small amount of GD_{1a}, GT_{1b} and sialic acid could be detected in the hippocampal extract, their contents remained unchanged following the deafferentation. The proteins in the hippocampal extract were analysed by two-dimentional gel electrophoresis. The relative amounts of several proteins were found to be changed by the operation.

152, I C 0930

CHANGES OF CELL MARKER PROTEIN LEVELS IN THE RETINA CAUSED BY THE ADMINISTRATION OF METHYLAZOXYMETHANOL DURING THE FETAL OR NEONATAL PERIOD OF RATS. NAGAYOSHI, M., HIRATA, Y. AND MATSUTANI, T. Dept. of Develop. Physiol., Inst. for Comprehensive Med. Sci., Fujita-Gakuen Health Univ. Sch. of Med., Toyoake, Aichi 470-11

The levels of several cell marker proteins in the retina were determined in rats with microencephaly induced by prenatal treatment with methylazoxymethanol (MAM) [15mg/kg maternal body weight / day; intraperitoneal injection], an antimitotic agent, on the 11th to 13th days of gestation (Exp. I group), and rats neonates were subcutaneously injected with a single dose [20mg / kg body weight] of MAM on the 1st day after birth (Exp. II group). The cell marker proteins were determined with a sensitive enzyme immunoassay. Elevated level of non-neuronal enolase (NNE; αα-enolase) was 1.5 fold of control value in the retina of Exp. I group. However, on the MAM-postnatal treated retina, the level of NNE was reduced to about 70% of the control value. On the other hand, the levels of neuron-specific enolase (NSE; rr-enolase) and S-100b protein, as a marker of astroglial cell, were not changed much in both the Exp. I and II groups. A further study will be necessary to elucidate the relationship between distribution of NNE in the retinal cells and a functional role of NNE in visual system.

153, I C 0945

CONVULSIVE ACTIVITY OF 2-GUANIDINOETHANOL. EDAKI, A.*, WATANABE, Y.*, KATAYAMA, Y.* & YOKOI, I. Dept. Neurochem., Inst. Neurobiol., Okayama Univ. Med. Sch., Okayama 700

We identified a new guanidino compound, 2-guanidinoethanol (GEt), in human urine, and the CNS action of GEt was investigated in the rat. GEt was synthesized from O-methylisourea and 2-ethanolamine, according to Weiss and Krommer with some modification by us. In all experiments, 300 mM of GEt solution was used.

Several min after the intraventricular injection of 25 µl of GEt solution, male SD rat started to show myoclonic twitching, running fit and tonic and clonic convulsions.

EEG with epidural electrods revealed initiation of spike discharges (Sp-D) several min after intraventricular injection of GEt (25 µl). Thereafter polyspikes, 3 cps spike & wave complex and finally ictal-seizures developed about 30 to 60 min after injection.

EEG revealed Sp-D in 2-10 min at the side of GEt application on pia mater (3 µmol), and then a burst of multiple Sp-D developed. During a burst, Sp-D propagated to the opposite cerebral hemisphere. Two hours after the topical application, propagation of Sp-D was completed.

154, I C 1000

APPLICATION OF HIGH RESOLUTION H-NMR SPECTROSCOPY TO STUDIES ON RAT BRAIN ISCHEMIA

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NMR spectra with Bruker's WP80SY-WG were taken after decapitation of Wistar rat, using 3 kinds of brain tissue samples : the 1st, native tissue strip of 50 mg wet weight aspirated into the Teflon tube of 2.4 mm i.d. and blown into the 5 mm NMR tube containing 0.2 ml D2O ; the 2nd, native tissue brei of 0.3 mg made by homogenating a mixture of whole brain(2 g wet weight) and 3 ml D2O ; the 3rd, lyophilized tissue strip of 10 mg dry weight taken into 0.2 ml D2O.

FT spectra after 32 accumulations of NMR FID pre-saturated with Homogated-decoupling at the water signal were observed as follows : in the 1st sample, the sharp peaks of 10 in number were appeared with band width 4-6 Hz and S/N 2-10 on the high field side of water signal ; in the 2nd, they became broader in band width ; in the 3rd, they showed much more narrowing without Decoupling than those of the 1st.

Peak-assignment in FT spectra was established at 1.3, 2.4 and 2.8 ppm each by addition of 500 μg lactate, 50 μg glutamine and 50 μg aspartate.

The Spin-Echo method taking adequate t in the pulse sequence of 90°x-t-180°y-t-aquisition successufully resulted in peak-enhancement of the FT spectra above-mentioned.

155, I C 1015

KININASE IN CEREBROSPINAL FLUID AND CENTRAL ACTION OF BRADYKININ AND ITS METABOLITES.

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Incubation of synthetic peptides with rat cerebrospinal fluid(CSF) in vitro and the analyses of the incubation mixtures by reversed-phase high performance liquid chromatography(HPLC) demonstrated that rat CSF contained a kininase II like activity which metabolized bradykinin(BK) first to its amino terminal heptapeptide(BK 1-7) and then to pentapeptide(BK 1-5) while converting angiotensin I to angiotensin II and which was inhibited by EDTA, o-phenanthroline and BK-potentiators. The UV absorption profile of the gelfiltration HPLC of dialyzed and freeze-dried rat CSF on TSK 3000 SW(Toyo Soda,Japan) consisted of three major peaks partially overlapping each other and some minor ones preceding them. Most of the BK metabolizing activity was recovered in the earlier fractions including some of the minor peaks, their retention times being shorter than those of such standard proteins as rabbit IgG(MW= 160K) or yeast glutamate dehydrogenase(MW=290K) under a certain chromatographic condition without protein denaturation. The intracisternal administration of 100 pmoles of BK caused transient hypotension sometimes followed by hypertension in urethane-chloralose anaesthetized rats. Similar responses were observed with the corresponding doses of the BK metabolites, BK 1-7 and BK 1-5.

156, I C 1030

CHANGES IN CONCENTRATION OF GANGLIOSIDE FRACTIONS IN THE dw CEREBRUM.

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The concentration of gangliosides was studied in the dw cerebrum from postnatal day 5 to day 40. In the dw cerebrum, the concentration of gangliosides increased up to postnatal day 15 and, thereafter, stopped increasing, whereas that of the control cerebrum continued to increase up to postnatal day 40. Among the fractions of gangliosides of the dw cerebrum, the concentration of GM4, GM3, GM2, GM1, GD1a, GD3, GT1b and GQ1b stopped increasing after postnatal day 15 and, on postnatal day 40, the concentration of each fraction mentioned above was found to be significantly less than the levels of the respective fraction of the controls.

157, I C 1045

A DEVELOPMENTAL CHANGE OF GANGLIOSIDE CONTENT IN MATERNAL HYPERPHENYLALANINEMIA IN RATS. HARADA, Y., ASOU, H., AND HIRANO, S. 2nd Dept. Physiol., Toho Univ. Sch. Med., 5-21-16, Ohmori-Nishi, Ohta-ku, Tokyo

An animal model of maternal hyperphenylalaninemia was made by the gavage of 2000 mg/kg of L-Phe to pregnant rats three times per day from day 10 through day 14 of gestation. Dams were allowed to litter naturally. The brains of the neonates or young were removed and weighed on days 4, 15, 21 and 49 after birth. The brains were cut into three parts, i.e., cerebrum, cerebellum, and diencephalon with medulla oblongata. Their content of gangliosidic N-acetyl neuramic acids and the gangliosides pattern were studied. The gangliosides pattern was varied with the brain regions and with the growth and development of animals. Animals derived from hyperphenylalaninemic mother showed significant reduction of the cerebral weight. And the concentration of sialic acids was decreased in the cerebrum of these animals, although the gangliosides pattern was not altered by the treatment.

158, I C 1100

BRAIN GANGLIOSIDES OF NEUROLOGICAL MUTANT MOUSE. HIRANO, S.[1], ASOU, H.[1], HARADA, Y.[1], OKANO, H.[2], MIKOSHIBA, K.[2], FUJISHIRO, M.[3] AND TSUKADA, Y.[3] Dept. Physiol., Toho Univ. Sch. Med., Tokyo 143[1], Inst. Protein Res., Osaka Univ., Osaka 565[2], and Dept. Physiol., Keio Univ. Sch. Med., Tokyo 160[3].

We have analyzed the ganglioside composition of neurological mutant mice, shiverer and myelin deficient (mld), which suffer from a membrane disease affecting myelin formation and maintenance, both having an abnormal and poor myelin formation of the central nervous system. The results obtained were summarized as follows, the lack of monosialo-gangliosides, especially GM_3 and GM_4, observed in those mutant mice brain may be related to the abnormal oligodendrocyte differentiation and contribute to a defect in myelin compaction not found in the normal mouse brain and in other dysmyelinating mutants.

159, I C 1115

RELATION BETWEEN LIPID COMPOSITION OF MYELIN-LIKE MEMBRANE AND CONDUCTION VELOCITY OF VENTRAL NERVES OF SHRIMPS AND EARTHWORMS. YAMAGUCHI, H. AND KISHIMOTO, Y.* Dept. Physiol., Sch. Med., Univ. Tokushima, Tokushima 770, *Dept. Neurol., Johns Hopkins Univ. Sch. Med., Baltimore, Maryland 21205, U.S.A.

We showed that there are differences in conduction velocity and myelin component especially lipids between shrimp (Penaeus duorarum) and the earthworms (Lumbricus terrestris). In view of the important role of myelin in facilitating saltatory nerve conduction, we measured nerve conduction velocities of ventral nerves in two spiecies above, which had been had 90-120 and 30 m/sec, respectively. On the other hand, the lipid composition of myelin-like membrane fractions from ventral nerves of both animal types were examined. Most of the lipids in shrimp nerve, including glucocerebroside, sphingomyelin, phosphatidylcholine, -serine, -ethanolamine, ethanolamine-plasmalogen and cholesterol appeared to be concentrated in this fraction. The ventral nerves of earthworms are wrapped in copious layers of loosely bound membrane, superficially resembling the myelin sheath of vertebrates. However, neither galactocerebroside nor sulfatide which are considered to be marker for myelin, was present, and only traces of glucocerebroside, which is abundant in shrimp nerve, were detected. The lipids were rich in cholesterol and phospholipid. Sphingomyelin, which is considered a ubiquitous component of animal membranes, was not detected.

160, I C 1130

THE STRUCTURE OF MYELIN MEMBRANE GLYCOPROTEIN. SAKAMOTO, Y., YOSHIMURA, K.*, NISHIJIMA, T.* AND UYEMURA, K. Dept. Physiol., Saitama Med. Sch., Moroyama, Saitama, 350-04

Mammalian peripheral nerve myelin contains a large quantity of glycoproteins, which may play an important role in myelin structure. Among these glycoproteins, the PO protein is a major glycoprotein (M.W. 28,000 dalton). In order to understand relationship between glycoproteins and myelin structure, we analyzed primary structure of bovine PO protein. After purification of PO protein by SDS gel filtration, the sequence of the PO protein was studied by a combination of proteolytic digestion and cyanogen bromide cleavage. The peptides digested with lysyl endopeptidase, trypsin, and staphylococcal protease were fractionated by reverse phase HPLC. Using a gas phase sequenator, GC-MS and FAB-MS, primary structure of 219 amino acid residues of the PO protein was determined. It contains an extremely hydrophobic center region (Tyr125-Ile150), as follows; (-Tyr-Gly-Val-Val-Leu-Gly-Ala-Val-Ile-Gly-Gly-Val-Leu-Gly-Val-Val-Leu-Leu-Ala-Leu-Leu-Leu-Phe-Tyr-Leu-Ile-). Probably this reigon spans a membrane lipid bilayer. The N-terminal region including the carbohydrate-attached site (Asn 93), previously reported, and the C-terminal domain seem to be exposed to extracellular and cytoplasmic space, respectively. The C-terminal region is extremely basic and may interact with acidic lipid in the opposite membrane layer.

161, I C 1145

IMMUNOHISTOCHEMICAL STUDY OF REACTIVE ASTROCYTE IN THE COLD INJURED RAT BRAIN. TAKAMIYA,Y.,TOYA,S.,OTANI,M.,MURAKAMI,H.,IMANISHI,T.,#KOHSAKA,S.,@MIKOSHIBA,K.,##OGAWA,Y.,and #TSUKADA,Y. Dept. Neurosurg.,#Dept. Physiol., Keio Univ. Sch. Med.,@Protein Res. Ins. Osaka Univ.,##Dept. Neuropathol., Tokyo Metro. Ins. for Neurosci.

It is well known that reactive astrocyte increases in number around a wound in the brain following injury. Immunohistochemical studies were performed on rat brain following cold injury using antisera to glial fibrillary acidic protein(GFAP) and S-100 protein. From 2 days after the operation, GFAP positive cells began to increase in number and in density around the wound and spread to the areas distant from the wound by 3 days. The distribution of reactive astrocytes coincided with a flow of edema fluid suggesting the association of trophic factors in the fluid. S-100 positive cells were also increased in the same manner as GFAP positive cells. The results may suggest that the expressions of GFA and S-100 proteins in the reactive astrocytes are thought to be occurred following the proliferation of protoplasmic astrocytes. To testify this suggestion, proliferation of astrocytes was investigated immunohistochemically with monoclonal antibody to bromodeoxyuridine(BUdR).

162, I C 1300

AGING EFFECTS ON BRAIN METABOLISM OF SEROTONIN AND DOPAMINE. HORI, S. AND OHTANI, S.* Dept.Neurochem., Tokyo Metropolitan Institute for Neurosciences, Tokyo 183

Metabolism of neurotransmitters in brain is changed by aging of animal. In this paper, we examined the age-dependent changes of serotonin and dopamine metabolism in human cerebro-spinal fluid and rat brain. Human cerebro-spinal fluid (0.5 - 1 ml) were obtained by lumbal puncture from the patient of appendicitis or bone fracture at the ages between 6 and 75 years old. The contents of tryptophan, 5-HIAA and tyrosine in the cerebrospinal fluid were not significantly changed during the experimented ages. On the other hand, the content of HVA in the cerebrospinal fluid was gradually decreased from the age of 6 years old to the age of 20 years old, but after 20 years old, its content did not significantly changed up to 75 years old. These results suggest that dopamine containing neurons in human brain gradually decrease up to 20 years old and after them keep the stationary level up to 75 years old. To confirm these results, the content of HVA in the rat brain were examined. HVA content in brain did not change up to 31 weeks after birth, but after 37 weeks, its content significantly decreased. These results shows why Parkinson's disease which is the degenerative disease of the dopamine containing neuron in the nigra-striatum is almost appeared after the middle age.

163, I C 1315

NEUROPEPTIDES AND INSULIN RELEASE. YANAIHARA, C.,[1] HASHIMOTO, Y.,*[1] MOCHIZUKI, T.*[1] AND YANAIHARA, N.[1,2] [1]Lab. Bioorg. Chem., Shizuoka Coll. Pharm., Shizuoka 422, and [2]Lab. Cell. Metabol., Nat. Inst. Physiol. Sci., Okazaki 444

As a part of our study to analyze the implication of peptidergic nervous regulation in pancreatic endocrine functions, we examined in this study, the influences of fourteen biologically active peptides including 9 neuropeptides comparatively on glucose-induced insulin release from the isolated perfused rat pancreas. VIP, PHI(rat), GIP, helodermin, and neuromedin B at 10^{-9} - 10^{-7}M enhanced significantly both phases of glucose (150 - 300 mg%)-induced biphasic release of insulin. Substance P and substance K exerted only weak potentiating effects on either or both phases of the insulin release and the effects were not statistically significance. GRP and bombesin potentiated, though not significantly, only the first phase of the release. Secretin (human), ANF (rat) and CCK8 had little effects on the insulin release. Conversely galanin as well as somatostatin-14 suppressed significantly the glucose-induced insulin release. The pattern of the potentiating effect on insulin release differed depending on peptide used. This observation seems to be correlated with diverse modes of these peptide effects on cyclic nucleotide accumulation and/or Ca^{2+} handling in the pancreatic B cell at an earlier stage of a series of intracellular reactions leading to insulin release.

164, I C 1330

INTRACELLULAR CO-EXISTENCE AND BIOSYNTHESIS OF NEUROPEPTIDES, PHI AND VIP. HOSHINO, M.,[1] OGINO, K.,*[2] SUZUKI, T.,*[1] YANAIHARA, C.[2] AND YANAIHARA, N.[1,2] [1]Lab. Cell. Metabol., Nat. Inst. Physiol. Sci., Okazaki 444, and [2]Lab. Bioorg. Chem., Shizuoka Coll. Pharm., Shizuoka 422

Neuropeptides VIP and PHI share a common precursor of 170 amino acid residues. We have previously isolated VIP-28 from human neuroblastoma NB-OK-1 cells proving the production and release of this peptide in the cells. The present study focussed on VIP/PHI-related peptides in the cells as processing products of the precursor. PHI-27 (human) was isolated from extract of the cells and sequenced. The production of VIP-28 was exceedingly higher than that of PHI-27. Even the production of intermediate forms containing PHI sequence was as a whole lower than those related to VIP. As major VIP/PHI common biosynthetic intermediates, 12K- and 8K-dalton components were demonstrated. Processing of the precursor in terms of VIP, VIP-28 was almost exclusively the final product, while regarding PHI, PHI-27 was rather a minor component and, instead, the major product was a 5 - 6K-dalton component, presumably N-terminal-extended form of PHI. The VIP/PHI precursor itself was also demonstrated to be released into culture medium. The present results demonstrate that the productions of the two active peptides from the common precursor are not necessarily synchronized on an equimolar basis at least in the system currently used.

165, II P (44) 1330

FUNCTION AND MORPHOLOGY OF IDENTIFIED HISTAMINERGIC APLYSIA NEURON, C2
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Identified Aplysia neuron C2 had previously been shown to contain high concentration of histamine;in addition, 3[H]-histamine injected into its cell body was found to move along the axons by fast transport. Furthermore, several electrophysiological actions of C2 on identified follower cells were simulated by the application of histamine. C2 converts 3[H]-histamine: 16 % of the labeled precursor was converted to histamine 1 hour after injection. No conversion occurred after injection of other identified Aplysia neurons that are known to use other neurotransmitter substances. We also examined the fine structure of C2. The widespread distribution of axon terminals is consistent with the idea that C2 is modulatory in function. Characteristic 100 nm dense-core vesicles are present in all regions of the neuron, and are labeled after intrasomatic injection of 3[H]-histamine. 3[H]-histamine is taken up selectively by the cell body and axons of C2. Thus, compelling evidence for the role of histamine as a transmitter has been obtained in C2. Characterization of these features of C2 will serve for identifying other neurons that use histamine as a transmitter.

166, II P (45) 1330

MYELINATION BY BULK-SEPARATED OLIGODENDROCYTES TRANSPLANTED INTO THE SHIVERER MUTANT MOUSE BRAIN.

KOHSAKA, S.[1], INOUE, H.[1], YOSHIDA, K.[2], SHINOZAKI, T.[2], TAKAYAMA, H.[2], OTANI, M.[2], TOYA, S.[2], MIKOSHIBA, K.[3], INOUE, Y.[4], AND TSUKADA, Y.[1]

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Normal oligodendrocytes were obtained from 7-day-old mouse (BALB/c) brains by the Percoll gradient method. The oligodendrocytes (2×10^6 cells) were transplanted into the corpus striatum of 4-week-old shiverer mutant mice which are characterized by the lack of myelin basic protein (MBP). Myelination by the transplanted oligodendrocytes were investigated immunohistochemically and electron microscopically 6 weeks after the transplantation. Certain areas in the corpus striatum were intensely stained with MBP antiserum. Electron microscopic examination revealed that some axons were surrounded by the normal type myelin sheaths with major dense lines. These results clearly indicate that matured oligodendrocytes are able to survive and myelinate the host axons in the adult brain.

167, II P (46) 1330

METHIONINE METABOLISM IN EXPERIMENTAL HYPERPHENYLALANINEMIC RAT BRAIN.

HIRANO, K., KANAMATSU, T., NAKAI, K. AND HIRANO, S. 2nd Dept. Physiol., *Amino Acid Research Unit General Research Center, Toho Univ. Sch. Med. Tokyo 143

To investigate a methionine metabolism in brain tissues of experimental hyperphenylalaninemic rats, L-phenylalanine were force-fed to the rats by a stomach tube twice a day for one week. During this week, an ordinary commercial diet and the commercial diet added with 7% L-phenylalanine were supplied ad. lib. from 10:00 a.m. to 8:00 p.m. and from 8:00 p.m. to 10:00 a.m. respectively. There was no difference in methionine content between the control and experimental rats. However, reduction of cystathionine content was found in experimental animals. One hour after intracerebroventricular injection of ^{35}S-methionine, the radioactivities of cystathionine incorporated from ^{35}S-methionine was found to be 50% of that of methionine itself in both the control and experimental rats. Therefore, these data indicate that the turnover rate of cystathionine was enhanced in experimental hyperphenylalaninemic rats.

168, I A 0945

SCREENING SYSTEMS FOR MONOCLONAL ANTIBODIES WHICH AFFECT SYNAPSE FORMATION. OHGUCHI, Y., KOBAYASHI, K.* AND KURODA, Y. Dept. Neurochem. Tokyo Metropolitan Inst. for Neurosciences, Fuchu-shi, Tokyo 183.

Little is known about the molecular mechanism of synapse formation. In order to search unknown functional molecules, screening of monoclonal antibodies which affect such function is one of the limitted strategies. However, usual screening of hybridoma supernatants is impossible for the synapse formation, because it takes long time to get results. To overcome this difficulty, we try two-step screening method; the first is to make a library of monoclonal antibodies against cell surface antigens and the second is to screen them in the in vitro synapse formation system between cultured neurons. Monoclonal antibody library was made by immunizing cloned pheochromocytoma (PC-12) cells and ELISA-screening. About 60% of the cloned hybridoma secreted monoclonal antibody against a cell surface antigen. Adrenal chromaffin cells or superior cervical ganglion neurons from 8 to 10 days rat were cultured with nerve growth factor. Synapse formation was examined by observing evoked e.p.s.p.s under various conditions and factors, including the monoclonal antibodies.

169, I A 1000

MONOSYNAPTIC CONNECTIONS BETWEEN CEREBELLAR GRANULE AND PURKINJE CELLS IN DISSOCIATED CELL CULTURE STUDIED BY SIMULTANEOUS INTRACELLULAR RECORDING. TOMOO HIRANO, YOSHIHIRO KUBO and MICHAEL M. WU. Department of Neurobiology, Institute of Brain Research, School of Medicine, University of Tokyo, Hongo 7-3-1, Bunkyo-ku, Tokyo 113

Synapses between rat granule and Purkinje cells and voltage-gated ionic currents of granule cells were studied in dissociated cell culture. Purkinje and granule cell cultures were obtained from the cerebella of fetal and new born rats. The Purkinje cells were identified with a monoclonal antibody Leu-4, while granule cells were identified by their small cell size and by electrophysiological demonstration of their excitatory connection with Purkinje cells. Simultaneous intracellular recording from both Purkinje and granule cells with patch pipettes showed that an action potential of a presynaptic granule cell induced an excitatory postsynaptic potential in a Purkinje cell with relatively short and constant latency of 4 msec (shortest case 3 msec) at 20-23 °C. The latency shortened with increased temperature. Q_{10} was approximately 3.5, giving a calculated latency of the EPSP of less than 1 msec at 37 °C. Thus the EPSP was considered monosynaptic. Ionic currents of thus identified granule cells were studied with the whole cell voltage clamp technique. Early and late inward currents and outward currents were recorded. The outward current decreased by using Cs in the intracellular solution. The early and late inward currents disappeared by the substitution of Na with tetramethylammonium and Ca with Mg, respectively. These results indicate that early inward, late inward and outward currents of granule cells are carried by Na, Ca and K, respectively.

170, I A 1015

RESPONSES OF CULTURED CEREBELLAR NEURONS TO EXCITATORY AMINO ACIDS AND ANALOGUES. MORI-OKAMOTO,J. AND TATSUNO,J. Dept. of Physiol., National Defense Medical College, Tokorozawa, Saitama 359

Iontophoretically applied L-glutamate(GLU) and L-aspartate(ASP) induced depolarizing responses in cultured cerebellar neurons explanted from chick embryos. The sensitivities of the neurons to both amino acids increased in the course of maturation. These depolarizations were associated with rather variable changes in input resistance. In more than a half of the neurons tested, however, such input resistance changes were found to be dependent upon membrane potential, i.e., greater increases in input resistance in a potential range of -30 to -60 mV, but only in the presence of Mg^{2+}. GLU- or ASP-induced depolarization was antagonized, but to different extents, by 2-amino-5-phosphonovalerate, 2-amino-4-phosphonobutyrate, D-α-aminoadipate and glutamic acid diethylester. The potencies of these antagonists to suppress the depolarizations induced by GLU, ASP and excitatory amino acid analogues, quisqualate, N-methyl-D-aspartate and kainate, were then compared. The receptor subtypes involved in the effects of GLU and ASP on cultured chick cerebellar neurons are discussed.

171, I A 1030

GLUTAMATE-EVOKED INTRACELLULAR Ca^{2+} ELEVATION IN SINGLE HIPPOCAMPAL NEURONS : ITS DEVELOPMENT UNDER CULTURE. OGURA, A., KUDO, Y. AND AMANO, T. Dept. Neuroscience, Mitsubishi-Kasei Institute of Life Sciences, Minamiooya 11, Machida-shi, Tokyo 194.

It is known that a capability of synaptic long-term potentiation in hippocampal neurons develops during early postnatal days. This has been explained by a development of glutamate-responsiveness in those neurons. It is therefore interesting to know whether such developmental process is reproducible under culture conditions where synaptic input and output are absent. We recently established a fluorometrical system for a quantitative monitoring of an intracellular Ca^{2+} concentration ($[Ca^{2+}]i$) on a single cell basis. We applied this system to single neurons isolated from 18-day embryonic rat hippocampi and maintained under culture. We found that glutamate (10^{-8}-10^{-4}M) caused a significant elevation of $[Ca^{2+}]i$ in a dose-dependent manner and that the sensitivity increased (the minimal dose needed to evoke detectable response became lower and the whole dose-response curve shifted to left) as days after culture proceeded. The neurons isolated from 16-day embryos showed lower sensitivity when compared with those from 18-day embryos and cultured for the same periods. The neurons from 20-day embryos, conversely, showed higher sensitivity. These results suggest that the hippocampal neurons develop their glutamate-sensitivity *in vitro* as well as *in situ*.

172, I A 1045

EFFECTS OF SYNTHETIC DERIVATIVES OF GLYCINE HAVING CYCLOPROPANE RING ON MOLLUSCAN GIANT NEURONS. WATANABE, K. AND TAKEUCHI, H. Dept. Physiol., Gifu Univ. Sch. Med., Gifu 500

In the present study, effects of synthetic derivatives of glycine having cyclopropane ring, dl-α(carboxycyclopropyl)glycine, dl-α(methylenecyclopropyl)glycine, (-)-cyclopropylalanine and N-t-butoxycarboxy-dl-α(carboxycyclopropyl)glycine methylester, were examined with respect to the following identifiable giant neurons of an African giant snail (Achatina fulica Férussac): PON, TAN, RAPN, VIN and v-RCDN. The effects of these derivatives of glycine on the neurons mentioned were compared with those of putative neurotransmitters of amino acids, i. e., glycine, GABA and β-hydroxy-L-glutamic acid, on the same neurons.

Effects of dl-α(carboxycyclopropyl)glycine were markedly inhibitory on the three neurons, PON, VIN and v-RCDN, but excitatory on RAPN. This substance was completely ineffective on TAN.

Effects of dl-α(methylenecyclopropyl)glycine and (-)-cyclopropylalanine were excitatory on RAPN, whereas these substances were ineffective on the other four neurons tested.

On the other hand, N-t-butoxycarboxy-dl-α(carboxycyclopropyl)glycine methylester was completely ineffective on all of the neurons tested in the present study.

173, I A 1100

AMINO ACID RESPONSE INDUCED IN *XENOPUS* OOCYTES BY mRNA FROM MOUSE BRAIN. ASANUMA, A., HORIKOSHI, T. AND YANAGISAWA, K. Dept. of Physiol., Tsurumi Univ., Sch. of Dent. Med., Tsurumi-ku, Yokohama.

Taurine is the most abundant free amino acid in animal. In central nervous system (CNS), taurine has the inhibitory effect as GABA. But, because of complicated arrangement of neurons and of their small sizes, it is difficult to study in detail the responses of neurons to a putative transmitter. To avoid these difficulties, taurine receptor was incorporated into the surface membrane of the oocytes of the *Xenopus laevis* by injection of the mRNA from the mouse brain, and the receptor was studied electrophysiologically. Dose-response relations of four amino acids, taurine, GABA, glycine, and β-alanine were measured by the ordinary voltage clamp method. And also current-voltage relations of these amino acids were measured. Taurine responses were different from GABA responses in 1) dose-response relations, 2) current-voltage relations, 3) bicuculline inhibitory effect. And taurine responses were different from β-alanine and glycine responses in their maximum current and sensitivity. From these results, followings can be said. 1) Taurine receptor must be different from that of the other amino acids, GABA, β-alanine and glycine. 2) Taurine could be a neurotransmitter of a certain neuron in CNS.

174, I A 1115

MECHANISM UNDERLYING UPTAKE AND RELEASE OF ^{3}H-TAURINE IN THE BULLFROG LUMBAR SYMPATHETIC CHAIN. TOSAKA, T., SAKAI, S., HASHIGUCHI, T. AND TASAKA, J. Dept. Physiol., Tokyo Med. Coll., Shinjuku-ku, Tokyo 160

We have shown that a specific uptake mechanism of taurine existed in lumbar sympathetic chain of the bullfrog. The kinetic constants, Km and Vmax, of ^{3}H-taurine uptake were 71.7 nM and 47.6 fmole·mg^{-1}·min^{-1}, respectively. The uptake of ^{3}H-taurine was dependent on extracellular Na^{+} concentration with a Michaelis-Menten type of kinetics. The Hanes-Woolf plot revealed a linear relation to square of extracellular Na^{+} concentration, attaining half-maximal saturation at 37.7 mM. Preganglionic tetanic stimulation, supra-maximal for C-fiber, induced a marked increase in ^{3}H-taurine release. The release was not affected in Ca-free solution containing 2 mM Mn^{2+} and 6 mM Mg^{2+}. On the other hand, deterioration of transmembrane Na^{+} gradient, by either reducing extracellular Na^{+} or elevating intracellular one, suppressed ^{3}H-taurine release. The release was not linked with Na-K pump. It was thus concluded that taurine was incorporated together with sodium ion and that Na spike might play a triggering role on the release of taurine.

175, I A 1130

INHIBITORY ACTION OF TAURINE ON SYNAPTIC TRANSMISSION IN SYMPATHETIC GANGLIA OF THE BULLFROG. HASHIGUCHI, T., SAKAI, S., TOSAKA, T. AND TASAKA, J. Dept. Physiol., Tokyo Med. Coll., Shinjuku-ku, Tokyo 160

We have shown that Na-dependent uptake and release mechanisms of taurine existed in lumbar sympathetic chain of the bullfrog. To elucidate the physiological role of taurine, the effects of taurine on synaptic transmission were studied in the bullfrog sympathetic ganglia. In partially curarized ganglion, taurine, at a concentration between 1 to 10 mM, reduced an amplitude of a compound action potential recorded by air-gap method. This inhibitory effect appeared to be mediated mainly by presynaptic action of taurine, since taurine had little effect on electrical properties of postsynaptic membrane. Intracellular recording from a preganglionic B-fiber revealed that taurine depolarized the axonal membrane with an increase in conductance. ^{3}H-acetylcholine (ACh) release in response to preganglionic stimulation was actually decreased in the presence of 10 mM taurine. Conditioning stimulation applied to the preganglionic C-input partially suppressed the synaptic transmission activated through the B-input. These results suggested that taurine reduced release of ACh so as to inhibit synaptic transmission.

176, I A 1145

MUSCARINIC EFFECTS ON THE ACTION POTENTIAL IN CULTURED SYMPATHETIC NEURONS BY THE MODULATION OF Ca ENTRY. MOCHIDA, S., KOBAYASHI, H. and DEIE, M.* Department of Physiology, Tokyo Medical College, Shinjuku-ku, Tokyo 160.

Conventional intracellular recordings were made to study the muscarinic effects on the action potential (AP) of cultured superior cervical ganglion cells of rabbits. Bath-applied acetylcholine (ACh, ≥10 nM), in the presence of D-tubocurarine, caused diverse changes in AP configuration: 1) decrease in AP height, 2) acceleration of repolarizing phase, 3) decrease in the initial peak of after-spike hyperpolarization (AHP), 4) shortening of the late phase of AHP and 5) depression of after-spike depolarization. These changes were observable before any detectable change in the resting membrane potential. A selective M_1 agonist McN-A343 (≥10 nM) caused all of the above changes. QNB (1 μM) and an M_1 antagonist pirenzepine (1 μM) inhibited the action of ACh (10-100 nM) but an M_2 antagonist gallamine (50 μM) did not show any antagonism. In the Ca free solution, the changes 2-5 were already remarkable without ACh and further application of ACh produced no more or only slight change. In the Na free or TTX-containing (0.1 μM) medium, the Ca-dependent component of AP was depressed by ACh. From the above results, we conclude that the changes in AP caused by the muscarinic action of ACh may primarily be due to the inhibition of Ca entry during the AP.

177, I A 1300

EXCITATORY MUSCARINIC RECEPTOR AND ION CHANNELS IN BULLFROG SYMPATHETIC GANGLION CELLS.
TSUJI, S.* AND KUBA, K. Dept. Physiol., Saga Med. Sch., Saga 840-01.

The excitatory action of a muscarinic agonist, generating the slow excitatory postsynaptic potential in the bullfrog sympathetic ganglion cell, was studied using a single-electrode voltage-clamp technique. A membrane current induced by muscarine (0.1-30 μM) consisted of at least two major components: one is a current induced by reduction of K^+-conductance known as Im and the other is an inward current having a reversal potential more positive than -30 mV. The magnitudes of these components in individual cells are different, resulting in three types of excitatory muscarinic response; Im, non-Im and mixed types.

The dose-response curve obtained from the Im type cell was almost independent of membrane potential, while that of the non-Im or mixed type cell showed a complexed voltage-dependence. Furthermore, the pretreatment with Ba^{2+} (4 mM) increased significantly the non-Im component in some Im type cells. These results confirm the previous conclusions (Kuba & Koketsu, 1976; Akasu, et al., 1985, Jones, 1985 and in part brown & Adams, 1980) that the activation of the muscarinic receptor produces changes in the conducting state of different ion channels, closures of Im channel and opening of non-Im channel, and suggest that a coupling mechanism between the muscarinic receptor and the ion channels is flexible.

178, I A 1315

EFFECT OF EXTRACELLULAR CHOLINE CONCENTRATION ON CHOLINE KINASE AND CHOLINE ACETYLTRANSFERASE ACTIVITIES IN ISOLATED SUPERIOR CERVICAL GANGLIA OF RATS.
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In a search for functional roles of choline kinase (CK) which catalyses phosphorylation of choline to form phosphatidylcholine (lecithin) in cholinergic nerve terminals, we applied neural stimuli to superior cervical sympathetic ganglia (SCG) excised from rats during aerobic incubation at 37°C in vitro. Ganglionic CK activity was significantly enhanced by the addition of ACh (1mM) or high concentration of choline (50μM) within half an hour. However, neither additions of low concentration of choline (5μM) nor depolarization stimuli caused by high $[K^+]_o$(70mM) produced an increase in ganglionic CK activity. On the contrary, high $[K^+]_o$ stimuli clearly activated choline acetyltransferase (ChAT), an ACh synthesizing enzyme, correspondingly with reduced CK activity at low extracellular (EC) choline concentration. These results strongly suggest that a large amount of choline taken up from EC-fluid accelerates metabolic pathway toward to phosphorylation of choline with catalysis by CK, eventually to form lecithin in the membrane, whereas a small amount of choline uptake conversely decreases CK activity, correspondingly increases the neurotransmitter (ACh) synthesis by activating ChAT in the cholinergic nerve terminals in the SCG.

179, I A 1330

CHOLINE ACETYLTRANSFERASE ACTIVITY IN MUSCLES OF THE AGED MICE.
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The activity of choline acetyltransferase (CAT), which catalyzes synthesis of acetylcholine from the substrates choline and acetyl-CoA, at the motor end-plate of aged mice were investigated radiochemically using homogenized preparation assayed with [^{14}C] acetyl CoA as substrate. The muscle tissue (diaphragm, extensor digitorum longus, EDL, and soleus muscles) was obtained from aged mice (24-37 month old, C57 BL) and young mice controls (2-5 month old, C5B BL).

The comparative study showed that CAT activity was higher in old muscles than in young muscles, showing no deficit and even increase in transmitter releas in old peripheral synapses. These results imply that the partial denervation has not taken place in aged muscles, since CAT activity decreased markedly in denervated muscles. In a few experiments the diaphragm muscles were divided into two fractions one being neuromuscular fraction (NM fraction) and the other the remainder of the muscle (M fraction). The result showed that the total CAT activity was mainly present in the NM fraction.

180, I A 1345

THE AFFERENT NEUROTRANSMITTER IN THE ACOUSTICO-LATERALIS RECEPTORS: EXTRACTION OF AN ACTIVE FACTOR FROM SENSORY EPITHELIA. OKANO, K., UMEKITA, S. and OBARA, S. Dept. of Physiol., Teikyo Univ. Sch. of Med., Tokyo 173

Several biogenic active factors have been shown to excite the afferent nerves of acoustico-lateralis receptors. A more direct approach, extraction from the sensory epithelia, was attempted. Plotosus electroreceptors consist of subcutaneous cluster of 70-80 ampullae, and can be easily isolated. Biological activity of extracts was tested by bath-application to the electroreceptors and to the semi-circular canal organs, both isolated from Plotosus. Both responded to almost equal extract doses, e.g. 2-5 ampullary clusters/ml, with reversible afferent facilitation. Extraction from the ampullae with hot DW (over 90°C, 5 min) produced most reproducible results, suggesting a heat-stable factor. In comparison, the supernate of cold DW homogenate was less stable and varied among samples, presumably due to interaction with related enzymes. The activity remained in aqueous phase on partition with n-BuOH, and could not be retained on Bond Elute C18, both of which suggested a hydrophilic nature. Chromatography with H_2O on Bio-Gel P-2 indicated that the main activity was of low MW, but other than L-glutamate. The activity largely disappeared on fractionation with Sephadex G-10 column. These data suggest a transmitter-like activity common to both sensory receptors of the acoustico-lateralis system.

181, II A 0945

RELEASE OF L-DOPA FROM VOCALIZATION NUCLEI,ROBUSTUS ARCHISTRIATALIS (RA) OF ZEBRA FINCH IN VITRO, SAKAGUCHI,H. AND SAITO,N., Dept. Physiol., Dokkyo Univ., Med. Sch., Mibu, Tochigi, 321-02

In zebra finch, robustus archistriatalis (RA) is a sexually dimorphic nucleus associated with song control, and is well developed in the male. Release of catecholamines from slice preparations of male RA during electrical stimulation was examined.

A brain slice of adult zebra finch including RA was transferred after 1 hour incubation to a chamber and perfused with oxygenated Krebs-Ringer solution. Analyses of catecholamine concentration in the samples were performed by a liquid chromatograph/electrochemistry (LCEC) system with an electrochemical detector. Repetitive stimulation (2Hz) of fibers from the rostral part of RA increased release of L-dopa in the solution. This increase was reduced by low Ca^{2+} (0.1 mM) and high Mg^{2+} (10.3 mM) which abolished the postsynaptic potentials. Rostral to the RA, there are many bipolar cells that send proximal axon terminals to RA (Maekawa, unpublished data) and these terminals may contribute to the release of L-dopa after stimulation.

182, II A 1000

INTRACELLULAR INJECTION OF cAMP PRODUCES INWARD CURRENT SIMILAR TO THE DOPAMINE-INDUCED RESPONSE. SASAKI, K., MATSUMOTO, M., SHOZUSHIMA, M., TAKASHIMA, K., AND SATO, M. Dept. Physiol., Sch. Med., Iwate Med. Univ., Morioka, Iwate 020.

Dopamine(DA) induces inward current in the identified ganglion cells of Aplysia when observed under the voltage clamp method. This response is associated with a decrease in slope conductance of the membrane and augmented in the presence of IBMX or by the depolarization of the resting membrane. It is markedly augmented in Ca^{++}-free media, but depressed in Na^{+}-free media. Intracellular injection of cAMP into the same cell produces an inward current similar to the DA-induced response. The cAMP-induced response is associated with the decrease in slope conductance, and augmented in Ca^{++}-free media, or in the presence of IBMX. It is also augmented by membrane depolarization, but depressed in Na^{+}-free media. These similarities suggested that DA-induced receptor activation of this type caused an increase in intracellular cAMP, which mediated an inward current measured under the voltage clamp. This inward current is probably due to the voltage dependent increase in membrane permeability mainly toward Na^{+}, but not Ca^{++}.

183, II A 1015

REGULATORY MECHANISM OF ADRENALINE-INDUCED L.T.P. IN BULLFROG SYMPATHETIC GANGLIA.
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Adrenaline potentiates transmitter release for a long time (2-5 h) through the activation of a cyclic AMP-dependent process in bullfrog sympathetic ganglia. The type of adrenoceptor involved in the potentiation (adr.-l.t.p.) and its regulatory mechanism were studied by recording fast excitatory postsynaptic potentials in a low Ca^{2+}, high Mg^{2+} solution and analyzing the quantal content.

The adr.-l.t.p. was blocked by a beta-antagonist, propranolol (1 μM), but not by an alpha-antagonist, phenoxybenzamine (1 μM), suggesting the involvement of beta-adrenoceptor in adr.-l.t.p. mechanism. An adr.-l.t.p. was not generated by a 5 min-exposure to adrenaline, but induced by treatment for more than 10 min. A further increase in exposure time (20, 30, 40 and 60 min) did not enhance the adr.-l.t.p. However, dibutyryl cyclic AMP (1 mM) produced a progressive rise in evoked release which continued over 60 min. Furthermore, when the ganglion was pretreated with dibutyryl cyclic GMP (100 μM), the generation of adr.-l.t.p. was blocked. These results suggest that adr.-l.t.p. is presumably regulated by the desensitization of beta-adrenoceptor and a process involving endogenous cyclic GMP through the action of an unknown transmitter.

184, II A 1030

THE EFFECT OF VASOACTIVE INTESTINAL POLYPEPTIDE ON THE NEURONS IN CAT VESICAL PELVIC GANGLION.
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To investigate the role of VIP on the transmission of parasympathetic ganglia, intracellular and voltage-clamp recording techniques were employed on the neurons in isolated cat vesical pelvic ganglion. VIP (0.05-50 μM) applied to the neurons directly through a micropipette by pressure ejection produced a depolarizing response (2-15 mV) dose-dependently in 85 % neurons tested. The VIP depolarization was associated with a spontaneous firing of the action potentials. VIP depolarization was not blocked in a low Ca/high Mg solution, indicating a direct effect of VIP to produce the depolarizing response. Voltage-clamp experiments showed that VIP produced a inward current associated with a decreased membrane conductance. The VIP current decreased in its amplitude by increase in the holding membrane potential and eventually reversed its polarity at -102 mV. The reversal potential shifted according to Nernst equation by changing the external K^+ concentrations. Brief application of muscarine (5 μM) produced a long-lasting increase in the amplitude of VIP depolarization. It was concluded that VIP directly causes the depolarizing response, hence facilitates the parasympathetic neuron of cat urinary bladder.

185, II A 1045

VIP ELICITS GANGLIONIC DEPOLARIZATION AND SELECTIVELY FACILITATES MUSCARINIC EXCITATIONS IN A SYMPATHETIC GANGLION.
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The effects of vasoactive intestinal polypeptide (VIP) were studied in the superior cervical ganglion of the cat in vitro and in situ using sucrose gap and multiunit recording, respectively. VIP (0.03 to 0.12 nmoles) produced a dose dependent prolonged (3-15 min) depolarization of the gangloia and enhanced the ganglionic depolarization produced by the muscarinic agonist, acetyl-B-methylcholine(MCH). VIP (1.8 to 10 nmoles) injected intraarterially enhanced and prolonged the postganglionic discharge elicited by MCH, enhanced muscarinic transmission in ganglia treated with an anticholinesterase agonist and enhanced the late muscarinic discharge elicited by acethlcholine(ACH). VIP did not affect the early nicotinic discharge elicited by ACH or by electrical stimulation of the preganglionic nerve. In chronically decentralized ganglia, VIP (3-30 nmoles) produced a slow onset (30-60 sec) and prolonged (2-5 min) discharge which did not produced in normal ganglia. The discharge was not altered by cholinergic antaginist but abolished by GABA(10 nmoles) or leucine-enkephalin(25 nmoles). It is concluded that VIP elicits ganglionic depolarization and has facilitatory action on muscarinic excitatory mechanisms in the superior cervical ganglion.

186, II A 1100

THE EFFECT OF SUBSTANCE P ON THE NEUROMUSCULAR JUNCTION IN RAT.
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The Fourth Department of Internal Medicine, School of Medicine, Toho University, Tokyo, 153

The effect of Substance P on the miniature endplate potentials (MEPPs) was studied.

In normal potassium Ringer (5mM) Substance P significantly increased the frequency of MEPPs depending on the concentration of calcium and magnesium.

The concentration of Substance P which began to increase the frequency of MEPPs was 4.3×10^{-8} M on one fiber and 4.5×10^{-8} M on the other fiber.

The frequency of MEPPs during control period was 4.5 ± 1.4Hz(mean value during 10 seconds) and after application of Substance P was 43.5 ± 8.5Hz (mean value on peak during 10 seconds)on a fiber.

187, II A 1115

SUBSTANCE P RECEPTORS EXPRESSED IN XENOPUS OOCYTES FROM RAT BRAIN mRNA. HARADA, Y., TAKAHASHI, T., KUNO, M., NAKAYAMA, K. AND NAKANISHI, S. Dept. Physiol. & Institute Immunol., Kyoto Univ. Fac. Med., Kyoto 606

Messenger RNA extracted from the rat brain was injected into Xenopus oocytes. Following incubation for 3 to 5 days, the response of injected oocytes to the bath application of substance P (SP; 1 to 4 μM) was examined under voltage clamp. At a holding potential of 0 mV, the SP application produced an outward current which was reversed in polarity when the oocyte was hyperpolarized to about -45 mV. The reversal potential depended upon the external Cl^- concentration. In this respect, the SP response was similar to that produced by the application of 5HT. In some cases, the response to SP was desensitized after the first application, whereas other oocytes responded to repeatedly applied SP. When the SP response was desensitized, the oocyte was still responsive to 5HT. On rare occasion, non-injected oocytes responded to the SP application. After incubation with actinomycin D, however, the injected oocyte still responded to SP, whereas no SP response could be elicited in non-injected oocytes. It is concluded that the SP receptor can newly be synthesized in Xenopus oocytes following injections of exogenous mRNAs.

188, II A 1130

SUBSTANCE P AUGMENTS A PERSISTENT SLOW INWARD CALCIUM-SENSITIVE CURRENT IN VOLTAGE-CLAMPED SPINAL DORSAL HORN NEURONS OF THE RAT. MURASE, K. AND RANDIC, M.* Info. Comput. Sci., Toyohashi Univ. Tech., Tempaku, Toyohashi 440 Japan, and *Vet. Physiol. Pharmacol., Iowa State Univ., Ames, IA 50011 USA.

Spinal dorsal horn neurons of 10-26 day-old Sprague-Dawley rats in slice preparations perfused with Ringer solution containing 0.5-1uM tetrodotoxin and/or 10-20mM tetraethylammonium at 29°C, were studied by using a single-microelectrode sample-and-hold voltage-clamp technique. Slow persistent inward currents were recorded during 0.5-2sec depolarizing voltage commands to membrane potentials positive to about -40mV from holding potentials at the resing level. The inward current was depressed by removing external Ca, or by adding 0.1-0.2mM Cd, 5mM Co, or 0.1mM verapamil, and was increased by adding 1mM Ba or 1-10uM Bay-K 8644. Substance P (SP) augmented the persistent slow inward Ca-sensitive current in a dose-dependent manner, though the effective concentration of SP (0.01-10uM) varied from cell to cell. It is suggested that this effect may be instrumental in the previously reported actions of SP on the spinal dorsal horn neurons; generating the slow depolarization associated with membrane conductance decrease, the increase in membrane excitability and the "bursting" behavior. In addition, in some neurons SP reduced the M-like current, which effect may contribute to, but not explain, generation of the SP-induced slow depolarization. supported by NSF and USDA.

189, II A 1145

EFFECT OF LUTEINIZING HORMONE-RELEASING HORMONE (LH-RH) ON THE NICOTINIC TRANSMISSION OF BULLFROG SYMPATHETIC GANGLIA. HASUO, H. AND AKASU, T., Dept. Physiol., Kurume Univ. Sch. Med., 67 Asahi-machi, Kurume 830, Japan

Intracellular and voltage-clamp recordings were made from neurons in bullfrog sympathetic ganglia to investigate an interaction between the cholinergic and the peptidergic neurons. Bath-application of LH-RH (200 nM-4 μM) depolarized the membrane (3-15 mV) associating with increment of input membrane resistance. LH-RH (20 nM-4 μM) reduced the amplitude of the fast excitatory postsynaptic potential (fast e.p.s.p.) in a dose dependent fashion. LH-RH (1 μM) produced a 71.4 ± 8.3 % (mean ± SD, n=9) depression. The quantal content of fast e.p.s.p. in a low Ca^{2+}-high Mg^{2+} Ringer solution was determined by both variance and failure methods. LH-RH (1 μM) decreased the quantal content 62.5 ± 16.2 % (n=5). LH-RH (1 μM) did not change the frequency of miniature (m) e.p.s.p., while it slightly depressed the m.e.p.s.p. amplitude (11.6 ± 4.5 %, n=6). In 60 % neurons tested, LH-RH (4 μM) caused a 25.7 ± 6.2 % (n=9) decrease in the amplitude of the acetylcholine-induced current (ACh current) produced by iontophoretic application of ACh to atropine (1 μM)-treated neurons. These results suggest that LH-RH decreases the nicotinic transmission of the bullfrog sympathetic ganglion, mainly by reducing the release of ACh from presynaptic nerve terminals.

190, II A 1300

THE EFFECT OF TRH-T ON THE NEUROMUSCULAR JUNCTION IN RAT.
H.UCHIDA, H.NEMOTO, K.SASAKI and M.KINOSHITA,
The Fourth Department of Internal Medicine, School of Medicine, Toho University, Tokyo, 153

The effect of Thyrotropin-Releasing Hormone Tartrate (TRH-T) on the miniature endplate potentials (MEPPs) was studied.

In normal potassium Ringer (5mM) TRH-T significantly increased the frequency of MEPPs depending on the concentration of calcium and magnesium.

The concentration of TRH-T which began to increase the frequency of MEPPs was the value ranging from 1×10^{-7} M to 2×10^{-6} M.

The frequency of MEPPs during control period was 5.4±2.2-38.1±9.7Hz (mean value during 10 seconds) and after application of TRH-T was 131.7±5.89-228.4±7.28Hz(mean value on peak during 10 seconds).

191, II A 1315

EFFECTS OF THE AGONIST-INDUCED CURRENTS ON THE REMOVAL OF THE RECEPTOR-BOUND AGONISTS IN MOLLUSCAN AND FROG GANGLION CELLS. MARUHASHI,J., *INOUE,M., *AKAIKE,N. & *OOMURA,Y. Dept. Biol., Daiichi Col. Pharm. Sci. Fukuoka 815 and *Dept. Physiol., Fac. Med.,Kyushu Univ. 60, Fukuoka 812.

Glutamate(Glu)-induced depolarizing responses due to Na^+ permeability increase continued over 30 min after washout Glu in snail neurons during perfusion of N-acetylimidazole(NAI)(10-20 mM)-Ringer solution, under current clamped condition. Under voltage clamped condition, Glu-induced currents during NAI perfusion behaved short even in Glu applying period. These results suggest that Glu-induced currents removed the receptor-boud Glu from the receptors.

Under the whole cell voltage clamped condition, the Cl^- currents in GABA-sensitive neurons of frog dorsal root ganglion had the same phenomena described above. The clamped currents in high concentration of GABA were large , but declined rapidly. In low GABA concentration, GABA induced currents were small and their responses decreased slowly. In a rough estimate, the slopes of GABA-induced responses proportional to the square of GABA-induced currents strength.

192, II A 1330

RESPONSE PATTERNS OF EXCITASTORY POSTSYNAPTIC CURRENT (EPSC)IN RESPONSE TO LATERAL COLUMN (LC) AND DORSAL ROOT (DR) STIMULATION IN FROG SPINAL MOTONEURON. Matsuura,S., Kuno,M., Hirakawa,T. Dept. Physiol. Osaka City Univ. Med. Sch., Osaka 545

Voltage clamp technique was applied to the frog spinal motoneuron to analyse the response behaviors of excitatory postsynaptic potential and current (EPSP & EPSC) evoked by stimulating DR and LC. Stimulus intensity was arranged to evoke almost the same magnitude of LC- and DR- EPSPs without firing of the neuron. Amplitude of LC-EPSC to evoke 1 mV of LC-EPSP was a little larger than the amplitude of DR-EPSC for the same magnitude of DR-EPSP in many motoneurons. Mean rise time of DR-EPSC was a little larger than that for LC-EPSC, and mean time constant of decay showed a lager value in the former. The relation between the current intensity and clamped voltage was usually linear for the EPSCs and the reversal potentials were at levels of membrane potential between -5 and -30 mV. In the motoneurons where early and late components of LC-EPSP, each referred to electrical and chemical transmission, were observed, reversal potential of the early EPSC was more positive side than that for the late EPSC. Small fluctuation of EPSC (unit EPSC) became evident at the clamped voltage far from the reversal potential for the stimulus-evoked EPSCs, even when spontaneous unit EPSPs were not apparent at the resting potential.

193, II A 1345

ELECTRICAL ACTIVITIES AND THEIR STRUCTUARAL RELATIONS IN THE NEUROPILES OF THE CRAYFISH CEREBRAL GANGLION. CHICHIBU, S., CHIBA, A. AND YAGINUMA, S. Dept. Physiol., Kinki Univ. Sch. Med., Sayama, Osaka 589

Within the cerebral ganglion of the crayfish (P. clarkii), the mechanoreceptive afferent fibers from the endopodium of the first antenna terminate at the ipsilateral neuropile (I ant. neuropile) forming the glomerular structure. The organization of the neuropile is generally consisting of several glomeruli in the radiant orientation. The glomerulus is formed by a finely tangled nerve fibers over a small core of the calcium salt grains. The localization of the calcium salts was detected by several histochemical methods including the von Kossa's and the quinalizarin stains. Densities were measured by the microscopic spectrophotometry. The Holmes-Blest silver impregnation revealed the size of the glomerulus as 10 μm x 50 μm with calcium-salt core of 2 μm x 15 μm. Spontaneous electrical activity observed with the tungsten microelectrode showed small epsp-like potentials having 0.5-3 mV amplitude. The amplitude histogram was a monomodal distribution of the Poisson type.

194, II A 1400

ACTIONS OF ADENOSINE AND CALCIUM ION CONCENTRATION ON THE QUANTAL TRANSMITTER RELEASE AT THE NEUROMUSCULAR JUNCTION. TAKEUCHI, N., TAKIKAWA, Y., WAKO, H. AND YANA, K. Dept. Physiol., Sch.Med., Juntendo Univ., Hongo, Tokyo 113

The inhibitory action of adenosine on quantal transmitter release was investigated in neuromuscular junction of the frog, in a calcium concentration $[Ca^{++}]_o$ range enabled to count the quantal number of transmitter. In normal Ringer solution, spontaneous quantal release (m.e.p.p.) was depressed by the application of adenosine with dose-dependent manner. The maximum inhibition produced by adenosine was about 45% of control and the mean value of the half-maximum was 1μM in normal K^+ solution. In high K^+(12mM) solution the dose inhibition curve showed a shift to the higher concentration of adenosine. Adenosine did not markedly influence the quantal size. When sub-m.e.p.p. or giant m.e.p.p. was involved in the spontaneous release, adenosine selectively decreased the frequency of the normal mode m.e.p.p. When $[Ca^{++}]_o$ was changed, $\log[Ca]_o$ - log frequency curve was sigmoid and the curve was simply shifted downwards by adenosine in both normal and high K solutions. Adenosine dose - inhibition relation of evoked quantal release in lower $[Ca^{++}]_o$ solution was essentially similar to that of the spontaneous release in normal solution. Statistical analysis of the time sequence of the quantal release showed that lower $[Ca^{++}]_o$ solution and the application of adenosine produced a tendency of some periodic change in the release probability.

195, II A 1415

EFFECTS OF DIVALENT CATIONS ON FREQUENCY FACILITATION. SHIBUYA, Y.* AND MAENO, T. Dept. of Physiol., Shimane Med. Univ., Izumo, Shimane 693

It is well known that under certain conditions the amount of transmitter released from a synapse by each nerve impulse is remarkably increased by repetitive stimulation. In 1969, Maeno reported a logarithmic relation between the mean quantal content of the endplate potential (m) and the frequency of stimulation (f); i.e.

$$\log m = \log m_o + kf$$

where k is the coefficient of frequency facilitation and m_o is m extrapolated at $f = 0$. This phenomenon is termed frequency facilitation. Recently, Zengel and Magleby (1980) showed that stimulation induced increase in evoked transmitter release can be classified into components such as facilitation, augmentation and potentiation, and that Ba and Sr ions selectively increased the augmentation and facilitation components, respectively. In order to see relation between the frequency facilitation and the components of facilitation, augmentation and potentiation, effects of Ba and Sr ions on the frequency facilitation was analyzed in the present experiments. Since Ba and Sr specifically increased k and m_o, respectively, the slope of the above linear f-log m relation might be related at least in part to the precess of augmentation.

196, II A 1430

EFFECTS OF A SPIDER TOXIN (JSTX) ON THE HIPPOCAMPAL PYRAMIDAL NEURONS. SAITO, M., KAWAI, M. AND MIWA, A. Dept. Neurobiol., Tokyo Metropolitan Inst. for Neurosci., 2-6 Musashidai, Fuchu-city, Tokyo Japan 183

Effects of a spider toxin (JSTX) derived from the venom gland of Nephila clavata on single pyramidal neurons of hippocampus were studied using slice preparation of the guinea pig. The excitatory postsynaptic potentials (EPSPs) and succeeding action potentials evoked by Shaffer collateral stimulation were suppressed by topical application of JSTX, whereas the antidromic action potentials in response to alveus stimulation were preserved. The resting membrane conductance was not affected by the toxin. The effective concentration of JSTX to suppress EPSPs was 1-5 x 10^{-3} U, which was comparable dose required to block EPSPs in the crustacean neuromuscular synapses. Ionophoretic application of L-glutamate (below 10nA) on the sensitive spots in the apical dendrites produced depolarization and spike generation in the soma membrane. This glutamate potentials were effectively suppressed by an application of JSTX. Contrastingly, depolarization proudced by L-aspartate was little affected by JSTX. Quisqualic acid acts similarly to glutamate on the CA-1 pyramidal neurons and the effects were suppressed by JSTX. The results suggest that Schaffer collateral input to the pyramidal neuron is glutamatergic and type of the glutamate receptor is possibly quisqualate-preferring.

197, II A 1445

ON THE SEA URCHIN VENOM WHICH BLOCKS FROG NEUROMUSCULAR TRANSMISSION. ANRAKU, M., KIHARA, H. AND HASHIMURA, S. Dept. Physiol., Kagoshima Univ. Fac. Med., Kagoshima 890

The neurotoxic activity which blocks frog neuromuscular transmission was found in the extracts from the outer parts of the sea urchin, Echinothrix diadema, collected on Amami-Ohshima. The neuroactive component(S) from the venom of this sea urchin was tried to purify by Sephadex G-50 and DEAE Sepharose column chromatographies. In the experiments used the crude venom, the indirectly evoked contraction of the toe muscle was blocked, while the directly evoked contraction of the muscle decreased gradually. The frequency of the miniature endplate potentials (MEPP) increased slightly (about 2.5 times) and endplate potential (EPP) decreased by the venom. MEPP amplitude and the membrane potential of the muscle were not significantly changed. In low Ca and high Mg Ringer, the number of failures in EPP responses increased by the application of the venom. The results suggest that the effect of the venom on the neuromuscular transmission is probably due to its presynaptic action.

198, II P (1) 1330

HISTOLOGICAL AND PHARMACOLOGICAL INVESTIGATIONS OF THE TWO SYMMETRICALLY SITUATED GIANT NEURONES IDENTIFIED ON THE ANTERIOR SURFACE OF THE PEDAL GANGLIA OF AN AFRICAN GIANT SNAIL (ACHATINA FULICA FERUSSAC). YONGSIRI, A. and TAKEUCHI, H. Dept. Physiol., Gifu Univ. Sch. Med., Gifu 500

Morphological and pharmacological investigations of the two giant neurones, RPeNLN (right pedal nerve large neurone) and LPeNLN (left pedal nerve large neurone), situated symmetrically on the anterior surface of the pedal ganglia of an African giant snail (Achatina fulica Férussac) were performed.

The two neurones (about 250-300 μm in diameter) had the symmetrical axonal pathways; of their four main axonal branches, the three main branches innervated the ipsilateral pedal nerves, whereas the last main branch projected to the contralateral pedal nerves.

The pharmacological features of the two neurones were very similar. Both were inhibited markedly by dopamine (minimum effective concentrations (MECs): 3×10^{-6}–10^{-5} M), DL-octopamine (MECs: 2×10^{-6}–2×10^{-5} M), 5-hydroxytryptamine (MEC: 3×10^{-6} M), GABA (MEC: 3×10^{-4} M), L-homocysteic acid (MECs: 3×10^{-5}–10^{-4} M) and erythro-β-hydroxy-L-glutamic acid (MEC: 3×10^{-5} M). Acetylcholine showed varied effects, either excitatory or inhibitory, on the two neurones examined. No substance were found to have any marked excitatory effects on the neurones.

199, II P (2) 1330

DECREASES OF ACTION POTENTIAL AMPLITUDES, IN SODIUM-FREE AND CALCIUM-FREE CONDITIONS, OF IDENTIFIABLE GIANT NEURONES OF AN AFRICAN GIANT SNAIL (ACHATINA FULICA FÉRUSSAC) SUN, X. P., Funase, K. and TAKEUCHI, H. Dept. Physiol., Gifu Univ. Sch. Med., Gifu 500

Decreases of the action potential amplitude in sodium-free and calcium-free states were observed with respect to the following ten giant neurones identified in the the suboesophageal ganglia of an African giant snail (Achatina fulica Férussac): PON (periodically oscillating neurone), TAN (tonically autoactive neurone), RAPN (right anterior pallial neurone), d-RPLN (dorsal-right parietal large neurone), VIN (visceral intermittently firing neurone), FAN (frequently autoactive neurone), d-VLN (dorsal-visceral large neurone), l-VMN (left-visceral multiple spike neurone), v-VLN (ventral-visceral large neurone) and v-l-VOrN (ventral-left-visceral oral neurone).

The action potentials of all the giant neurones tested in the present study were decreased in both the sodium-free and calcium-free states. Of these, action potentials of RAPN and FAN were more decreased in the sodium-free state than in the calcium-free state, whereas those of TAN, VIN, d-VLN and v-l-VOrN were more decreased in the calcium-free state than in the sodium-free state. Action potential of FAN was the most decreased in the sodium-free state, while that of VIN was the most decreased in the calcium-free state.

200, II P (3) 1330

IDENTIFICATION AND PHARMACOLOGICAL CHARACTERISTICS OF THE THREE GIANT NEURONES IN THE LEFT BUCCAL GANGLION OF AN AFRICAN GIANT SNAIL (ACHATINA FULICA FERUSSAC). MATSUOKA, T. AND TAKEUCHI, H. Dept. Physiol., Gifu Univ. Sch. Med., Gifu 500

The central nervous system of the snail species is composed by the three ganglion-complexes, the suboesophageal ganglia, the cerebral ganglia and the buccal ganglia. Of the three ganglion-complexes, the buccal ganglia, which is composed by the right and the left buccal ganglia, are the highest and the smallest.

In the present study, the three giant neurones (diameter: about 100 μm, commonly) were identified in the left buccal ganglion, and their pharmacological characteristics to the main putative neurotransmitters were studied.

An identifiable neurone, situated orally in the ganglion, had no spontaneous firing. The neurone was excited by DL-octopamine (DL-OA), 5-hydroxytryptamine (5-HT), GABA, erythro-β-hydroxy-L-glutamic acid (erythro-L-BHGA), L-homocysteic acid (L-HCA) and histamine (HA), and inhibited by dopamine (DA) and acetylcholine (Ach).

Another identifiable neurone, found medially in the ganglion, showed the spontaneous spike discharges. The neurone was excited by 5-HT and L-HCA, excited slightly by GABA and erythro-L-BHGA, and inhibited by DA, DL-OA, HA and Ach.

The other neurone, situated laterally, had no spontaneous firing. The neurone was excited by DA, DL-OA, 5-HT, erythro-L-BHGA and L-HCA, and inhibited by HA and Ach.

201, II P (4) 1330

THE CHANNEL CHARACTERISTICS OF NICOTINIC RECEPTORS ON CARDIAC GANGLION CELLS.
IKEDA, K. AND NISHI, S. Dept. Physiol., Kurume Univ. Sch. Med., Kurume 830

The cardiac ganglia were isolated from the guinea-pig atrium, and the fast EPSP and ACh-induced responses were recorded intracellularly from atropinized ganglion cells. It was found that propranolol, a β-adrenoceptor blocker, markedly inhibited the ionophoretically elicited ACh depolarization without appreciably depressing the fast EPSP. The fast EPSP was shortened by propranolol. Voltage-clamp analysis revealed that the falling phase of the fast EPS-current was formed of two exponential components, one having a short time constant and the other a long time constant. Propranolol selectively suppressed the slow component. The noise analysis of the membrane currents produced by superfusion of ACh yielded two Lorentzian curves, one with a high corner frequency and the other with a low corner frequency. Propranolol eliminated the latter selectively. These findings suggest that cardiac ganglion cells are endowed with two types of nicotinic receptor; one type may be subsynaptic and linked to the ionic channels with a short life time and the other type may be extrasynaptic and coupled to the channels with a long life time.

202, II P (5) 1330

HYPERPOLARIZING AND DEPOLARIZING ACTIONS OF DOPAMINE ON THE NUCLEUS ACCUMBENS NEURONS OF THE GUINEA-PIG.
UCHIMURA, N., HIGASHI, H. and NISHI, S. Dept. Physiol., Kurume Univ. Sch. Med., Kurume 830

The effect of dopamine (DA) on the nucleus accumbens septi (NAS) neurons in guinea-pig brain slices was studied by intracellular recordings. DA caused three types of membrane potential change; a biphasic response consisting of an initial hyperpolarization and a subsequent depolarization, monophasic hyperpolarizing response and monophasic depolarizing response. The DA-induced hyperpolarization was always accompanied by a decrease in membrane resistance, while the DA depolarization was associated with an increase in membrane resistance. The DA-hyperpolarization was reversed in polarity at -85.5 mV, and the DA-depolarization at -87.3 mV. Both responses were augmented in low potassium medium and diminished in high potassium solution. Haloperidol, an antagonist of DA receptors of both the D-1 and D-2 type, reversibly suppressed the initial hyperpolarization as well as the subsequent depoalrization induced by DA. The D-2 receptor blocker sulpiride selectively abolished the DA depoalrization. Dibutyryl cyclic AMP specifically enhanced the DA-induced hyperpolarization. These results suggest that the hyperpolarizing and depolarizing actions of DA on NAS neurons are exerted via different receptor sites, the former by the D-1 receptor and the latter by the D-2 receptor.

203, II P (6) 1330

AUTO-REGRESSION POWER SPECTRAL ANALYSIS OF GABA-INDUCED NOISE CURRENTS IN CAT DORSAL ROOT GANGLION CELLS.
HIJIRIKAWA, K., TANAKA, E., HIGASHI, H. AND NISHI, S. Dept. Physiol., Kurume Univ. Sch. Med., Kurume 830

The GABA-induced chloride current of neurons in the isolated cat dorsal root ganglion is associated with an augmentation of noise fluctuations. We have previously obtained the power density spectra of GABA-induced current fluctuations by means of the fast Fourier transform method(FFT). This method, however, is incapable of making period-grams including the low frequency spectra of relatively short-lasting phenomena. For solving this problem, we have tried to apply the auto-regression(AR) method to estimate power spectra from the experimental time series data of noise fluctuation currents and to dissolve them into the Ist and 2nd order components of the spectra. It was found that many 2nd-order components with high resonance frequencies dominantly appeared in the spectra of background current fluctuations. The spectra showed large time-dependent changes during the rising phase of GABA-induced current because of a rapid increase in GABA concentration, whereas the spectra were relatively steady during the falling phase of GABA current and consistent with the previously obtained FFT spectral data (cut-off frequency, 13 Hz; time constant, 12 ms at -70 mV, 26°C). The result showed that the AR-method is useful to estimate the power density spectra that time-dependently change and to detect single Lorentzian curves in complexed spectra.

204, II P (7) 1330

ANION SELECTIVITIES OF GABA-CONTROLLED CHLORIDE CHANNELS. AKAIKE, N., OOMURA, Y. AND YAKUSHIJI, T. Dept. Physiol., Fac. Med., Kyushu Univ. 60, Fukuoka 812

Effects of foreign anions on GABA-controlled Cl channel were studied in the isolated frog sensory neurons using concentration-clamp technique which allows internal perfusion and rapid exchange of external solution within a few msec under voltage-clamp condition. When Cl in the external solution was replaced by various anions while the external Cl is kept a constant, Br shifted the dose-responses curve of GABA-induced inward Cl current to the left side without any change the maximum value, and changed the activation and inactivation kinetics. I, NO_3 and HCOO changed differently the kinetic properties without shifting GABA dose-response curve. CH_3COO suppressed the maximum current and also changed the response kinetics. When the internal Cl was replaced with various anions at constant external Cl, different anions showed different maximum conductances, which are carried by individual anions, without shifting the GABA dose-response, but gave similar current kinetics. All over the results suggest that the external anions can change not only the binding affinity of GABA to its receptor but also kinetic properties of currents, while one can know the 'real' interaction of anion with charged sites during their passage through the GABA activated Cl channel when anions are internally perfused.

205, II P (8) 1330

INTRACELLULAR Ca DECREASES AFFINITY OF GABA RECEPTOR IN FROG SENSORY NEURONS. INOUE, M., OOMURA, Y., YAKUSHIJI, T. AND AKAIKE, N. Dept. Physiol., Fac. Med., Kyushu Univ. 60, Fukuoka 812

Sensory neurons were mechanically and enzymatically isolated from frog dorsal root ganglia. The neuronal activities were recorded with "concentration clamp" method which combines internal perfusion and rapid solution change techniques. The membrane potential was clamped at -50 mV and voltage-dependent Ca current was produced by depolarizing command pulses of 50 mV having various durations just before the GABA application. A preceding Ca current suppressed the GABA-activated Cl current and the inhibition depended upon the amount of free Ca, since the inhibitory effect was influenced by the concentration of internal EGTA. The preceding Ca current shifted the GABA dose-response curve to the right side without any change of the maximum. The effectiveness on the GABA dose-response curve was in the order of Ca > Sr >> Ba current. These results suggest that subsequent increase in the concentration of intracellular Ca by Ca influx decreases an affinity of the GABA receptor in the membrane. This new mechanism for the modulation of agonist-receptor interaction by intracellular Ca may also participate in the postsynaptic control of synaptic transmission in in vivo conditions.

206, II P (9) 1330

THE ELECTRICAL PROPERTIES OF PENTOBARBITAL-ACTIVATED CHLORIDE CURRENT. MARUYAMA, Y., OOMURA., Y., TOKUTOMI, N. AND AKAIKE, N. Dept. Physiol., Fac. Med., Kyushu Univ. 60, Fukuoka 812

The kinetic properties of the activation and inactivation (desensitization) of pentobarbital (PB)-induced Cl current were studied in the isolated frog sensory neurons using the 'concentration clamp' technique which allows internal perfusion and rapid exchange of the external solution within a few msec. The results were compared with those of γ-aminobutyric acid (GABA)-gated Cl current. The PB was 1/135 less potent than GABA at the concentration producing a hlaf-maximum response. Both the activation and inactivation phases of PB-induced Cl_3 current consisted of double exponential components at higher concentration than 10^{-3} M, in which the time constant of activation in the slow component were 10 times larger than that in GABA-induced slow component. Moreover, these slow and fast activation components of PB-induced current showed different recovery processes from their complete desensitization. These observations imply that barbiturate receptor-ionophore complexes may be composed of two different types which have different kinetics and affinities.

207, II P (10) 1330

EFFECTS OF PENTOBARBITAL ON THE POSTSYNAPTIC POTENTIALS IN THE HIPPOCAMPAL SLICES FROM THE GUINEA PIG. TANIMOTO, M., YONEDA, K. AND OKADA, Y. Dept. Physiology, Sch. of Med., Kobe Univ. Kusunokicho, Chuo-ku, Kobe, 650, Japan

Hippocampal slices(300 μm thick)were prepared from the guinea pig and incubated in the standard medium(Krebs-Ringer solution containing 10 mM glucose). Postsynaptic field potentials(PSPs) were recorded from the pyramidal cell layer of CA_{3-4}(A) region of hippocampus and the granular cell layer(B) in the dentate gyrus with the electrical stimulation to granular-mossy fiber path for (A) and perforant path for (B), respectively. Pentobarbitone-Na(PB) was applied to the medium at the concentration range between 10^{-6} and 10^{-3}M. The dose-responses of PB on the PSPs were different in the two regions. PB at the concentration of 25 μM did not affect the PSPs in (A) whereas it showed 60% inhibition on that of (B). At the concentration of 50 μM, PB caused 40% inhibition for the PSPs in (A) and 80% for (B). At the concentration of 100 μM, PB showed 80% inhibition for (A) whereas 100% inhibition for (B). Over 200 μM, the PSPs of both regions were completely inhibited. Thus the neurotransmission in (A) was more sensitive to the inhibitory effect of PB.

208, II P (11) 1330

CHEMOSENSITIVITY OF THE AFFERENT NERVE TERMINALS AND DIVALENT CATION EFFECTS IN A TONIC SENSORY RECEPTOR. OBARA, S., NAGAI, T. and SATO, H.* Dept. Physiol., Teikyo Univ., Sch. Med., Tokyo 173.

In tonic electroreceptors of Plotosus, iontophoresis of L-glutamate (Glu) proved to induce single unit afferent discharges in the absence of the natural transmitter. Responses to Glu, graded in impulse frequency (F) and in time course, are presumably postsynaptic in that Glu induces slow PSP-like depolarization in the nerve terminals. Glu responses, however, were gradedly reduced in higher Mg saline, which may suggest changes either in chemosensitivity of the nerve or in ability to fire repetitively. Presynaptic effects were excluded, since high Mg (20 mM) or Co (4 mM) abolished the orthodromic response completely, while Glu response persisted though reduced in size. Possible changes in chemosensitivity to Glu were tested by mass recording of slow potentials from the nerve, but with no consistent results. Postsynaptic excitability was tested by direct polarization of the nerve terminals and single-unit recording. F responses to currents of half-cycle sine wave (0.5Hz) were graded, and similar to Glu responses in time course. The responses to nerve polarization and Glu responses were similarly reduced in high Mg. Thus, major effects of high Mg appear to involve changes in repetitive firing ability in the afferent terminals.

209, II P (12) 1330

NATURE OF THE SLOW OUTWARD CURRENT IN THE C-NEURONS OF RABBIT CERVICAL NODOSE GANGLION. MIYAZAKI, T. AND KOBAYASHI, H. Department of Physiology, Tokyo Medical College, Shinjuku 6-1-1, Shinjuku-ku, Tokyo 160

Three types of active membrane current can be detectable in the C-neurons of rabbit cervical nodose ganglion by the single-electrode voltage-clamp. Among these currents, the slow outward current, which we regarded as the persistent current at the resting potential, was found to be depressed by lowering $[Ca^{2+}]_o$ in combination with addition of manganese. This current has very slow time course of activation and doesn't reach the steady state even at the end of 10 sec command pulse. The time constant of the decay at -40 mV was 4.6 ± 1.6 sec (n=14, ranging: 3.0 to 7.3 sec). The reversal potential as measured by that of tail current was -62.0 ± 5.7 mV (n=34, ranging: -48 to -72 mV) in the standard Krebs solution. This reversal potential shifted in the depolarizing direction by some 40 mV per 10-fold increase in $[K^+]_o$. In addition, in the Na^+-free medium, a transient inward current due to a voltage-dependent Ca^{2+} influx preceded the slow outward current. From these results, we concluded that the slow outward current mainly consisted of voltage- and Ca^{2+}-dependent K^+ current. Bradykinin inhibited this current in part so as to introduce a depolarizing shift of resting potential. We further infered that this current may contribute to the maintenance of resting membrane potential and the control of membrane excitability.

210, II P (13) 1330

EVIDENCE FOR THE COEXISTANCE OF THE MONOAMINE AND NEUROPEPTIDE IN THE DORSAL UNPAIRED MEDIAN NEURONS OF THE INSECT. TANAKA Y. AND WASHIO, H. Lab. Neurophysiol., Mitsubishi-Kasei Inst. Life Science, Machida 194

Dorsal unpaired median (DUM) neurons of the cockroach, Periplaneta americana have modulatory actions on the muscle contraction produced by motoneurons. Intracellular stimulation of the identified DUM neuron caused both reduction in the tetanic tension (RTT) and the increase in the basal tension (IBT) of the coxal depressor muscle, 177d. Octopamine is responsible for the RTT but not for the IBT. Therefore, we are attempting to isolate and characterize the bioactive substance which causes the IBT. We stained the cell bodies of the DUM neuron with neutral red which specifically stains monoanine containing neuron and collected them. Using a high pressure liquid chromatography fractionation, we isolated the bioactive substance for IBM. The bioactivity was stable in 2N acetic acid and completely destroyed by the incubation with protease, suggesting that the bioactivity was associated with peptide. These results suggest that the the DUM neuron is not only octopaminergic but also peptidergic.

211, II P (14) 1330

EFFECTS OF CONVULSANTS ON CALCIUM-DEPENDENT PROTEIN PHOSPHORYLATION IN RAT CORTICAL SYNAPTOSOMES. IMAI, S., ONOZUKA, M., FURUICHI, H., KISHII, K. AND SUGAYA, E. Dept. Physiol., Kanagawa Dental Coll., Yokosuka 238

Effects of the convulsants pentylenetetrazole (PTZ), picrotoxin and strychnine sulfate on protein phosphorylation associated with calcium influx were examined using ^{32}Pi and $^{45}CaCl_2$ in synaptosomes from rat cerebral cortex. PTZ markedly stimulated the incorporation of ^{32}P into protein 1 as determined by SDS polyacrylamide gel electrophoresis and autoradiography. PTZ also stimulated calcium accumulation by synaptosomes. Similar effects were observed by the calcium ionophore A23187. The PTZ-stimulatory effect on both of them was markedly inhibited by cobalt and lanthanum ions. The calmodulin antagonists W-7 and W-5 reduced the PTZ-stimulated effect on protein 1 phosphorylation by about 75% and about 15% respectively; whereas these antagonists had practically no effect on PTZ-stimulated synaptosomal accumulation of calcium. In contrast, picrotoxin and strychnine sulfate slightly increased phosphorylation of this protein, and caused very little increase in calcium accumulation by synaptosomes. None of the convulsants effects any change in phosphorylation in Ca-free medium containing EGTA. These results suggest that PTZ causes enhancement of calcium dependent phosphorylation and consequently stimulates calcium/calmodulin-mediated nerve terminal functions.

212, II P (15) 1330

EFFECT OF HISTRIONICOTOXIN ON SYNAPTIC AND NON-SYNAPTIC ACh RECEPTOR CHANNELS IN THE BULL FROG SYMPATHETIC GANGLION. OGURA, T. AND WARASHINA, A. Dept. of Physiol., Niigata Univ. Sch. of Med., Niigata, 951

One of histrionicotoxin derivatives (C_5H_{10}-HTX; gifted by Dr. Y. Kishi) was applied to sympathetic ganglia of the bull frog to investigate its action on acetylcholine (ACh) receptors. C_5H_{10}-HTX (150μM), like curare, had an effect to depress completely the depolarizing response induced by iontophoretically applied ACh, while the synaptic transmission elicited by electrical stimulation delivered presynaptically was also blocked. At a relatively low concentration of C_5H_{10}-HTX(40μM), however, the synaptic transmission was still retained after the ACh potential was completely suppressed. The toxin effects at higher concentrations were reversed by long-term washing. It required longer period of wash to restore the ACh potential than to restore the action potential elicited by presynaptic stimulation. From these results, it is inferred that there are two types of ACh receptor channels, i.e., synaptic and non-synaptic ACh receptor channels. Non-synaptic ACh channels are considered to have a higher affinity for C_5H_{10}-HTX and a better accessibility to iontophoretically applied ACh than synaptic ACh channels.

213, II P (16) 1330

EFFECTS OF HYCANTHONE ON THE NEUROMUSCULAR TRANSMISSION. ENOMOTO, K. Dept. of Physiol., Shimane Med. Univ., Izumo, Shimane 693

The effects of the antischistosomal drug, hycanthone, on the synaptic transmission at the frog neuromuscular junction were studied. The mean quantal content increased in the presence of 20 μM hycanthone. The amplitude of the miniature end-plate current was unaffected by 20 μM hycanthone, while 2 μM hycanthone decreased the ionophoretic ACh response (ACh induced current). The decay time constants of the evoked end-plate current and the miniature end-plate current were increased with 1-5 μM hycanthone, but were decreased concentrations over 20 μM. It was concluded that the primary site of action of hycanthone is the 'transient state' or ACh bound but closed conformation of the ACh receptor ion channel, but this drug also has other sites of action (presynaptic nerve terminal and open conformation of ACh receptor-ion channel complex).

214, II P (17) 1330

EFFECTS OF DIVALENT CATIONS ON THE POST-TETANIC DECLINE IN MINIATURE END-PLATE POTENTIAL FREQUENCY AND IN END-PLATE POTENTIAL AMPLITUDE AT THE FROG NEUROMUSCULAR JUNCTION. NARITA, K., KITA, H. AND KAWASAKI, F. Dept. of Physiol., Kawasaki Med. Sch., Kurashiki, Okayama 701-01

Using sciatic nerve-sartorius muscle preparations of Rana temporaria, we have studied the time course for the decline in miniature end-plate potential (MEPP) frequency and in end-plate potential (EPP) amplitude following tetanic stimulation (50 Hz, 15 sec-3 min) of the nerve in solutions containing various divalent cations. (1) With increasing concentrations of Mg^{2+} (up to 11 mM), simple exponential decay curves of MEPP frequency shifted to ones with a shoulder, indicating that the rate of decline was initially low and then increased. (2) The shoulder, which was characteristic of high Mg^{2+}, disappeared when the concentration of Ca^{2+} (up to 0.2 mM) was increased. (3) Increasing the concentration of Sr^{2+} (up to 0.4 mM) did not abolish the shoulder. (4) In the presence of 1.5 mM Ca^{2+} and 10 mM Mg^{2+}, both MEPP frequency and EPP amplitude followed simple exponential decay curves. (5) When 3 mM Sr^{2+} was added to 10 mM Mg^{2+}, a shoulder appeared on the decay curve of MEPP frequency, while the decline in EPP amplitude followed a simple exponential curve. (6) In both cases, there were no noticeable differences between the half-decay times of MEPP frequency and EPP amplitude, but the former took a much longer time to return to the pre-tetanus level.

215, II P (18) 1330

LONG-TERM FACILITATION OF CA1 PYRAMIDAL CELL ACTIVITY INDUCED BY ASSOCIATION OF TWO ORTHODROMIC INPUTS IN HIPPOCAMPAL SLICES. MIYAKAWA, H. and KATO, H. Dept. Pysiol., Yamagata Univ. Sch. Med., Yamagata 990-23

Field potentials were recorded from the CA1 Pyramidal cell layer of guinea-pig hippocampal slices. Stimulation of the perforant pathway (PP) was associated with a train of intense Schaffer collateral (Sch) stimulations(200Hz, 5 pulses). Intervals between PP and Sch were fixed at 20 msec, and the associated stimuli were delivered every 5 sec for over 240 sec period.

The amplitude of the population spike evoked by the PP test stimuli increased gradually after the cessation of the associated stimuli, reached a plateau level ($169\pm27\%$, n=7) within 10 min and maintained for more than 40 min. In accordance with the amplitude facilitation, the peak latency of population spikes became shorter ($93\pm5\%$, n=7). When trains of Sch stimulation alone were delivered, the amplitude of Sch evoked response showed so called Long-term potentiation, although that of PP evoked response did not undergo significant changes ($90\pm24\%$, n=5). These results indicate that efficacy of PP-Pyramidal cell synapse can be facilitated by association of Sch-Pyramidal cell inputs.

216, II P (19) 1330

CHANGES OF THE AMPLITUDE OF THE POPULATION SPIKE AND EPSP AFTER REPEATED PAIRED STIMULATION IN GUINEA-PIG HIPPOCAMPAL SLICE. ITO, K. AND KATO, H. Dept. Physiol., Yamagata Univ. Sch. Med., Zao Iida Yamagata 990-23

We have already reported that the amplitude of the population spike increases gradually after repeated paired stimulation (RPS) and keeps its plateau level over a long period in CA1 neurons of the sliced hippocampal preparation. Paired stimulation consisted of an orthodromic stimulus and a train of five antidromic stimuli (200Hz) was delivered 50 times every 5 sec.

In this experiment, we have recorded both the population spike and the population EPSP simultaneously by glass electrodes placed in the pyramidal cell layer and the stratum radiatum, respectively. After RPS, the amplitude of population spike has gradually increased, but that of the population EPSP has negligibly increasd. At 60 min after RPS, the ampilitude of the population spike has reached 193% (n=6) of the control with statistical significant increase ($p<0.05$), and that of the population EPSP has reached 112% (n=6) without significant increase. Furthermore, the positive slope just before the population spike which represents the synaptic input current to CA1 neurons has not statistically changed. These facts indicate that the facilitation of the population spike after RPS occurs rather postsynaptically than presynaptically.

217, II P (20) 1330

THE BLOCK OF THE SYNAPTIC TRANSMISSION INDUCED BY THE INCREASED TEMPERATURE IN CA1 NEURONS OF GUINEA-PIG HIPPOCAMPUS IN VITRO. FUJII, S. AND KATO, H. Dept. of Physiol., Yamagata Univ. Sch. Med., Yamagata 990-23

The effects of the increased temperature on the synaptic transmission were examined in CA1 neurons of the guinea-pig hippocampal slice preparation by heating the bath medium. When the medium was heated from 30 ℃, the population spike evoked by the stimulation of stratum radiatum was blocked reversibly at about 42 ℃, while the antidromic spike response elicited by the stimulation of alveus kept it's amplitude up to 48 ℃. The temperature at which the population spike disappeared was almost same during the series of the heating trials for a slice and was not dependent on the heating gradient(0.2-0.5 ℃/min). However, it was dependent on both the stimulating and recording conditions. The population spike disappeared at lower temperature when the intensity and frequency of the stimulus was increased and when the response was recorded deep in the slice with high frequency stimulation. The vanishing temperature for the population spike was increased in proportion to the concentration of bath-applied theophylline(0.01-1.0mM). Futhermore, application of L-phenylisopropyl adenosine(0.005mM) blocked the synaptic transmission at significantly lower temperature than that of control. From these results, we have supposed that the reversible blockade of the synaptic transmission by the temperature increase may be caused by the released adenosine compounds from the presynaptic terminals.

218, II P (21) 1330

ACUTE EFFECTS OF LITHIUM ON SYNAPTIC TRANSMISSION IN HIPPOCAMPAL SLICE. HIGASHITANI,Y. AND KATO,H. Dept. Physiol., Yamagata Univ. Sch. Med., Yamagata 990-23

The mechanisms through which lithium exerts its therapeutic action still remain largely unexplained. We investigated whether acute effects of lithium is mainly due to blockade of Na-K pump or interaction with calcium.

Slices from rat hippocampus, 400μm thick , were mainteined in a perfusion chamber at 34°C. Perfusion with LiCl (5-10mM) produced an increase in field EPSPs recorded in Str.radiatum in response to stimulation of Schaffer collateral commissural fibers. The rate of this increase in field EPSPs was greater in 2.5mM calcium solution than in 1.5mM calcium solution. Soma membrane was usually depolalized about 3mV by 10mM LiCl and threshold for spike generation was decreased. Afterhyperpolalization and paired-pulse facilitation was not affected significantly by 5-10mM LiCl perfusion.

These results indicate that effects of lithium can be explained mainly by Na-K pump blockade and that lithium does not affect calcium metabolism, but calcium may affect the effect of lithium.

219, II P (22) 1330

EFFECTS OF THE REDUCTION AND DEPRIVATION OF GLUCOSE ON THE POSTSYNAPTIC POTENTIALS IN THE HIPPOCAMPAL SLICES FROM THE GUINEA PIG.

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Hippocampal slices(300 μm thick) were prepared from the guinea pig and incubated in the standard medium(Krebs-Ringer solution containing 10 mM glucose). Postsynaptic field potentials(PSPs) were recorded from the granular cell layer(A) in the dentate gyrus and pyramidal cell layer of CA_{3-4}(B) and CA_{1-2}(C) regions with the electrical stimulation to the perforant path for(A), granular-mossy fiber path for (B) and Schaffer's collaterals for (C), respectively. Concentration of glucose in the perfusion medium was reduced to 7, 5, 4, 3, 2, 1, 0.5, and 0 mM and the effects of the reduction and deprivation of glucose on the PSPs were studied. The sensitivity against the reduction of glucose differed in the PSPs recorded in the granular cell layer and pyramidal cell layer. The PSPs in both (B) and (C) reduced the amplitude and extinguished in 30 min with the glucose concentrations below 4 mM, whereas PSPs in (A) was preserved stable with glucose concentration down to 1 mM. ATP and creatine-P levels in each slice were compared with the PSPs.

220, I D 1300

HETEROGENEITY OF GANGLIA OF THE GUINEA PIG MYENTERIC PLEXUS: AN IN VITRO STUDY OF THE ORIGIN OF TERMINALS WITHIN SINGLE GANGLIA USING A COVALENTLY BOUND FLUORESCENT RETROGRADE TRACER. TAKAKI, M. AND GERSHON, M.D.* Dept. Physiol., Okayama Univ. Med. Sch., Okayama 700,* Dept.Anat. & Cell Biol., Columbia Univ., College of P & S, New York

The fluorescent dye 4-acetoamido, 4'-isothiocyanostilbene-2,2'-disulphonic acid (SITS) was found to be an effective tracer, labeling neuronal perikarya, evidently by retrograde transport. SITS fluorescence was found in about 12 % of the neurons within the ganglion into which it was injected and also in approximately ten times more neurons in discretely located distant ganglia. Individual SITS-injected myenteric ganglia were found to vary greatly in the ratios of intraganglionic SITS-labeled neurons to the total number of neurons within the injected ganglion. The ratios of the number of intraganglionic SITS-labeled neurons to SITS-labeled neurons in distant ganglia projecting to the injected ganglion from elsewhere in the myenteric plexus also varied greatly. Although the majority of projections were found to be from orally located ganglia, individual ganglia were observed that received predominantly or exclusively anal or oral projections. This anatomical heterogeneity in the location of afferent inputs to individual myenteric ganglia is probably reflected in a functional heterogeneity as well and will have to be taken into account in further studies of the physiology of the myenteric plexus.

221, I D 1315

EFFECT OF ATP ON CALCIUM DEPENDENT POTASSIUM CONDUCTANCE OF MYENTERIC NEURONES. MORITA, K., KATAYAMA, Y. AND TATSUMI, H. Dept. Autonom. Physiol., Med. Res. Inst., Tokyo Med. and Dent. Univ., Tokyo 101.

Intracellular recordings were made from the guinea-pig myenteric neurones *in vitro*. ATP was applied either by superfusion (10 nM - 100 μM) or pressure ejection. ATP usually caused a concentration-dependent membrane hyperpolarization (H response) in AH cells, on the other hand, ATP usually produced a depolarization in S cells (D response). The H response and the D response are due to an increase and a decrease in membrane conductance to potassium ions, respectively; these responses reversed in polarity at about potassium equilibrium potential. Both H and D responses were reversibly reduced or abolished in calcium-free/high magnesium (10 mM) solution but persisted in TEA-containing solution (1 - 10 mM). Lower concentrations of caffeine ($\leq$ 10 μM) augmented both responses, whereas higher concentrations (100 μM - 1 mM) reversibly depressed the H response but did not the D response. These results indicate that myenteric neurones may be classfied according to the action of ATP, and suggest that ATP may regulate calcium-dependent potassium conductance in myenteric neurones.

222, I D 1330

EFFECTS OF SUBSTANCE P ON CALCIUM-DEPENDENT POTASSIUM CONDUCTANCE OF THE MYENTERIC NEURON OF THE GUINEA-PIG ILEUM. KATAYAMA, Y., MORITA, K. AND TATSUMI, H. Dept. Autonomic Physiology, Medical Research Institute, Tokyo Medical and Dental University, Chiyodaku, Tokyo, 101 Japan.

Intracellular recordings were made from myenteric neurons of the guinea-pig ileum *in vitro*. Substance P caused a membrane depolarization in current-clamped neurons and an inward current in voltage-clamped neurons, due to decreasing potassium conductance. Although the substance P-induced response was preserved in a low Ca solution in which synaptic potentials were completely abolished, it was reversibly depressed after prolonged treatment with a Ca-free/high-Mg solution. The peptide-induced response was inhibited by Ba (1-3 mM), but was not appreciably altered by TEA (up to 10 mM). Furthermore, a slow after-hyperpolarization and/or a tail current in response to depolarizing command were depressed during the substance P-induced response in AH cells which have prominent calcium-dependent potassium conductance. These findings suggest that the substance P-induced response might be brought about probably by inactivating the calcium-dependent potassium conductance in AH cells and possibly also in S cells.

223, I D 1345

EFFECTS OF ATROPINE, D-CHLORPHENIRAMINE MALEATE AND DG-5128 ON POSTPRANDIAL MOVEMENTS OF GASTROINTESTINAL TRACT. FUJII,K. AND OKAJIMA,M. Dept. Physiol., Hiroshima Univ. Sch. Med., Hiroshima 734

In order to clarify the role of Ach muscarinic receptor, histamine H_1 receptor and adrenaline α_2 receptor in the gastrointestinal wall, the effects of atropine, d-chlorpheniramine maleate (histamine H_1 receptor antagonist, d-CPM) and DG-5128 (adrenaline α_2 receptor antagonist) on postprandial movements of gastrointestinal tract were investigated in conscious dogs. The gastrointestinal movements was recorded using a strain gauge force transducer. The serum gastrin was measured with a gastrin radioimmunoassay kit.

(1) Postprandial movements of gastric antrum and duodenum was strongly reduced by intravenous injection of atropine (0.05-0.10 mg/kg). The remaining movements which were not inhibited by atropine were abolished by d-CPM (2.5 mg/kg, s.c.).

(2) Increase of serum gastrin level caused by feeding was unaffected by atropine and d-CPM.

(3) Postprandial movements of gastric antrum and duodenum was enhanced by DG-5128 (5.0 mg/kg, i.v.). This excitatory responses was abolished by atropine.

224, I D 1400

ROLE OF PEPTIDERGIC NEURONS ON INTRINSIC MUCOSAL REFLEX OF SMALL INTESTINE IN DOGS. NEYA, T., MIZUTANI, M. AND NAKAYAMA, S. Dept. Physiol., Okayama Univ. Med. Sch., Okayama 700

It was studied whether opioid neurons and substance P-containing neurons (SP neurons) in the enteric plexuses modurated oral excitatory and anal inhibitory responses elicited by intrinsic mucosal reflex. The reflex was induced in the denervated small intestine of the dog by electrical stimulation of mucosal surface (5-20 Hz, 0.5-2 msec, 15-30 V). Atropine (0.2 mg/kg, i.v.) abolished oral excitation in some instances but reduced only some extent in the other.

Naloxone (0.1-2.8 nmol/min) infused into mesenteric artery abolished or reduced in various extents the oral excitatory response which was abolished or reduced largely by atropine. SP-antagonist, (D-Pro^2, D-Trp^{7,9})-SP (0.1 μmol/min, i.a.) reduced largely the oral excitatory response. After repeated administration of SP (50 pmol by 5-7 times at intervals of 3 min, i.a.), both atropine-sensitive and atropine-resistant oral excitatory responses were abolished. The anal inhibitory response was resistant to naloxone, SP-antagonist and repeated administration of SP.

It is, therefore, suggested that opioid neurons, at least in part, operate cholinergic oral excitation produced by intrinsic mucosal reflex and SP-neurons operate cholinergic and non-cholinergic oral excitation.

225, I D 1415

OPIOID-INDUCED HYPERPOLARIZATION BY δ RECEPTOR ACTIVATION IN THE GUINEA-PIG SUBMUCOUS NEURONES. MIHARA, S. AND NORTH, R. A.* Neuropharmacol. Lab., 56-245, M.I.T., Cambridge MA 02139, U.S.A.

Intracellular recordings were made in vitro from neurones in the submucous plexus of the guinea-pig caecum. [Met]enkephalin, [Leu]enkephalin, [D-Ala^2, D-Leu^5]enkephalin (DADLE) and [D-Ser^2, Leu^5]enkephalin-Thr (DSLET) caused membrane hyperpolarizations when applied in concentrations of 30 nM - 10 μM. Normorphine, [D-Ala^2, MePhe^4, Gly^5] enkephalin-ol (DAGO), [D-Ala^2, MePhe^4, Met(o)^5]enkephalin-ol (FK33824), dynorphin A and tifluadom had no effect at concentrations up to 10 μM. The hyperpolarization was due to an increase in the membrane potassium conductance. [Met]enkephalin-induced hyperpolarizations were antagonized competitively by naloxone and by N-bisallyl[amino-isobutyrate^{2,3}, Leu^5]enkephalin (ICI 174864). The Schild plots for these antagonisms had slopes not different from one, and the dissociation equilibrium constants were 5-50 nM for naloxone and 5-60 nM for ICI 174864. The results indicate that the opioid receptors on guinea-pig submucous neurones which are coupled to potassium channels are of the δ type.

226, I D 1430

INHIBITORY NEUROTRANSMITTERS WORKING AT THE REGULATORY REGIONS FOR CIRCULATION AND RESPIRATION IN THE NUCLEUS TRACTUS SOLITARII. MIURA, M. and TAKAYAMA, K. Dept. Physiol. 1st Div., Gunma Univ. Sch. Med., Maebashi 371

Recently, we demonstrated that the NTS response, a field potential evoked in the nucleus tractus solitarii (NTS) by stimulation of the afferent A fibers of the carotid sinus nerve, was inhibited by the application of naloxone and substance P antagonist, and suggested that both opioid peptide and substance P may act as neurotransmitters on terminals of the baro- and chemoreceptor fibers of the carotid sinus nerve. The NTS response showed an increase in the negative wave under the background anodal current (disinhibition), while a decrease in the negative wave under the background cathodal current (intensified inhibition).

Using chloralose anesthetized cat (30 mg/kg, iv), we examined what kind of the inhibitory neurotransmitter is working at the NTS regulatory regions for circulation and respiration. The NTS response was recorded under the background cathodal current, and tested by the application of 10 mM bicuculline (GABA antagonist) and 3 mM prazosin (noradrenalin antagonist). Only prazosin augmented the size of the NTS response, indicating that noradrenalin may be a neurotransmitter of intercalated inhibitory neurons around the secondary carotid sinus nerve neurons.

227, I D 1445

SENSITIVITIES OF NEUROTRANSMITTERS IN THE NUCLEUS TRACTUS SOLITARII NEURONS DERIVED FROM TISSUE CULTURES OF NEONATAL RATS. OKADA, J. and MIURA, M. Dept. Physiol. 1st Div., Gunma Univ. Sch. Med., Maebashi 371

Using paired razor blades, the neonatal rat brain was sliced at the obex level (3-5 days). From the brain slices (1mm thick), tissue fragments of the nucleus tractus solitarii were excised under a dissecting microscope. The tissue fragments were minced and maintained for at least one week prior to the electrophysiological experiment in a mixture of Eagle's minimum essential medium, 5% fetal bovine serum and 10% heat-inactivated horse serum. The electrophysiological experiments were performed on 6 types of neurons (small oval, large oval, fusiform, polygonal, pyramidal and multipolar neurons). Unit discharges of a single cultured neuron were recorded extracellularly with a suction micropipette. Tested neurons showed spontaneous firing at a rate of 0.8-10 impulses per second. The activity of a neuron was unchanged, facilitated or inhibited by the iontophoretic application of various kinds of neurotransmitters, like amines, amino acids, peptides and ACh. The results of this study were similar to those of the prenatal cultured neurons (Brain Res., 233, 83, 1982; ibid, 268, 377, 1983). Most notable findings were different response to GABA. All prenatal cultured neurons were inhibited by GABA, but some postnatal cultured neurons (20%) showed a mixed response composed of early facilitation and later inhibition.

228, I D 1500

PROJECTION TO HYPOTHALAMUS OF NEURONS WITHIN SOLITARY TRACT NUCLEUS INFLUENCED BY HEPATIC VAGAL AFFERENTS IN RATS.
KOBASHI, M. AND ADACHI, A. Dept. of Physiol., Okayama Univ. Dent. Sch., Okayama 700

The effects of hepatic vagal afferent signals on neurons which project to hypothalamus were investigated within the solitary tract nucleus (NTS) in urethan-chloralose anesthetized rats. Antidromic responses were evoked by electrical stimulation of anterior hypothalamic area (AH), paraventricular hypothalamic nucleus (PVH), dorsal area (DA), lateral hypothalamic area (LH) and posterior hypothalamic nucleus (PH). Some of these neurons that responded to antidromic stimulation were also responded with excitation or inhibition by single shock electrical stimulation of hepatic branch of vagus nerve. Among them, some neurons projecting to LH or PVH showed a decrease in discharge rate in response to portal infusion of hypertonic saline. It is confirmed that hepato-portal sodium or osmotic afferent signals project from NTS to LH or PVH directly.

229, I D 1515

ADRENERGIC NERVES IN THE HYPOTHALAMO-BULBAR PATHWAY OF THE VAGAL NERVE
MIYAMOTO,J.K., IDE,Ch., OKUBO,T., KUROSAWA,E., MARUYAMA,E. and FUJITA,Y. Dept. of Physiol., Saitama Kenritsu Eiseitandai, Urawa, 338.

Changes in efferent discharges of cervical vagal nerves produced by injection of noradrenaline (NA), 5 hydroxy-tryptamine (5-HT), prostaglandins, calcium channel blockers (Verapamil, Diltiazim), phenoxybenzamine (PBZ) and phentolamine (PA) into the anterior hypothalamus and brain stem were studied in N_2O 65%, O_2 35% anesthetized rabbits.

The injection of NA, 5-HT and prostaglandins produced invariably a sustained increase of the cervical vagal efferent discharges. This increase was greater when the substances were injected into the hypothalamus than when injected into the brain stem including the dorsal motor nucleus of the vagus. PBZ and PA blocked the responses induced by NA, 5-HT and prostaglandins. Also, the vagal efferent background discharges were decreased or suppressed. The effect of PBZ or PA was greater with hypothalamic injection than lower brain stem injection. Calcium channel blockers produced a transient (10-20 min) decrease or supression of the vagal background discharges followed by a period of increased activities lasting about 20 minutes before returning to control level.

Thus, the neuronal pathways of the vagal nerves into the diencephalon and brain stem are mediated by adrenergic synapses. The density of such adrenergic synapses are greater in the anterior hypothalamus than in the lower brain stem.

230, I D 1530

RELEASE OF PEPTIDE HISTIDINE ISOLEUCINE(PHI) AND VASOACTIVE INTESTINAL POLYPEPTIDE (VIP) BY ELECTRICAL STIMULATION OF THE VAGUS.
YASUI, A., NARUSE, S., YANAIHARA, C. and YANAIHARA, N. National Institute for Physiological Sciences, Okazaki, 444 and Shizuoka College of Pharmacy, Shizuoka, 422.

We have previously shown that VIP and PHI are co-released into portal circulation on electrical vagal stimulation in the dog. Portal plasma immunoreactive(IR) PHI, however, is significantly higher than IR-VIP, suggesting that VIP and PHI, sharing a common precursor, may not be released on an equimolar basis. The present study dealt with molecular feature of IR-PHI released on the vagal stimulation. Portal plasma obtained during the vagal stimulation as well as diluted acetic acid extracts of the dog gastrointestinal(GI) tissues were analyzed by gel filtration on Sephadex G50 column. PHI radioimmunoassay was carried out with N-terminal specific(IR-PHI-N) and C-terminal specific(IR-PHI-C) antisera, respectively. On gel filtration, major components of IR-PHI-C and IR-VIP increased in the portal plasma corresponded to standard PHI-27 and VIP-28, respectively. IR-PHI-N, on the other hand, consisted of two components: one corresponding to PHI-27 and the other of larger molecular size. The larger form was also found throughout the GI tract of the dog. The exaggerated release of IR-PHI-N on vagal stimulation could be attributed to this larger IR-PHI.

231, I D 1545

EFFECTS OF HYPOTHALAMIC STIMULATION ON NOREPINEPHRINE TURNOVER IN PERIPHERAL TISSUES.
SAITO, M., MINOKOSHI, Y.
Dept. Med. Biochem., Sch. Med., Ehime Univ., Ehime 791-02

To clarify a functional connection between the hypothalamus and the sympathetic nervous system, effects of electrical stimulation of the hypothalamus on norepinephrine (NE) turnover, an index of sympathetic activity, were examined in anesthetized rats. NE turnover was estimated from the disappearance of NE from heart, pancreas, liver, spleen, and brown adipose tissue (BAT) after blockade of NE synthesis with α-methyl-p-tyrosine. Electrical stimulation of ventromedial nucleus (VMH) increased NE turnover remarkably in the liver and pancreas, and to the less extent in heart, spleen and BAT, whereas stimulation of the lateral hypothalamus (LH) had no appreciable effects on NE turnover in all these tissues. The effect of VMH stimulation on NE turnover in BAT was completely abolished when the sympathetic nerves entering into BAT were surgically severed. It was concluded that the VMH is an area involving central connections for the sympathetic nervous system.

232, I D 1600

THYROTROPIN-RELEASING HORMONE-INDUCED CHANGES IN ELECTROENCEPHALOGRAPHIC AND VAGAL ACTIVITY IN THE CROSS-CIRCULATED BRAIN OF THE RAT. Tonoue,T. and Seino,K.* Dept. Physiol. II, Azabu Univ. Sch. Vet. Med., Sagamihara 229

In order to clarify the role of thyrotropin-rleasing hormone (TRH), the effects of centrally administered TRH on vagal efferent and cortical electroencephalographic (EEG) activity were assessed in rat brains which were functionally isolated from the body trunk and maintained via the cross-circulation. Upon withdrawal of inputs from the trunk, cervical vagal activity was markedly attenuated. The decreased activity was partially restored by TRH with a latent period of a few min. On the other hand, the cortical EEG was not severely affected by the functional isolation of the brain from the trunk. TRH immediately but transiently augmented the fast waves of the EEG in the rats. The findings indicate that inputs from the trunk are required to generate output signals in most of the vagal nerves and that TRH triggers a change in the brain state toward arousal. The change produced by TRH in brain activity appears to simulate the state which makes possible the generation of vagal efferent activity even though inputs from the body trunk are withdrawn.

233, I D 1615

EFFECTS OF SUBSTANCE P ANTAGONISTS ON SOMATO-ADRENAL SYMPATHETIC NERVE REFLEXES IN ANESTHETIZED RATS. FUJINO, M.*2, KUROSAWA, M., SAITO, H.*1, SATO, A. AND SWENSON, R.S.* Dept. Physiol., Tokyo Metropol. Inst. of Gerontol., Tokyo 173.

Substance P (SP) is considered to be involved in transmission of descending information from the brainstem to spinal sympathetic preganglionic neurones and also in synaptic transmission of primary afferent information along unmyelinated fibers within the spinal dorsal horn. The present study was designed to test the effects of three synthetic peptides known to contain SP antagonizing properties upon the two identified supraspinal adrenal sympathetic reflex responses (A- and C-reflexes) evoked respectively by a single electrical stimulation of myelinated A and unmyelinated C afferents of a hindlimb nerve in anesthetized rats. These peptides were (D-Arg^{1}, D-Trp^{7,9}, Leu^{11})SP, Arg-Gly-Gln-Phe-Phe-Gly-Asp(OBu^{t})$_2$, Arg-Gly-Gln-Trp-Phe-Gly-Asp(OBu^{t})$_2$. Both of the A- and C-reflexes as well as spontaneous activity of the adrenal sympathetic nerve were almost equally reduced by an intrathecal application of the SP antagonists in a dose dependent manner. These three SP antagonists qualitatively revealed similar effects.These data suggest that these SP antagonists may act inhibitoryly on descending pathways (probably containing SP) from the supraspinal structure to the spinal sympathetic neurones producing the A- and C- reflexes, rather than acting on the unmyelinated primary afferents in the dorsal horn of the spinal cord. (Present adress: 1 Dept. Pharmacol., Hokkaido Univ. Sch. Med., Sapporo 060, 2 Central Res. Div. Takeda Chemical Industries, Ltd., Osaka 532)

234, I D 1630

CHANGES IN THE AUTONOMIC NERVOUS SYSTEM PRODUCED BY MECHANICAL STIMULATION OF THE UTERUS IN THE RAT. HOTTA, H.*, ROBBINS, A.* AND SATO, Y. Dept. Physiol., Tokyo Metropolitan Institute of Gerontology, Tokyo 173.

Changes in blood pressure and heart rate produced by mechanical stimulation of the uterus were investigated in urethane-chloralose anesthetized rats. A small balloon was inserted into the uterine horn to produce horn stimulation by balloon inflation. Uterine cervix stimulation was produced by pressing the cervix with a glass rod via the vagina. Both uterine horn and cervix stimulations resulted in hypotension and bradycardia. In contrast, pinching of either the hindpaw or clitoris caused an increase in blood pressure and heart rate. In some cases, bilateral vagotomy did not influence these responses, while in other rats the hypotension and bradycardia were enhanced. After bilateral sectioning of the hypogastric nerves, the reflex induced by uterine horn stimulation disappeared, but the reflex from uterine cervical stimulation persisted. Bilateral transection of the pelvic nerves eliminated or attenuated the uterine cervically-produced reflex. These results indicate the uterine afferent pathways for reflex hypotension and bradycardia are via the hypogastric nerves from the uterine horn and the pelvic nerves from the uterine cervix, and the efferent pathway is mainly sympathetic.

235, I D 1645

PROLIFERATIVE ACTIVITY OF SUPERIOR CERVICAL GANGLIONIC AND ADRENAL MEDULLARY CELLS.
OGAWA, M., ISHIKAWA, T.* and OHTA, H.** Dept. Physiol., Dept. Anat.* and Dept. Neuropsychiatry**, Kochi Medical School, Nankoku, Kochi 781-51

The superior cervical ganglionic(SCG) neurons and the chromaffin cells of the adrenal medulla are derived from cells that have migrated out of the neural crest. In the present study we have investigated and compared the proliferative activity of both cells during the embryonic and neonatal stages in rats. The proliferative activity (DNA synthesis) of cells was detected by demonstrating immuno-histocytochemically the incorporation of 5-bromodeoxyuridine(BUdR) into their nuclear DNA using a monoclonal antibody against BUdR (Gratzner, Science 218: 474, 1982). The SCGs were isolated from several stages of fetus or neonate after giving a single dose of BUdR to mother or neonatal rats, and subsequently the cells were cultured. After the morphologic characteristics of neurons were identified in culture, the cells were fixed and examined. The proportion of immuno-reactive SCG neurons decreased from about 9% at E16, to 3.5% at E18, to 0.5% at birth and 0% at 4 days old. While the adrenal chromaffin cells showed that about 15% of them were proliferative even at 10 days old. These results indicate that most of the precursor cells of SCG neuron cease their proliferation at midterm of gestation, while many of the adrenal chromaffin cells have potential to proliferate during neonatal stsge.

236, II D 1400

EFFECTS OF PTH AND CALCITONIN ON HYPOGASTRIC NERVE-MEDIATED CONTRACTION OF VAS DEFERENS OF GUINEA PIG IN VITRO.
MATSUMOTO, A., YONEMURA, K. AND ISHIKO, N. Dept. of Physiol., Miyazaki Medical College, Miyazaki 889-16

Recent studies on uremic patients suggest that parathyroid hormone (PTH) is a candidate of uremic toxin responsible for causing neurologic disorders, since an elevation of PTH concentration in blood plasma parallels with an impairment of peripheral nerve conduction velocity in the patients. Using hypogastric nerve-vas deferens preparation of guinea pig, we examined the question of whether PTH can modify nerve-mediated smooth muscle contractions in vitro and also whether the effect of calcitonin is comparable with that of PTH.

Application of synthetic human PTH (1-34) in a concentration of 1 μg/ml produced a slight decrease in the amplitude of muscle contractions. On the contrary, calcitonin (10 MRC U/ml) showed an increasing effect on them. Experiments in Krebs solutions, ionic concentrations of which were changed so as to simulate those in blood plasma of patients with chronic renal failure, revealed that both effects of PTH and calcitonin are augmented in a low Ca^{++} solution, but not altered in high K^{+}, high Mg^{++} or high H_3PO_4 solutions.

237, II D 1415

EFFECTS OF PENTOBARBITAL, α-CHLORALOSE AND URETHANE ON RENAL SYMPATHETIC NERVE ACTIVITY IN AWAKE CATS.
MATSUKAWA K. AND NINOMIYA I. Dept. of Cardiac Physiol., National Cardiovascular Center, Research Institute, Fujishiro-dai, Suita, Osaka 565

We compared influences of pentobarbital, α-chloralose, and urethane on renal sympathetic nerve activity (RNA) in conscious cats. RNA, heart rate (HR), mean arterial pressure (MAP), and respiratory movement were continuoustly measured before and after intravenously administrating the anesthetic. Blood gas concentration was also monitored. Chloralose (40-50 mg/kg) and urethane (0.5-1.0 g/kg) highly increased RNA, whereas pentobarbital (20-30 mg/kg) decreased it. MAP varied among animals with chloralose but it was reduced with pentobarbital. In many experiments, RNA and MAP changed in the same direction. In addition, in some cats blood gas concentration of arterial blood samples did not alter under the anesthesia. These results suggested that the renal sympathetic nerve activity was mainly modified by nonuniform effect of the anesthetics on the central nervous system rather than by the baroreceptor or aortic chemoreceptor reflex.

238, II D 1430

POSSIBLE GANGLIONIC REFLEX ARC THROUGH PTERYGOPALATINE GANGLION.

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Synaptic connections between pre- and postganglionic nerve have been studied on pterygopalatine ganglion of the rabbit in vitro.

The most neurons of pterygopalatine ganglion received synaptic inputs from preganglionic fiber in the vidian nerve (preganglionic nerve). About 50% of the pterygopalatine neurons projected their postganglionic fibers to each of three posterior nasal nerves (postganglionic nerve). In some neurons, nicotinic e.p.s.p.s and an orthodromic spike evoked in response to electrical stimulation of one posterior nasal nerve as well as the vidian nerve, and also an antidromic action potential occurred in response to stimulation of the other posterior nasal nerve.

The thermosensitive afferent discharges were recorded from posterior nasal nerves by application of a cooling physiological solution to the nasal membrane. The e.p.s.p.s were also recorded intracellularly from some pterygopalatine ganglion cells in response to the same cooling stimulation applied to the nasal membrane. These results appear to indicate that some pterygopalatine ganglion neurons receive synaptic inputs from thermosensitive afferent fibers and constitute a ganglionic reflex arc.

239, II D 1445

ELECTROGENESIS MECHANISM OF SLOW IPSP IN HAMSTER SUBMANDIBULAR GANGLION CELLS.

SUZUKI, T., SHIOZAKI, K. AND SAKADA, S. Dept. Physiol., Tokyo Dent. Coll., Chiba 260

In this study, hyperpolarization induced by applying bethanechol (BCh, 1 M) to single cells from micropipette, using pressure injection system was investigated by intracellular recording in order to analyze the electrogenesis mechanism of slow IPSP in the parasympathetic ganglion. BCh-hyperpolarization induced by 10 pressure pulses (air pressure 2 kg/cm^2, 50 msec) was 10.7 ± 1.9 mV (mean ± S.E.) in amplitude and 5.1 ± 0.4 min in duration (resting E_m=-54 ± 2.3 mV). Effects of Ca^{2+}-free solution and TTX on BCh-hyperpolarization excluded a possibility of existence of interneuron mediating its generation. Atropine prevented this hyperpolarization. The amplitude of hyperpolarization was nullified at E_m levels of -90--93 mV in normal Krebs solution and -120--130 mV in K^+-free solution. Two types of G_m change (increase and decrease) during BCh-hyperpolarization were observed in voltage clamp study. Ba^{2+} ion and quinine prevented BCh-hyperpolarization. Thus Ca^{2+}-activated G_K increase might be involved in generation of BCh-hyerpolarization.

240, II D 1500

ELECTROPHYSIOLOGICAL PROPERTIES OF SYMPATHETIC POSTGANGLIONIC NEURONS INNERVATING SUBMANDIBULAR GLAND OF HAMSTER.

MORITA, M., SUZUKI, T., SAITO, T. AND SAKADA, S. Dept. Physiol., Tokyo Dent. Coll., Chiba 260

Sympathetic neurons innervating submandibular gland were identified by recording of antidromic response evoked by stimulation of the glandular nerve trunk in isolated superior cervical ganglion of young hamster, and were investigated electrophysiologically by intracellular recording. The value of resting E_m were -48.0±7.4 mV (mean±S.D., range -37--67 mV, n=42). Input membrane resistance (R_m) and time constant were 34.7±11.9 Mohm (20.1-62.6 Mohm, n=15) and 5.8±2.5 ms (3.1-10.9 ms, n=15). The critical level of spike firing was -33.1 mV (n=32). The amplitude and duration of orthodromic and antidromic spike were 63.0±10.4 mV (47-81 mV), 6.2±1.3 ms (4-8 ms) and 64.1±7.3 mV (44-81 mV), 6.5±1.4 ms (4-9.5 ms), respectively. Spikes were followed by long lasting after-hyperpolarization (9-24 mV, 43-508 ms, n=34). The amplitude and duration of fast EPSP and slow EPSP were 4-22 mV, 15-75 ms and 3-11 mV, 14-150 s. R_m decreased during fast EPSP (8.7-21%) and increased during slow EPSP (23-28%). The conduction velocities of axon of the neurons were 0.34±0.07 m/s (0.17-0.53 m/s, n=141).

241, II D 1515

RELATION BETWEEN THE FLUCTUATION OF PAROTID SECRETORY POTENTIAL AND THE CHANGES IN ION CONCENTRATIONS OF PAROTID SALIVA. INOMATA, K., TAKAKUWA, M., HOSHI, M., KURAHASHI, M., YOSHIDA, M. AND IWASE, K. Dept. of Oral Physiol., Sch. of Dent., Higashi-Nippon-Gakuen Univ., Ishikari-Tobetsu, Hokkaido 061-02

We summed up the electric charges of each ion in parotid saliva obtained by sour stimulation on tongue, and defined this summation of electric charges as total charges. In this study, the relation between the fluctuation of parotid secretory potential and that of total charges was studied in several subjects. The time course of parotid secretory potential was closely consistent with that of total charges. The result obtained here confirmed that of our previous study where the same experiments were repeated several times in one subject. Therefore, it is considered that the close relationship between parotid secretory potential and total charges is rather general phenomenon.

242, II D 1530

CULTURE OF NODOSE GANGLION NEURONS FROM NEW BORN RABBIT. SATO, M., HOSHINO, T., YOSHIZAKI, K. AND KOYANO, H. Dept. Physiol., Akita Univ. Sch. Med., Akita 010

Sympathetic neurons and dorsal root ganglion cells (sensory) require added nerve growth factor (NGF) for their survival in culture. On the other hand, recent report showed that nodose ganglion (NG) neurons (sensory) from new born rabbit survived well for a long term without addition of NGF, but its application (1 μg/ml) was found to be effective in accelerating the growth of neurites and neural somata judging morphological aspects (Sato, Brain Res., 345: 192, 1985).

To confirm this effectiveness of NGF both uptake of [^{3}H]leucine by cultured neurons and release of labeled-proteins from the neurons to culture medium were compared between NG neurons cultured with NGF and without. NG cells (1×10^4/6 mm in diameter) were cultured in serum-containing minimum essential medium. On the third day after treating with cytosine arabinoside for 2 days, [^{3}H]leucine was added to the culture medium. Both [^{3}H]leucine uptake and labeled-proteins release were a little higher in NG neurons cultured with NGF than in that without NGF. Thus, present data confirmed the previously-described finding.

243, II D 1545

NEURONAL CONTROL OF LIPID METABOLISM IN BROWN ADIPOSE TISSUE. MINOKOSHI, Y. AND SAITO, M. Dept. Med. Biochem., Sch. Med., Ehime Univ. Ehime 791-02

Thermogenesis by brown adipose tissue (BAT), which is under a direct control of the sympathetic nerves, is known to be associated with activation of lipid breakdown. In the present study, we investigated effects of electrical stimulation of the sympathetic nerves on lipid synthesis, by measuring ^{3}H-incorporation from ^3H_2O into fatty acids and glycerol moieties of lipid fraction extracted from interscapular BAT in anesthetized rats.

Intermittent electrical stimulation caused two different kinds of response, depending on stimulus parameters: when electrical stimuli consisting of a 20-sec train of monophagic square pulses were applied at 3 min interval, ^{3}H incorporation into glycerol was enhanced, but those into fatty acids did not change. However, when stimuli consisting of a train of much shorter duration, e.g. 2 sec, were applied, ^{3}H incorporation into fatty acids increased to the same extent as those into glycerol moiety.

These results indicate that sympathetic nerves control directly both synthesis and breakdown , i.e., turnover, of triglyceride in BAT.

244, II D 1600

EFFECT OF TASTE STIMULATION ON THE RATE OF EFFERENT DISCHARGES IN THE PANCREATIC BRANCH OF THE VAGUS NERVE IN THE NORMAL AND DECEREBRATED RAT.

NIIJIMA, A. AND FUKUDA, A. Dept. Physiol., Niigata Univ. Sch. Med., Niigata 951

Effect of taste stimulation on the efferent discharges in the pancreatic branch of the vagus nerve was observed in the normal and decerebrated rat. An increase in discharge rate following stimulation with 10% sucrose over the tongue for 3--5min, and a decrease of it following application of 5% NaCl for same duration were observed in normal as well as decerebrated rats.

The results indicate that the existence of reflex pathway from taste receptors to the vagal pancreatic nerve through the brain stem, probably through NTS and DMV. This pathway may play a part of role for cephalic phase of insulin secretion.

245, II D 1615

RELATIONSHIP BETWEEN ANTIGRAVITY MUSCLE CONTRACTION AND MUSCLE SYMPATHETIC NERVE ACTIVITY IN MAN.

MANO, T., SAITO, M., IWASE, S., YAMAZAKI, Y., and INAMURA, K. Dept. VI, Res. Inst. Environ. Med., Nagoya Univ., Nagoya 464.

The present study aimed to investigate the relationship between antigravity muscle contraction and sympathetic nerve activity in standing man. Subjects were 10 healthy male volunteers. Muscle sympathetic nerve activity (MSA) was recorded from the tibial nerve at the popliteal fossa using a tungsten microelectrode with tip diameter of 1 micrometer (impedance : 3-5 Megohm) in standing position, simultaneously with electromyographic discharges (EMG) in the antigravity soleus muscle. Effects of sustained and rhythmic contractions of the soleus on MSA and EMG were observed. Sustained contractions were effected by forward inclination of the body and standing on one foot. Rhythmic contractions were induced by voluntary alternating dorsi- and plantar flexions of the ankle. Effects of electrically-induced rhythmic contractions up to 8 Hz of the soleus on MSA were also analyzed. As results, MSA in standing subjects increased with EMG during sustained contractions of the soleus, but it decreased during voluntary and electrically-induced rhythmic contractions in the same muscle. The results indicate that sympathetic outflow to the leg antigravity muscles in standing man is modulated differentially by the mode of contraction in these muscles, being enhanced by sustained contractions, while being suppressed by rhythmic ones.

246, II D 1630

COMPARISON OF RESPONSES IN MUSCLE SYMPATHETIC NERVE ACTIVITY TO SUSTAINED AND RHYTHMIC HANDGRIP EXERCISE.

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Muscle sympathetic nerve activity(MSA) was recorded in seven healthy men, from the tibial nerve at the popliteal fassa using a tungsten microelectrode before and during sustained as well as rhythmic(1Hz) muscle contractions. The muscle contraction was performed by handgrip at tension of 30% of the maximal voluntary contraction for two minutes in supine position. Heart rate(HR) was counted from R-wave of electrocardiogram and mean blood pressure(MBP; 1/3 pulse pressure + diastolic pressure) was calculated from the blood pressure measured by the auscultation method. MSA expressed as burst rate(BR; bursts/min) and HR at rest before the exercise were not different in sustained and rhythmic contractions. The average value of BR, HR and MBP increased during static and rhythmic contractions against the resting value. However, during rhythmic contractions, the average value of BR was lower by 23.2% and HR was higher by 7.5% comparing to the value during sustained contraction. These differeces were significant($p < 0.05$). But the average values of MBP were almost same in both exercise. The lower response of MSA during rhythmic contractions would be related to the efficient circulation in active muscles of the forearm, which may be induced by enhanced muscle pumping.

247, III P (19) 0900

CHOLINERGIC MODULATION AND EFFECTS OF DYNORPHIN ON THE NON-ADRENERGIC NON-CHOLINERGIC INHIBITORY POTENTIALS IN THE DUODENAL SMOOTH MUSCLE OF THE GUINEA-PIG.

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The role of acetylcholine in modulating the non-adrenergic non-cholinergic (NANC) system in intestine has not been investigated. Atropine and scopolamine increased the amplitude of the inhibitory potential (i.p.) in the longitudinal smooth muscle while physostigmine and neostigmine decreased the amplitude of the i.p. The frequency of the spontaneous action potentials in the longitudinal smooth muscle was increased by dynorphin without the continuous membrane depolarization and the excitatory effect of dynorphin was not blocked by atropine. The amplitude of the i.p. was increased by dynorphin in the presence of atropine. These results suggest that (1) the NANC system is modulated by cholinergic nerves, (2) dynorphin has the non-cholinergic excitatory action on the longitudinal smooth muscle and (3) the NANC system is activated by dynorphin in the presence of atropine.

248, III P (20) 0900

PARTICIPATION OF SUBSTANCE P-ERGIC NEURONS ON THE NEURAL CONTROL OF THE GUINEA-PIG BILIARY TRACT MOTILITY.

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The effects of substance P(SP) have been studied on the control of the guinea-pig small intestinal motility. The aim of this study was to investigate actions of SP-ergic enteric neurons on the biliary tract motility. The guinea-pig gallbladder(GB), common bile duct(CBD) and ampulla(AM) were separately removed and set up in an organ bath. SP(0.5 - 70 nM) induced the dose-dependent contraction on GB, CBD and AM. The SP-induced contractions(SP-C, 50 nM) were reduced by atropine(At, 1.6 μM) and tetrodotoxin(TTX, 0.1 μg/ml) on GB(by 60%), CBD(by 90%) and AM(by 20%). SP-C of GB, CBD and AM were abolished by SP desensitization(SP-D), and were reduced after 5-HT desensitization, while SP-D reduced the 5-HT-induced contractions(5HT-C, 3 μM). 5HT-C of CBD were abolished by TTX and At, but those of GB and AM were reduced. After repetitive transmural stimulation(20 Hz, 0.5 msec) of CBD for 10, 20 and 30 sec, SP-C were reduced by 45, 70 and 75%, respectively. 5HT-C of GB, CBD and AM were reduced after repetitive transmural stimulation. Conclusion: The motility of GB and AM is regulated by SP-ergic neurons in parallel with serotonergic neurons via postganglionic cholinergic neurons. On CBD, postganglionic cholinergic neurons are regulated by serotonergic neurons which are controlled presynaptically by SP-ergic neurons.

249, III P (21) 0900

EXCITATORY EFFECTS OF ACETYLCHOLINE ON THE PRE- AND POST-SITES OF NEUROMUSCULAR JUNCTION IN THE GUINEA-PIG VAS DEFERENS.

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The sucrose-gap method was used to observe the effects of ACh on the membrane potential of smooth muscle cell of guinea-pig vas deferens. ACh at a concentration of 10^{-6}M, evoked a depolarization which was slow in time course (slow depolarization). At higher concentrations, ACh evoked another depolarization which was fast in time course (fast depolarization) and overlapping the early part of the slow depolarization. The fast depolarization was suppressed by guanethidine, dTC and hexamethonium, but was not affected by TTX or adrenoceptor antagonists. The slow depolarization, on the other hand, was inhibited by atropine. The reversal potential of the fast depolarization was about 28 mV positive to the resting membrane potential of this smooth muscle cell, the value of which was similar to that of ATP-induced depolarization. Whereas, the reversal potential of slow depolarization was about 18 mV negative to the resting potential. It is suggested that in this tissue, ACh liberates non-adrenergic transmitter, probably ATP, acting on the nicotinic receptor at the adrenergic nerve terminal, and that ACh also acts on the muscarinic receptor present at the smooth muscle membrane, inducing the depolarization resulting from the reduction of membrane conductance to K ions.

250, III P (22) 0900

A POSSIBLE CHOLINERGIC-ADRENERGIC MECHANISM IN THE LONGITUDINAL SMOOTH MUSCLE OF THE GUINEA-PIG VAS DEFERENS.

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The neurogenic contraction of guinea-pig vas deferens consisted of two (initial and second) phases. Guanethidine strongly suppressed both phases. Prazosin, on the other hand, inhibited only the second phase. Thus, the initial phase seems non-adrenergic, while the second phase, adrenergic. In addition, both phases were suppressed by atropine and potentiated by physostigmine. pentolinium, a nicotinic receptor antagonist, suppressed only the second phase. Whereas, other nicotinic receptor antagonists, dTC or hexamethonium, markedly enhanced both phases. Taking into account that exogenously applied ACh induces only excitatory action in this tissue, and that these antinicotinic drugs do not affect the response to ATP, NA or potassium, dTC or hexamethonium may have an effect on the sensitivity of nerve fibres to electrical stimulation. The present results indicate that the release of non-adrenergic transmitter from the adrenergic nerve terminal is at least partly modulated by cholinergic nerves in this tissue.

251, III P (23) 0900

REFLEX RESPONSES IN PUDENDAL BRANCHES INNERVATING THE EXTERNAL URETHRAL AND ANAL SPHINCTERS TO THE PELVIC NERVES STIMULATION IN DOGS.

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In dogs decerebrated under Ketamine anesthesia, reflex discharges in pudendal branches to the external sphincters of the urethra(PEU) and anus(PEA), and discharges in the pelvic branches to the urinary bladder(PV) and rectum(PR) were recorded simultaneously after stimulation of the central cut-ends of PV and PR (15 V, 1 msec). Single stimulation of PV increased discharges of PEU and PEA with a latency of 20-40 msec. The stimulation of PR increased outflow in PEA with a latency of 10-30 msec, but not affect discharges of PEU. Repetitive stimulation (2-10 Hz) of PV induced excitatory responses in PEU and PEA which were followed by inhibition as the appearance of the outflow in PV. On the cessation of the stimulation of PV, after-discharges appeared on PEU and PEA. Repetitive stimulation of PR increased discharges in PEU and PEA, when discharges in PR were increased, discharges in PEA were inhibited but not those in PEU. After cutting the spinal cord(C1), the inhibitory and excitatory responses in PEU and PEA, and excitatory response in PR were maintained, however, the response in PV was abolished. From the results, it may be concluded that the outflow in PEU and PEA are not always showed changes of the same direction.

252, III P (24) 0900

CHOLECYSTOKININ ANTAGONIST (PROGLUMIDE) POTENTIATE THE INHIBITORY EFFECT OF MORPHINE ON MICTURITION REFLEX IN RATS.

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Recent reports suggested that neuropeptide cholecystokinin (CCK) has physiological antagonistic role on the endogenous opiate system by the observation that CCK antagonist potentiated the morphine analgesia in rats. But CCK-opiate interaction in autonomic nervous system is not well known. We examined the possibility that CCK antogonist may potentiate the inhibitory effect of intrathecal (IT) morphine on micturition reflex.

In most cases, small doses of morphine (1 - 2μg IT) has minimum effect on urinary reflex. Systemic administration of proglumide-Na (0.005 -0.05μg/kg i.v., gift from KAKEN) on these animals produced complete depression of urinary reflex, which was antagonized by opiate antagonist naloxon (1mg/kg i.v.). Proglumide on untreated animals did not have marked effect on micturition reflex. In some cases, we observed that 2μg morphine inhibited the urinary reflex and large doses of proglumide (10mg/kg i.v.) reversed this inhibition.

The results suggested 1) the existence of CCK-opiate interaction in the autonomic nervous system such as micturition reflex pathway, 2) the reciprocal effect of proglumide: potentiation in small doses and inhibition in large doses to the effect of IT morphine.

253, III P (25) 0900

BEHAVIOR OF THE INFERIOR MESENTERIC GANGLION CELLS DURING DEFECATION AND MICTURITION IN THE DOG. FUKAI, K., FUKUDA, H. AND OKADA, H. Dept. Physiol., Kawasaki Med. Sch., Kurashiki 701-01

There have been reported some different results on how the sympathetic fibers in the lumbar colonic nerve act during defecation. So we aimed to confirm the problem by recording unit activities in the inferior mesenteric ganglion in decerebrate dogs. The mean conduction velocity of the postganglionic fibers was 0.65±0.24 m/sec(n=81) and the mean firing frequency was 2.1±1.5 Hz(n=57). The frequency of 4 units increased simultaneously with an increase of the renal nerve outflow in the response to cutaneous noxious stimulus, so the units are thought to be those innervating the colonic vascular smooth muscle. The remaining 49 units responded to the cutaneous stimulus with a decrease or no change in the discharges. These units may innervate the colonic smooth muscle. Discharges in the units were increased by distension of the distal colon (81%), rectum (56%) and urinary bladder (71%), and also by the stimulation of the anal mucosa (54%). It is concluded that the activity of the sympathetic fibers to the colon increases during defecation and micturition except that in only 2 units an inhibitory effect was induced.

254, III P (26) 0900

EFFECTS OF METHOPYRAPONE ON THE UPTAKE AND DISTRIBUTION OF [3H]DOPAMINE IN MOUSE ADRENAL MEDULLA. HIRANO, T., FUKUDA, A. AND NIIJIMA, A. Dept. Physiol., Niigata Univ. Sch. Med., Niigata 951

The effect of methopyrapone on the uptake and distribution of [3H]dopamine in adrenal chromaffin cells was investigated by autoradiography. Administration of this drug redults in complete arrest of cortisol synthesis and in an increased ACTH secretion.

Methopyrapone (300mg/kg body weight) was injected i.p. 1.5 h preceeding the isotope injection. [3H]dopamine (8 μCi/g body weight) was also injected i.p. and the mice were killed at 30min after the injection of the isotope.

An injection of methopyrapone resulted in an temporal reduction in the size of chromaffin cells, which was recovered within 24 h. The uptake of [3H]dopamine was remarkably increased by methopyrapone administration in both A and NA cell. This results suggest a possibility that ACTH directly enhances the uptake of [3H]dopamine in adrenal chromaffin cells.

255, III P (27) 0900

RETROGRADE TRANSPORT OF NERVE GROWTH FACTOR IN SUPERIOR CERVICAL SYMPATHETIC GANGLION OF THE RAT. TAKAHAMA, K., IWATA, M., ANDO, M., HORI, S.[1], KATO, K.[2], NAGATA, Y., Dept. of Physiol., Sch. of Med., Fujita-Gakuen Health Univ., Toyoake, Aichi 470-11, [1]Dept. of Neurochem., Tokyo Metropol. Inst. Neurosci., Fuchu, Tokyo 183, [2]Dept. of Biochem., Inst. for Develop. Res., Aichi Pref. Colony, Kasugai, Aichi 480-03

Content of nerve growth factor (NGF) in various rat tissues was measured with high sensitive enzyme immunoassay, and its highest content was found in superior cervical sympathetic ganglion (SCG). The ganglionic NGF content was rapidly decreased within 3 to 6 h after cutting or crushing postganglionic nerves (axotomy), and stayed at low level for a week. Cutting of postganglionic external carotid nerve caused much severer decrease in the ganglionic NGF content than that of internal carotid nerve did. On the contrary, when preganglionic nerve was crushed or ligatured (denervation), ganglionic NGF level increased dramatically nearly twice the control after 6 h, reaching the maximum at 9 h after the operation. By crushing the middle part of the longitudinal SCG body with fine tipped forceps, NGF content in preganglionic half was clearly declined, correspondingly NGF content in postganglionic half was greatly enhanced after operation. These temporal changes of the ganglionic NGF content after surgical operations strongly suggest that NGF was retrogradely transported from sympathetically innervated target tissues through postganglionic axons and blood stream, and was accumulated in the SCG.

256, III P (28) 0900

EFFECTS OF CALCIUM ION ON THE ACTIVE RESPONSE OF RABBIT OTIC GANGLION CELLS. YOSHIZAKI, K., HOSHINO, T., SATO, M. and KOYANO, H. Dept. Physiol., Akita Univ. Sch. Med., Akita 010.

The present study demonstrated the effects of calcium ion on the active response consisting in spike, afterhyperpolarization (AH, about 400 msec duration) and long lasting hyperpolarization (LLH, 2-10 sec duration), recorded from rabbit otic ganglion cells. The spike was blocked by 50 nM TTX in perfusion solution but was prolonged by 10 mM TEA in 50 nM TTX solution. The higher concentration of calcium ion in perfusion solution ($[Ca^{++}]_o$: 5.0 mM) changed little the spike height in calcium standard solution ($[Ca^{++}]_o$: 2.1 mM), while the lower concentrations ($[Ca^{++}]_o$: 0.5 and 0.1 mM which were added equivalent Mg^{++} in the place of removed Ca^{++}) reduced the height. AH diminished in amplitude and duration as $[Ca^{++}]_o$ decreased from 5.0 mM to 0.1 mM. LLH also diminished in amplitude and duration as $[Ca^{++}]_o$ decreased from 5.0 mM to 0.5 mM, and was blocked by 0.1 mM of $[Ca^{++}]_o$. It is concluded that the spike height and the amplitude and duration of AH and LLH depend on the calcium concentration in perfusion solution.

257, III P (29) 0900

INFLUENCES OF TRIGEMINAL STIMULATION ON THE DORSAL NUCLEUS NEURONS OF THE VAGUS NERVE. KOMATSUBARA, J., KAJIWARA, K., TAKAGI, T. and SUGAYA, E. Dept. of Physiol., Kanagawa Dental Coll., Yokosuka.

To elucidate the mechanism of the Reilly syndrome in oral medicine, interactions between trigeminal nerve input and the firing patterns of dorsal nucleus neurons of the vagal nerve were investigated.

Trigeminal stimulation was applied to the contra- and ipsi-lateral infraorbital and mandibular nerves. A glass microelectrode containing fast green FCF was used and recording sites were identified by microstaining with electrophoretically injected dye.

The firing pattern of the dorsal vagal nuclear neurons could be divided into three groups; i.e. neurons which manifested an excitatory effect by trigeminal nerve stimulation, neurons which manifested an inhibitory effect by trigeminal stimulations and neurons indifferent to trigiminal nerve stimulation. The distribution map of these neurons showed no regularity in the dorsal nucleus of the vagus.

These findings suggest that the trigeminal input influences either directly or indirectly the dorsal nucleus neurons of the vagal nerve and affects the thoracic and abodominal viscera, and consequently prolonged irritation of the trigeminal nerve provokes the Reilly syndrome in oral medicine.

258, III P (30) 0900

NORADRENALINE (NA) EFFECTS ON THE RAT DORSAL VAGAL MOTOR NUCLEUS (DMV) NEURONS IN VITRO. FUKUDA, A., NABEKURA, J., MINAMI, T. AND OOMURA, Y. Dept. Physiol., Fac. Med., Kyushu Univ. 60, Fukuoka 812

The DMV receives direct projections from the medullary noradrenergic cell groups. We studied NA effects on the DMV neurons of male rats using intracellular recording. NA depolarized 52% and hyperpolarized 32% of the neurons which were responded by antidromically vagal stimulation. Eleven % of the neurons showed biphasic (hyperpolarization - depolarization) response. NA depolarization and hyperpolarization were blocked by prazosin and yohimbine, respectively, but not by propranolol or timolol. The depolarization was accompanied by a membrane conductance (Gm) decrease and the hyperpolarization by a Gm increase. The reversal potentials for the former and the latter were -91 and -90 mV, respectively, and shifted in change of external K^+. The NA effects were not affected by Ca-free and high Mg solution. It suggests that NA effects mediated by change in K^+ permeability are direct effects on post-synaptic α_1- and α_2- adrenoceptors, respectively. In some cases, prazosin plus NA induced hyperpolarization on neurons which showed depolarization or no effect to NA in normal Ringer solution. These results indicated that most DMV neurons have both α_1- and α_2- adrenoceptors, and that responses to NA are regulated by predominance of one of these receptors.

259, III P (31) 0900

EFFECT OF AMYGDALA STIMULATION ON THE NEURONAL ACTIVITY OF THE DORSAL VAGAL COMPLEX.
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The effect of amygdala stimulation on neurons of the dorsal vagal complex (DVC), such as the nucleus of the tractus solitarius and the dorsal motor nucleus of the vagus, was investigated in urethane-chloralose anesthetized rats. DVC neurons were identified by their characteristic responses to subdiaphragmatic vagus stimulation. They were examined extracellularly for their responses to stimulation of the amygdala; central nucleus, medial nucleus and basolateral nucleus. Majority of DVC neurons responded to stimulation of the central nucleus with the pattern of inhibition, while the responses to the medial and basolateral nuclei were mainly excitation and excitation-inhibition. These results indicate that each amygdala nucleus exerts different effects on the DVC neuronal activities and that the amygdala plays an important role in modulation of the vagal functions.

260, III P (32) 0900

EFFECTS OF CENTRALLY-ACTING MUSCLE RELAXANTS ON MUSCLE SYMPATHETIC ACTIVITY IN MAN.
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Among centrally-acting muscle relaxants, chlorphenesin carbamate (CPC) and eperisone hydrochloride (EP) have been reported to take effect by inhibiting the polysynaptic reflexes at the spinal interneuron level, as well as by suppressing the activities of gamma-motoneuron and muscle spindle. In order to investigate if these agents contribute to the muscle relaxant action through the sympathetic nervous mechanisms, besides the somatosensory-motor ones, the effects of CPC and EP on the muscle sympathetic activity (MSA) were observed in human volunteers. Subjects were 20 healthy male medical students with thoroughly informed consent of the experiment. MSA was identified and recorded percutaneously from the tibial nerve in supine position, using a tungsten microelectrode with a tip diameter of 1 micrometer (impedance : 3-5 Megohm). A single dose of 750-1500 mg of CPC, or 150-300 mg of EP was administered orally. The drug-induced changes of MSA were continuously monitored as the change of MSA burst number/min (burst rate) in supine position at rest. The drug effects on the change of MSA burst rate during hand-grip exercises were analyzed in the same position of the subject. The drug effects on MSA responsiveness to head-up tilting, expressed as the slope of regression line between the sine of the tilting gradient and the burst rate, were also analyzed. As the results, CPC and EP reduced the MSA burst rate in supine position at rest by 31% maximally, and suppressed the exercise-induced increase of MSA. The drugs suppressed also responsiveness to head-up tilting by 25.4% in average. These results indicate that some of centrally-acting muscle relaxants, such as CPC and EP, suppress the sympathetic nerve activity to muscle. This effect may cooperate to the muscle relaxant actions through somatosensory-motor mechanisms of these agents.

261, III P (33) 0900

THE EFFECT OF ACUPUNCTURE STIMULATION ON THE ACTIVITY OF EFFERENT SYMPATHETIC POSTGANGLIONIC FIBERS IN MAN.
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The effects of acupuncture at the points of heel (Kon-ron) and neck (Ten-chu) were studied on the vasomotor nerve activity to soleus muscle in man by using a fine steel electrode. The spontaneous efferent sympathetic discharges correlated well with cardiac and respiratory rhythm. Acupuncture remarkably inhibited these efferent discharges. this result may explain at least in part the mechanism of acupuncture therapy.

262, I E 0915

DISTRIBUTION ANALYSIS OF CONDUCTION VELOCITY OF PERIPHERAL NERVES.
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A new and simple method to extract informations on the distribution of conduction velocity(DCV) of peripheral nerves was proposed, and a discovery of the conservation law concerning the compound action potentials(CAP) was reported, which made it possible to standardize the amplitude of CAPs recorded at different sites.

This method which is based on the Mellin transformation of CAPs enables one to compute the arbitrary order of moments of DCV from the monopolar CAPs recorded at several sites remote from the stimulation point. Assessment of the method was carried out with the artificial CAPs generated with computer experiments, and revealed that the moments of DCV were able to be computed under a practical experimental condition with precision of several percent and within a several minutes of computational time with a microcomputer(PC9801E). CAPs recorded from the median nerves of normal and diabetic subjects of man were submitted to the examination of the applicability of the method, and the effectiveness and the limitation of the method were critically reported.

263, I E 0930

PERIPHERAL NEURAL MESSAGES PARTICIPATED IN ELECTROACUPUNCTURE EFFECTS ON THE RAT TAIL FLICK REFLEX.
MATSUI, A., TSURUOKA, M. AND MATSUI, Y. Dept. of Physiol., Showa Univ. Sch. of Dent., Tokyo 142

Using the tail flick reflex, peripheral neural messages participated in electroacupuncture stimulation(EAS) and innervation on the Zusanli skin point were investigated electrophysiologically in lightly anesthetized rats. On the meridian point, there was a certain area which had a relatively low threshold intensity for producing Aβ-action potential in the common peroneal nerve and also a larger amplitude of the action potential elicited by EAS of a constant intensity. The muscle activity of the tail muscle(M. extensor caudae medialis) elicited by noxious heat stimulation of the tail skin was suppressed by the Aβ-action potential produced by EAS and also by selectively direct stimulation of Aβ fibers in the common peroneal nerve transected under the capitulum fibulae. The results suggest that neural features of the Zusanli point are low threshold and high innervation density of Aβ-fibers on the point. Suppression of the muscle activity by EAS, therefore, could be regarded as the effect induced mostly by Aβ afferent nerve impulses.

264, I E 0945

EFFECTS OF NGF ON CELL DEATH OF AXOTOMIZED SENSORY NEURONS IN NEONATAL RATS.
KASHIHARA, Y., MIYATA, Y. AND KUNO, M. National Institute for Physiological Sciences, Okazaki 444

When a muscle nerve is crushed on the day after birth in the rat, the monosynaptic EPSPs elicited in spinal motoneurons by afferent volleys from the muscle are markedly depressed within a few weeks. This synaptic depression is partially reversed by daily treatment with nerve growth factor (NGF). We have examined whether this effect is due to prevention of the possible cell death of axotomized Group Ia sensory neurons by NGF. The medial gastrocnemius (MG) nerve was unilaterally crushed near the muscle on the day after birth in Wistar rats. After a postoperative period of 25-35 days, the lumbar dorsal root ganglion cells were labeled retrogradely with HRP applied to the MG nerves on both the control and operated sides. On the average, a 43% loss of the MG sensory neurons was observed on the crushed side. The extent of cell death was significantly greater in large (Aα) sensory neurons than in small (Aδ, C) neurons. Daily NGF treatment prevented the cell death of small sensory neurons but was ineffective in preventing cell death of large neurons. It is concluded that the NGF effects on central synaptic function is due to a partial reversal of the depression occurred at the synapses formed by the axotomized Group Ia sensory fibers.

265, I E 1000

ELECTROACUPUNCTURE SUPPRESSION PRODUCED BY Aβ AFFERENT NERVE IMPULSES FROM DIFFERENT DERMATOMES.
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Dept. of Physiol., Showa Univ. Sch. of Dent., Tokyo 142

Suppressive effects of Aβ afferent nerve impulses from meridian points at different dermatomes, the Hoku and the Zusanli, on the tail flick reflex were investigated in lightly anesthetized rats. The integrated electromyogram of the tail muscle(M. extensor caudae medialis) elicited by noxious heat stimulation was used as an indicator of electroacupuncture effect. At both the Hoku and the Zusanli points, electroacupuncture stimulation decreased the muscle activity without increasing the threshold temperature which produces muscle activity. The suppressive effect of the Hoku stimulation was antagonized by naloxone(1mg/kg, i.p.), while that of the Zusanli stimulation failed to be antagonized by naloxone(1mg/kg, 20mg/kg, i.p.). These results suggest that the Hoku stimulation inhibits presynaptically the input of the noxious message in the spinal cord through the opiate system, but the Zusanli stimulation inhibits presynaptically this input through the non-opiate system.

266, I E 1015

EFFECTS OF PERIPHERAL STIMULATION ON SELF-MUTILATION OF THE RAT INDUCED BY NERVE SECTION OF THE HINDPAW.
MIYAGAWA,H.※ YASUMO,W., ASADA,H., NISHIGORI,A. AND YAMAGUCHI,Y. Dept. Health Sci., Coll. Integ. Arts & Sci., Osaka Pref. Univ., Sakai 591

After peripheral nerve sections of the hind paw of the rats, self-mutilation occurs on the ex-innervated and adjacent areas in several days to some weeks. Such self-mutilation is thought to be a model of chronic pain related to phantom pain or phantom sensation. In this study, we examined effects of peripheral electrical stimulation on the self-mutilation. Wister strain rats were used and chronic section of the unilateral sciatic and saphenus nerves was performed. Stimulating electrodes was chronically implanted either near the stump or in the hindleg contralateral to the section. THe animals were stimulated daily for one hour a day and the stimulation was repeated for three weeks from the next day of the nerve section. Frequency of stimulation was 30 c/sec and two sorts of stimulation strength were used: one was just below the muscle contraction threshold (weak), and another was maximal strength the rats could endure (strong). The peripheral electrical stimulation influenced markedly on time of onset of self-mutilation. The weak stimulation to the contralateral hindleg markedly suppressed self-mutilation, but the weak stimulation near the stump tended to facilitate it.

267, I E 1030

PROLONGED ACTIVATION OF ALPHA-MOTONEURONS FOLLOWING ELECTRICAL AND VIBRATORY STIMULATION IN ANEMICALLY DECEREBRATED CATS.
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Experiments were performed on cats anemically decerebrated under ether anaesthesia. The medial and lateral gastrocnemius-soleus nerve were electrically stimulated at thershold of G-I fibres, at various interval, while discharges were intracellulary recorded. The medial gastrocnemius muscles were vibrated at various interval, while discharges were extracellulary recorded from functionally single ventral root fibres.

Instantaneous after-discharges showed no strict relation to the interval of the electrical stimulation and vibration, although the after-discharge rate varied to some degree depending on the interval of electrical and vibratory stimulation. Auto-correlograms of after-discharges showed that their intervals were multiple integers of a basic interval. The after-discharges were fired from small membrane potential fluctuations. The most motoneurons showing after-discharge had a longer afterhyperpolarization and a larger maximum EPSP than those motoneurons showing no after-discharge.

The results suggest that property of producing after-discharges is dependent on peripheral inputs as well as on the type of motoneuron.

268, I E 1045

MORPHOLOGICAL AND PHYSIOLOGICAL PROPERTIES IN THE EXTERNAL URETHRAL AND ANAL SPHINCTER MOTONEURONS AND MUSCLE TYPES OF EXTERNAL ANAL SPHINCTER IN THE CAT.
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External urethral and anal sphincter motoneurons were stained intracellularly with HRP in the pentobarbital anesthetized cats. Cell bodies were located within the Onuf's nucleus. Mean diameters of cell bodies (19.7-38.6μ) and of stem dendrites (1.9-5.2μ) were small and in the similar range to those of hindlimb γ-motoneurons. Despite the small diameter of stem dendrites, long dendrites equivalent to hindlimb α-motoneurons extended to the dorsal and ventro-medial directions. Dendrites to the dorsal direction branched around the intermedio-lateral nucleus and extended medially to lamina V and VI of Rexed. Mean diameter of cell body versus axonal conduction velocity (CV) and input resistance versus CV were correlated and these plots were distributed along the extrapolated line of the correlations observed in hindlimb motoneurons, respectively. Histochemical study of external anal sphincter revealed the existence of type I (slow) and type II (fast) muscle fibers. This was consistent with the result that the durations of spike after-hyperpolarization were in the range of slow and fast hindlimb motoneurons. There was, in addition, another type of muscle fiber that had ATPase activities in both alkali (pH 10.3) and acid (pH 4.6) preincubation.

269, I E 1100

DENDRITIC SPIKES IN PIGS, CATS AND RABBITS.
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The spikes of the dendrites (D-spikes) of the motoneurone were recorded in the soma as all-or-none potentials of 2-6 msec in duration and 1-5 mV in magnitude. They could be observed in motoneurones of infant pigs and adult rabbits in an anesthetized state. However, they were more frequently encountered in infant pigs and adult cats & kittens in a decerebrated state. In these animals in this state one third to more than one half of the motoneurones sampled exhibited D-spikes. D-spikes could be triggered monosynaptically by tibial nerve stimulation. But in most cases they were produced when higher threshold afferents were stimulated. Consequently, it was thought that D-spikes were as a rule polysynaptically produced. More than 2 D-spikes of different origins could be produced in the same motoneurone. They tended to summate giving rise to a larger and slower wave (D-wave). The D-wave was instrumental in generating a repetitive discharge. There was a depolarizing slow wave with notches (5-10 msec in duration) which occurred in all-or-none fashion, showed a refractoriness and could be abolished by injection of a hyperpolarizing current. These properties were similar to those of the D-spike. Such a slow wave was therefore regarded as a D-wave.

270, I E 1115

THE ANALYSIS OF SKIN REFLEX PATHWAYS.
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Neuronal pathways mediating skin reflexes especially from foot pads to toe extensors of the sole were analysed in Nembutal anesthetized cats usually spinalized at Th13-L1. Stimulation of the central pad evoked excitation of all the toe extensors, whereas reflexes from the toe pad were predominantly inhibition which was the strongest on extensors of the same digit. The cord dorsum potential evoked from the toe pad was maximal at L6, which was rostral to the level of the motor nuclei of toe extensors (L7-S2). A partial transection of the lateral funiculus at caudal L6 abolished or much decreased the inhibition from a toe pad but little affected the excitation from the central pad. Neurones that were antidromically excited from the motor nucleus at low thresholds were searched for at L6 and found in the dorsal horn. Intraaxonal staining with HRP of fibres in the lateral funiculus showed that those excited from the foot pads could terminate in motor nuclei. It was concluded that the reflexes from the toe pad are mediated at least partly by funicular neurones in the dorsal horn whose axons descend in the lateral funiculus to terminate in the motor nuclei.

271, I E 1130

Fibers-architecture of spinal cord in rabbit. Part III. The spino-vestibular tracts.
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We devised a stereotaxic instrument for studies on spinal cord. (Ikawa-Ban's Instrument). Stereotaxic lesions were placed in the various cervical gray matters by means of the Ikawa-Ban's Instrument. Eight rabbits were used in present experiment. The animals were killed three weeks after the operation. The brain and the spinal cord stained by Marchi's method. In the eight rabbits spino-vestibular tract (Sp•Vest.Tr.) were traced to their termination in the vestibular nucl.
The summary is as follows:
1. The bilateral Sp•Vest.Tr. originating from the medial border cells of the anterior horn in the cervical cord. Ascend by way of the ventral funiculus and the reticular formation (Ret.F.). These fibers project to the inferior, medial, lateral and superior Vest. nucl. 2. The crossed Sp•Vest.Tr. originating from the lateral base of dorsal horn at the level of the 2nd cervical cord ascend by way of the medial ventro-lateral funiculus and Ret.F. The fibers project to the lateral Vest. nucl. and inferior Vest. nucl. 3. The Sp•Vest.Tr. rising in the 1st cervical cord of the dorsal horn leads to the ipsilateral medial Vest. nucl. by way of the lateral funiculus. 4. These three groups are the Sp•Vest.Tr. which project to the Vest. nucl. by way of the Ret.F. on the level of the nucl. olivaris superior as well as on the level of the rostral part of nucl. nervi facialis.

272, II E 1145

TIME COURSE OF Ia INHIBITION AT REST AND ON VOLUNTARY MOVEMENT IN MAN.
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Our original study on human subjects revealed that the Ia inhibition of the soleus H-reflex by stimulation of the common peroneal nerve which innervates ankle and toe flexors starts at a conditioning-test stimulus interval of about 1ms and has a maximum effect at around 2ms, and that the effect is facilitated by active dorsiflexion of the foot (Tanaka, Prog. clin. Neurophysiol. 8: 117-128, 1980). A recent report from an other group, however, showed a slower time course, which was delayed systematically by approximately 1ms, and did not verify the facilitation (Crone et al., Exp. Brain Res., 59: 418-422, 1985). We reinvestigated the issues on six normal subjects for explanation of the discrepancies. Attention was paid particularly to the phase just prior to the initiation of ankle dorsiflexion, when the facilitation of the Ia inhibitory pathway was apparent without any segmental effects which would be evoked secondarily by active movement (Kagamihara and Tanaka, J. Physiol. Soc. Japan, 47: p.465, 1985). Our previous result on the time course of the effect was also confirmed. The discrepancy of results could be explained by some methodological differences; position of the stimulating electrodes and setting procedure of the test H-reflex size at rest and on voluntary movement.

273, I E 1300

EFFECT OF FRAGMENT A-B OF TETANUS TOXIN ON THE TRANSMISSION OF THE MOTONEURONE IN THE SPINAL CORD.
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Tetanus toxin (mol. wt. 150,000) at low doses blocks both inhibitory and excitatory synapses (Kanda & Takano, J. Physiol. 235, 319-333, 1983). The tetanus toxin molecule consists of three portions: Fragment A, B and C (Matsuda et al., Biken J. 26, 133-143, 1983). The N-terminal Fragment A-B (mol. wt. 100,000) was prepared by mild treatment of the toxin with papain and highly purified. Toxin or Fragment A-B (5 μl) was injected into the spinal cord L_7 segment of the cat, near the motoneurone pool to be tested. The monosynaptic reflex (MSR) of the gastrocnemius muscle was conditioned by stimulating the antagonistic peroneal nerve. While by whole toxin the MSR was blocked later than its inhibition, by Fragment A-B both the MSR and the inhibition were depressed almost at the same time. These effects by Fragment A-B, however, appeared later than those by whole toxin. The cat injected with Fragment A-B was still alive at a time when the cat should be dead if it were injected with a similar amount of whole toxin. Fragment A-B (tetanus toxin without C-terminal) reached equally both inhibitory and excitatory synapses probably through diffusion and not axonal transport.

274, I E 1315

AN IDENTIFICATION OF A NERVE-CONTRACTOR MOTONEURON IN THE ABDOMINAL GANGLION OF APLYSIA.
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We found that Aplysia nerves were changing their lengths, and that one particular neuron in the abdominal ganglion directly regulated the length of many nerves (cerebrovisceral connectives as well as siphon, genital and pericardial nerves). By the intracellular application of horseradish peroxidase, it was revealed that the axons of the neuron run into the thick epineurium of those nerves where numerous muscle fibers were arrayed longitudinally. The intracellular stimulation of the neuron shortened the nerves in a firing frequency dependent manner, even after the synaptic transmissions in the ganglion were blocked by the separate perfusion of Ca free solution (EGTA 1mM). Thus, based on several physiological and histological findings, the neuron was identified as a nerve-contractor motoneuron which innervated the epineurial muscles and actively controlled the length of the nerves.

275, I E 1330

CRAYFISH LOCAL NON-SPIKING NEURONS FORM PARALLEL PATHWAYS AS PREMOTOR INTERNEURONS.
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Neuronal circuit elements governing a reflexive uropod movement in response to tactile stimulation was surveyed by intracellular marking. The circuit is found to include the local spiking interneurons as well as non-spiking interneurons. The local bilateral spiking neurons distribute sensory signals to the contralateral premotor non-spiking neurons. The local non-spiking neurons interpose between these local spiking ones and the uropod motoneurons forming multichannel parallel pathways. These interneurons can be divided into two groups of 1) one which forms either excitatory or disinhibitory connection and 2) another which forms either inhibitory or disfacilitatory connection from primary afferents or bilateral spiking neurons to closer motoneurons. Execution of the overt reflex seems to be determined by the activity balance between these two groups of the opposing connectivities. We hypothesize that this parallel processing is essential for behavioral plasticity.

276, II P (37) 1330

CHRONIC STIMULATION OF THE DORSAL ROOT AND DENDRITIC SPIKES OF MOTONEURONES IN INFANT PIGS.
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Chronic electrodes were implanted to stimulate the L6 or L7 dorsal root of infant pigs. For chronic stimulation, either 500 Hz or 50 Hz pulse trains were employed. The stimulus strength was such that both monosynaptic and polysynaptic pathways were stimulated without causing pain whatsoever. After 12-36 hours of chronic stimulation in 3-9 days, motoneurones were studied in acute experiments. In the state anesthetized with Nembutal 7 of 17 motoneurones stimulated with 50 Hz pulses and 9 of 20 control motoneurones showed dendritic spikes. In the decerebrated state without anesthesia, 34 of 50 motoneurones stimulated with 50 Hz and 24 of 36 control motoneurones exhibited dendritic spikes. These results indicated that 50 Hz stimulation was not effective in enhancing dendritic spikes. Nor was there any evidence that other electrical potentials such as EPSPs were enhanced. On the other hand, as we reported already, chronic stimulation of the dorsal root with 500 pulses considerably enhanced the dendritic activities of the motoneurone. A possibility was therefore pointed out that in the natural state it was through an excitatory interneurone capable of generating a discharge at a high frequency comparable to 500 Hz that plastic changes could be induced in the motoneurone.

277, II P (38) 1330

NMA-Induced locomotor activity in hind limbs of new-born rats.

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Effects of N-methyl-D,L-aspartate (NMA) on the generation of locomotor activity were studied using isolated lumbar spinal cord-hind limb preparations in new-born rats (0-3 days old). Electromyographic activities were recorded from the ankle flexor and extensor muscles of both sides. Bath-applied NMA (10-30 μM) evoked alternating rhythmic activity between the flexors and extensors. The frequency of the rhythmic activity in each muscle depended on the NMA dose. The mean burst duration in extensors was considerably longer than that in flexors at low concentrations of NMA. When the NMA dose was increased, the mean burst duration in extensors markedly decreased, compared with that in flexors. The activity in the corresponding muscles of the two hind limbs always occurred alternatingly within the concentration range described above. This pattern of muscle activity was not affected by the dorsal root transection. The NMA-induced rhythmic activity was also observed after the spinal cord was split mid-sagittally. However, the frequency of the rhythmic activity was significantly lower and the mean burst duration in each muscle much longer than those before splitting. It was concluded that central pattern generators, activated by NMA, exist in both sides of the lumbar spinal cord.

278, II P (39) 1330

INTRACELLULAR RECORDING FROM PRIMARY AFFERENT FIBERS IN THE ISOLATED SPINAL CORD OF THE RAT.

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Intracellular recordings were made from primary afferent fibers in the in vitro lumbar spinal cord removed from the neonatal rat aged 5-10 days old. Isolated spinal cord was superfused with an artificial cerebrospinal fluid saturated with 95% O_2 and 5% CO_2. Primary afferent fibers were identified by the appearance of an all-or-none action potential following stimulation of the dorsal rootlets. The dorsal roots or the sciatic nerve which did not include recorded afferent fibers were stimulated with graded stimulus intensities and changes in the membrane polarization of afferent fibers were analyzed. Although in many instances neither depolarization nor hyperpolarization could not be detected, some primary afferent fibers were depolarized in response to weak stimulation. And it was also observed that stimulation with intensities which should be sufficient to activate every category of the fibers evoked prolonged depolarization lasting up to several hundred ms in a few primary afferent fibers tested.

279, II P (40) 1330

OPIATE RECEPTOR IN THE SPINAL CORD OF THE ACUPUNCTURE AFFERENT PATHWAY EXPLORED BY NALOXONE REVERSIBLE EVOKED POTENTIAL CAUSED BY ACUPUNCTURE STIMULATION OF THE TIBIAL MUSCLE.

HISHIDA,F., SATO,T. and TAKESHIGE,C. Dept. of Physiol., Sch. of Med., Showa Univ., Tokyo 142

It was found previously that both acupuncture analgesia (AA) caused by low frequency tibial muscle stimulation and morphine analgesia (MA) caused by intraperitoneal 0.5 mg/kg morphine were blocked by intrathecal naloxone or by lesion of the anterolateral tract and that intrathecal 0.05 μg morphine-produced analgesia was equivalent to AA and MA. Therefore, it was suggested that opiate receptor existed in the acupuncture producing afferent pathway in the spinal cord. It was also found that this pathway ascended through the dorsal part of the periaqueductal central gray (D-PAG) and the reticular gigantocellular nucleus (NRGC). In the present experiment, the existence of opiate receptor in the spinal cord of the acupuncture afferent pathway was examined by naloxone effect on the evoked potential in the D-PAG and in the NRGC caused by tibial muscle stimulation. Intraperitoneal 1 mg/kg naloxone completely blocked such evoked potential, while had no effect on evoked potential in the lateral PAG caused by abdominal muscle stimulation which was identified as a non-acupuncture point.

280, II P (41) 1330

CHANGES OF SOME NEUROTRANSMITTER CANDIDATE CONTENTS IN RAT SPINAL CORD AFTER LAMINECTOMY AND SCIATIC NERVE TRANSECTIONS., FUJITA, K. and NAGATA, Y., Dept. of Physiol., Sch. of Med., Fujita-Gakuen Health Univ., Toyoake, Aichi 470-11

Attempting to determine neurotransmitter candidates between primary and secondary motor and sensory neurons in rat spinal cord, we measured acetylcholine (ACh) synthesizing and decomposing enzyme activities and some amino acid contents in the cord after transectioning thoracic spinal cord, or uni- or bilateral sciatic nerve truncks. Choline acetyltransferase (ChAT) and acetylcholinesterase (AChE) activities hardly changed in both cranial and caudal portions of the spinal cord after 1 to 3 weeks of laminectomy. Although content of free amino acids, such as glycine, aspartate, glutamate in both spinal portions did not change , γ-aminobutyric acid (GABA) tended to decrease, and taurine to increase within 1 to 3 weeks after laminectomy. These changes suggest that ACh is not to be considered as a neurotransmitter candidate for spinal primary neurons. Some amino acids like taurine or GABA may take part for transmitter candidates among spinal neurons. By transectioning sciatic nerve truncks, ChAT and AChE activities declined considerably in the innervated skeletal muscles, and these enzyme activities also decreased especially in dorsal part of the lumbar cord after 1 to 3 weeks of nerve transections. The interpretations of these result is quite debatable and further histochemical study must be necessary.

281, II P (42) 1330

PINNA AFFERENT IMPULSES RESPONSIBLE FOR SCRATCH REFLEX IN SPINAL CATS. KUROSAWA, Y. AND AOKI, M. Dept. Physiol., Sapporo Medical College, S.1, W.17, Chuo-ku, Sapporo 060

We previously reported that afferent fibers from pinna receptive field for scratch reflex were traced in the upper cervical segments by anterograde WGA-HRP method.

In the present experiments, the properties of pinna afferent impulses responsible for scratch reflex were studied in C1 spinalized cats. Tactile stimuli were applied to the bursella or dorsal aspect of scapha. Fictitious scratch reflex discharge was recorded in n. gastrocnemius and causative pinna afferent impulses were simultaneously recorded using tungsten microelectrodes inserted into C2 dorsal root ganglion or dorsal root. Scratching rhythm (4 Hz) was found to be initiated with latencies of 0.8-1.0 sec when rapidly adapting touch receptors were activated. Such rhythmic discharge was maintained during the non-rhythmic afferent impulses (20-50 Hz). Afferent conduction velocities estimated by latencies of spike evoked by electrical stimulation of the receptive fields ranged from 30 to 50 m/s.

282, II P (43) 1330

SLOW POTENTIALS IN THE UNEXCITABLE CELLS OF SPINAL CORD. TSURUHARA, H. and TAKAHASHI, T. Dept. Physiol., Kyoto Univ. Sch. Med., Kyoto 606

Intracellular recordings were made from unexcitable cells in the marginal zone of the rat spinal cord *in vitro*. The unexcitable cell showed high resting membrane potentials compared with marginal neurons, and its value changes with extracellular potassium concentration in a manner predicted by the Nernst equation. Following dorsal root stimulation, the unexcitable cell showed a slow depolarizing potential of several mV in amplitude and several tens of second in duration with no appreciable changes in the input resistance. It is suggested that the slow depolarizing potential is caused by extracellular accumulation of potassium released by neighboring neural activity.

283, I E 1345

INTERSTITIAL VESTIBULAR INTERACTION IN THE CONTROL OF HEAD POSTURE. II. ACTITITY OF VESTIBULAR NUCLEI AND HEAD POSTURE. FUKUSHIMA, K., FUKUSHIMA, J. AND KATO,M. Dept. Physiol., Hokkaido Univ. Sch. Med., Sapporo, 060

Our previous paper showed that the characteristic head posture resulting from INC lesions in cats cannot be explained by simple removal of activity of direct excitatory interstitiospinal neurons projecting to neck motoneurons (Fukushima et al., 1985). We also showed that the head tilt following unilateral INC lesions interacts with that produced following hemilabyrinthectomy. Experiments were done in cats to determine whether the activity of vestibular nuclei is needed for the occurrence of the head tilt following INC lesions. Results: (1) unilateral INC lesions that were performed in cats which had previously been given bilateral labyrinthectomies and in which vestibular symptoms were almost compensated, still produced the typical head posture. (2) lesions of the medial and/or the lateral vestibulospinal tracts(s) that should abolish the activity of direct vestibuloneck fibers did not influence the head tilt that had resulted from the unilateral INC lesions. (3) unilateral INC lesions that were given in cats which had received electrolytic lesions of most of the vestibular nuclei and a part of the medullary reticular formation still produced head tilt to the opposite side. These results indicate that the vestibular nuclei are not needed for the characteristic head posture following INC lesions.

284, I E 1400

EXCITATORY ACTIONS OF NORADRENALINE ON ELECTRICAL ACTIVITY OF RAT LOCUS COERULEUS NEURONS. SAKAGUCHI, T., KIMURA, F.* AND NAKAMURA, S. Dept. Neurophysiol., Inst. Higher Nervous Activity, Osaka Univ. Med. Sch. Osaka 530

Noradrenaline (NA) is known to inhibit spontaneous activity of locus coeruleus (LC) neurons and such an inhibition by iontophoretic application of NA is mediated by α2-adrenoceptors located on the soma-dendritic membranes of LC neurons. In the present experiments, we found that when NA was applied iontophoretically at low concentrations, LC neurons in the developing brain were excited rather than inhibited. In rats (1 to 14 days old) anesthetized with urethane, single unit activity in the LC was recorded extracellularly and NA was iontophoretically applied at concentrations of 1, 10 and 100 mM. All LC units examined were inhibited by NA at a concentration of 100 mM, whereas NA at concentrations of 1 and 10 mM frequently caused excitation of LC neurons. The excitation by NA occurred more frequently in LC neurons which were not spontaneously active or firing at low rates. Furthermore, we found that excitatory responses evoked by stimulation of the dorsal noradrenergic bundle arising in the LC were blocked by iontophoretic application of the α1-antagonist BE 2254 (generously supplied by Dr. E. Hofferber, Beiersdorf AG). These results suggest the presence of positive feedback mechanism in the LC, which is associated with activation of α1-adrenoceptors located on the soma-dendritic membranes of LC neurons.

285, I E 1415

2-DEOXYGLUCOSE UPTAKE IN THE BRAINSTEM OF THALAMIC CATS DURING PLRF ELICITED FORELIMB MOVEMENTS. SHIMAMURA, M., EDGERTON, V.R.*, KOGURE, I., AND FUWA, T. Dept. of Neurophysiol., Tokyo Metro. Inst. for Neurosci., Tokyo 183, Japan and Dept. of Kinesiology, UCLA, Los Angeles, CA 90024, U.S.A.

Tracer amounts of [^{14}C]-2-deoxy-D-glucose (2-DG) were detect areas of the brainstem in thalamic cats during forelimb movements induced by PLRF stimulation. Under ether anesthesia, cats were transected at stereotaxic A_{12} level and Th_{10} segment. Two hours later, 100uCi/Kg of 2-DG was infused i.v. and 3 cats were keeping stationary (rigid) and 3 were stimulated in the left paralemniscal pontine reticular formation (PLRF) during 45 min. Then the brainstem was removed and made histological sections for autoradiograms. Optical densities of the autoradiograms corresponding to specific anatomical structures of the brainstem were determined. Stimulation of the PLRF evoked coordinated movements of forelimb, the forelimb, ipsilateral side of the stimulation was flexed, while the contralateral forelimb was extended. In PLRF stim. cats, the ratio of 2-DG uptake in the brainstem was higher than that of rigid cats, and the pontine reticular formation ipsilateral side of the stimulation and the contralateral vestibular nuclei was considerably higher in ratio of uptake. These structures may utilize for supraspinal controls on the forelimb movements.

286, I E 1430

THE EFFECTS ON INITIATION OF SPONTANEOUS LOCOMOTION AFTER LESIONING SUBTHALAMIC LOCOMOTOR REGION. UDO, M. AND SHIMADA, T. Div. Neuromuscular Skills, Fac. Health and Sport Sci., Osaka Univ., Osaka 560

It is well known that subthalamic locomotor region (SLR) is important in initiating spontaneous locomotion (SL). During a few weeks after the SLR was destructed bilaterally, the chronic cats do not initiate locomotor movement. They eat food when accessible without step, but they do not leave the place to approach food. A few weeks after the destruction of bilateral SLR, the chronic cats become to exhibit SL.

In the present study, we confirmed the above behavior after destruction of bilateral SLR. On 20-40 days after the destruction, we decerebrated the chronic cats at different levels and found that the chronic cats decerebrated at the precollicular-postmammillary level can exhibit SL on the treadmill. Since it has been well described that the precollicular-premammillary cats do exhibit SL, while the precollicular-postmammillary cats do not, it can be postulated that some structures caudal to the precollicular-postmammillary level have become effective in initiating SL. By making lesions in bilateral substantia nigra (SN), we estimated that neurones and/or fibers passing through SN are responsible for initiating SL in chronic cats without SLR. The contribution of the SN neural elements is less dominant in the cats with intact SLR, since the SN lesions in them did not disrupt initiation of SL.

287, I E 1445

THE CENTER OF RABBIT ANIMAL HYPNOSIS.
OKAMOTO,T., HISAMITSU,T., LUO,C.P. and TAKESHIGE,C. Dept. of Physiol., Sch. of Med., Showa Univ., Tokyo 142

The duration of animal hypnosis (DAH) caused by inversion of rabbit was reduced by fine lesions with electrode insertion of around the brachium conjunctivum nucleus (BCN). Stimulation of this region prolonged the DAH. Low frequency tibial muscle stimulation as the acupuncture stimulation or stimulation of the dorsal periaqueductal central gray as the acupuncture afferent pathway prolonged the DAH. After lesion of the further rostral acupuncture afferent pathway such as the lateral septum or the anterior hypothalamus reduced the prolonged DAH to the control DAH. In the cases of the non-increase of DAH by electrode insertion to around the BCN, stimulation of this region prolonged the DAH. Therefore, this region might act as a part of the regulatory system on DAH.

It was concluded that the center of the animal hypnosis is located in around the BCN, and that the acupuncture afferent pathway regulates DAH through around the BCN.

288, I E 1500

EYE MOVEMENTS EVOKED BY MICROINJECTION OF GABA AGONIST INTO THE RAT SUBSTANTIA NIGRA
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Recent studies revealed that unilateral injection of GABA agonist (muscimol) into monkey substantia nigra pars reticulata (SNr) induced irrepressible saccades towards contralateral visual field (Hikosaka & Wurtz, J. Neurophysiol. 53: 292, 1985). We examined rat eye movements after microinjection of muscimol into SNr. The head of the rat was fixed tightly and its body movements were restricted by a special jacket. Magnetic search coil mehtod were used to detect eye movements. A small wire coil was glued directly onto the cornea by means of a drop of adhesive agent. A stainless steel tube for drug injection was lowered to SNr through a guide tube. The amount of muscimol injected was 1.0ul (0.1ug/ul saline). An injection of muscimol into SNr was followed by stereotypic fast eye movements to the side contralateral to the injection site. Subsequently muscimol-induced eye movements became to be like nystagmus in which the slow phase was directed to the ipsilateral side. The neck EMG contralateral to the injection was in most cases coactivated with fast eye movements to the same side. When released in home cage, the animal showed continuous circling contralateral to the injection. These muscimol-induced eye movements are basically the same as seen in the monkey after muscimol injection in SNr. These results suggest that SNr plays an important role in eye movements in the rat as well as in the monkey.

289, I E 1515

ADRENAL MEDULLA CELLS OF NEWBORN RAT GROW TO NEURONS IN THE CAUDATE NUCLEUS, AND ALLEVIATE MOTOR IMBALANCE IN RAT WITH UNILATERAL LESION IN NIGROSTRIATAL DOPAMINE PATHWAY.
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Newborn rat adrenal medulla cells were transplanted in the caudate nucleus of rats with unilateral lesion in nigrostriatal dopamine pathway, and correlation between cell growth and behavior recovery was investigated. In well-recovered animals circling following Met-amphetamine injection reduced in the 6th and stopped completely in the 8th week after transplantation. The behavior improvement was more evident in the latter than in the first half of the test period (60 min after Met-amphetamine administration). Transplanted cells (tyrosine hydroxylase like immunoreactive, THLI) grew to mature neurons; elongated and ramified dendrites and axons with abundant varicosities and growth cones. In poorly-recovered animals THLI cells were medium-sized with scant ramification. Data suggest that adrenal medulla cells develop into neurons in the host caudate and ameliorate motor imbalance. Recovery depends partly on the degree of cell differentiation.

290, I E 1530

DYNAMICS OF ADAPTIVE CHANGE IN VESTIBULOOCULAR REFLEX.
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Adaptive modification of direction of vestibuloocular reflex (VOR) by optokinetic motion perpendicular to body rotation was examined. Cats were trained for 2-4 hours in three ways: (1) Yaw was done by rotating the cat sinusoidally about a vertical axis at 0.25 Hz. Horizontal canals were stimulated. Optokinetic stimulus was rotated vertically at the same frequency and phase. (2) Upright pitch was done by placing the cat in its normal posture and rotating it about a medial-to-lateral horizontal axis. Otoliths and vertical canals were stimulated. Optokinetic stimulus was rotated about a vertical axis. (3) Onside pitch was done by placing the cat on its side and rotating it about a vertical axis. Vertical canals were stimulated. Optokinetic stimulus was rotated vertically. The gains and phases of VOR perpendicular to body rotation in the dark were measured at 0.05-2.5 Hz. The gains during yaw and onside pitch were maximal at the training frequency. The added otolith stimulation in upright pitch produced a higher gain at low frequencies.

291, I E 1545

FACILITATORY AND INHIBITORY EFFECTS INDUCED BY CUTANEOUS STIMULATION ON JAW OPENING REFLEX OF THE RAT.
Yasumo,W., *Asada,H., Nishigori,A. and Yamaguchi,Y. Dept. Health Sci., Coll. Integ. Arts & Sci., Osaka Pref. Univ., Sakai 591 and * Coll. Biomed. Tech., Osaka Univ., Osaka 560

Effects of cutaneous stimulation (CS) of various parts of the body was studied on jaw opening reflex (JOR) of the rat. The experiment was performed under pento-barbital sodium anesthesia. The JOR was evoked by dental pulp stimulation and the reflex EMG of digastric muscle was recorded. The CS was a square pulse and was given to various parts of the body; face, fore- and hind-paw, belly and back. A short period (5-20 msec) of JOR facilitation appeared after the CS and the inhibition followed (50-150 msec after the CS). The JOR inhibition by the CS was strong in the order: face, forepaw, hindpaw, belly and back. When the sensory nerves were stimulated at a level of the dosal root, strong JOR inhibition was obtained. Stimulation of infraorbital and cervical nerves was most effective in all for JOR inhibition. Stimulation of thoracal and lumbar nerves was much less effective for the inhibition than the former.

292, I E 1600

SYNAPTIC ACTIVATION OF TRIGEMINAL AFFERENTS ON AXOTOMIZED FACIAL MOTONEURONS IN THE CAT. TANAKA, T., ASAHARA, T. AND NISHIMURA, Y. Dept. Physiol., Mie Univ. Sch. Med., Tsu, Mie 514

Synaptic potentials in the facial motoneurons(FMNs) of cat anesthetized with sodium pentobarbital were recorded on stimulation of the infraorbital branch of the trigeminal nerve(IO) on both sides and the spinal trigeminal nucleus(SPN) after axotomy. By stimulation of the ipsilateral IO, EPSPs with latencies of 1.5-6.5 msec were evoked. In 53 out of 86 axotomized FMNs, the EPSPs had long latencies of 2.5-6.5 msec. In contrast normal FMNs exhibited similar long EPSPs in 29 out of 209 units. Ipsilateral IO stimulation evoked polysynaptic IPSPs in 36 axotomized FMNs(30 per cent of 122 units). For survival periods of 30-90 days, there was a significant reduction in the number of the IPSPs. Stimulation of the contralateral IO elicited polysynaptic PSPs and no significant changes were observed after axotomy. In 90 axotomized FMNs, stimulation of SPN produced EPSPs with short latencies of 0.6-2.0 msec, which was comparable to the EPSPs evoked in normal FMNs. The time to peak of these monosynaptic EPSPs ranged from 1.0-7.7 msec, averaging 3.7 msec. In normal FMNs the time to peak was 2.6 msec on the average. The means are significantly different at the 0.01 level. The findings suggest that there is a loss of the synaptic input to the soma of the axotomized FMNs.

293, I E 1615

INTRACELLULAR RESPONSES OF TRIGEMINAL SENSORY NEURONS TO PERIPHERAL AND CENTRAL STIMULATIONS. SUNADA, T., KURASAWA, I., HIROSE, Y.* AND NAKAMURA, Y. Depts. Physiol. and Dent. Anesthesiol.*, Fac. Dent., Tokyo Med. Dent. Univ., Tokyo 113

Intracellular responses of neurons in the trigeminal spinal nucleus oralis were studied in chloralose-anesthetized cats. The majority of neurons were classified into two groups based on the pattern of responses to single shocks applied to the frontal, infraorbital and inferior alveolar nerves, each belonging to one of the three principal divisions of the trigeminal nerve. One responded with an EPSP and a spike potential followed by an IPSP (Type I), and the other with a rather long-lasting EPSP superimposed often by two or more spikes (Type II). Type I neurons usually received excitatory inputs from one of the above-mentioned nerves, had the receptive field innervated by the same nerve, and received inhibitory inputs from the other nerves as well as outside the receptive field. However, Type II neurons received excitatory inputs from more than one nerve, and inhibitory responses were not found. Type I neurons responded either anti- or orthodromically to stimulation of the contralateral thalamus, and IPSP-EPSP sequences were often evoked by stimulation of the face region of the contralateral somatosensory cortex. In contrast, Type II neurons responded only orthodromically to the thalamic stimulation, and IPSPs were not evoked by the cortical stimulation. The results demonstrate that postsynaptic processes are involved in the modulation of synaptic transmission in the trigeminal sensory nucleus.

294, I E 1630

RECURRENT INHIBITION OF BULBAR RETICULAR NEURONS AND ITS ROLE IN CORTICAL INDUCTION OF MASTICATORY RHYTHM IN GUINEA PIGS. NOZAKI, S., IRIKI, A. AND NAKAMURA, Y. Dept. Physiol., Fac. Dent., Tokyo Med. Dent. Univ., Bunkyo-ku, Tokyo 113

We reported that neurons in the oral part of the gigantocellular reticular nucleus (GCo), projecting to the dorsocaudal part of the nucleus (GCc), were monosynaptically activated by neurons in the dorsal part of the paragigantocellular reticular nucleus (dPGC) in guinea pigs. Repetitive stimulation of the cortical masticatory area (CMA) supplies tonic inputs via dPGC neurons to GCo neurons to generate a rhythmical activity. The present study investigated roles of inhibition in generation of the rhythmical activity in GCo neurons and the nature of this inhibition, by recording intracellularly from GCo neurons, with the following results: 1) Repetitive CMA stimulation induced a rhythmical alternation of EPSP and IPSP in GCo neurons. 2) IPSPs in GCo neurons followed a spike(s) occurring spontaneously, evoked from the dPGC, antidromically from the GCc and directly by intracellular depolarizing current. 3) Cooling of the GCc abolished antidromic spikes and IPSPs evoked from the GCc, while neither the IPSP following spontaneous and orthodromic spikes nor the CMA-induced rhythmical EPSP-IPSP alternation was affected. 4) Systemic bicuculine application abolished the IPSPs mentioned above and the CMA-induced rhythmical IPSP in GCo neurons. We conclude that GCo neurons receive a possibly GABA-mediated recurrent inhibition, which would be involved in the CMA-induced rhythmical IPSP.

295, I E 1645

SYNAPTIC BASIS OF RHYTHMICAL TRIGEMINAL PREMOTOR NEURON ACTIVITY UNDERLYING CORTICALLY INDUCED MASTICATORY RHYTHM. IRIKI, A., NOZAKI, S. AND NAKAMURA, Y. Dept. Physiol., Fac. Dent., Tokyo Med. Dent. Univ., Bunkyo-ku, Tokyo 113

We demonstrated in the guinea pig the premotor neurons (PNs) excitatory to digastric (EDs) and excitatory and inhibitory to masseter motoneurons (EMs and IMs), which were involved in rhythmical synaptic potentials in the trigeminal motoneuron induced by repetitive stimulation of the cortical masticatory area (CMA). The PNs responded with a spike burst to each pulse of repetitive CMA stimulation, whose number increased in EMs and decreased in EDs and IMs during the jaw closing phase of CMA-induced mastication. In the present study, intracellular recording from PNs in paralyzed guinea pigs demonstrated that 1) single CMA stimulation evoked an EPSP followed by an IPSP in EDs and IMs, while only an EPSP with a longer duration in EMs, 2) the amplitude of IPSPs in EDs and IMs as well as EPSPs of EMs to each pulse of repetitive CMA stimulation increased during the jaw closing phase, and 3) a lesion in the reticular formation (RF) medial to VII nucleus abolished the CMA-evoked IPSPs in EDs and IMs, shortened the EPSPs in EMs and abolished the rhythmical change in amplitude of EPSPs in the PNs during the repetitive stimulation. We conclude that each pulse of repetitive CMA stimulation evokes an EPSP in the PNs, and coincident with the jaw closing phase EDs and IMs receive inhibitory inputs and EMs excitatory inputs via the masticatory rhythm generator in the RF.

296, II E 0915

EFFECT OF DESTRUCTION OF TRIGEMINAL ASCENDING PATHWAYS ON THE JAW MOVEMENT PATTERN. INOUE,T.,NAGASHIMA,T.,NAKAMURA,T.AND MORIMOTO,T. Dept.Oral Physiol., Osaka Univ.Fac.Dent., 1-8 Yamadaoka, Suita, Osaka 565

Previous study indicates that the jaw movement pattern is remarkably changed by the section of the bilateral maxillary and inferior alveolar nerves. This result shows that oral sensations transmitted by the trigeminal nerve contribute greatly to the control of jaw movements during mastication. To examine which part of the trigeminal ascending system is concerned with the regulation of jaw movements, the change in the jaw movement pattern following destruction of the cortical masticatory area or the ventrobasal nucleus of the thalamus (VB) was analysed in the rabbit. After aspiration of the cortical masticatory area, some animals could still eat food voluntarily. On the other hand, animals having VB lesion could not feed by themselves, but they chewed foods inserted into the mouth. Different from normal animals, those with lesions could not chew continuously but chewing was often ceased in a single masticatory sequence. The chewing patterns, however, were similar to those of normal ones. It is concluded that the cortical masticatory area and VB to which oral sensations project are not essential to determination of the pattern of masticatory jaw movements.

297, II E 0930

INPUT ORGANIZATION OF RETICULOSPINAL NEURONS FROM THE CEREBRAL CORTEX AND TECTUM IN THE CAT. ISA, T. and SASAKI, S. Dept. of Neurophysiol., Institute of Brain Research, School of Medicine, Univ. of Tokyo, Tokyo 113.

Most of the reticulospinal neurons(RSNs) located in the nucleus reticularis pontis caudalis(N.r.p.c.) and nucleus reticularis gigantocellularis(N.r.g.) received convergent monosynaptic EPSPs from cortico- and tectofugal fibers. RSNs in N.r.p.c. received larger tectal than cortical EPSPs, while those in N.r.g. received the EPSPs in the reversed order. The origin of corticoreticular projection were examined from the location of neurons labeled retrogradely following injection of HRP either in N.r.p.c. or N.r.g. Labeled neurons were located, following injection in N.r.p.c., in the prefrontal cortex(P.f.), area 6aα, 6aβ and medial half of 4γ. In contrast, they were distributed in area 4γ and area 6aα following injection in N.r.g. Microstimulation technique revealed that many of corticoreticular neurons(CRNs) and corticospinal neurons in area 6 and medial half of area 4γ issued branches to both N.r.p.c. and N.r.g., while CRNs in the lateral half of area 4γ and P.f. plus a part of area 6 issued branches only in the N.r.g. and N.r.p.c., respectively. Intracortical stimulation evoked dominant EPSPs in RSNs in N.r.p.c. from area 6 and medial half of area 4γ and and small EPSPs from P.f., while it evoked large EPSPs in RSNs in N.r.g. from lateral 2/3 of area 4γ and small EPSPs from area 6 but not from P.f.

298, II E 0945

ASCENDING AND DESCENDING AXON COLLATERALES OF THE POSTERIOR CANAL-ACTIVATED EXCITATORY VESTIBULAR NEURONS IN THE CAT. UCHINO,Y.,ICHIKAWA,T., NAKAJIMA,H.*,ISU,N.**& WATANABE,S.Dept.Physiol.Kyorin Univ.Mitaka-shi Tokyo 181, *Dept.Oto-Laryngol.St.Marianna Univ.Kawasaki-shi,Kanagawa 213, **Instrumentation and Control Div.National Aerospace Lab.Chofu,Tokyo 182.

We studied axonal branches of excitatory vestibular neurons, related to the posterior canal nerve (PCN) activities, by means of local stimulation and spike-triggered averaging technique. 124 PCN-activated vestibular neurons were identified as vestibulo-ocular neurons by the antidromic stimulation of the contralateral inferior rectus motoneuron pool. Majority of the neurons in the medial nucleus were not activated antidromically from the cervical spinal cord. In the descending and ventral lateral nuclei, majority of these vestibulo-ocular neurons were also activated antidromically following stimulation of the upper cervical spinal cord (vestibulo-ocular-collic,VOC). Most of these VOC neurons were activated monosynaptically following stimulation of the PCN. None of the VOC had axons descending as far as the thoracic level. Three VOC neurons, activated from the C1 motoneuron pool with low threshold, produced unitary EPSPs in 7 of 8 (2/2,1/2 & 4/4) neck flexor motoneurons.

299, II E 1000

FUNCTIONAL DIFFERENCES BETWEEN DORSAL AND VENTRAL SUBDIVISION OF Y-GROUP NUCLEUS OF VESTIBULAR NUCLEAR COMPLEX IN CATS. SATO, Y. AND KAWASAKI, T. Dept. Physiol. Fac. Med. Toyama Medical & Pharmaceutical University, Toyama 930-01

On cytoarchitectural grounds the y-group nucleus can be divided into two subgroups: a ventral subgroup of tightly packed fusiform neurons; a dorsal subgroup of loosly packed neurons. In the present investigation functional differences between those two subdivisions were investigated in cats anesthetized with sodium pentobarbital. Extracellular recording was made from single neurons in the y-group nucleus. Neurons in the dorsal subgroup were antidromically activated by electric stimulation applied to the caudal half of the oculomotor nucleus on the contralateral side, and polysynaptically activated from the bilateral vestibular nerve. Spontaneous dischrges of these neurons were depressed by stimulation of the caudal zone of the ipsilateral flocculus. On the other hand, neurons in the ventral subgroup were antidromically activated from the floccular caudal zone, and monosynaptically activated from the ipsilateral vestibular nerve. Thus, neurons in the dorsal subgroup receiving inhibitory input from the caudal zone of the flocculus project to the contralateral caudal half of the oculomotor nucleus, while those in the ventral subgroup receiving vestibular input project to the ipsilateral caudal zone of the flocculus.

300, II E 1015

EFFECTS OF STIMULATION OF RAPHE NUCLEUS AND LOCUS COERULEUS ON LUMBAR MONOSYNAPTIC REFLEX PATHWAYS IN THE CAT. EDAMURA, M., OHTSUKA,K. AND AOKI,M. Dept. of Physiology, Sapporo Medical College, Chuoku, Sapporo 060.

In this study, we aimed to elucidate whether activation of the raphe-spinal and coeruleo-spinal pathways produces any changes in the excitability of lumbar monosynaptic reflex (MSR) pathways. Experiments were performed on cats anesthetized with α-chloralose (50mg/kg, i.v.) or decerebrated at the precollicular level. Test MSRs elicited by stimulation of hind-limb nerves (tibial nerve to extensor and common peroneal nerve to flexor) were recorded from L7 ventral root. Brainstem was exposed for conditioning stimulation and raphe nuclei (RN; N.R.magnus and N.R.pallidus), locus coeruleus (LC) and subcoeruleus (SC) were electrically stimulated (10-100μA, 500Hz for 20ms). Amplitude changes in lumbar MSRs were measured before and after conditioning stimulation. RN stimulation increased MSR amplitudes by 50-150% between 30-50ms after the onset of the conditioning stimulation. An increase in flexor MSR was greater than in extensor MSR, although such increase in MSRs depended on stimulus intensity. In addition, effects of LC and SC stimulation were examined. It was observed that activation of this pathway produced a change in the excitability of lumbar MSRs and the results were compared with those of RN stimulation.

301, II E 1030

CORONAL CORTICALLY EVOKED RESPONSES ON SINGLE SUPERIOR SALIVATORY NEURONS IN THE CAT. ISHIZUKA, K., MURAKAMI, T. AND NAKAYAMA, K.
Dept. of Oral Physiol., Nippon Dental Univ., Niigata, Niigata

Cortically evoked responses on single superior salivatory (SS) neurons were studied in urethane-chloralose anesthetized cats. A total of 16 single SS neurons were identified by antidromic stimulation of the right chorda tympani nerve. Their responses were tested to stimulation of the ipsilateral anterior coronal gyrus (CG), anterior orbital gyrus (OG), lingual (LN) and chorda tympani (CT) nerves. Thirteen neurons responded polysynaptically to CG stimulation , 12 to OG stimulation, 15 to LN stimulation and 6 to CT stimulation. The mean latencies of these responses were 24.0, 32.0, 9.1 and 12.0 ms, respectively. All neurons responded to CG and/or OG stimulations were also activated by LN stimulation and some of them by CT stimulation. The convergence of excitatory inputs from both gyrus were found in most of single SS neurons which also received those from peripheral sensory nerves. These results suggest that excitatory inputs from both gyrus play an important role for submandibular salivary secretion.

302, II E 1045

ADAPTIVE PLASTICITY IN OCULAR FOLLOWING RESPONSE OF MONKEY
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The adaptability of the ocular following responses elicited by brief ramp movements of the visual scene was studied. Monkeys faced a tangent screen onto which a random dot pattern was projected via an X-Y mirror galvanometer system, and their eye movements were recorded with the magnetic search coil technique. Adapting stimuli were double ramp sequences designed to initiate ocular following and then induce visual errors that would challenge any adaptive mechanisms regulating the performance of such tracking. Both ramps lasted 150ms, and could differ from one another in speed (speed steps) or direction (direction steps). Speed steps involved either an increase or a decrease. Monkeys were repeatedly exposed to these adapting stimuli over a period of 3 days. Ocular following responses were calibrated with 100ms test ramps. Repeated exposure to speed steps resulted in clear increases or decreases, respectively, in the ocular following responses by the test ramps. Repeated exposure to direction steps resulted in the emergence of an orthogonal component of ocular following.

We concluded that the ocular following responses of the monkey are subject to visually mediated adaptive regulation that influences both the magnitude and direction of tracking.

303, III P (34) 0900

OPTIMAL STIMULUS CONDTIONS FOR AUDITORY BRAINSTEM RESPONSES. MIYAZAKI,H., HURUKAWA,C.*,SEKIYA,T.* AND KATOH,S.* Maharishi Research Institute,Higashi 1-3-1, Shibuyaku,Tokyo

It is well known that wave V of the Auditory Brainstem Responses(ABR) of which origin can be considered the inferior colliculus(midbrain) is useful index for the consciousness level. In order to gain an effective stimulus condition to evoke the wave V selectively, we investigated the relation between parameters of the acoustic stimuli and of the response. The ABR was recorded along the surface of the scalp with the Ag-AgCl electrode placed on lt,rt.ear(A1,A2) and midline frontal(Fz). Seven normal subjects(25-30 aged,males) took the seat, beeing feeling relaxed, with closed eyes and were stimulated to the both ears by click(1 kHz) burst sound of which parameters were intensity(45,60,80 dB), frequency(2,10,20,50 Hz) and duration(0.1,0.2,0.5 ms). Changing the stimulus parameters, we recorded the wave V with latency of meanvalue 6.20 ms(5.88-6.88 ms) and with amplitude of meanvalue 0.65 μv(0.39-0.99 μv). It is confirmed experimental that more effective stimulus to evoke the wave V is within the limits of 60-80 dB in the stimulus intensity and of 0.1-0.5 ms in the duration.

304, III P (35) 0900

CHANGES IN CENTRAL NERVE ACTIVITY WITH DESTRUCTION OF THE INTERNAL CAPSULE. SAKURAI, H., NAITO, H. AND YASUHARA, M. Dept. Physiol., Kansai Med. Univ., Osaka 570

The effect of destruction of the internal capsule(IC) of the rabbit on the arousal reaction and evoked muscular discharge was studied. The effect on the photo-palpebral reflex(PPR) and the photo-evoked eyelid microvibration(MV) induced by flash stimulus was also investigated. Destruction of IC was by electrocoagulation and the comparative changes after destruction were recorded up to 4 weeks. The threshold of the arousal reaction and the evoked muscular discharge increased markedly following IC destruction. The amplitude of both early and late PPR components was most decreased, 24 - 48 hours after IC destruction, then recovered hereafter. These changes can be attributed to an inhibition of consciousness and motor activity by IC destruction. The changes in amplitude of MV, however, can be divided into 2 groups, one in which the amplitude is decreased and the other in which the amplitude increased. Clarification of the mechanism wherby this occurs must await the results of experiments in which the basal ganglia other than IC are destroyed.

306, III P (37) 0900

AFFERENT CONNECTIONS OF THE SUPERIOR SALIVATORY NUCLEUS IN THE RAT. MATSUO, R. Dept. Oral Physiol., Osaka Univ. Faculty of Dent., 1-8 Yamadaoka, Suita, Osaka 565.

To clarify the afferent connections of the superior salivatory nucleus in the rat, horseradish peroxidase (HRP) was injected into the superior salivatory nucleus determined by its antidromic responses to the stimulation of the parasympathetic preganglionic fibers innervating the submandibular and sublingual glands. HRP-labeled neurons were found in the cerebral cortex, the bed nucleus of the stria terminalis, the paraventricular nucleus, the lateral hypothalamic area, the central nucleus of the amygdala, the parabrachial area, the nucleus of the solitary tract, the reticular formation around the trigeminal motor nucleus, and the lateral reticular formation at the levels of the caudal pons and the medulla oblongata. HRP-labeled cells were seen bilaterally with an ipsilateral predominance (the cerebral cortex was contralateral predominance). Above mentioned structures as well as the superior salivatory nucleus were electrically stimulated, and the flow rate of saliva was measured from both sides of the submandibular glands. Larger amount of saliva was always obtained from the ipsilateral gland. A copious flow of saliva was induced by stimulations of the superior salivatory nucleus, the nucleus of the solitary tract, the parabrachial area, and the reticular formation around the trigeminal motor nucleus. However, stimulations of the cerebral cortex, the amygdala, and the hypothalamus induced a small amount of saliva.

307, III P (38) 0900

CATECHOLAMINE CONTENT IN THE BRAIN OF SPONTANEOUSLY HYPERTENSIVE RAT (SHR) UNDER IMMOBILIZED STRESS. OKAMURA, K. AND NOMURA, M. Dept. Physiol., Fukita-Gakuen Health Univ. Sch. Med., Toyoake, Aichi 470-11

There is some disagreement about the catecholamine content in the regional brain of SHR. Thus we measured the noradrenaline(NA) and adorenaline(AD) contents in the regional brain of SHR and Wistar Kyoto rat(WKY) at 4 and 12 weeks old. The NA and the AD contents in the medulla oblongata and the diencephalon in SHR at 4 weeks old were higher than those in WKY. But there was no strain changes between SHR and WKY at 12 weeks old.

Under the immobilized stress, the NA and the AD contents remarkably decreased in SHR of 4 and 12 weeks old rats.

Young and adult SHR might have some hyperreactivity due to severe stress like the immobilized stress. It was very interesting to find, even in young SHR, that before the development of hypertension, there were high contents of the NA and the AD in the medulla oblongata and the diencephalon.

308, III P (39) 0900

BRAINSTEM AND SPINAL NEURONAL STRUCTURES IN RELATION TO MICTURITION IN CATS.
SUGAYA, K., OHTA, Y., MATSUYAMA, K., and MORI, S. Dept. of Physiol., Asahikawa Med. Col., Asahikawa 078-11

In a lightly anesthetized intact cat, microstimulation (rectangular pulse: duration, 0.2 ms; intensity, up to 180 μA; 50 pulses/s; stimulus period, 3-5 s) of an area corresponding to nucleus locus coeruleus alpha evoked micturition. In this study, free or WGA-HRP was iontophoretically injected into the effective micturition inducing site by means of double-barreled micropipettes. After survival of 48 hours, the cats were sacrificed by cardiac perfusion under deep anesthesia. Following results were obtained: (1) retrogradely labeled cells were observed mainly in the dorsal hypothalamic area, the periaqueductal gray, gigantocellular tegmental field, lateral tegmental field; (2) labeled fibers coursed from LC alpha caudally and then ventromedially through dorsomedial portion of the superior olivary complex; (3) fine nerve fibers were also distributed within the nucl. intermedio-lateralis and intermedio-medialis of the lumbo-sacral cord and Onuf's nucleus. These spinal nuclei have been shown to innervate the bladder and urethra. These cells were trans-synaptically labeled when WGA-HRP was injected into the effective micturition area of the pons.

309, III P (40) 0900

PONTO-MEDULLARY SUPPRESSION OF POSTURAL MUSCLE TONE IN THE DECEREBRATE, REFLEX STANDING CAT.
OHTA, Y., TAKAKUSAKI, K., MATSUYAMA, M., and MORI, S. Dept. of Physiol., Asahikawa Med. Col., Asahikawa 078-11

In a precollicular-postmammillary decerebrate, reflex standing cat, repetitive stimulation (rectangular pulses: duration, 0.2 ms; intensity, up to 50 pulses/s; stimulus period, 5-10 s) of the dorsal part of the mid-pontine tegmentum (DTF: P3 to P7, LRO, H-4.5 to H-6.0) suppresses extensor muscle tone in the hindlimbs. Induced effects outlast the period of DTF stimulation. As a part of neuronal structures mediating such suppessing effects upon extensor muscle tone, participation of the reticulospinal tract, having the cells of origin in the nucleus reticularis gigantocellularis (Gc), has been identified. In this study, attempts have been made to elucidate neuronal structures which activate these Gc cells. To do this, two methods were employed: (1) microinjection of HRP into the nucleus Gc; (2) microinjection of carbachol, which is a long-acting cholinomimetic agent, into appropriate pontine areas. It was found that the cells in the nucleus reticularis pontis oralis (PoO) send their axons to the nucleus Gc, and that injection of carbachol into the nucleus PoO abolished extensor muscle tone as in the case of DTF stimulation. Induced effects were restored by systemic administration of atropine, which is a cholinergic blocking agent.

310, III P (41) 0900

FUNCTIONAL ROLES PLAYED BY CELLS IN THE NUCLEUS RETICULARIS GIGANTOCELLULARIS DURING MLR-INDUCED CONTROLLED LOCOMOTION; WITH REFERENCE TO POSTURAL SUPPORT.
MATSUYAMA, K., OHTA, Y., SUGAYA, K., TAKAKUSAKI, K., AND MORI, S. Dept. of Physiol. Asahikawa Med. Col., Asahikawa 078-11

In acute precollicular-postmammillary decerebrate cats, locomotion on a moving treadmill can be induced by stimulating the mesencephalic locomotor region (MLR). An important feature of electrically induced treadmill locomotion is that its success depends upon an appropriate level of postural muscle tone; neither too little nor too much. We have demonstrated that an area setting the level of postural muscle tone and thereby regulating the effectiveness of stimulation-induced locomotion is located in the midline of the pons. We have already shown that the cells located in the nucleus reticularis gigantocellularis (Gc) are orthodromically and antidromically activated by stimulating the dorsal part of mid-pontine tegmentum and the spinal cord, respectively. In this study, we have tried to analyze discharge patterns of these cells before, during and after termination of MLR-induced locomotion. In contrast to the report of Orlovsky (1972), only a few of these Gc cells were activated polysynaptically by a single or train stimulation to the MLR, and they tended to increase their discharge tonically during MLR induced locomotion. Functional significance of these Gc cells will be discussed in relation to postural support during locomotion.

311, II E 1100

PROJECTION OF VISCERAL AFFERENT INPUT ONTO NUCLEUS VENTRALIS POSTEROLATERALIS. TAGUCHI, H., MASUDA, T., KOYAMA, N. AND YOKOTA, T. Dept. Physiol., Med. Coll. Shiga, Otsu 520-21.

Responses of units in the nucleus ventralis posterolateralis (VPL) to electrical stimulation of the greater splanchnic and/or inferior cardiac nerves were studied in urethan-chloralose anesthetized cats. A great majority of units in the caudal VPL were low-threshold mechanoreceptive units. They were not driven by Aδ visceral afferents. Units responsive to these afferents were found in two classes of nociceptive units, i.e., nociceptive specific (NS) and wide dynamic range (WDR) units. They were located in the shell region of the caudal VPL. Receptive fields of NS units responsive to splanchnic Aδ afferents were located in the posterior forearm, posterior arm, area of scapula, chest and abdomen. WDR units responsive to the same afferents had at least a part of their receptive fields in these regions. Receptive fields of NS units responsive to cardiac afferents were located in the neck, shoulder, upper extremity, area of scapula and chest. WDR units responsive to the same afferents had at least a part of their receptive fields in these regions.

312, II E 1115

NOCICEPTIVE NEURONS IN VENTROBASAL COMPLEX OF PRIMATE THALAMUS. KOYAMA, N., MASUDA, T. AND YOKOTA, T., Dept. Physiol., Med. Coll. Shiga, Otsu 520-21.

Previously, we discovered two classes of trigeminal nociceptive neurons i.e., nociceptive specific (NS) and wide dynamic range (WDR) neurons in the shell region of the somatosensory part of nucleus ventralis posteromedialis (VPM proper) in the cat. NS neurons were located in the caudal third of the VPM proper, whereas WDR neurons were encountered in a narrow band just in front of the NS zone. These two classes of neurons showed a somatotopic organization. Both NS and WDR zones were found to extend into the shell region of the nucleus ventralis posterolateralis (VPL), thus surrounding the ventrobasal complex consisting of the VPM proper and VPL. In the present study, the ventrobasal complex of the thalamus was studied in urethan-chloralose anesthetized Japanese macaques. In this species, the VPL can be divided into two parts, i.e., nucleus ventralis posterolateralis oralis (VPLo) and nucleus ventralis posterolateralis caudalis (VPLc). Both NS and WDR neurons were found in the shell region of the VPLc. Otherwise, findings were much the same as in the cat.

313, II E 1130

MODULATION OF LATERAL HYPOTHALAMIC NEURONAL ACTIVITY BY NON-VAGAL AFFERENTS IN RATS. OHTA, A.※ and SHIRAISHI, T. Dept. Physiol., Tokai Univ. Sch. Med., Isehara 259-11

It has been showed that lateral hypothalamic (LHA) neuronal responses are directly related to gastrointestinal (GI) functions. LHA efferents not only regulate feeding, but they also control gastric acid secretion. They are elicited by changes in concentration of certain various chemicals in the blood and cerebrospinal fluid, and by activity of visceral organs and/or other CNS regions. However, the routes and roles of GI ascending impulses are still not well understood. We recently investigated the influence of GI distension, mainly duodenal, on LHA neuronal activity. The results showed that about one-third of the LHA neurons responded to mechanical stimulation of the duodenum. The responses of these neurons were classified as increase and decrease types; although the physiological significance of the responses are still unknown. Interestingly, these LHA-responses were still evident after uni-, and or bi-lateral subdiaphragmatic vagotomies, mainly above the stomach level. It is suggested that the LHA receives strong non-vagal ascending visceral information.

314, ⅡE1145

EFFECTS OF REPETITIVE STIMULI ON THE NEURONAL ACTIVITY IN VB NUCLEI.

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Dept. of Physiol., Sch. of Hygienic Sciences, Kitasato Univ., Sagamihara, Kanagawa and Dept. of ME, Seishin-Igaku Inst., Itabashi-ku, Tokyo

Neuronal discharges in ventrobasal thalamic nuclei(VB) of immobilized cat were recorded extracellulary.

The receptive fields of body surface were stimulated electrically with low (<5Hz), middle (10Hz) and high (60Hz<) frequency for 30 min respectively.

When the stimulus rate was increased by stages, the response pattern of evoked discharges were not changed with low frequency and became regular with middle. With high frequency, the evoked discharges were vanished about 5 min after stimulation.

The other hand, as staged decrease of stimulus rate, the initial latency of evoked discharges delayed with time course during high rate stimulation, and the number of evoked discharges were reduced with low frequency.

There were observed no significant fluctuation on ECoG during stimulation.

315, ⅡE1300

HYPOTHALAMIC REGULATION OF Na-PUMP ACTIVITY IN RAT SKELETAL MUSCLE. KATAFUCHI, T., YOSHIMATSU, H., OOMURA, Y. AND AKAIKE, N. Dept. Physiol., Fac. Med., Kyushu Univ., Fukuoka 812

Rats fed a K^+-deficient diet for 5-7 weeks have been shown to result in increased $[Na]_i$ and decreased $[K]_i$ in the skeletal muscles. Peripheral nerve section, spinal transection and treatment with α-adrenoceptive blocking agents restored $[Na]_i$ and $[K]_i$ contents in "tonic" soleus muscle (SOL), but not in "twitch" extensor digitorum longus muscle (EDL), indicating that the Na-pump of SOL was inhibited by the CNS through the sympathetic nervous system. To test possible involvement of the hypothalamus in the Na-pump suppression, we investigated the effects of hypothalamic lesions on the muscular $[Na]_i$ and $[K]_i$ during hypokalemia. The anomaly of ion contents of SOL was restored by bilateral electrolytic lesion of the ventromedial hypothalamic nucleus. Lesions of the anterior hypothalamus or the dorsomedial hypothalamic nucleus aggravated the anomalous ion content. Lesions of hypothalamic nuclei did not alter the effects of hypokalemia on $[Na]_i$ and $[K]_i$ in EDL. The results indicated that the hypothalamic regulation of the Na-pump in SOL depends on the individual hypothalamic regions. Further, no effects of denervation and hypothalamic lesion on the ion content of EDL may suggest that the Na-pump of EDL is affected by an unknown humoral factor, such as endogenous ouabain-like substance rather than neural ones.

316, ⅡE1315

TRANSPLANTATION OF NORMAL ARCUATE NUCLEUS INTO THE BRAIN OF RAT TREATED WITH MONOSODIUM GLUTAMATE. INOUE, H., KOHSAKA, S., SHINOZAKI, T.#, TAKAYAMA, H.#, YOSHIDA, K.#, OTANI, M.#, TOYA, S.#, AND TSUKADA, Y. Dept. of Physiol. and #Dept. of Neurosurg., Sch. Med., Keio Univ., Tokyo 160

Treatment with monosodium glutamate(MSG) during the neonatal period is known to produce selective lesion of the arcuate nucleus in rat brain, which is the major site of production of growth hormone releasing hormone (GRH), followed by a secondery reduction of growth hormone(GH) synthesis in the anterior pituitary. Normal arcuate nuclei were obtained from hypothalamic areas of newborn rat brains and were transplanted into the third ventricles of 27-day-old rats which were treated with MSG on alternate days for the first 10 days of life. Ninety days after birth, the anterior pituitary were investigated for GH synthesis by immunohistochemical staining with GH antiserum and by electron microscopic examinations. The results indicate that the impaired GH synthesis of anterior pituitary were significantly improved in some recipients by the grafts of arcuate nucleus in which the GRH containing neurons were clearly detected by immunohistochemical staining with GRH antiserum.

317, II E 1330

EFFECTS OF ELECTRICAL STIMULATION OF HYPOTHALAMUS ON SEXUAL BEHAVIOR IN THE FEMALE MONKEY. KOYAMA, Y.*, FUJITA, I., NISHINO, H. AND OOMURA, Y.* Natl. Inst. Physiol. Sci., Okazaki 444, * Dept. Physiol., Fac. Med., Kyushu Univ., Fukuoka 812

To locate the brain areas involved in female sexual behavior, various parts of the hypothalamus of the female macaque monkey were stimulated under partially-restrained conditions with the partner male in front of her. Immediately after the stimuli (duration:0.5 ms; frequency:50 Hz; pulse number:125; intensity: 300-500 μA), delivered to the preoptic area, lateral, dorsomedial, ventromedial and posterior hypothalamus, the female moved her body restlessly and extended her legs towards the partner. This behavior was in some cases followed by presenting-like posture; the stimulated female lifted her rump towards the partner responding to the partner's touching. Since these behaviors occurred reproducibly after the stimulus and were seen only in the female, these behaviors were considered to be stimulus-evoked ones and components of female sexual behavior. The results suggest that the hypothalamus has facilitatory roles in the sexual behavior of the female monkey.

318, II E 1345

ELECTRICALLY EVOKED MOUNTING AND GROOMING IN THE MALE MONKEY. FUJITA, I., KOYAMA, Y.*, NISHINO, H. AND OOMURA, Y.* Natl. Inst. Physiol. Sci., Okazaki 444, * Dept. Physiol., Fac. Med., Kyushu Univ., Fukuoka 812

The effects of electrical stimulation of the hypothalamus on sexual behaviors were examined in male rhesus monkeys (Macaca mulatta). Cathodal rectangular pulses (duration: 0.5 ms; frequency: 50Hz; pulse number: 125) were systematically applied to various sites in the preoptic area (POA) and the hypothalamus of partially-restrained animals, and the effects on the behavior were analysed with a video camera. Electrical stimuli of 15-100 μA to the medial POA, dorsomedial and lateral hypothalamic areas (DMH and LH) elicited 'touching' to female's back and rump. Stronger stimuli of 150-500 μA to DMH, LH and ventromedial hypothalamus (VMH) elicited 'mounting' following the 'touching'. 'Grooming' were elicited by electrical stimuli of 15-300 μA to some loci in the LH and lateral POA. 'Mounting' and 'grooming' occurred reproducibly after the stimulus. The results suggest that specific parts of the hypothalamus are involved in the regulation of 'mounting' and 'grooming' of the male monkey.

319, II E 1400

VISUAL INFORMATION PROCESSING AMONG THE INFEROTEMPORAL CORTEX, AMYGDALA AND LATERAL HYPOTHALAMUS IN MONKEY. ONO, T., FUKUDA, M. AND NISHINO, H. Dept. Physiol., Fac. Med., Toyama Med. and Pharmaceu. Univ., Toyama 930-01.

Effects of reversible cooling of inferotemporal cortex (ITCx) and amygdala (AM) on respective AM and lateral hypothalamus (LHA) neural activity were studied in monkey operant bar press feeding behavior to determine interactions of these centers. Cooling probes were chronically placed bilaterally on ITCx of one monkey, and in AM of two monkeys. Activity of 43 AM neurons was tested (6, food-sight related; 11, nonfood-sight related ; 21, arousal related; 5, no response). ITCx cooling changed the spontaneous firing of 15 (2 increased, 13 decreased). Of 17 neurons responding primarily to sight of food or nonfood, responsiveness of 8 (47%) changed from selective to nonselective upon ITCx cooling. Activity of 55 LHA neurons was tested (22 food-sight related ; 6 ingestion related; 22, arousal related; 5, no response). AM cooling changed the spontaneous firing of 21 (12 increased, 9 decreased). Visual responses of 9 food related and 2 arousal related neurons were depressed by AM cooling. Responses of 3 ingestion related LHA neurons were depressed by AM cooling, but 3 ingestion related responses in AM were not affected by ITCx cooling. The data suggest importance of dynamic interactions among ITCx, AM and LHA in discriminating between food and nonfood.

320, II E 1415

THE INFLUENCE OF THE KINDLING EFFECT ON THE ELECTROPHYSIOLOGICAL PHENOMENA(PART 4). OKAMOTO, M., IKEDA, H., NAITO, H. AND YASUHARA, M. Dept. Physiol., Kansai Med. Univ., Osaka 570

The threshold of the arousal-like reaction and the evoked muscular discharge due to stimulation of the cerebral cortex were examined in the following 4 groups of rabbits. 1) no kindling group. 2) amygdaloid kindling group(AMG-K). 3) hippocampal kindling group(HPC-K). 4) cerebral cortical kindling group(CX-K). Both the threshold of the arousal-like reaction and the evoked muscular discharge showed no change or a rise in the "no kindling" group while the threshold declined in the others(2-4). In the "no kindling" group, no marked changes were observed in the photo-evoked eyelid microvibration(MV) and photo-palpebral reflex(PPR). The amplitude of MV increased and reached a maximum in a few days and then declined in the "AMG-K" group, was prominent in the "HPC-K" group and small in the "CX-K" group. There was no change in the early PPR components(PPR1-PPR4) in all the kindling groups. On the other hand, the amplitude of the late components(PPR5-PPR8), which are believed to appear via the brain stem reticular formation, increased in all the kindling groups.

321, II E 1430

SEPTO-HIPPOCAMPAL PATHWAYS IDENTIFIED WITH LAMINAR FIELD POTENTIAL ANALYSIS AND HRP-LABELING METHOD IN RATS. OKA, H. and YOSHIDA, K., Dept. of Physiol., Fukui Med. Sch., Fukui 910-11

In our previous study in rats, the laminar field potential analysis revealed that hippocampal negative responses to the medial septal nucleus stimulation were localized in the alveus and the stratum oriens (distribution area of basal dendrites of hippocampal pyramidal cells). The retrograde HRP-labeling method showed that cell bodies in the medial septum-diagonal band complex were labeled with HRP injected into the stratum oriens and the hilar region, but not with HRP injected into other strata or layers of the hippocampus or the fascia dentata. In the present study, we further examined septohippocampal connections in rats with anterograde HRP-labeling method, to provide detailed distribution of septal fiber terminals to the hippocampal formation. A single injection of HRP was stereotaxically given into the medial septum-diagonal band complex with a Hamilton syringe under pentobarbital anesthesia. A large number of axons labeled anterogradely with HRP could be traced from the injection site to the hippocampal formation. The labeled axons ended in the stratum oriens of fields CA1 to CA3 and the hilus of the fascia dentata. In referring to data on acetylcholine receptor, the distribution pattern of anterogradely labeled terminals seemed to accord well with that of the nicotinic receptor sites in the hippocampal formation.

322, II E 1445

DENDRITIC AND AXONAL ARBORIZATION PATTERN OF GABAERGIC LOCAL CIRCUIT NEURONES IN RAT HIPPOCAMPAL CA1 REGION. KAWAGUCHI, Y. National Institute for Physiological Sciences, Okazaki 444

In the border area between stratum lacunosum-moleculare(st.lac.-mol.) and stratum radiatum(st.rad.) of rat hippocampal CA1 region relatively many GABAergic neurones were observed with glutamic acid decarboxylase immunocytochemistry. These neurones were injected intracellulary with HRP in slice perparation. The HRP-stained neurones were identified as GABAergic with postembedding GABA-immunocytochemistry(0.5 um semithin section). The stained neurones were of non-pyramidal type with aspiny or sparsely spiny dendrites and showed four types of dendritic pattern: the dendrites extend 1)only in st.lac.-mol., 2)just between st.lac.-mol. and st.rad., 3)only in st.rad., 4)in both. The axonal pattern was divided into three groups: the axons ramify 1)in st.lac.-mol., 2)between st.lac.-mol. and st.rad., or 3)in st.rad. Taken together with the fact that there are different inputs between st.lac.-mol. and st.rad., these local circuit neurones are considered to receive specific inputs and make feedforward inhibition on limited parts of pyramidal cell dendrites. Then electronmicroscopic observation was also tried.

323, II E 1500

MONKEY AMYGDALA NEURON RESPONSES TO POSITIVE AND NEGATIVE AFFECTIVE SITUATIONS.
NISHIJO, H., ONO, T., NAKAMURA, K. AND KAWABATA, M. Dept. Physiol., Fac. Med., Toyama Med. and Pharmaceu. Univ., Toyama 930-01.

Neuron activity in the monkey amygdala (AM) was analyzed in 4 kinds of operant bar press tasks related to reward or punishment to investigate neuronal responsiveness to visual, auditory, somesthetic and gustatory stimuli. Of 564 neurons recorded, 294 (52.1%) responded to some stimuli. 1) 38 (6.7%) responded to visual and 18 (3.2%) to auditory stimuli. Of these 56 neurons, 29 responded to reward and punishment-related and to unfamiliar stimuli, but not to familiar neutral stimuli, and were classified as attention involved neurons. All other responding neurons were in some other classification. 2) 35 (6.2%) responded primarily to gustatory stimuli, and 9 of these responded to visual or auditory stimuli. 3) 38 (6.7%) showed phasic and 77 (13.7%) showed tonic multimodal responses to various stimuli. 4) 14 (2.5%) responded selectively to only certain objects or sounds. 5) 74 (13.1%) could not be classified. Some neurons responded to certain reward-related objects or to food in both the discrimination and ingestion phases, and were modulated by reversal or extinction. The results suggest AM importance in stimulus-affective association that depends on multimodal sensory information processing and contributes to emotional behavior.

324, II E 1515

DISTRIBUTION PATTERN OF LEARNING RELATED NEURONS IN MONKEY PREFRONTAL CORTEX.
YAMATANI, K., ONO, T., NISHINO, H. AND FUKUDA, M. Dept. Physiol. and Neurosurg., Fac. Med., Toyama Med. and Pharmaceu. Univ., Toyama 930-01.

Lesion and electrophysiological experiments implicate the prefrontal cortex (PFC) in the integration of sensory stimuli and reward information to control behavior. To investigate these functions systematically, activity of 896 single neurons was recorded from the PFC of monkey during video scheduled 1) Delayed matching-to-sample (DMS), 2) DMS with response delay (DMSRD), 3) Go/No-Go and 4) operant bar-press feeding tasks. Right-left differentiating neurons were mainly located in area 8 and the periprincipal sulcal area. Areas 8 and 9 contained a large proportion of neurons that might be related to movement preparation, and area 10 contained many neurons that might be related to movement suppression and reward. Neurons that might function during decision making were distributed almost evenly in the PFC. Responses of neurons in the periprincipal sulcal area were combined in ways that might be related to initiation or suppression of behavior to obtain a reward. It was concluded that the periprincipal sulcal area might be the highest integration site in programming goal-oriented behavior.

325, I P (1) 0900

THE SEGREGATION BETWEEN THE VPM AND THE VPL IN THE RAT THALAMUS: A MAPPING STUDY BY SINGLE NEURONS.
SUGITANI, M., OOYAMA, H., YANO, J. AND SUGAI, T. Dept. Physiol., Kanazawa Medical Univ., Ishikawa 920-02

In the rat thalamus, the nucleus ventralis posteromedialis (VPM) relaying trigeminal input and the nucleus ventralis posterolateralis (VPL) relaying spinal input have not been distinguished in most of physiological and anatomical studies. In the stereotaxic atlas of the rat brain by Paxinos and Watson (1982), however, the VPM and the VPL are clearly delineated. In order to investigate whether this anatomical delineation was also applicable physiologically, whole ventrobasal complex (VB) was systematically mapped, based on cutaneous receptive fields of a number of single neurons. Thus, following features became clear: 1) The most rostral part of the VB consisted exclusively of the VPL. 2) In the middle of rostrocaudal extent of the VB, the VPM occupied dorsomedial part of the VB extending from the dorsal cap to the ventromedial edge, whereas the VPL occupied relatively small contiguous part ventrolaterally. 3) More caudally, the VPM showed a relative increase in volume without major changes in the relative positions of the VPM and the VPL. 4) Neurons with trigeminal input and those with spinal input were never intermingled in the VB. These results indicate that the VPM and the VPL in the rat can be distinguished physiologically, in good accordance with above-mentioned anatomical work.

326, I P (2) 0900

THE ROLE OF LIMBIC-HYPOTHALAMIC SYSTEM IN METABOLIC ADAPTATION OF PYRUVATE TO IMMOBILIZATION STRESS. OHRI, A., HAMAGUCHI, K., KINOSHITA, C., EDASHIGE, N., KITAOKA, K. AND SETO, K. Dept. Physiol., Kochi Med. Sch., Kochi 781-51

The effects of lesions of the basal hypothalamus and limbic structure on the pyruvate metabolic responses to daily repeated exposures to immobilization stress in the liver of rabbits have been investigated. The experimental results were as follows: (1) The pyruvate metabolic responses to the 1st exposure to immobilization stress (exposure on the1st day) were considerably altered by lesions of the periventricular arcuate nucleus (ARC), ventromedial hypothalamus (VMH), stria terminalis (ST) and dorsal fornix (FX). (2) The pyruvate metabolic responses to immobilization stress were completely abolished by seven times repetition of exposures to immobilization stress in the rabbits with lesions of ARC and VMH; they were similar to sham-operated groups. (3) In rabbits with lesions of ST and FX, the pyruvate metabolic responses to the 7th exposure (exposure on the 7th day) to immobilization stress were almost the same as those after the 1st exposure to immobilization stress, but these metabolic responses were completely abolished by the seven times repetition of exposures to immobilization stress in the sham-operated animals.

327, I P (3) 0900

THE AFFERENT AUDITORY PATHWAY TO THE LATERAL HYPOTHALAMIC CUE TONE DISCRIMINATION RELATED NEURONS OF THE RAT. NAKAMURA, K., ONO, T., KAWABATA, M. AND MURAMOTO, K. Dept. Physiol., Fac. Med., Toyama Med. and Pharmaceu. Univ., Toyama 930-01.

Lateral hypothalamic (LHA) neurons responded during feeding, intracranial self-stimulation (ICSS) in the posterior LHA and to cue tone stimuli (CTS) predicting these rewards. To clarify the origin of afferent inputs that induced these neural responses, this study examined effects of local procainization of the ventral tegmental area (VTA) and amygdala (AM) on LHA neural responses and licking behavior. VTA procainization stopped licking to obtain ICSS for several minutes, but not licking for glucose. During VTA procainization, LHA neural responses to CTS that predicted both rewards disappeared and spontaneous firing rate decreased, but neural responses during licking for glucose and during stimulation of the ICSS site did not. AM procainization stopped licking for glucose but not licking for ICSS. During AM procainization, LHA spontaneous firing increased for several minutes, and neural responses to glucose and associated CTS disappeared, but responses to ICSS and associated CTS did not. The data suggest deep VTA and AM involvement in ICSS and feeding, respectively, and LHA involvement in both. LHA neural responses to CTS are induced or influenced by afferent inputs originating in or passing through the VTA and AM.

328, I P (4) 0900

KINETICS OF INDOLAMINES IN THE CHRONIC RAT HYPOTHALAMUS: VOLTAMMETRY ANALYSIS. AOYAGI, K., SHIMIZU, N. AND OOMURA, Y. Dept. Physiol., Fac. Med., Kyushu Univ. 60, Fukuoka 812

Involvement of brain serotonergic (5-HT) function on feeding behavior after immobilization (IMB) stress was studied. Two hr IMB during light period decreased the daily food intake by 40%. The IMB-induced anorexia was antagonized by methysergide, a 5-HT receptor blocking agent, for the first 3 hr of dark period, while naloxone had no effect. To investigate the possibility that brain 5-HT mechanism participates in this anorexia, 5-hydroxyindoleacetic acid (5-HIAA), the metabolite of 5-HT, in the cerebrospinal fluid (CSF) were analyzed with high-performance liquid chromatography with an electrochemical detector. 5-HIAA in CSF increased to 180% of pre-IMB level after 2-hr IMB. Further, changes in 5-HIAA level in the lateral hypothalamic area (LHA) was studied using the voltammetory with carbon fiber electrode. The voltammogram showed an oxidative current peak at about 250 mV (vs. Ag/AgCl) which was confirmed to reflect the change in 5-HIAA level by pharmacological manipulations (sensitivity, 10^{-6} M). The concentration of 5-HIAA in the LHA increased by 50% during IMB. In conjunction with the results of behavioral and electrochemical studies, we suggest that the feeding suppression caused by IMB is mediated through the 5-HT mechanism in the LHA.

329, I P (5) 0900

SUBFORNICAL ORGAN NEURONS WITH EFFERENT PROJECTIONS TO THE RAT HYPOTHALAMIC PARAVENTRICULAR NUCLEUS. SAITO, H., TANAKA, J., KABA, H. AND SETO, K. Dept. Physiol., Kochi Med. Sch., Kochi 781-51

Twenty-three neurons in the region of the subfornical organ (SFO) were antidromically activated by electrical stimulation of the hypothalamic paraventricular nucleus (PVN) in male rats under urethane anesthesia. The activity of all identified units was excited by microiontophoretically (MIPh) applied angiotensin II (AII) and the effect of AII was blocked by MIPh-applied saralasin (Sar), an AII antagonist, but not by atropine (Atr), a muscarinic antagonist. In these units, 12 were also excited and 11 were not affected by MIPh-applied acetylcholine (ACh) and the effect of ACh was attenuated by not only MIPh-applied Atr but also Sar. Intravenously administered AII excited the activity of both types of identified units in the region of the SFO. Microinjected AII into the region of the SFO produced either an excitatory response (n=9) or no effect (n=4) in the activity of putative vasopressin (VP)-secreting units in the PVN. These results suggest that there are specific AII- and both AII- and ACh-sensitive types of neurons in the region of the SFO with efferent projections to the PVN, and that these neurons may act to enhance the activity of putative VP-secreting neurons in the PVN in response to circulating AII.

330, I P (6) 0900

RESPONSES OF NEURONS IN THE REGION OF THE SUBFORNICAL ORGAN TO VASOPRESSIN. TANAKA, J., KABA, H., SAITO, H. AND SETO, K. Dept. Physiol., Kochi Med. Sch., Kochi 781-51

In urethane-anesthetized male rats, 30 neurons in the region of the subfornical organ (SFO) were antidromically identified as projecting to the median preoptic area (MPO) (n=9), medial septum (MS) (n=8), hypothalamic paraventricular (PVN) (n=7) or supraoptic (SON) (n=6) nucleus using an electrophysiological approach. All identified SFO neurons were examined for response to microiontophoretic application, intracarotid or intravenous injection of vasopressin (VP). The activity of SFO neurons projecting to the MPO (n=6) or MS (n=4) was excited by microiontophoretically (MIPh) applied VP while all SFO neurons projecting to the PVN or SON were not affected. The activity of all responsive SFO neurons to MIPh-applied VP was also excited by intracarotid or intravenous VP, whereas all unresponsive SFO neurons projecting to the MPO or MS were not affected. On the other hand, the activity of SFO neurons projecting to the PVN (n=4) or SON (n=3) was inhibited by not only intracarotid VP but also intravenous VP. These results suggest that VP-sensitive SFO neurons with efferent projections to the MPO or MS may modulate the excitability of MPO or MS neurons in response to circulating VP.

331, I P (7) 0900

SIMULTANEOUS RECORDINGS FROM TWO TYPES OF HIPPOCAMPAL NON-PYRAMIDAL CELLS AND THE ELECTRICALLY INDUCED PAROXYSMAL DISCHARGES. KOGURE, S. Dept. of Physiol., Nippon Med. School, 1-1-5, Sendagi, Bunkyo-ku, Tokyo, 113

As previously reported, there were two types of hippocampal non-pyramidal cells, as distinguished from their behaviors during penicillin and electrically induced seizure: TYPE I neuron located in or near the pyramidal cell layer showed a depression - re-firing sequence during both seizures, whereas TYPE II distributed in the stratum oriens exhibited a sustained firing in synchrony with the paroxymal waves.

In the present experiment, unit discharges of both types were simultaneously examined during the paroxysmal discharges induced by low frequency (2-5Hz) stimulation in the hippocampal CA1 area of lightly anesthetized and immobilized rabbits. The following results were obtained during the process leading to the proxysmal discharges: (i) With the repetitive stimulation, at first the responding firing rates of both types of neurons increased and their firing durations prolonged. (ii) Then TYPE I's rate and duration, gradually decreased in parallel with the diminution of the positive component of the evoked potential, wereas TYPE II exhibited more prolonged responses. (iii) Subsequently, the population spike in the evoked potential changed to a multiplicated form, and finally iv) The paroxsymal discharges appeared during inter-stimulus interval.

332, ⅢE1300

METABOLIC MAPPING OF OPTOKINETIC PATHWAYS TO THE CEREBELLUM BY MEANS OF 2-DEOXYGLUCOSE AUTORADIOGRAPHY IN THE RAT. MORI,K. AND MIYASHITA,Y. Dept. Physiol., Fac. Medicine, Univ. of Tokyo, Hongo, Tokyo 113.

By [^{14}C]2-Deoxyglucose (2-DG) autoradiography we mapped spatial distribution of metabolic activity in the cerebellum and the related brainstem nuclei during monocular optokinetic stimulation in pigmented rats. Constant velocity rotation of a checkered drum (45cm in diameter) produced uni-directional nystagmus for 45 minutes after a 2-DG injection (i.v., 160 μCi/kg). Autoradiographic images obtained according to Sokoloff et al.(1977) were fed into a drum-scanner (2605, Abe-Sekkei) and analyzed in a image processor (IP8500, Gould/DeAnza). Under temporo-nasal optokinetic stimulation, significantly higher activity was found contralaterally to the stimulated eye in the dorsal cap of the inferior olive, the nucleus reticularis tegmenti pontis and the lateral pontine nucleus, and ipsilaterally in the cerebellar paraflocculus and flocculus. The highest activity in the ipsilateral flocculus was localized in the central 1/4 of the rostro-caudal extension and, in the coronal plane, was seen as hot patches in the granule layer, which revealed specific localization of the optokinetic signal in the flocculus.

333, ⅢE1315

THE VISUAL NEURONS RESPONDING TO OPTOKINETIC STIMULATION IN THE CEREBELLAR FASTIGIAL NUCLEUS OF THE CAT. OHNO, M., OHHASHI, T.* AND KATO, M. Dept. Physiol. and Opthalmol., Hokkaido Univ. Sch. Med., Sapporo 060

In the present study, visual signal to the cerebellar fastigial nucleus (FN) was studied in the cats immobilized by gallamine under chloralose-urethane anesthesia. It has been demonstrated that 127 cells in the dorsocaudal FN responded to bipolar electrical stimulation (300-600 uA, 100 usec) of the optic chiasm.

Thirty six of the cells were also tested for response to optokinetic stimulation, reciprocating motion of a black and white stripe pattern (4 deg wide) or a random dot pattern (elements; 0.25 deg) at velocity from 3 up to 35 deg/sec. Fourteen FN cells were exited by the visual patterns moving in one direction and inhibited in the opposited direction. Twelve FN cells responded to the motion in the horizontal direction. Two cells were modulated in the vertical direction. In the most of responsive cells, depth of the modulation increased with velocity of the stimulating pattern. Those results suggest that the dorsocaudal part of the FN may be related to visual control of opkokinetic nystagmus.

334, ⅢE1330

DIRECTION OF SACCADIC EYE MOVEMENTS AND EFFECT OF BICUCULLINE ON SACCADIC EYE MOVEMENT ELICITED BY MICROSTIMULATION OF THE PRE- AND POSTSYNAPTIC COMPONENTS OF FASTIGIAL NEURONS. MURAKAMI.S AND NODA.H*# Colledge of Medical Tech. Hokkaido Univ.,Sapporo 060 # Dep. Visual Science Sch. Optometry Indiana Univ.,Bloomington IN.47405 U.S.A.

Microstimulation of the fastigial nucleus and of the white matter srounding it with electrical currents less than 10μA elicits a saccadic eye movement. As the stimulus electrode goes to and enters the fastigial nucleus, the direction of elicited eye movements changes from ipsilateral to contralateral side of stimulation. As the synaptic action of Purkinje cells is inhibitory, it is possible that the eye movements in the ipsi- and contralateral directions were caused by stimulation of the pre- and postsynaptic components of fastigial neurons, respectively. Then we studied elicited eye movements before and after bicuculline injection by using a magnetic search coil technique in four monkeys. We identified the reversal point of response direction and injected bicuculline(0.2-1.6μg) in 5 loci along the track. Positive effects of bicuculline were observed in 7 out 8 tracks tested. After the injections, the ipsi-lateral responses were almost completely suppressed,while the contralateral responses were either unchanged or enhanced. These effects continued for several hours and returened to preinjective size. These results show that the eye movements of the ipsilateral direction depends on the excitation of presynaptic components and those of the contralateral direction results from the excitation of postsynaptic components.

335, ⅢE 1345

SIMULTANEOUS MULTIPLE UNIT RECORDING FROM 32 PURKINJE CELLS IN RAT CEREBELLAR CORTEX.
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Present morphological and physiological results concerning the structural organization of the cerebellar cortex suggest that its neural networks process information in an intrinsically parallel fashion. In order to study this parallel organization, we improved a technique developed by Bower & Llinás (Soc. Neurosci. Abst., 1982, 1983) and recorded complex spikes from 32 Purkinje cells simultaneously in anethetized rat cerebellar cortex (Crus IIA). Recording electrodes were glass micropipettes with length of 2 to 3 mm. These electrodes were individually placed 250 μm from each other and arranged in a 4x8 matrix (0.75x1.75 mm) in a rostrocaudal and mediolateral direction, respectively. Electrical activity was amplified by 32-channel amplifiers, converted to TTL pulses by discriminators, and stored on floppy disks using a double buffering technique. Data analysis including auto- and cross-correlation, PST histogram and raster generation was done by VAX computer. Results show spontaneous oscillatory firing of complex spikes at a frequency of 8-12 Hz and synchronous firing in rostrocaudal bands which would cover most of the rostrocaudal span of a folium but which had a mediolateral span of 250-500 μm.

336, ⅢE 1400

UNDESCRIBED PROPERTIES OF PURKINJE CELL RESPONSE OBSERVED IN IN VIVO CAT'S CEREBELLUM.
TAKAHIRA, H. Dept. Physiol., Tokai Univ. Sch. Med., Isehara, 259-11

Although numerous reports have appeared since the publication of now classic monograph by Eccles, Ito and Szentágothai (1967), several important properties of Purkinje cell response in in vivo cerebellum have not been thoroughly described yet. For instance, the prolonged burst discharge and post-burst inhibition of Purkinje cells have been neither defined exactly nor correlated with already proposed model, such as climbing fiber input or parallel fiber input. This report deals with the former activity, elicited in all-or-none manner by single white matter stimulation in decerebrate cats.

The prolonged burst discharges of Purkinje cells occur in two forms: the one shows a prominent frequency adaptation without significant diminution of spike amplitude; the other displays a steady firing, preceded always by strong diminution of spike amplitude. The analysis by extracellular and intracellular recordings will be presented and the generation mechanism underlying these two different forms will be discussed.

337, ⅢE 1415

PROJECTIONS FROM THE PREPOSITUS HYPOGLOSSI NUCLEAR COMPLEX TO THE VESTIBULOCEREBELLUM OF THE RABBIT.
MAEKAWA, K., Dept. Physiol., Jichi Med. Sch., Tochigi-ken 329-04

To study the vestibulocerebellar projections from the prepositus hypoglossi nuclear complex, HRP was injected either into the flocculus (Fl) or into the nodulus (Nod). Labeled cells from the Fl were found bilaterally in the nucl. of Roller (Ro), the nucl. intercalatus (IC) and in the caudal half of the nucl. prepositus hypoglossi (PH). Labeled cells from the Nod were in the Ro, the IC and in the caudal two-thirds of the PH, thus confirmed the result previously reported in the cat (Kochabhakdi et al., 1978). Then, different fluorescent tracers (DAPI, PI, DY) were injected in the Fl and in the Nod. After two or three days survival, retrogradely labeled cells were surveyed in the PH nuclear complex using a fluorescent microscope. Projection cells to the Fl and to the Nod scattered and intermingled in the area above mentioned. About 5-10% of labeled cells were double-labeled which indicated that their axons collateralized to project to the Fl and to the Nod.

338, III E 1430

LONG-TERM EFFECTS OF 3-ACETYLPYRIDINE-INDUCED DESTRUCTION OF CEREBELLAR CLIMBING FIBERS OF THE RAT. KARACHOT,L.*, ITO, M. AND KANAI, Y.* Dept. of Physiol., Fac. of Med., Univ. of Tokyo, Bunkyo-ku, Tokyo 113 Japan

The inhibitory action of Purkinje cells on vestibulo-spinal tract (VST) cells was examined in the rats deprived of climbing fibers with 3-acetylpyridine (3-AP) intoxication. Wister rats were used under Nembutal anesthesia 10-160 days after 3-AP treatment. A systematic survay with intracellular microelectrode recording from 661 VST cells in 15 control rats and 1771 VST cells in 29 3-AP-treated rats revealed four basic changes in the monosynaptic IPSPs induced by stimulation of Purkinje cell axons in lobules II-III. 1) The rate of IPSP occurrence (0.64 in control) decreased gradually down to 0.32 by the 70th day, and thereafter increased up to 0.53 by the 160th day. 2) Larger IPSPs were observed less frequently. 3) IPSP latency was prolonged by about 0.25msec. Analysis of the relationship between the IPSP latency and the dorsoventral location of VST cells suggests that the cause for the prolongation of the IPSP latency is an increased synaptic delay at Purkinje cell axon terminals. 4) The stimulus threshold for evoking the IPSPs was almost always below 0.1mA in control, but 0.1-0.25mA were common after the 40th day. Deprivation of climbing fibers thus exerts long-term influences on excitability of Purkinje cell axons and synaptic transmission from Purkinje cell axons to VST cells.

339, II E 1700

REEXAMINATION OF THE RAMP-GENERATOR HYPOTHESIS OF THE BASAL GANGLIA IN PALLIDAL NEURON DISCHARGES OF AWAKE MONKEYS. HAMADA, I., DeLONG, M.R.*, MANO, N. and MIYAO, Y.* Dept. of Neurophysiol., Tokyo Metropolitan Inst. for Neurosciences, 2-6 Musashidai, Fuchu-shi, Tokyo 183

Activities of pallidal neurons and EMG of forelimb muscles were recorded in two rhesus monkeys during performance of visual tracking tasks. Visual target was displaced by step or ramp voltage, and the monkeys performed wrist flexion and extension of 30° at a velocity of about 200°/s or 15°/s respectively. Peripheral inputs to those neurons were examined by passive movements of the forelimb joints. Neurons which satisfied the following criteria were assumed as wrist-related neurons. 1.Changes in discharge rate during active wrist movements were time-locked to the start of active wrist movements. 2.Discharge rate was clearly modulated by passive wrist flexion or extension. All wrist-related pallidal neurons significantly modulated their discharge rate during both step and ramp wrist movements. The peak discharge rate was higher during step movement than during ramp movement. These results suggest that the basal ganglia do not have a preferential role in the control of slow limb movement, but control both fast and slow limb movements.

340, III P (54) 0900

PROJECTION FROM THE PREFRONTAL CORTEX ONTO THE CEREBELLAR HEMISPHERE IN THE MONKEY. SASAKI, K. AND GEMBA, H. Inst. for Brain Res., Fac. Med., Kyoto Univ., 606 Kyoto

It was previously reported that, in acute experiments of monkeys under light Nembutal anaesthesia, mossy and climbing fibre responses in the hemispherical part of the cerebellum were most markedly set up by stimulation of the forelimb motor cortex, and that stimulation of the premotor and prefrontal (area 9,10) cortex was less effective (1). In the present study, electrodes of thin silver wires were chronically implanted in the cerebellar cortex and used for recording responses to stimuli delivered through chronically implanted electrodes in various areas of the cerebral cortex in unanaesthetized state. In the cerebellar hemisphere, mainly crus II, mossy and climbing fibre responses were elicited at respective latencies of 7-15 and 14-25 ms. Cerebral areas were noted in order of predominancy of the stimulating effect as follow: the prearcuate area, the caudal part of principal area, the premotor cortex, the forelimb areas of the motor and somatosensory cortices. Such most remarkable influences of the prefrontal stimulation upon the cerebellar hemisphere are presumably mediated by indirect pathways to pontine and olivary nuclei. The result supports the assumed functional significance of the frontal association cortex in activating the cerebro-cerebellar interaction for initiation of voluntary movements (2). 1. Sasaki et al., Exp. Brain Res. 24: 495-507, 1976. 2. Sasaki, Cerebro-Cerebellar Interactions, Elsevier, pp. 105-124, 1979.

341, III P (55) 0900

FUNCTIONAL ROLE OF CEREBELLO-PREPOSITUS CIRCUIT IN THE CONTROL OF GAZE IN THE CAT.
OHTSUKA, K., EDAMURA, M. AND AOKI, M. Dept. of Physiol., Sapporo Medical College, Chuo-ku, Sapporo, 060.

We previously reported the properties of eye movements evoked by stimulation of the vermis, lobules V-VII in the cat, and suggested that the vermis played a role in the control of eye position. In the present study, the neuronal connection between the cerebellum and the prepositus nucleus (PN), which is recently regarded as a premotor center encoding mainly horizontal eye position, was investigated in encéphale isolé cats. Anti- and orthodromic spikes evoked by stimulation of PN or the fastigial nucleus (FN) were recorded in the contralateral FN or PN respectively. PN neurons were found to be mutually connected with the contralateral FN neurons by excitatory monosynaptic pathways. Microinjection of lidocaine hydrochloride into FN reduced the excitability of the contralateral PN neurons, and the cats were unable to maintain an eccentric eye position. Microinjection of bicuculline into FN increased the tonic discharge of the contralateral PN neurons, and the eye deviated to the contralateral horizontal direction. These findings suggest that there exists a mutual connection between PN and FN, which generate background facilitation in PN neurons, and the excitability of this circuit is controlled by the inhibitory output of the vermis.

342, III P (56) 0900

VISUAL PROJECTION TO THE CEREBELLUM IN CARP - IN ASSOCIATION WITH DORSAL LIGHT TILT REACTION -.
MORI, S., WATANABE, S., TAKABAYASHI, A., SAKAKIBARA, M. AND TAKAGI, S. Dept. Aerospace Physiol., Res. Inst. Environ. Med., Nagoya Univ., Nagoya 464.

The resting posture of fish is controlled mainly by sensory input from the vestibulum and the eye. If illuminated laterally, they tilt their vertical axes toward the light in order to balance both sources of inputs. This innate character of fish is called the dorsal light tilt reaction (DLR). In the last meeting, we reported that the accessory optic system might be responsible for DLR since the reaction was not impaired by the optic tectum ablation and that the cerebellum might be the center of DLR since the massive visual input could be identified by an evoked potential technique. Further investigation revealed that the visual projection to the cerebellum terminated at two parts, the anterior center of corpus cerebelli and the lateral bottom of valvula cerebelli, and that the DLR center might locate at the latter part since DLR was impaired only by ablation of the valvula cerebelli.

343, II E 1530

RESPONSE PROPERTIES OF BRADYKININ SENSITIVE TOOTH PULP DRIVEN NEURONS (BK-TPNs) IN SI REGION OF CAT CEREBRAL CORTEX. IWATA, K., ITOGA, H., TAMURA, K., TODA, K. AND SUMINO, R. Dept. Physiol., Nihon Univ. Sch. Dent., Chiyoda-ku, Tokyo 101.

Single neuronal activities driven by electrical stimulation of tooth pulps (TPNs) were recorded from cerebral cortex in lightly anesthetized cat and response pattern of these neurons by intrapulpal application of bradykinin and locations of these neurons were studied. A total of 114 TPNs were recorded from middle to anterior part of the coronal gyrus and 26 TPNs were responded to intrapulpal application bradykinin (BK-TPNs). 17 BK-TPNs increased firing frequency after application (fa.BK-TPNs) and 9 BK-TPNs decreased firing frequency after application (dep.BK-TPNs). The others (108 neurons) did not respond to bradykinin (non BK-TPNs). Dep.BK-TPNs were located more ventrally than fa.types. Stimulus threshold of fa.BK-TPNs were higher than those of dep.types. Peak latency of fa.BK-TPNs were longer than those of dep. and non types. 50% of fa.BK-TPNs received noxious skin afferents of the oro-facial region, on the other hand, only small numbers (20%) of dep.types did. The majority of BK-TPNs, received input from more than 2 tooth pulps. All BK-TPNs were located in the deep layer (lamina IV) of area 3b. Therefore, it was concluded that BK-TPNs in area 3b of the middle to the anterior part of the coronal gyrus of the cerebral cortex would be involved in sensory processing of noxious information of trigeminal regions.

344, II E 1545

NEURONS ACTIVATED OR INHIBITED BY THE CONTACT OF THE HAND WITH STABILIZED OBJECTS, FOUND IN THE AREA 2 HAND REGION OF THE MONKEY SOMATOSENSORY CORTEX (SI).
IWAMURA, Y., TANAKA, M. AND HIKOSAKA, O. Department of Physiology, Toho University School of Medicine, Omori-Nishi, Otaku, Tokyo, 143

In the conscious monkey area 2, we found a neuron that was activated selectively when the monkey's hand was made contact with a stabilized table placed in front of the monkey, or any part of the monkey chair on which the monkey was sitting. It was not activated by other modes of somatic stimulation. Another neuron, which was located close to the above one, showed the opposite responses. Thus, it was inhibited when the monkey's hand was made contact with the stabilized objects, but was activated when the monkey grasped any movable objects such as a piece of food. Neither of these neurons was activated by the contact of the hand with the monkey's own body. The results suggest the presence of a neural mechanism in area 2 to discriminate stabilized objects from movable ones. It excludes the monkey's own body, similarly to those related to the discrimination of fluffy objects from hard ones (Iwamura et al 1985).

345, II E 1600

VESTIBRAL INPUT TO THE FIFTH SOMATIC SENSORY CORTEX (SV). MORI, A., MATSUURA, N., NAITO, K. AND SUMINO, R. Dept. Physiol., Nihon Univ. Sch. Dent., Chiyoda-ku, Tokyo 101

We have reported (Mori et al. Neurosci. Abstr. 15, 1985) that a new and complete somatic sensory area in the cat cortex was found in the medial bank of the anterior suprasylvian sulcus. We have designated this area as the Fifth Somatic Sensory Cortex (SV). In the present study we examined the pattern of the input from vestibral stimulation to the SV. The experiments were carried out on adult cats with a sedative dose of ketamine. The receptive fields of neurons were examined by using natural somethetic stimulation. The spikes were monitored on the oscilloscope and also fed into a speaker through a window discriminator. The electrode tracks were reconstructed using the lesions made during the experiments and analyzed with respect to the this region as defined using the criteria of Hasster and Muhs-Clement. A tungsten-in-glass pipette microelectrode was inserted to the SV. Unitary spikes were evoked by natural somesthetic and/or vestibular stimulus. Some neurons in the face, neck, shoulder and trunk areas of the SV were fired by both stimulus, mechanically on the skin over the face, neck and trunk, and by vestibule. However, the hindlimb and forelimb areas of the SV did not have convergence from vestibral input. In conclusion, these findings suggest that neurons of the SV have an integrational function of inputs of somatic and vestibular stimulus.

346, II E 1615

EFFECTS OF CHRONIC ABLATION OF THE SENSORI-MOTOR CORTEX AND THE SUPERIOR COLLICULUS ON THE HEAD-TURNING INDUCED BY THE STIMULATION OF THE CAUDATE NUCLEUS IN CATS.
OHNO, T. AND TSUBOKAWA, H. Dept. Physiol., Institute of Basic Med. Sci., The Univ. Tsukuba, Sakura-mura, Niihari-gun, Ibaraki 305.

The electrical stimulation of the caudate nucleus (Cd) on one side induces the contraversive head-turning(HT) with latencies of 150-740 msec, followed by postural changes and the contraversive circling. In this study, we investigated the contribution of the sensori-motor cortex and its surrounding areas (SMCx) and the superior colliculus (SC) to the induction of HT. Experiments were carried out with awake unrestrained cats of which SMCx had been suctioned out or SC had been lesioned by kainic acid on one side. Cats were trained to stand still and Cd was stimulated systematically with trains of current pulses through a tungsten electrode. Cats with SMCx ablation did not show persistent postural asymmetry, and the stimulation of Cd on the side of SMCx ablation induced a similar type of contraversive HT as in cats without SMCx ablation. The chronic encroachment of SC produced a postural asymmetry with the neck slightly flexed toward the side of the lesion. On the side of SC lesion, the stimulation of Cd became much less effective in inducing the contraversive HT. The present results are consistent with the view that the substantia nigra pars reticulata and SC form parts of the pathway responsible for the induction of HT.

347, II E 1630

AN ANALYSIS OF RECURRENT UNITARY EPSPS PRODUCED IN PT CELLS. KANG, Y., KAYANO, F., ENDO, K. and ARAKI, T. Dept. Physiol., Kyoto Univ. Fac. Med. Kyoto 606

By means of triggering an averaging computer, recurrent unitary EPSPs evoked by the activity of axon collaterals of single donor slow PT cells were recorded in recipient fast PT cells. The computer was triggered by the spontaneous activity of donor PT cells or by the current pulse of direct stimulation (< 50 nA) applied through the extracellular recording electrode which was assumed to attach to the surface membrane of donor PT cells. The following electrical parameters of PT cells, in which unitary EPSPs were recorded, were measured or calculated by applying a hyperpolarizing current pulse; τ_m (membrane time constant), τ_1 (first equalizing time constant), L (electrotonic length). In view of several reports on morphology and cable properties of PT cells, the electrotonic length of the apical dendrite was assumed to be about 1.5 times of that of the basal dendrite and a value of 5 for the apical dendritic to somatic conductance ratio was assumed in order to estimate the electrotonic length of the apical and basal dendrites, and the theoretical shape index curve for unitary EPSPs was calculated. The rising time of 30 recurrent unitary EPSPs ranged 1.8-3.6 msec. The responsible synapses for these EPSPs were estimated to locate at electrotonic distances of 0.6-0.8 λ on the basal dendrite, the electrotonic length of which being estimated to be 0.7-0.8 λ.

348, II E 1645

MOTOR CORTEX NEURONAL ACTIVITY RELATED TO A KEY PRESS MOVEMENT OF IPSILATERAL, CONTRALATERAL AND BILATERAL HAND. TANJI, J. AND OKANO, K. Dept. Physiol., Hokkaido Univ. Sch. Med., Sapporo 060

Monkeys were trained to perform a key press movement with their right, left or bilateral hands according to instruction signals displayed on a lamp panel. The instructions were given 2 - 4 sec prior to a visual movement-trigger signal, also given on the panel. EMG studies revealed that muscle activities prior to the key press were limited to digit and forearm muscles of the limb instructed to move. 200 task related neurons were recorded from the hand area of motor cortex. Of these, 123 exhibited activity changes (increase or decrease) exclusively prior to onsets of the contralateral and bilateral key press movement. In most of them (with the exception of 6 neurons) magnitudes of their activity changes accompanying contra- and bilateral movement were similar. 18 neurons were active prior to the ipsilateral and bilateral movement. 16 neurons possessed reciprocal relation to the ipsi- and contralateral movement. The remaining neurons were related to all three of the ipsi-, contra- and bilateral movement in various degrees. Thus, although in a majority of motor cortex neurons the activity was akin to that of hand muscles, there were exceptions frequent enough to warrant further analysys.

349, III E 0915

CYCLIC AMP SYSTEM OF POLARIZED CEREBRAL CORTEX IN THE RAT.
MORIWAKI, A., HATTORI, Y., HAYASHI, Y., SUNAMI, T. AND HORI, Y.
Dept. of Physiol., Okayama Univ. Med. Sch., Okayama 700

In rats, 30, 3 or 0.3 μA of anodal direct current was applied for 30 min to the surface of the left sensorimotor cortex (anodal polarization). One day after anodal polarization, rats were sacrificed by decapitation, and the cerebral cortex was quickly extirpated and dissected into four parts. The polarized point was in the left anterior cortical area. After the slices of each cortical area were incubated for 10 min in Krebs-Ringer bicarbonate-glucose buffer with or without 0.1 mM norepinephrine, cyclic AMP contents were determined and compared among the cortical areas. In rats receiving 30 or 3 μA, the ratios of cyclic AMP content in norepinephrine-treated slices to that in untreated slices were greater in the left anterior area than in the right anterior. In rats receiving 0.3 μA, the ratios were greater in the right anterior area than in the left anterior. The changes in cyclic AMP response to norepinephrine appeared to be due partially to fluctuation of cyclic AMP levels in untreated slices caused by anodal polarization.

350, III E 0930

ELECTROPHYSIOLOGICAL AND MORPHOLOGICAL STUDIES ON NON-PYRAMIDAL TRACT NEURONS IN THE MOTOR CORTEX OF KITTENS.
YAMAMOTO,T., SAMEJIMA,A. AND OKA,H. Dept. Physiol., Fukui Med. Sch., Fukui 910-11

Intracellular recording combined with HRP injection was performed in the motor cortex of kittens under Nembutal anesthesia. Thirty five neurons in various cortical layers were studied electrophysiologically by stimulation of the cerebellar nuclei(CN) and/or the medullary pyramid(Py). Eleven out of these neurons were recovered and identified as non-pyramidal tract neurons(non-PTNs) morphologically. Non-PTNs were activated by CN stimulation even at very early postnatal day. The postnatal changes of the latency of CN-EPSPs were nearly the same as those observed in PTNs. The characteristic point of the CN activation of non-PTNs is that IPSPs were first detected around the third postnatal week, that is much later than in the case of PTNs. This indicates that the local circuits responsible for IPSPs develop later in I-III cortical layers. Morphological analysis was performed in 71 non-PTNs in layers I-VI, including sixty neurons which were not characterized electrophysiologically but stained with HRP intracellularly, and was compared with our previous study on the PTN(Oka et al.'85). Morphological findings on layer II and III cortical neurons suggest that the postnatal development of the layer II and III neurons starts later than PTNS.

351, III E 0945

REAPPEARANCE OF DENSE GENICULOCORTICAL PROJECTION ONTO LAYER I AFTER REVERSE SUTURE IN KITTENS.
KATO, N. and KAWAGUCHI, S. Inst. Brain Res., Fac. Med., Kyoto Univ., Kyoto 606

The distribution of geniculocortical(G-C) afferents markedly changes during early postnatal period in kittens(Kato et al,'83,'84): particularly, afferents in layer I, dense at birth, noticeably decrease in density by 1 month old to become as sparse as in adult cats. Using the orthograde and retrograde HRP methods, we investigated whether this developmental change is influenced by binocular, monocular or reverse lid suture. Binocular or monocular suture, beginning before normal eye opening up to 43-50 days of age, had no influence upon the decrease of the density in layer I. However, when this procedure of monocular suture was followed by opening the sutured lid and closing the other lid (reverse suture), the density of G-C afferents in layer I, examined 1 week later, was much higher than in normal kittens of the same age, without difference of density in the other layers. In agreement with this finding, HRP injection into layer I of area 17 labelled much more numerous neurons in the lateral geniculate nucleus in kittens with reverse suture than in normal kittens; the labelled neurons were slightly larger in reverse-sutured kittens. These results, combined with our previous findings, suggest that G-C projection onto layer I plays a part in organization and proliferative reorganization of the neuronal circuit in the visual cortex.

352, III E 1000

UNIT ACTIVITIES IN CAT CORTICAL AREA 20 WHICH CORRELATED WITH PUPILLO-CONSTRICTION RESPONSES. BANDO,T., Dept. Physiol., Yamanashi Med. Sch., Tamaho, Nakakoma, Yamanashi 409-38, Japan.

Pupillary constriction was evoked by stimulating a part of PMLS area in cat rostral occipital cortex, closely adjacent to the area from which lens accommodation was elicited(Neurosci.Res.,1985). Pupillary responses evoked from PMLS prominently reduced by local lesion or cooling of area 20 in caudolateral occipital cortex(J.Physiol.Soc.Jpn.,1985). Based on these and additional results obtained by combined stimulation of PMLS and area 20, it was suggested that the output of PMLS pupillo-constrictor area was relayed in area 20.

Single units were sought in area 20, which were correlated with spontaneously-ocurring pupillary constriction, and their responses to stimuli given in PMLS and lateral posterior nucleus of the thalamus were studied in cats anesthetized by -chloralose and urethane. They were orthodromically activated with short latencies by LP stimulation, consistent with direct fiber connection between LP and area 20, but were driven from PMLS only with much longer latencies. It is suggested that PMLS pupillo-constrictor area projects to area 20 indirectly, probably through LP.

353, III E 1015

CORTICOCORTICAL CONNECTIONS BETWEEN THE CORTICAL AREAS RELATED TO EYE MOVEMENTS IN CATS. NAKAI, M., TAMAI, Y., MIYASHITA, E. and TSUJIMOTO, T., Dept. of Physiology, Wakayama Medical College, Wakayama 640

We examined corticocortical connections between the cortices related to eye movements in the cat using retrograde HRP tracing method combined with electrophysiological technique. Experiments were carried out using encéphale isolé preparations made under inhalation anesthesia (40% oxygen, 60% nitrous oxide 1.0-2.0% halothane) and local anesthesia (1% xylocaine) to all wound tissues. Following results were obtained. (1) In the frontal area, mesial wall under the cruciate sulcus received fiber projection from the medial bank of the presylvian sulcus and the internal kneelike portion of the coronal sulcus received projection from the lateral bank of the presylvian sulcus. (2) These frontal cortical areas all received projections from the ipsilateral ventral bank of the anterior ectosylvian sulcus. (3) The ventral bank of the anterior ectosylvian sulcus received afferent input from the caudal lateral suprasylvian visual area (PLLS and DLS). It was suggested that the "frontal oculomotor area" in the cat seemed to be subdivided into the medial and the lateral parts on the view of the fiber projections, and the afferent inputs from the anterior ectosylvian area to the "frontal oculomotor areas" might play an important role for eye movements in the cat.

354, III E 1030

SUPPRESSION OF VISUALLY TRIGGERED SACCADES BY ELECTRICAL STIMULATION OF THE MONKEY FRONTAL EYE FIELD. AZUMA, M., NAKAYAMA, H. AND SUZUKI, H. Dept. Physiol., Hirosaki Univ. Sch. Med., Hirosaki 036

Monkeys were trained to fixate their eyes on a straight-ahead visual target, and then to make gaze shifts from it to the other visual target appearing at various position in the visual field, thus generating saccadic eye movements with a lag of 130-200 ms. While they performed the saccades, we applied intracortical microstimulation to the frontal eye field (FEF) and examined the effect of the stimulation on visually triggered saccades. (1) When repetitive stimuli of 200 Hz were applied to the lateral part of the FEF for 0.5 sec from the onset of the target appearance, the saccade generation was delayed. The delay became gradually larger with the increase of the stimulus strength until 100-250 ms on the maximal strength of 70 μA. (2) The suppression was effectively generated when stimuli were applied at the period just before the saccade onset. (3) The stimulation gave rise to the suppressive effect on the saccades of any direction and any amplitude. (4) The suppressive effect was strongest when the stimuli were applied to the very lateral part in the FEF and the part corresponded to the area representing the center of the visual field. (5) We may conclude that the lateral part of the FEF has function to suppress the generation of the saccadic eye movements and then to maintain the fixation of the eyes.

355, III E 1045

GABA-ERGIC INHIBITION UPON NEURONAL ACTIVITIES RELATED TO A VISUAL REACTION TIME TASK IN THE MONKEY PREFRONTAL CORTEX. SAWAGUCHI, T., MATSUMURA, M. AND KUBOTA, K. Dept. of Neurophysiol., Primate Res. Inst., Kyoto Univ., Inuyama, Aichi 484

GABA-ergic inhibition upon neuronal activities was investigated in the prefrontal cortex while monkeys were performing a visual reaction time task. GABA and/or its antagonist, bicuculine (BMI), were applied iontophoretically to neurons related to the task and to spontaneously inactive, task-unrelated "silent" neurons. In all of 81 task-related neurons GABA reduced the rate of discharge, and in all of 93 task-related neurons BMI increased the background and task-related activities. Further, BMI uncovered task-related activities in 38 silent neurons. These results suggest that GABA-ergic neurons inhibit tonically the prefrontal neurons, task-related as well as task-unrelated, thereby forming spatial patterns of the neuronal activities related to the task.

356, III E 1100

EEG CHANGES OF TEH MONKEY PREFRONTAL CORTEX DURING LEARNING OF A VISUAL DISCRIMINATION TASK WITH GO/NO-GO PERFORMANCES. KUBOTA, K. Dept. Neurophysiol., Primate Res. Inst., Kyoto Univ., Aichi 484

A previous study showed that the prefrontal neurons become increasingly involved in a visual discrimination task during learning from a poor performance level, though intermediate, to well-trained levels (Neurosci. Res. 3:106-129, 1985). These observations were extended to mass activity changes. Event-related EEGs were recorded from eight pairs of surface and depth implanted electrodes of the dorsolateral prefrontal cortex of two monkeys during learning of the same discrimination task. In undertrained state, notable EEG changes were not recognized except for transient triphasic potentials for visual CUEs. In well-trained state, gradually developing surface negative-depth positive potentials appeared before onsets of CUE and RESPONSE Periods and further increased after these onsets. These also appeared a transient surface negative-depth positive potential before GO perfromance. In intermediately trained state, these potentials were smaller than in well-trained state. These results are consistent with those of the single neuron study.

357, III E 1115

CORTICAL FIELD POTENTIALS ASSOCIATED WITH AUDIO-INITIATED HAND MOVEMENTS IN THE MONKEY. GEMBA, H. AND SASAKI, K. Inst. Brain Res., Fac. Med., Kyoto Univ., 606 Kyoto.

Monkeys were trained to lift a lever with wrist extension in response to auditory stimulus. During the learning process of the task over several months, field potentials were recorded with chronically implanted electrodes on the surface and at a depth of 2.0 -3.0 mm in various cortical areas. In the early learning period, in which monkeys associated the auditory stimulus with the movement for getting a reward, the potentials developed and changed mainly in the auditory association cortex. They increased further in the later period of learning, when the monkey acquired fast and stable performance. The forelimb motor cortex also revealed increasing activities in the later period, which were mediated by the neocerebellum. No appreciable increase of activities in the prefrontal and premotor cortices was seen during the learning process. However, the potentials in the prefrontal and premotor cortices increased temporarily when frequency of the auditory stimulus was changed. Monkeys were also trained to discriminate auditory stimuli with different frequencies, i.e., to move the hand within about 500 ms duration of the positive (go) stimulus, e.g., 1000 Hz sound, but not to move on the negative (no-go) stimulus, e.g., 2000 Hz. As the discrimination progressed, characteristic potentials occurred and gradually increased in the prefrontal area on the positive stimulus with the movement.

358, III E 1130

A THALAMO-CEREBRAL CONNECTION IN VOCAL CENTER OF SONG BIRD. OKUHATA, S. AND SAITO, N. Dept. of Physiol., Dokkyo Univ. Sch. Med., Mibu, Tochigi, 321-02

The passerine song is controlled by connections between discrete neuronal nuclei. The connective circuits include two systems; the HVc → RA → nXIIts is a motor driving system for vocalization, and other group of nuclei includes HVc → Area X → DIP → MAN → HVc, a modulator for the driving system.

In canary, HVc was determined, by a collision technique, to receive synaptic projections from MAN and send its fibers to Area X which innervated DIP (nucleus dorsointermedius posterior thalami). The HRP labeled axons of Area X terminated in DIP forming multiple branches of their terminals that encompassed the DIP neurons which projected to MAN. The fact that lesion of MAN absolutely disrupted song development in juvenile male zebra finch has been reported (Bottjer, 1984). Accordingly, the HVc, Area X, DIP, and MAN constitute a recurrent loop that may feed back to partially contribute to learning of song patterns.

359, II E 1145

SLOW POTENTIALS OF AUDITORY NEURONS IN CEREBRAL VOCALIZATION NUCLEUS OF CANARY. MAEKAWA, M. AND SAITO, N. Dept. of Physiol., Dokkyo Univ. Med. Sch., Mibu, Tochigi, 321-02.

The cerebral vocalization nucleus in canary, the caudal nucleus of the ventral hyperstriatum (HVc), receives synaptic projections from the cerebral auditory center, field L and is well developed as a voco-auditory association area. Auditory responsive units were found within the HVc including its border area (termed SH). Most auditory neurons in the SH responded with a phasic pattern to pure tone. Intracellular recordings in the SH showed slow spike potentials in neurons whose depolarization elicited burst discharges of fast spikes, and was followed by hyperpolarization. The slow spike was assumed to be of intrinsic electrogenesis rather than synaptic, to be of a different ionic basis than synaptic potentials and to subserve phasic auditory responses of the SH neurons. These intrinsic slow spikes may characterize the SH which functions in voco-auditory association.

360, I P (8) 0900

SPATIAL PROPERTY OF INHIBITORY END-ZONES OF SIMPLE AND B-CELLS IN CAT STRIATE CORTEX. YAMANE, S., MASKE, R.* AND BISHOP, P.O.*
Bionics Section, Electrotechnical Laboratory, Umezono, Sakuramura, Niiharigun Ibarakiken 305. *Australian National Univ.

Responses of simple and B-cells in the striate cortex of anaesthetized and paralyzed cats were examined by using visual stimuli; narrow optimally-oriented light bars moved in preferred direction at optimal velocity. The bar length was increased at both ends to plot the bilateral length response curves. As the bar lengthened from its shotest length, the response increased rapidly to a peak and thereafter decreased to a lower plateau level. There is a linear relation between the maximum slope of the sharp initial drop from the peak to the plateau level of the curve and the strength of the end-zone inhibition for simple and B-cells. This relation suggests that the length of the two end-zones as given by a bilateral length response curve is approximately constant regardless of the strength of the inhibition for a change in the inhibition from 10 - 100%.

361, I P (9) 0900

INTERACTION OF TWO MOVING PATTERNED STIMULI ON THE RESPONSES OF THE COMPLEX NEURON OF THE CAT. KAJI,S. and KAWABATA,N.* Bionics, Electrotech.Lab. Umezono, Sakura, Ibaraki 305

We examined the changes in responses of complex cells in cat's striate cortex to a test stimulus, a textured (non-oriented) stimulus moving in the preferred direction, superimposed upon a conditioning stimulus, either a textured or grating (oriented) stimulus that was moved in different directions. The cell discharges elicited by the test stimulus were reduced by conditioning another textured stimulus moving in non-preferred directions and increased when both moved in the preferred direction. A grating as a conditioning stimulus, showed similar but stronger inhibitory effects on the responses to a test stimulus. Neural processing for directional movement is, therefore, affected by other neural processing for directional movement, and still more by that for orientation.

362, I H 1500

SPECTRAL SENSITIVITY OF THE HUMAN VISUALLY EVOKED POTENTIALS TO CHECKERBOARD PATTERN REVERSAL STIMULATION. NAKAMURA, T. AND MORITA, Y. Grad. Sch. Electr. Sci. Technol., Shizuoka Univ., Hamamatsu 432 and 1. Dept. Physiol., Hamamatsu Univ. Sch. Med., Hamamatsu 431-31

Spectral sensitivities of the human visually evoked potentials (VEP) to checkerboard pattern reversal stimulation (test field 4°35', check size 24', 6 Hz) without background illumination were obtained at high and low irradiance levels of the pattern and compared with the psychophysical results, determined by threshold measurements for recognizing patterns. VEPs were recorded monopolarly from Oz-earlobes and averaged. The pattern irradiance was set at levels of 0.5-1.5 (low) and 2.0-3.0 (high) log units above the psychophysical thresholds. Spectral sensitivities were computed from criterion amplitude of V-log I functions.

Spectral sensitivities measured by VEP at high irradiance level showed the tendency of decreasing around 580 nm and increasing around 620 nm, while psychophysical curves had a peak between 520-540 nm, resembling in red region to the CIE photopic function. These results of VEP-measurements indicate the existence of R-G opponency. At low irradiance level the same phenomena were observed in three out of five cases.

363, I H 1515

BASIC STUDIES ON THE EMG COMPONENTS OF THE PHOTICALLY EVOKED LID POTENTIAL CHANGES. HOSHINA,Y., OZAKI,T., TANNO,T. and NIKARA,T. Dept. Physiol., Hirosaki Univ. Sch. Med. and Lab. of Physiol., Sch. of Allied Med. Sci. Hirosaki Univ., Hirosaki 036

In the present report, the properties of the early rapid components of the average lid potential changes elicited by flash stimulation were studied polygraphically from the standpoint of orbicularis oculi reflex in rabbits in addition to humans. The early rapid components of the average evoked lid potential changes in rabbits were clarified to correspond to the average evoked MV responses under various conditions, which were described to be originated in the orbicularis oculi in human blink reflex. The early rapid components, that is electromyographic(EMG) ones, obtained by flash stimulation to a single eye appeared in the occulded or extirpated side in human subjects. On the other hand, they disappeared almost completely in rabbits. Furthermore, the EMG components in rabbits were increased in amplitude by dark adaptation or strengthening the stimuli and almost extincted by the administration of pentobarbital soduim at moderate doses, although the early rapid components related to the ERG still remained.

From these results, it was suggested that the EMG components of the average evoked lid potential changes were the electrical excitation of the effector in the orbicularis oculi reflex in rabbits as well as humans.

364, I H 1530

CHANGES IN EXCITABILITY OF THE BRAIN STEM RETICULAR FORMATION IN THE PRESENCE OF FLASH STIMULUS. NAITO, H., TAKEMURA, K., HORI, A., YAMAMOTO, T. AND YASUHARA, M. Dept. Physiol., Kansai Med. Univ., Osaka 570

The threshold of the arousal reaction, elicited by stimulation of the brain stem reticular formation(RF) of the rabbit with 100 Hz, increased on attachment of a contact lens(CL) in the absence of flash stimulus, but decreased in the presence of flash stimulus. The frequency of the spontaneous unit discharge of the RF decreased with CL in the absence of flash stimulus but increased in the presence of flash stimulus. The amplitude of the recruiting response in the cerebral cortex EEG, elicited by stimulation of the nucleus ventralis anterior(VA) with 8 Hz, increased on attachment of a CL in the absence of flash stimulus but decreased in the presence of flash stimulus. The changes in the threshold of arousal reaction and in the frequency of RF unit with CL were abolished by destruction of the VA. These results suggest that the decrease in excitability of the RF, by attachment of the CL in absence of the flash stimulus, and the increase in the presence of the flash stimulus can be attributed to a rise in indirect inhibition and decline in indirect inhibition of the RF, respectively, via the diffuse projection system.

365, I H 1545

RESPONSES OF EEG THETA COMPONENT TO CONTINUOUS LIGHT STIMULI. KATADA, A., KOIKE, T., FUJISAWA, S.,*SUZUKI, H. AND*OZAKI, H. Lab. of Physiol-Psychol., Tokyo Gakugei Univ., Koganei, Tokyo 184,*Lab. of Physiol. for the Developmentally Handicapped, Ibaraki Univ., Mito 310

The present study intended to make clear on some characteristics of blocking effects of EEG theta component to continuous light stimuli. The subjects were mentally retarded adults without any pathological findings and any paroxysmal abnormal waves, because we considered some of them as stopping or retarding on the way of brain maturation. The EEGs were monopolarly recorded from the waking subjects with closed eyes. Electrodes were located in six regions along the midline. The light stimulus was given the subjects for 15 seconds 7-20 times. Interval between stimuli was more than 45 seconds. The auto-power spectra were obtained from the resting EEGs for 180 seconds and for 6 seconds just before each stimulus, and the stimulated EEGs for 12 seconds just after each stimulus by a mini-computer(PDP 11/34).

1) Alpha component showed the blocking effects to the light stimuli. 2) The blocking effects showed only in alpha component, when both alpha and theta components appeared in the averaged spectrum. 3) Theta component of 6-8 Hz without other ones showed the blocking effects. 4) Theta component of 4-6 Hz did no_ show the blocking effects regardless of having other component or not.

366, I H 1600

EEG TOPOGRAPHY OF THETA ACTIVITY DURING MENTAL CALCULATION.
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Dept. of physiol., Natl. Def. Med. Coll., Tokorozawa 359.

Theta activity during mental calculation was investigated topographically in eight healthy college students (4 good and 4 poor calculators) in relation to occipital alpha activity using half second EEG blocks. EEG was recorded from 12 locations in successive subtractions such as 1) 100-7,93-7,-- 2) 105-7,98-7,-- 3) 200-7,193-7,-- 4) 205-7,198-7,--. The data were A/D converted (sampling rate 256/sec) for following computor processings: 1 Dividing the EEG blocks into Large Alpha Block (LAB) and Small Alpha Block (SAB) by amplitude of occipital alpha activity. 2 Difference maps of theta activity (Average maps of calculation minus Average maps of control) were obtained by Unbiased Polynomial Interpolation for LAB and SAB in good and poor calculators. 3 Correlation map between alpha and theta activities was used for finding the topographical parallelism of the two activities. 4 Statistical study was made to clarify the degree of difference of the above four maps by calculation of F values using ten parameters of the unbiased polynomials.

367, I H 1615

OVERALL SPATIAL AND TEMPORAL CHARACTERISTICS OF EEG COMPONENTS WITHIN ALPHA-FREQUENCY BAND.
SUZUKI, H., OZAKI, H.(Facult. Ed., Ibaraki Univ., Mito, 310), KATADA, A., NAGASE, Y.* and KOIKE, T.(Tokyo Gakugei Univ., Koganei, 184)

Different components are often detected within alpha-frequency band in the human EEG. The natures of those components were considered with special reference to their frequency, regional distribution and dominancy, vulnerability to stimulation, or temporal variability. Each two second epoch of EEGs from 16 sites of the scalp in waking adults was analyzed through FFT method, and it was displayed successively as a contour map of power for each frequency component. The most dominant component appeared in bilateral or alternative occipital parts, but another component was often observed in Pz, C3 or C4. Frequency of the latter component was slightly different from that of the former one, but it was sometimes very close to each other. Under illumination, those components were uniformly suppressed but they recovered from attenuation in different ways respectively. Accordingly, the characteristics of those different components were more clearly differentiated in the recovery processes from alpha attenuation.

369, I H 1630

AUDITORY BRAIN STEM RESPONSES AS RELATED TO SYMPTOMS OF SCHIZOPHRENIA.

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Auditory brain stem responses (ABSRs) were studied on both normal and schizophrenic subjects. Click stumuli, which were delivered binaurally through headphones, evoked all ABSR wave forms (I, II, III and IV, V waves) in the normal and non-deteriorated subjects recorded between vertex and mastoid. In the schizophrenic patients with marked deterioration of personality, not all ABSR wave forms were elicited and the amplitudes were low (about a half of the control value) without prolongation of peak latencies (less than 4 %).

A follow up study on same patients of catatonic type showed that the ABSR wave forms changed in amplitudes and latencies in relation to exacerbation and relief of the clinical symptoms of the illness, which were evaluated by brief psychiatric rating scale.

The results suggest that the changes in ABSR wave forms may be attributable to some specific feature of schizophrenia.

370, III P (48) 0900

RELATIONSHIP BETWEEN BLOOD GLUCOSE LEVELS AND THE OCCURRENCE OF KINDLING IN INFANT RAT

Lee,S., Kawawaki,H., Matsuura,S. Dept. of Physiol., Osaka City Univ. Med. Sch., Osaka 545

A bipolar electrode was implanted into left amygdala under ether anesthesia of male Wistar rats on 13 or 14 days of age and electrical stimulations of a train of 125 pulses (intensity;400 μA, frequency;62.5 Hz, stimulus interval 30 min) were applied 16 and 17 days of age. General convulsions (stage IV or V by the kindling criteria of Moshe') were ususally induced by the stimulations. When hypoglycemia was produced by act-rapid insulin (25 units/kg) to examine the durations of after-discharges (ADs) of EEG waves by test electric stimulation at different levels of blood glucose on the 18th day after birth, blood glucose level decreased from the control level of 83.0 ± 10.3 mg/dl to 37.4 ± 4.36, 25.0 ± 7.07 and 17.0 ± 7.84 mg/dl 30, 60 and 120 min after the application, respectively. With the decrease of glocose level, duration of ADs increased, without no apparent change in the amplitude of ADs, from 66.2 ± 11.6 sec to 72.9 ± 18.7, 86.5 ± 26,0 and 96.4 ± 36.6 sec, respectively. The data from the rats which showed loss of body weight during the course of experiments were discarded. Acute hyperglycemia which was induced by diazoxide caused no apparent change either in the duration of ADs or in the threshold for the production of electro-convulsions.

371, III P (49) 0900

CHANGES IN AFTER-DISCHARGES OF EEG WAVES BY CALCIUM ANTAGONIST IN KINDLING SEIZURES OF SUCKLING AND ADULT RATS.

Kawawaki,H., Lee,S., Matsuura,S. Dept. Physiol., Osaka City Univ. Med. Sch., Osaka 545

Anticonvulsant and prophylactic effects of Ca-antagonist (flunarizine) were examined in amygdaloid kindling preparations in suckings (18 days old) and adults (older than 3 months) of male Wistar rats. The sucklings were stimulated tenth daily with a 2 sec train of biphasic electrical pulses (62.5 Hz), each 1 msec in duration and 400 uA in peak to peak amplitude, and the adults were stimulated once a day with the same pulses. When the effects of a low dose of flunarizine (i.p.; 20 mg/kg) were examined 30 min after the application, about 25 % of decrease in the duration of after-discharges (ADs) of EEG waves was observed in the sucklings. With a higher dose (80 mg/kg), the AD duration showed a marked reduction in both sucklings and adults, and the reduction was 50 % and 74 %, respectively. Almost the same amplitude of reduction was observed, even when examined 24 hours later in the sucklings. When the higher dose of flunarizine was applied to examine the prophylactic effects from the minimum number of conditioning stimulations to induce kindling seizure, stage IV, the number of stimulations showed no apparent difference from that for the control rats either in sucklings or adults. The effects were very similar to those of phenytoin.

372, III P (50) 0900

FRONTAL THETA RHYTHMS IN THE NORMAL EEG OF THE WAKING ADULTS.

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It has been generally accepted that normal adults rarely show slow EEG activities during waking. But some adults showed considerable amount of theta rhythms at rest with eyes opened. On the other hand, during continuous mental works theta rhythms were often noted to appear predominantly in the frontal midline area (so-called Fmθ). The authors examined appearance of the theta rhythms, especially in the frontal areas, of waking normal adults for differentiating from abnormal ones. EEGs were recorded from 205 healthy university students (male and female, 18-23 years of age) at rest and during mental works. Ninty eight students (48 %) of them showed apparent theta rhythms continued more than one second in at least one of these conditions. Most of them belonged to Fmθ, having amplitudes of 20-50 μV (over 100 μV in some cases). The subjects, showing Fmθ during mental works, tended to show Fmθ also at rest although Fmθ incidence was much less at rest. Significant difference was not found in the frequency, potential distribution and phase difference between the Fmθs at rest and during mental works. Since the subjects normal ones, the theta rhythms above described considered as normal EEGs.

373, III P (51) 0900

LOCALIZATION AND CHARACTERISTICS OF RAT CEREBELLAR FIELD POTENTIALS EVOKED BY TOOTH PULP STIMULATION.

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Cerebellar field potentials evoked by tooth pulp stimulation were studied with rats anesthetized by urethane-chloralose. Bipolar tungsten electrodes were attached to lower incisors through which a train of electrical pulses were presented as noxious stimuli. Surface and depth recordings were carried out with stainless steel electrode of 200 μm in diameter. Large amplitude spikes of various latencies following complex spike discharges with latency less than 5 msec were observed in several areas of lateral and medial hemisphere. In crus II adjacent to vermis, contralateral stimulation gave a rapid ascent of positive-negative spike of 1.0 mV p-p at latency of 25 msec. In medial region of paramedian lobule, gradual positive potentials were evoked at 40 msec latency with amplitude of 400 μV by either of unilateral stimulation. Field potentials were recorded also in lateral regions of crus I and paramedian lobule where ipsilateral stimulation caused larger potentials than did contralateral one. In these areas, spike amplitudes and latencies were ipsilaterally of 300 μV at 7 msec and 500 μV at 25 msec, respectively. Multiple cerebellar projection in the present experiments and their cerebral inhibition observed in our previous study indicate characteristic features of cerebellar field potentials and the cerebro-cerebellar organization in nociception.

374, III P (52) 0900

POWER SPECTRAL ANALYSIS OF ELECTROENCEPHALOGRAPHIC ACTIVITIES IN MONOAMINERGIC NUCLEI AND PREFRONTAL AREA OF THE CAT BRAIN.

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Noradrenergic neurons in the nucleus locus coeruleus (NLC) and serotonergic neurons in the nucleus raphe dorsalis (NRD) densely and mutually project their axons and send them also to most cortical and subcortical areas of the brain. Electrodes were chronically inserted into the NLC, NRD and prefrontal area to record their electroencephalographic (EEG) activities during unanesthetized and unrestrained states of the cat. The frequency and power spectral analysis of the EEG activities at arousal and various stages of sleep showed the followings: Both the prefrontal area and the NLC showed periodic changes along with sleep and arousal, whereas the NRD did not show a marked periodicity. There were no obvious differences in the spectral pattern of prefrontal EEG during arousal, drowsy and REM stages, but the power at about 1.7 Hz specifically increased during the slow wave sleep. In the NLC, the spectral component at 6-9 Hz temporarily increased when slow wave sleep shifted to REM sleep. In the NRD, there was an elevation of 1.5-2.2 Hz components during slow wave sleep, while no marked spectral differences were noted during arousal, drowsy and REM stages.

375, ⅢP (53) 0900

LOCALIZATION OF AN ELECTRIC DIPOLE AND DIPOLE TRACING OF HUMAN BRAIN POTENTIALS - THE INVERSE PROBLEM. NAKAJIMA, Y., HOMMA, S., MUSHA, T*., OKAMOTO, Y*. AND HE, B*. Dept. Physiol., Sch. Med., Chiba Univ., Chiba 280 and *Dept. appl. Electr., Tokyo Inst. Technol., Yokohama 227

We have developed a new computer method for localizing an electric source generator (e.g. a current dipole) of the human brain potentials. Brain activity such as somatosensory evoked potentials and motor potentials was recorded with 21 surface electrodes over the scalp. To solve the inverse problem, it was assumed that only one dipole is elicited at a given time, and that a head is filled with a homogeneous medium. The exact geometry of the human head was measured from 17 slices of CT-images of a real human head to arrange a human head model with 320 triangles and 162 nodal points. A dipole with a given moment and location was assumed in the head model. Potential distribution over the head model surface was calculated using a boundary element method. A squared deviation between the observed and calculated potential distribution was numerically minimized by the aid of the simplex together with the boundary element method. This method was applied to early components of somatosensory evoked potential, motor potential and spikes of myoclonic seizure.

824, ⅢP (57) 0900

CHARACTERISTICS OF THE ELECTRICAL RESPONSE DURING REPITITIVELY STIMULATED CONTRACTION OF THE HUMAN MUSCLE. YAMAMOTO, T. Dept. Research and Development, Toyama Prefectural Rehab. Hospital, Toyama, 931

We have developed a method of measurement and its signal processing of the electrical response of the stimulated muscles via surface electrodes, which is over the skin of the muscular belly. The stimulater, used here is microcomputer--based, and controlled by the stimulating voltage. Concerning the basic stimulating pulse, comparatively high frequency(8 to 10 kHz) are used, which is AC sine wave, modulated with the lower stimulating frequency(40 to 120 Hz.) The signal processor of the electrical response is composed of gate controller, and filtered peak-hold circuit, etc. The muscle used is M. Biceps Brachii of several normal males.

The relation between the electrical and the torque responses are mainly examined. Experimental results show that (1) the processed electrical response and the torque are adapted by long term stimulation, and (2) it is possible to get consistently a lineasr relationship in the condition of the isometric condition, by handling the stimulating parameters(frequency, duration,etc) and the electrodes.

We conclude that the processed electrical response is an useful indicator for estimating muscular activity in the field of functional electrical stimulation.

376, I H 0915

INHIBITION ON THE CRAYFISH EYE-CUP WITHDRAWAL REFLEX. CHIBA, A., YAGINUMA, S. and CHICHIBU, S. Dept. Physiol., Kinki Univ. Sch. Med., Sayama, Osaka 589

Mechanical stimulation of receptors innervated by the tegumentary nerve elicited an eye-cup retraction reflex (EcR) in crayfish, Procambarus clarkii. Intracellular recording and Lucifer Yellow CH injection techniques were used to determine the morphological and functional characteristics of the oculomotor neurons (OCM) and their interneurons in the cerebral ganglion. Prolonged EcR is induced by a burst of impulses in the unilateral OCM of either side. Repetitive electrical stimuli to the tegumentary nerve caused the ipsilateral reptitive firing of the OCM and the local spiking interneurons, and an excitatory loop between these two neuron groups is estimated. On the contray, the ipsp OCM to the ipsilateral tegumentary nerve stimulation showed the bilateral distribution of the dendric arborization. The unilaterality of the EcR is due to the ipsilateral excitatory actions of the OCM as well as to the contralateral inhibitory ones to the stimulation of the ipsilateral cephalothorax. The ipsilateral tegumentary nerve stimulation produced longer burst responses in the OCM than that to the circumoesophageal connective.

377, I H 0930

RESPONSIVENESS TO PATTERNS IN INFEROTEMPORAL NEURONS IN MONKEYS PERFORMING DISCRIMINATION TASK. HIKOSAKA, K., WATANABE, J., SATO, T., SUYAMA, H.* AND IWAI, E. Dept. of Behav. Physiol., Tokyo Metropolitan Inst. for Neurosci., Fuchu, Tokyo 183.

Neuronal activities were recorded from the inferotemporal cortex (Area TE and Area TEO) while monkeys performed to discriminate four patterns presented successively. Warning stimuli of 500 msec duration (1k HZ, pure tones) were presented prior to pattern stimuli by 1.5 sec. The activities during the three periods of 500 msec were examined and compared with each other: the three periods were just before the onset of warning stimuli (as a spontaneous activities), just before the onset of pattern stimuli (as a prestimulus ones) and after pattern presentation (as a poststimulus ones). Sixty two out of 80 isolated neurons showed different responses to different pattern stimuli during the poststimulus period (differential type), while 16 did similar ones to the stimuli (nondifferential type). The prestimulus activities of 22 out of 62 (35.5%) differential neurons differed significantly from the spontaneous activities, while those of 3 out of 16 (18.8%) nondifferential neurons differed. The results suggested that the changes in the prestimulus activities is not simply attributed to responses to auditory stimuli but involved in the process of readiness or selective attention to the pattern stimuli presented succeedingly.

378, I H 0945

PRINCIPAL COMPONENT ANALYSIS OF THE IMAGES DURING THINKING PROCESS II.

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The first component of the images during thinking process is visual factor. For the nature of the second component are different between Japanese and Thai subjects, we advanced this study in Thailand. The subjects were 41 medical students(25 male, 16 female) of Chiang-Mai University. Problems of the thinking process questionnaire were of four types; logical, creative, episodic and sensitive. Images were classified into three types; visual, auditory and other senses: and into verbal and non-verbal. The principal component analysis of the images revealed similarly four components in Thailand; the first component named "visual factor", the second "sensitive thought", the third "remembering", the fourth "thought". The visual images were used most frequently by 67% of Japanese subjects, however, by Thai testee the visual and auditory coexistent type images were most frequently. There were some cases in Thailand which were used only sensitive images, but in Japan these cases were not. Particularly, the nature of sensitive problems, which composed the second component, "sensitive thought". are showed cultural difference. Most of female(ca 70%), both Thai and Japanese are non-visual image types.

379, I H 1000

ELECTROENCEPHALOGRAPHIC CHANGES ASSOCIATED WITH SHOCK-ELICITED ULTRASONIC VOCALIZATION IN THE RAT. Seino,K.*, Oohashi,K.* and Tonoue,T. Dept. Physiol.II, Azabu Univ. Sch. Vet. Med., Sagamihara 229

It has been established that rodents communicate with each other by ultrasonic vocalization. The subordinate male rat during agonistic behavior emits ultrasounds consisting of pulses longer than 800 msec with a frequency between 22 and 30 kHz. We found that the same type of ultrasonic vocalization was elicited by an electric footshock even in the isolated rat. Since the ultrasonic vocalization was extremely attenuated by the treatment with diazepam, an anxiolytic, we ascribed the reaction to the emotion of fear. In an attempt to investigate the possible association of EEG with the specific emotional state in animals, the cortical EEG powerspectra in the presence of and those in the absence of the ultrasonic vocalization were compared.

No remarkable frequency specific changes in EEG were associated with the ultrasonic vocalization. However, there appeared a general tendency of a decrease in power at 8.5 Hz and an increase in power at 16 Hz in the cortical EEG of rats under emitting the ultrasonic distress call.

380, I H 1015

GENETIC IMPROVEMENT AND BEHAVIOR ANALYSIS ON ACALLOSAL MOUSE IN ddN STRAIN.

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In the course of an experiment involving full sib matings from ddN strain mice, the mice occurred with unusual facial appearance; flat-face. These flat-face ones were assumed to be the result of a malformed short nose, hypoplastic maxilla and mandible, and hypertelorism. Histologically they were almost total absence of corpus callosum, and presence of abnormal longitudinal neuromatous bundles. These flat-face mice showed no significant delays in their growth and no fifference on their littersize. From this mating of flat-face mouse with normal face one, resulted the normal face offsprings, about ten percent of which were complete or partial absence of the corpus callosum. These acallosal mice showed no remarkable difference on their open field activity, acquisition and retention of avoidance learning.

381, I H 1030

EFFECTS OF LOCAL LESIONS OF CEREBRUM ON MAZE LEARNING IN RATS. ABE, K., KAMEDA, K.*, YUNOKI, T.* AND OBANA, E.* Dept. Physiol., Kumamoto Univ. Coll. Med. Sci., Kumamoto 862

Rats were given food through a maze once a day for about 20 days and memorized the maze. The transit time of the maze was more than 10 min at first but shorten within 20 sec by the maze learning for 5 to 10 days. After the maze learning for about 20 days, an electrode was inserted into various parts of cerebrum of these rats and its tip was kept at 60°C for 2 to 3 min to injure the cerebrum. After the cerebral injury, the maze learning was continued for 10 to 35 days and the transit time was measured. The injured regions of the cerebrum were examined with a microscope. The large bilateral lesions of the upper parts of the frontal or occipital lobe caused no alteration in the transit time. When the limbic lobe containing the hippocampus, which located in the situation of the mamillary body on an antero-posterior axis, was injured, the memories of the maze vanished. However, the repeating maze-learning for more than 10 days made these rats memorize the maze again. When the lesions were near the parts described above, a temporary loss of the memories of the maze was observed.

382, I H 1045

INTERRELATION BETWEEN FEEDING RELATED LATERAL HYPOTHALAMIC (LHA) NEURONS AND PREFRONTAL CORTEX IN THE MONKEY. OOMURA, Y., NISHINO, H., FUKUDA, A., KAI, Y. AND KARĀDI, Z. Dept. of Biol. Cont. Syst., Nat'l Inst. of Physiol. Sci., Okazaki 444

Single neuron activity was recorded in the monkey LHA during a bar press feeding task, and correlation between responses to task and output-input organization of LHA neurons was investigated. Feeding task consisted of: 1) cue light (CL) to start bar press (BP), 2) BP, 3) cue tone (CT) to stop BP and 4) ingestion reward (RW). Of 107 neurons, 24 (22%) were inhibited firings by electrophoretically applied glucose, ie, glucose-sensitive neurons (GS). GS responded significantly with inhibition during BP and RW. The inhibition during BP was blocked by NA-β antagonist on 30% of the neurons and that during RW by naloxone on the all neurons. Thus GS neurons have NA-β and opioid inputs to evaluate actual ingestive reward situation. While glucose-insensitive neurons (GIS) significantly responded with excitation at CL, initial part of BP period and CT. The response at the former two was blocked by DA antagonist and that at CT by NA-α antagonist. Thus GIS receives exogenous signals through DA and NA-α modulations. GS responded to stimulation of the dorsolateral prefrontal (DLF) and orbitofrontal (OBF) cortices, while GIS to DLF stimulation but not to OBF one. Both GS and GIS responded to stimulation of the locus ceruleus. These results suggest that the OBF has more intimate relations with LHA neurons that participate in humoral control of feeding than the DLF does.

383, I H 1100

CHANGES IN BRAIN MULTIPLE UNIT ACTIVITY RELATED TO OPERANT LEARNING OF EYE MOVEMENTS IN THE CAT. HANADA, Y., IKEGAMI, S. and KAWAMURA, H. Lab. of Physiol. Psychol., Mitsubishi-Kasei Institute of Life Sciences, Machida-shi, Tokyo 194.

For the purpose of clarifying neuronal activity changes underlying a learned response, multiple unit activity (MUA) was recorded from many brain areas of the cat during operant conditioning of vertical eye movements. In encéphale isolé cats with local anesthesia, eye movements were conditioned with electrical stimulation of the lateral hypothalamus as a reward. MUA was recorded for 5 seconds including about 3 sec recording preceding the eye movement.

Out of 144 recorded sites, MUA from 31 sites exhibited activity changes preceding conditioned eye movement. Among them, the increase of MUA was observed in 16 sites including 9 visual cortex, 4 sensori-motor cortex, 2 midbrain reticular formation sites and a superior colliculus site. On the other hand, the decrease of MUA was observed in 9 sites including 6 hypothalamic, 2 cortical sites, and a thalamic site. These findings indicated that the sites showing the decrease of MUA preceding individual operantly conditioned eye movement distributed more in the hypothalamic area than in the cortex or other brain areas.

384, I H 1115

ORBITOFRONTAL NEURONAL ACTIVITY TO ACCOMPANY WITH OPERANT CONDITIONED ERROR RESPONSE. ISHIKAWA, T., TANAKA, Y., MIYAZAWA, T., FUJITA, I.*, NISHINO, H.* AND OOMURA, Y.* Dept. Physiol., Nihon Univ. Sch. Med., Itabashi, Tokyo 173 and *Dept. Biol. Control System, National Inst. Physiol. Sci., Okazaki 444.

Orbitofrontal neuronal activities of the monkey cortex in visual discrimination task were studied. Responded behavior were required to press a bar repeatedly (FR=30) for food on red cue light and continuous bar pressing to avoid an electric shock to the neck skin on green cue light. Of the 123 units in left orbitofrontal cortex, about 30% showed a phasic increase in activity on the red and green light cue, and about 30% showed tonic increase on red light cue and phasic decrease on green light cue. Other 20% showed difference in activities on each cue, and 10% showed no response. In reinforcement and testing responses, the monkey occasionally showed error response to the conditioned error response to the cue light stimulus. The firing activities of some neurons corresponded to the conditioned error response. It was assumed possible that some neurons in the orbitofrontal cortex were related with the behavior.

385, I H 1130

THE NEURONAL ACTIVITIES IN THE LIMBIC SYSTEM DURING POSTPARTUM PARENTAL BEHAVIOR OF FEMALE RATS.

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Single or multiple unit activities were recorded during postpartum parental behavior from several limbic regions of female rats. In the medial preoptic area, its firing frequency increased when the mother approached a pup until she picked it up in her mouth and carried it back to the nest (retrieving). When she crouched over her young in order to expose her mammary region, it was suppressed below the baseline level. In the dorsal hippocampus, its firing started to increase when she approached a pup. However, it returned to the baseline level near the time she picked a pup. After picking, it again increased for a few second. In other recording of hippocampus, the firing further decreased for 2-3 sec after retrieving. During licking the pups, it was tonically suppressed. While the firing frequency was relatively low during nursing, burstic firing pattern was ocassionally observed. These results may confirm the assumption that the medial preoptic area and other limbic regions are involved in the control of parental behavior.

386, I H 1145

PLASMA CONCENTRATION OF SUGAR-ACID LACTONES IN NORMAL AND FOOD-DEPRIVED RATS.

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A series of experiments in our laboratory have shown that 2-deoxytetronic acid lactone (2-DTA: 3,4-dihydroxybutanoic acid lactone) suppresses food intake and that 3-deoxypentonic acid lactone (3-DPA: 2,4,5-trihydroxypentanoic acid lactone) facilitates food intake. In the present study, we measured plasma concentration of 2-DTA and 3-DPA by high resolution gas chromatography in the rat. Chronic catheter was implanted into the jugular vein of male Wistar rats (body weight: 350-400 g). Blood samples of 300 μl were collected from each rat every 12 hours for 3 days. A half of rats were deprived of foods and the other half had normal diet. In normal feeding rats, the mean concentration of 2-DTA during light time was 110 μM, while that of 3-DPA was 260 μM. After 48 hours of deprivation, some of food-deprived rats showed increased concentration of 2-DTA which was on average 80 % greater than that of normal feeding rats.

387, I H 1300

CLASSIFICATION OF NUCLEUS RAPHE DORSALIS NEURONS: THEIR FIRING PROPERTIES DURING SLEEP-WAKING CYCLE

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The spontaneous activity of the nucleus raphe dorsalis (NRD) neurons during sleep-waking cycle and the effects of sensory stimuli upon NRD neurons were studied in cats. We classified 71 NRD neurons into two groups by the coefficient of variation of firing intervals during active waking (AW): 41 regularly firing (clock-like) and 30 irregularly firing (non-clock-like) neurons. The majority of clock-like (38/41) and one-third of non-clock-like neurons showed decrease in their firing rate during slow wave sleep (SWS) compared with AW. All neurons of both types displayed their lowest level of activity during paradoxical sleep. During the late phase of SWS, many clock-like neurons (35/41) exhibited the reduction of their firing prior to the occurrence of ponto-geniculo-occipital waves in lateral geniculate nucleus, whereas non-clock-like neurons (25/30) did not show such a specific property. Many clock-like neurons were not responsive to nociceptive (formalin) and non-nociceptive (tap and/or hair bending) stimuli, while about half of non-clock-like neurons were driven by these stimuli. The results of this experiment show that two types of neurons exist in NRD, and suggest that they play a functionally different role in the brain.

388, I H 1315

AROUSAL FROM SLEEP IN CATS (III): A BRAIN ELECTROSTIMULATION STUDY. MATSUMOTO, H., MORITA, Y., SENO, H., *MATSUMOTO, J. AND **SATO, K. Dept. Physiol., Univ. Tokushima, Sch. Med., Tokushima 770, *Dept. Human Culture, Naruto Univ. Teachers Education, Naruto 772 and **Res. Foundation on Traffic Med., Tokyo 170

Based on the hypothesis that excitation of sympathetic activity may play an important role in arousal from sleep, we have continued a brain electrostimulation study in cats. For the brain electrostimulation, low voltage rectangular pulses (0.5-5V, 0.2msec) of gradual increase frequency varied from 14 to 80 Hz were used, and thresholds of EEG activation and behavioral arousal were measured under polygraphic recordings. The autocorrelogram, autoregressive power spectra of EEG and of its component waves were also computed with an autoanalysing system. Through stimulation of several brain sites (ventromedial hypothalamic nucleus: VMH, cerebral cortex: CX, mesencephalic reticular formation: MRF, anterior ventral nucleus of the thalamus: VA), the EEG activation and behavioral arousal were elicited with the lowest current intensity of 0.05-0.13 mA in the VMH stimulation. Moreover, the first order regression coefficient on the correlation between current intensity and EEG arousal duration was higher in the VMH stimulation than in that of CX, MRF and VA, respectively. Thus, we have suggested that the role of the VMH, a main sympathetic center, functions as a trigger operating arousal system in the brain.

389, I H 1330

SLEEP-WAKE AND TEMPERATURE RHYTHM OF CATS UNDER PROLONGED CONSTANT DARKNESS. KUWABARA N., AOKI,K. AND *SEKI,K. Life Sci. Inst., Sophia Univ. Tokyo. *JAMSTEC., Yokosuka.

Cat is broadly used in the neurophysiological study of sleep, though it has been scarcely used in the chronobiological study because it has been thought that it had a poor circadian organization. We have performed long-term observation of the sleep--wake rhythm and body temperaturer rhythm under exactly stable environment. In this experiment 16 cats, with chronic implantation of EEG, EOG, EMG electrodes and cortical surface thermister. Sleep state was classified into 4 states, awake, drowsy, SWS and REM sleep from the visual analysis of the polygraphic record in every one minute. B.temp was also collected in every one minute. In the conventional LD 12:12 and long-day LD 15:9, hourly total sleep time exhibited bi-modal nocturnal circadian variation, superimposed of an ultradian rhythm. FFT analysis revealed that there were both circadian and ultradian components. B.temp also exhibited circadian rhythm; low in the light and high in the darkness, with an ultradian component superimposed. Under prolonged constant darkness up to 60 days, both sleep-wake and B.temp circadian variations were maintained at the beginning of the constant darkness. However, about ten or more days after, their circadian rhythms were weakened and disappeared, remainning only an ultradian variation in both indices. FFT analysis supported these findings.

390, I H 1345

REGIONAL CEREBRAL BLOOD FLOW AND OXYGEN CONSUMPTION IN HUMAN SLEEP. OKUDAIRA, N., KANEMOTO, H., TAKAHASHI, K.*, UCHIDA, K.*, IIO, M.* AND TORII, S. Dept. of Physiology and 2nd Dept. of Internal Medicine, Toho University School of Medicine, Ohta-ku Tokyo 143 and Dept. of Radiology, Nakano National Chest Hospital, Nakano-ku Tokyo 165.

In order to investigate cerebral blood flow (CBF) and oxygen consumption ($CMRO_2$) during human sleep, 10 healthy medical students 19 to 25 years old (mean 21.7) were recruited and quantitative analysis of CBF and $CMRO_2$ was performed using $C^{15}O_2$ and $^{15}O_2$ gas and polysomnography (PSG). Partial, total, and/or rapid eye movement (REM) sleep deprivation were induced in order to obtain a more stable sleep state under positron emission tomography (PET) scanning accompanied by PSG and arterial blood drawing. Measurements of the regional CBF and $CMRO_2$ were carried out by the Jones' method and PET images from 45 mm to 61.5 mm above the orbito-meatal line were measured. Five of the subjects during non-REM, especially light sleep, 4 in REM sleep and 6 during wakefulness could be analysed for rCBF and $rCMRO_2$. The rCBF and $rCMRO_2$ during NREM and REM sleep conditions were lower than those of wakefulness, and were notably lower in the frontal cortex compared to the temporal and occipital cortices. This result supported our former finding, that significant reduction of cerebral glycogenic metabolites level in the frontal cortex occurred in NREM sleep compared to wakefulness (Okudaira, et al. Sleep Research, 12: 73, 1983).

391, I H 1400

INTERACTING SLEEP-MODULATORY EFFECTS OF SIMULTANEOUSLY ADMINSTERED SLEEP SUBSTANCES IN RATS.

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Delta-sleep-inducing peptide (DSIP, 2.5 nmol), muramyl dipeptide (MDP, 2 nmol) and uridine (10 pmol) are known to induce differential excess sleep in freely moving rats. This study deals with a 10-h simultaneous infusion of either all the three substances or two out of the three and reports some mutual relationships. DSIP combined with MDP exerted entirely no sleep-inducing effect. DSIP combined with uridine resulted in a little change in sleep parameters, although the total amounts of both slow wave sleep (SWS) and paradoxical sleep (PS) were slightly increased in the dark period. MDP combined with uridine caused a significant increase in both SWS and PS. The combination of the three substances induced a profound increase in SWS but not in PS. Thus, the combined administation of sleep substances caused no summative effect of sleep-promoting property of each substance. This may suggest the existence of an interacting regulatory mechanism.

392, I H 1415

DELAY OF URINATION IN AGED ANIMALS

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The time course of urination were compared between young and aged mice by simple regression analysis. The aged animal showed the delayed onset of urination, lower frequency and/or longer intervals, more urine volume and lower recovery of loaded water (urine/loaded water). In aged animals, the onset of urination mechanism was 40.7 ± 0.6 min after intraperitoneal injection of water, and the interval of urination was 55 ± 9 min, and the urine volume was 0.38 ± 0.06 ml. In contrast young animals showed the onset time 15.3 ± 1.8 min after loading and 28 ± 3 min of the interval of urination with 0.18 ± 0.02 ml of urine volume. The recovery rate of loaded water was less than 0.50 ± 0.05 in aged animals where the rate of young animals was more than 0.80 ± 0.15. The cold stress enhanced delay and longer interval of urination in aged animals inversely to young animals showing opposite direction both on the onset and interval of urination.

393, I H 1430

A STUDY ON THE INFLUENCE TO THE SPIRIT AND BODY BY THE ADJUSTMENT OF THE POSTURE.

KOZEKI, K. SAKAMOTO , M. AND ITOW, H. Body Reformatory School Tokyo 153

How to changethe state of the spirit and body by the adjustment of posture ?

We investigate on the above mentioned matter. The subjects are several males. The method of adjustmentis the pressure stimulation as the standard of the position of vertebra.

On the judgement of state of spirit and body we use the E E. G for the former and the state of distribution of foot pressure for the latter.

Thus we reporr the state of influence.

394, I H 1445

CEREBROPHYSIOLOGICAL STUDY ON THE KUKAI'S "SHOJI JISSO GI".
MATSUMOTO, J.
Naruto University of Teacher Education, Naruto 772

Kukai's (774-835) "Shoji jisso gi" ("Meanings of Sound, Word, and Reality" by D. E. Shaner, 1985) will be discussed from the viewpoint of the cerebral physiology, especially compared with theories of L. S. Vygotsky (1896-1934) and of I. P. Pavlov (1849-1936). The essence of the "Shoji jisso gi" is thought to be: The nature of language consists in the six kinds of defilement. Defilements are the objects of sight, hearing, smell, touch, taste and thought (by Shaner)". Physiologically, the defilements would be understood as the stimuli and among the defilements, the sixth one is not "thought" but "law", if translated literally.

Analyzing Kukai's conception on the language, language itself may correspond to the second signal, the five defilements to the unconditional sensitive stimuli, and the sixth one-"law"- to the conditional sensitive stimuli of Pavlov. Kukai's language may comprise both inner and outer language of Vygotsky.

Epistemological study of the philology will be furthermore continued, appreciating classical Japanese materialistic philosopher, Kukai's philological doctrine.

395, II P (48) 0900

LOW FREQUENCY FLUCTUATIONS OF SPONTANEOUS ACTIVITIES OF MIDBRAIN RETICULAR NEURONS AND THEIR CROSSCORRELATION
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During slow-wave sleep in the head restrained cat, neurons in the mesencephalic reticular formation (MRF) spontaneously fire with low Markovian properties and have the similar spectral density curve as white noise of frequency range of 0.02-1.0 Hz; whereas, during paradoxical sleep, they fire with high Markovian properties and with spectral densities inversely proportional to frequency (the 1/f spectrum) of at least 0.1-1.0 Hz (cf. Yamamoto et al., Brain Research, in press).

Looking for the causes of such low frequency fluctuations of the MRF neuronal activities, crosscorrelation analyses were performed on the neuronal pair which are positioned with an arbitrary distance each other. The results showed that the MRF neuronal activities of low frequency fluctuations were almost mutually independent. Although some crosscorrelations were statistically significant, the pattern of crosscorrelogram could not be easily generalized, and no synchronously firing pairs of units were observed especially in such an extremely low frequency band. Thus the low frequency fluctuations of the MRF neurons might be generated by the individual internal mechanism interacting with their surrounding networks.

396, II P (49) 0900

CORRELATIONS AMONG THE ACTIVITIES OF HIPPOCAMPAL THETA CELL, THETA WAVE AND PGO SPIKES
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Spontaneous neuronal activities in the cat hippocampal theta cell were recorded during slow-wave sleep (SWS), paradoxical sleep (PS) and attentive state. From the viewpoint of counting process of the window time of 250 ms, the coefficient of variation of the neuronal activities was largest during SWS. But when autocorrelation and spectral analyses were made, low frequency fluctuations of them were largest during PS.

In order to investigate the causes of such low frequency fluctuations of the theta cell activities during PS, crosscorrelation, autocorrelation and spectral analyses were performed among unit activities, theta wave and PGO spikes. Every pair of these three was closely correlated with each other. Both fluctuations of theta wave frequency and of PGO activities were similar to, but much smaller than, those of unit activities. These results suggest that brain stem PGO system may be a part of the source of fluctuations of unit activities which are supposed to be mediated by septum (theta wave pacemaker), though more complicated mechanisms should be considered for better understanding of the low frequency fluctuations of hippocampal neural activities.

397, II P (50) 0900

THE TIME SERIES ANALYSES OF HIPPOCAMPAL NEURONAL ACTIVITIES DURING SLOW-WAVE SLEEP, PARADOXICAL SLEEP AND ATTENTIVE STATE

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The time series analyses on spontaneous activities of hippocampal pyramidal neurons of head-restrained cats were conducted to investigate their dynamic properties during sleep and waking state.

From statistical analyses, the pooled mean discharge rate was highest during slow-wave sleep (SWS), intermediate during paradoxical sleep (PS) and lowest during attentive state of bird watching (BW). Whereas, coefficient of variation about time series of counts (window time of 500 ms) was highest during PS. As for the higher order statistical properties, the spectral profile showed that the low frequency fluctuation of pyramidal neuronal activities was prominent during PS. The spectral density curve either during BW or during SWS was similar to that of white noise.

These differences of firing pattern of pyramidal neurons between PS and BW indicate that the hippocampal pyramidal neurons during PS may be in the state uncontrolled from other systems in the brain, but that they are in the highly controlled state during BW. On the other hand, the activities of the hippocampal neuronal system during SWS are considered to be stationary and non-fluctuated, thus fitted with the rest theory of SWS.

398, II P (51) 0900

SPONTANEOUS LOCOMOTOR ACTIVITY OF THE SPONTANEOUSLY HYPERTENSIVE RATS (SHR) USING THE RUNNING WHEEL.

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SHR shows extreme superactivity compared to the normotensive Wistar Kyoto rats (WKY) when a stressful stimuli like an electric shock is given to the rats.

In order to clarify the real activity of SHR, we examined the spontaneous locomotor activity using a running wheel under the physiological condition.

SHR showed a value of running frequency more than 800 in light periods (7AM - 7PM), and 1,500 in dark periods (7PM - 7AM) at the first day. And the frequency in dark periods increased 3,000 through 4,000 to 5,000 at 10th through 20th to 30th day. In light periods, it also increased, 800 through 1,000 to 2,000 at 10th through 20th to 30th day.

Whereas, WKY showed a small increase: 300 in dark at the first day, and 1,700 at 30th day, and less than 100 for 30 days, in the light.

401, II P (54) 0900

EFFECTS OF 2-DEOXYGLUCOSE ON SLEEP IN THE RAT

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To investigate the effect of 2-deoxyglucose (2DG) on the central nervous system, changes of sleep and wake states were studied using the 2DG treated animals. Under nembutal anesthesia the electrodes for the polygraphic recording were implanted.One week after recovery from surgery, continuous polygraphic recordings of the animals were taken for 48 hr under the conditions of a 12-hr light-dark cycle. After a 24-hr control recording, animals were intraperitoneally given 0.1, 0.4, or 1.6 mmol/kg of 2DG at 20:00. A significant increase of slow wave sleep (SS) was seen during the 20:00-2:00 period in the 0.4 and 1.6 mmol/kg groups but not in the 0.1 mmol/kg group.And a significant decrease of paradoxical sleep(PS) was caused in the 1.6 mmol/kg group during the 20:00-6:00 period. The results were similar to those of the effects of cycloheximide (CX, an inhibitor of protein synthesis) as previously reported. But the action of 2DG might be distinguished from that of CX because a decrease of SS was not observed in the light period and the rebound-like increase of PS was seen during the 8:00-20:00.

402, I G 0915

Laterality and opical rotation in organisms 1) Effect of ingestion of optically rotatory compounds on visual acuity. TSUKEDA, K. Dept. Physiol. Fac. Med. Tokyo Univ. Tokyo

Ingestion of avian or piscine muscles on the right and left sides has been found to be slightly effective in maintaining visual acuity of the right and left eyes, respectively. Therefore, the effect of ingestion of compounds of known optical rotatory dispersion on visual acuity was investigated. Methods: The visual acuity of each single eye was determined under a condition with slight hysteresis. Then avian or piscine muscles on the left side were ingested. About 15 minutes later, the visual acuity of the right and left eyes was measured. About 5 hours later the effect of ingestion of right side muscles was similarly investigated. The effect of ingestion of bilateral muscles, each in the half mount, was also studied. Study was also made with sugars, amino acids, vitamins, peptides and coenzymes with known optical rotatory dispersion, each dissolved in water. Results: Ingestion of right and left muscles was slightly effective in maintaining visual acuity in the right and left eyes, respectively. Ingestion of bilateral muscles were slightly effective on the bilateral eyes. Right and Left rotatory compounds were slightly effective on the right and left eyes, respectively. The compounds tested were l-fructose, quinic acid, phenylalanine, inosinic acid, glutathione and ATP, and d-glucose, lactose, ascorbic acid, asparagic acid, sodium glutamate, biotine and CDP. It may be considered that our right and left eyes are mainly supported functionally by right and left rotatory compounds, respectively.

403, I G 0930

THE INFLUENS OF CONTENT OF HEPATIC GLYCOGEN AND OF HEPATIC FAT ON THAT OF CHOROIDAL RIBOFLAVIN OF A FROG. FUJISHITA, S. Dept. of School Nurse, Fac. of Education, Osaka Kyoiku Univ., Osaka 547

In the present study, frogs (Rana catesbiana) are employed as experimental amimals. From each of the frogs, not only the total contents of hepatic FAD and of choroidal flavins, but also the percentage of glycogen (G %) and that of hepatic fat (F %) are measured.

The frogs empolyed are clacified into 3 groups by means of the value of the product of G by F. When the product of G by F of a frog is greater than 25, between 17 and 25, or smaller than 17, the frog may belong to A, B or C zone. About the frogs belonging to the A group, it may be conclude that the greater the total hepatic FAD, the greater the total choroidal riboflavin. The same result may be found about the frogs belong to B and C groups.

404, I G 0945

DYNAMICS OF SECOND-ORDER NEURONS IN THE COCKROACH OCELLUS. MIZUNAMI, M. AND TATEDA, H. Dept. Biol., Fac. Sci., Kyushu Univ. Fukuoka 812

Dynamic responses of ocellar second-order neurons of the cockroach, Periplaneta americana, have been studied using white-noise modulated light. Incremental responses of second order neurons were almost linear with mean square errors of about 10 %. The incremental sensitivity increased by a factor of ten for a tenfold decrease in the mean illuminance, over a 4-log range of mean illuminance levels (0.002-20 $\mu W/cm^2$): The incremental sensitivity was exactly Weber-Fechner like. For the same mean illuminance range, response dynamics unchanged.

In all the visual systems so far studied, including vertebrate retinas and compound eyes of insects and limuli, changes in the cell's incremental sensitivity couple with changes in response dynamics. We conclude that sensitivity and dynamics are not interrelated in the cockroach ocellar second-order neurons, and that the coupling of dynamics and sensitivity is not a ubiquitous characteristics of the visual system.

405, I G 1000

FUNCTIONAL ROLE OF THE RECEPTIVE FIELD SURROUND OF THE MEDULLA NEURONS IN THE SWALLOWTAIL BUTTERFLY LARVA.

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Medulla neurons in the optic lobe of the butterfly larva receive strong input from one particular stemma (center) and weak antagonistic input from other stemmata (surround). The effect of background illumination of the surround on the activity of the medulla neurons was examined.

The surround illumination reduced the increased rate of maintained discharge caused by background illumination of the center of the on-center cells or increased the decreased rate of the discharge caused by center illumination of the off-center cells. The moderation of the maintained discharge served to unsaturate the response to a stimulus presented to the center, thereby increase incremental sensitivity and extend the luminance range over which the center response was graded. The surround illumination also reduced the variance of the impulse rate as well as the fluctuation of the membrane potentials. There was little change in the threshold of the center response by the surround illumination.

406, I G 1015

THE DIRECT EFFECT OF LIGHT ON THE RHODOPSIN METABOLISM DURING DAILY CYCLE IN THE COMPOUND EYE OF LOCUST.

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Diurnal changes in the total amount of retinal isomers were studied by high performance liquid chromatography (HPLC) in the locust compound eye. The animals were reared under 12:12 LD cycles of several kinds of light conditions and the rhabdoms were observed at the same time of the day. The changes of content of 11-*cis* retinal followed a cyclic pattern, the maximum around midnight and minimum around midday. The changes of all-*trans* retinal contents were depended to the light intensity. Under dimmer light condition, no apparent changes of all-*trans* retinal contents were observed. The animals that of the both of the compound eyes and the lateral ocelli except the median ocellus were covered with black lacquer were reared under low light condition show day active normal locomotor rhythm. In spite of the exsistence of locomotor rhythm, no rhythm of the rhabdom membrane and the pigment turnover within the eyes was observed. These results show that the eye rhythms are not controlled by endogeneous rhythms.

407, I G 1030

MUTATIONS THAT AFFECT BIO-SYNTHESIS OF THE VISUAL PIGMENT IN THE FRUIT-FLY, *DROSOPHILA MELANOGASTER*.

ISONO,K. TSUKAHARA, Y. Research Center for Applied Information Sciences, Tohoku Univ., Katahira ,Sendai 980.

Fly photoreceptors contain a visual pigment whose chromophore has been identified as 11-cis,3-hydroxyretinal(Tanimura, T., Isono, K. and Tsukahara, Y., Photochem. Photobiol., in press). When vitamin A deficient adult flies were supplemented with carotenoids, the pigment content rapidly increases to a normal level within a few days. Unlike carotenoids, most retinoids required a light irradiation for the neogenesis of the pigment. White-eyed flies were treated with a mutagen EMS. Male F_1s with mutagenized X chromosomes were deprived of vitamin A and then supplied with the chromophore precursor. They were then examined for the presence of the deep pseudopupil(DPP). DPP with an orthodromic light irradiation (DPP_o) requires a substantial amount of the pigment while DPP with an antidromic light (DPP_a) requires an intact rhabdomeric structures. From about 2000 flies screened, a total of eight mutants that showed the absence of DPP_o were recovered. Of these, six strains showed the presence of DPP_a, suggesting specific defects in the pigment neogenesis mechanism.

408, I G 1045

ANALYSES OF PHOTOTRANSDUCTION MECHANISMS USING VISUAL MUTANTS OF DROSOPHILA.
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We have found that phosphatidylinositol 4,5-bisphosphate (TPI) specific phosphodiesterase (PDE) activity was almost absent in the compound eye of Drosohila visual mutant, norpA (no receptor potentials). The enzyme activity was found to be closely correlated with the visual activity of the mutant eye which was measured by ERG and phototaxis. These findings were confirmed using a temperature sensitive norpA allele, named KO50; the enzyme activity of the flies kept at 18°C (phototactic) was 5 times higher than that of the one kept at 28°C (blind). When ambient temperature was shifted from 18°C to 28°C, the enzyme activity was reduced to lower level within 5 min. This change of PDE activity occurs in parallel with the rate of phototactic changes. Furthermore, it was found that PDE activity showed maximum value at 10^{-7} M of Ca concentrations.

GTP binding protein was also examined because it is known to be involved in the visual transduction in vertebrate. No difference was found between normal and the mutant fly. These findings support the idea that TPI specific PDE plays an important role in invertebrate phototransduction.

409, I G 1100

EFFECTS OF Ca^{2+} AND CYCLIC NUCLEOTIDES ON THE PHOTORESPONSE OF AN EXTRAOCULAR PHOTORECEPTOR IN ONCHIDIUM GANGLIA.
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The depolarizing photoreceptor potential (photoresponse) in an extraocular photoreceptor of the Onchidium abdominal ganglion results from the light suppression of a specific K^+ current, designated the light-sensitive K^+ current. The experiments were undertaken to unravel the role of Ca^{2+} and cGMP in the intracellular process of the photoresponse. Lowering the external Ca^{2+} increased the amplitude of the photoresponse. Inversely, high Ca^{2+} depressed the response. In addition, when a metabolic inhibitor, DNP or the ionophore A23187 was added to normal Ca^{2+} solution, the photoresponse was completely blocked. However, neither resting potential nor resting resistance was significantly influenced by their drugs. On the other hand, adding IBMX or analogues of cGMP, 8Br-cGMP and Db-cGMP led to hyperpolarization of the resting potential and an increase in the amplitude of the photoresponse. The effect of these drug manipulations was replaced by an increase in the light-sensitive K^+ current under voltage clamp. However, long-term (5-10min) exposure to each drug caused a loss of the photoresponse, unless Ca^{2+} was removed from the bath solutions.

These results were explained by the same cGMP hypothesis proposed for transduction in vertebrate photoreceptors.

410, I G 1115

MICHAELIS CONSTANT OF THE cGMP PHOSPHODIESTERASE IN FROG ROD OUTER SEGMENTS.
Kawamura, S. and Murakami,M. Dept. Physiol., Keio Univ. Sch. Med., Tokyo 160.

Light-activation of cGMP phosphodiesterase (PDE) in rod photoreceptors is thought to reduce the internal cGMP level and hence to reduce the sodium conductance of the plasma membrane. The PDE activity is determined by the equation of $V=Vmax\ S/(S+Km)$. The Michaelis constant (Km) of the PDE in the light has been reported to be greater than 1 mM in crude disk membranes, while about 100 μM in purified disk membranes. This result suggests the presence of a regulatory factor of the Km of the PDE and the loss of its activity during purification. If the factor exists, the PDE activity may be decreased by the increase of the Km under a steady illumination. Therefore the elucidation of the mechanism of the Km change will provide useful information about the molecular mechanism of light adaptation. We tried to find out what molecular species are involved in the Km change. It was found that the factor is associated with membrane-bound protein(s) and that this protein easily loses its activity by perturbation of its molecular environment.

411, I G 1130

EFFECTS OF L-GLUTAMATE AND RELATED AMINO ACIDS ON ISOLATED TURTLE PHOTORECEPTORS
KANEKO, A. AND TACHIBANA, M. Natl. Inst. Physiol. Sci., Okazaki 444

Photoreceptors in the vertebrate retina release acidic amino acids, L-glutamate (Glu) and/or L-aspartate (Asp), when they are depolarized (by an exposure to high K^+ environment, for example). Since these chemical compounds released from the presynaptic site may affect all surrounding cells, the present study was made to examine the effects of Glu and its agonists on photoreceptors in themselves. Isolated photoreceptors of Geoclemys reevesii were voltage-clamped by a patch electrode in the whole-cell recording configuration, and Glu, Asp, kainate (KA), quisqualate (QA) and N-methyl-D-aspartate (NMDA) were applied either by ionophoresis or by pressure. Glu, Asp and KA induced inward current (e.g., >-100 pA max. at -60 mV to Glu) in photoreceptors. The efficacy was KA > Glu > Asp. QA and NMDA were ineffective. No difference in sensitivity was found among photoreceptor subtypes, which were identified by morphology and color of the oil droplet. The sensitivity was localized to the synaptic terminal. The Glu-induced current was reduced in low Na medium, but the reversal potential could hardly be estimated due to a strong inward rectification of the Glu-induced current. Our results show that Glu or Asp depolarizes photoreceptors. This depolarization may contribute to sign-conserving signal transmission between photoreceptors, an interaction previously speculated.

412, I G 1145

THE STRUCTURE OF CONE TERMINALS AND THE CONNECTIVITY PATTERNS OF C-TYPE HORIZONTAL CELLS IN THE DACE RETINA.
UEKI, K. AND HASHIMOTO, Y. Dept. Physiol., Tokyo Women's Med. Coll., Tokyo 162

Three types of spectral responses were recorded from C-type horizontal cells (HC) in the dace retina using HRP-filled electrodes. They were called as biphasic (H2), triphasic (H3), and tetraphasic (H4) type. The connectivity patterns of C-type HC with different photoreceptor terminals were studied by electron microscope. H2, H3 and H4 cells were making contact with both large and small sized photoreceptor terminals in a different ratio of each other. The large terminal was designated as 'l-pedicle', and the small one as 's-pedicle' before. The 'l-pedicle' had an ordinary structure of the cone pedicle. The 's-pedicle', on the other hand, resembled closely to the rod spherule. Serial sections of photoreceptors with the 's-pedicle' containing stained processes were cut tangentially and were reconstructed three dimensionally. We confirmed that the 's-pedicles', not all of them, were belonged to cone terminals. A model of connections between photoreceptors and C-type HC was proposed.

413, I G 1300

MORPHOLOGY OF SKATE OUTER RETINAL LAYER.
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HRP was injected intracellulary to observe light as well as electronmicroscopic features of skate, Raja erinacea or oscellata, horizontal and bipolar cells. Ultrastructure of the outer plexiform layer was also observed in unstained preparation. There is only one class of receptors, rods, in the skate retina. The rod terminal contains 2 to 4 short synaptic ribbons. Many, large telodendria issue from the terminal. Two processes, one from the bipolar cell and the other horizontal cell, invaginate the rod terminal. Horizontal cell processes always form the lateral processes, usually from more than two cells. Invaginating bipolar cell processes appear to form basal junctions away from the synaptic ribbon never reaching it.

The skate outer plexiform layer is 5 um thick and is composed of the receptor telodendria and processes from bipolar and horizontal cells. Occasional conventional chemical synapses with membrane specialization and vesicle aggregation are observed in the layer.

414, I G 1315

ON THE QUESTION OF WHETHER ROD-DRIVEN HORIZONTAL CELLS HAVE AXON AND AXON TERMINAL.

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Cone-driven horizontal cells in the teleost retina are known to form a syncytium of two layers, one connecting cell bodies and the other axon terminals both via gap junctions. The similar possibility was investigated here as regards the rod-driven intermediate horizontal cells in the carp retina. The cell type in question was identified from its characteristic functonal properties (high sensitivity with peak at 520 nm and slow response kinetics) and HRP-EM examinations (synaptic contacts with rods). The spatial decline of response amplitude to a slit of light placed at various distances from the recording electrode followed a single (rather than double) exponential function, unlike the situation of the cone-driven horizontal cells. Morphologically, besides dendrites there was a slender lateral process running horizontally from the cell body in eighteen out of a total of thirty HRP-labelled intermediate horizontal cells. This structure was different ,however, in its morphological nature from either the axon or axon terminal of the cone-driven external horizontal cells. From this observation together with the present physiological result, the rod-driven horizontal cells do not seem to develop the second layer of electrotonic coupling.

415, I G 1330

MEMBRANE PROPERTIES OF THE AXON TERMINAL OF RETINAL HORIZONTAL CELLS. **YAGI, T. AND KANEKO, A.** Natl. Inst. Physiol. Sci., Okazaki, Aichi 444.

Syncytium of the soma and that of the axon terminal is connected electrically in fish horizontal cells (Yagi, J. Physiol. in press). This conclusion was inferred from a cable analysis made on an assumption that the axon terminal has a low membrane conductance. To examine this assumption, membrane properties of the axon terminal dissociated from the goldfish retina were studied under whole-cell voltage clamp conditions using patch pipettes. The axon terminal superfused with an artificial saline containing 10 mM K^+ showed linear current-voltage (I-V) relationship in the range of -50 mV ~ +30 mV, but showed an inward (anomalous) rectification below E_K (-62.5 mV). Depolarization activated little Ca or K currents; no change in I-V curves was observed by an application of Co and TEA to the external medium. As the extracellular K concentration was increased, K current through the anomalous rectifier was activated at more positive membrane potential and its conductance was increased. External Cs blocked the anomalous rectification. In the control saline the slope conductance was less than 0.1 nS (10 $\mu S/cm^2$) in the linear range of I-V curves, and 0.78 ± 0.33 nS (mean ± SD, n=13) below E_K. These values were much lower than those of the soma. The present results show that the membrane conductance of the axon terminal is extremely low in the operating range of the membrane potential.

416, I G 1345

Na-Ca EXCHANGE IN HORIZONTAL CELLS ISOLATED FROM THE CARP RETINA. **YASUI, S. AND *KANEKO, A.** Natl. Inst. Basic Biol. and Natl. Inst. Physiol. Sci., Okazaki 444.

Steady depolarization (at -40∿+50 mV) of isolated horizontal cells (by a patch electrode in the whole-cell clamp configuration) induced a sustained voltage-gated Ca current. This steady Ca current was also present in cells which had been depolarized for >1.5 hrs by bath application of 100 μM L-glutamic acid. Such Ca influx could increase $[Ca^{2+}]_i$ by roughly 10 μM/sec, if Ca^{2+} were not removed from the cytoplasm. Replacement of Na^+ in Ringer solution by Li^+ reduced the steady Ca current. The % reduction depended on the membrane potential; it was usually small at higher membrane potentials (>+20 mV). These results suggest that horizontal cells have a Na-Ca exchange machinery for Ca extrusion by utilizing Na potential gradient. Since Li^+ does not substitute for Na^+ in the exchange, replacement of Na^+ by Li^+ should cause intracellular accumulation of Ca^{2+} which would result in a Ca-dependent Ca-inactivation. In the dark, intact horizontal cells are kept depolarized above the activation threshold of Ca current. Perhaps, the Na-Ca exchange mechanism may function as well in such *in situ* situation to maintain the intracellular Ca homeostasis.

417, I G 1400

CALCIUM RESPONSES OF IN SITU HORIZONTAL CELLS OF THE CARP RETINA. TAKAHASHI, K.-I. AND MURAKAMI, M., Dept. Physiol., Keio Univ. Sch. Med., Tokyo 160.

In the carp retina perfused with solutions containing high Ca and some K channel blockers, all types of horizontal cells produced a regenerative action potential which had an overshoot of more than 20 mV and lasted for several seconds. The action potential occurred spontaneously in some cells, and was more frequently triggered when the cells were depolarized either by bath application of L-glutamate (Glu) or L-aspartate (Asp), or by an EPSP evoked when transretinal electrical stimulation was given. The action potential was not blocked by TTX but by Co. These results indicate that the in situ horizontal cell membrane contains Ca channels as does so the membrane of dissociated cells. During the overshoot of the action potential, an electrically evoked EPSP as well as a light-induced response appeared with reverse polarities to those elicited during the rest. Their reversal potentials were estimated between -5 and -10 mV. At the same potential range, the membrane potential change induced by Glu or Asp reversed the polarity, too. These observations suggest that the ionic mechanisms of the EPSP may be identical with those of the depolarization caused by Glu or Asp, and that both amino acids are potent candidates for the neurotransmitter of photoreceptors.

418, I G 1415

RESPONSES OF L-TYPE EXTERNAL HORIZONTAL CELLS(LEHC) TO GREEN TEST LIGHT UNDER RED BACKGROUND ILLUMINATION. UMINO, O. AND WATANABE, K. Dept. of Physiology, Tokyo Women's Medical College, Tokyo 162

The response of carp LEHC to a green test light(diffuse) was greatly enhanced when the red background light(diffuse) was applied to the retina. With a prolonged background illumination, the response amplitude to the test light was decreased and reached a steady state. The enhancement component(EC), related to the on-phase of the response, did not change during the background illumination. On the other hand, the beginning of the off-phase of the response to the test flash occurred earlier due to the background, resulting in a steady decrease of response amplitude. The background stimulation caused a decrease of parameter $I_{1/2}$ of V(response) - I(light intensity) relationship, followed by a decrease of parameter V_{max}. When a small spot was used for both test and background illumination, the response to the test light was slightly increased during the introduction of the background. GABA, which is a putative transmitter of LEHC, eliminated the EC of the response. Immediately after the onset of background, the peak of the spectral response curve (λ_{max}) occurred at around 510 nm, although λ_{max} was around 610 nm in darkness. These results suggest that the red cone input to LEHC enhances the green cone input to LEHC by decreasing $I_{1/2}$ of V-I relationship. This EC is probably produced by the action of GABA from LEHC which alters the green cone input.

419, I G 1430

RESPONSE LATENCIES OF HORIZONTAL CELL SUBTYPES IN THE CARP RETINA.
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The response latency of horizontal cells retina was investigated in the carp by means of the stimulus-response crosscorrelation using random intensity-modulation of monochromatic lights. R/G type horizontal cells produced two response components with a clear difference in latency; short-latency hyperpolarizing response to green and long-latency depolarizing one to red light. The latency difference could not be made smaller than 14 ms by increasing the mean intensity of test light. L-type horizontal cells produced only a single component; short-latency hyperpolarizing response to all wavelengths, similar to the short-latency one to green light in the R/G type cells. The frequency response characteristics of the depolarizing component of R/G units to red light were different from those of the hyperpolarizing one that pertained to either L or R/G types. R/Y/B type horizontal cells produced three response components with latency differences. These results were reconciled with similar measurements each made under the appropriate selective chromatic adaptaion. The latency differences revealed here are consistent with the feedback model that accounts for spectral response characteristics of horizontal cell subtypes.

420, I G 1445

DYNAMICS OF SKATE HORIZONTAL CELLS. Ken-Ichi Naka National Institue for basic Biology, Okazaki 444

Recordings were made from the horizontal cells of all rod retina of skate, Raja erinacea. Stimulus was white-noise modulated light of various mean illuminance and incremental sensitivity was defined by the first order kernels obtained by cross-correlating the input against the resulting response. Horizontal cell response to the early phase of the stimulus, as with the step evoked resposnes, was very nonlinear: the cell responsed much better to decrement than to increment from a mean illuminance. When fully field (light) adapted, the cell responded linearly to modulation around a mean illuminance and the cell's incremental sensitivity was Weber-fechner like over a mean illuminance of 3-log units. This expereiment shows that it is very important to test visual neurons with modulation around a mean illuminance. Responses obtained by flashes given in the dark may lead to false conclusions.

421, I G 1500

SPATIAL PROPERTIES OF RETINAL CELLS IN CARP. TAKABAYASHI, A., WATANABE, S., & MITARAI, G. Dept. Aerospace Physiol., Inst. Environ. Med., Nagoya Univ. NAGOYA 464 and Dept. Physical Ed., Chukyo Univ., TOYOTA 470-03

The application of dopamine(DA) resulted in drastic changes of center/surround response relation in L-type horizontal cells(LHCs), which is characterized by an increase of response amplitude to spot light and a reduction of response amplitude to annular illumination. Thus, these spatial properties of LHCs can contribute to the integration of information which is to flow through bipolar cells(BC) to the proximal retina. We reexamined the effects of DA on the BC in the isolated carp retina perfused with oxygenated saline.

Application of DA(50-100 μM) into the saline depolarized dark membrane potential of on-center BC by about 2-4 mV and resulted in the decrease of response amplitude to both spot(0.4 mm dia) and annular(1.0 mm i.d./2.5 mm o.d.) light stimulation These results are consistent with the assumption that the surround response of BCs is mediated by HCs. However, BC's reduction of depolarizing response to spot light was small compared with increase of HC's hyperpolarizing response and simultaneous recordings from BC and HC did not show entirely the parallel time course of DA effect. These findings suggest that DA also acts directly on BC membrane.

422, I G 1515

SIMULATION STUDY OF THE SPATIO-TEMPORAL MECHANISMS OF THE RETINAL HORIZONTAL CELL LAYER
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The retinal horizontal cell shows clear nonlinearities in its dynamic response waveform to a flash of light, depending on the light intensity and the spot size. These nonlinearities seem to originate from the same mechanism and are responsible for making a tremendously wide receptive field. An heuristic nonlinear cell-to-cell gap junction model has been proposed to explain the experimental evidence of nonlinearity (Vis. Res. 23, 1983). Concerning the electrical properties of gap junctions, varieties of nonlinear static characteristics have been reported for different materials. However, not much is yet known about the dynamic properties and/or mechanisms of gap junctions.

Here, a dynamic nonlinear gap junction model is proposed. The model basically assumes nonlinear gap conductance, which is a function of the potential difference between two neighbouring cells, and that the potential at which the conductance switches to high or low values changes dynamically. The different static characteristics mentioned above can be generated by giving different steady-state relationships between the switching potential and the membrane potential difference. A 2-dimensional horizontal cell layer model has been constructed by connecting horizontal cell models described by ionic currents (IECE Tech. Rep. MBE84-86, 1985) with the proposed gap junction model. Computer simulation of the flash response has produced response waveforms very similar to those mentioned above, disregarding the static nonlinear characteristics of the gap junction. The results suggest that the retinal inter-horizontal cell gap junction might have such dynamic nonlinearity.

423, I G 1530

ELECTRICAL COUPLING BETWEEN BIPOLAR CELLS IN CARP RETINA. SAITO, T. AND KUJIRAOKA, T. Dept. Physiol., St. Marianna Univ. Sch. Med. Kawasaki 213

Intracellular recordings were made simultaneously from pairs of neighboring bipolar cells by advancing two independent microelectrodes into the carp retina. Bipolar cells were identified by their response properties and in several samples verified by intracellular injection of Lucifer yellow. Current of either polarity injected into one of the bipolar cell pair elicited a sign-conserving, sustained potential change in the other bipolar cell without any measurable synaptic delay. This electrical coupling was reciprocal, and it was observed between similar cell types in function and in morphology. The coupling efficiency, at least over the physiological response range, appears to be almost identical for both depolarizing and hyperpolarizing currents. Our results strongly suggest a spacial summation of signals at the level of bipolar cells which makes central receptive field areas much larger than their dendritic fields.

424, I G 1545

DOSE-DEPENDENT EFFECTS OF SOMATOSTATIN-14 AND -28 ON THE LIGHT RESPONSE OF GANGLION CELLS IN THE ISOLATED MOUSE RETINA. SUZUKI, H., NAKAYE, T. AND TASAKI, K. Dept. of Physiol., Tohoku Univ. Sch. of Med., Sendai 980

Immunohistochemical study demonstrated that somatostatin-like immunoreactivity was present in the amacrine and interplexiform cells in the mouse retina. In addition, immunoreactive substances extracted from the retina coeluted with synthetic somatostatin-14 (SS-14) and -28 (SS-28) on Sephadex G-50. To test physiological action of somatostatin, we recorded spikes extracellularly from ganglion cells in isolated, superfused retinas. Low concentration (<1 nM/l) of SS-28 caused "excitatory" effect on the response to an optimally-presented light spot; over 1 nM/l suppressed responses. No effects of SS-14 was observed for concentration less than 1 nM/l; higher concentration produced suppression seen with high concentration of SS-28. The size of receptive field (RF) became larger in 17 of 37 cells bathed in low concentration of SS-28 and became smaller in 12 cells. Notwithstanding excitatory effect of SS-28, the RF size did not change in 8 cells. As mentioned above, dose-response relation is bimodal, "excitatory" and "inhibitory", rather than sigmoidal. Somatostatin affects the functional role of the retina in a complicated manner as is seen in the RF size. Judging from minimum effective dose, somatostatin may be a candidate of a transmitter or a neuromodulator in the retina.

425, I G 1600

DENDRITIC MORPHOLOGY OF MONOAMINERGIC CELLS REVEALED BY INTRACELLULAR INJECTION OF LUCIFER YELLOW IN FIXED CARP RETINA. TERANISHI, T. AND NEGISHI, K. Dept. Neurophysiol., Neuroinformation Res. Inst., Kanazawa Univ. Sch. Med., Kanazawa 920

The dendritic morphology of putative dopaminergic (DA) and serotonergic (5-HT) cells in carp retina was investigated by identifying their fluorescent cell bodies (preloaded with noradrenaline) in isolated, aldehyde-fixed preparations and by injecting iontophoretically into them with Lucifer yellow (LY) under microscopic control. The LY-injected cells were examined in flatmount and radial cryosections. Their pyriform somata were located at the inner margin of the inner nuclear layer, and gave rise to 3-5 primary dendrites that branched repeatedly within the inner plexiform layer (IPL). Dendrites of DA cells were distributed diffusely while those of IA cells branched mainly in sublamina a of the IPL. In some DA cells, a distal process was found to extend to the OPL, representing the interplexiform type of cells. Their round or oval dendritic field covered an area of about 0.1 mm^2 (n=59) for DA cells and of about 0.2 mm^2 (n=32) for 5-HT cells on the average. Cell density of both classes of cells was about 30 cells/mm^2 and, therefore, their dendritic field coverage was approximately 3 for DA cells and 6 for 5-HT cells.

426, I G 1615

IMMUNOHISTOCHEMICAL EVIDENCE FOR THE EXISTENCE OF TWO SUBPOPULATIONS OF PUTATIVE SEROTONERGIC AMACRINE CELLS IN FISH RETINA. NEGISHI, K. AND TERANISHI, T. Dept. Neurophysiol., Neuroinformation Res. Inst., Kanazawa Univ. Sch. Med., Kanazawa 920

Histochemical and immunohistochemical studies on goldfish and carp retinas revealed the existence of two subpopulations of putative serotonergic amacrine cells. One subpopulation was larger in soma size (5-7 μm diameter), was intensely immunoreactive to a monoclonal antibody against serotonin, and was heavily labeled by preloading with 5,6- or 5,7-dihydroxytryptamine (DHT). The other subpopulation of cells was smaller in soma size (2-3 μm), was weakly immunoreactive to the antibody, and was only lightly labeled by preloading with indoleamines. Smaller serotonergic (Ss) cells exceeded larger serotonergic (Sl) cells in number by several-fold. In several days after injection of 5,7-DHT, Sl cells were largely eliminated while Ss cells were still visualized by preloading with indoleamines. Therefore, the Sl cells correspond to indoleamine-accumulating (IA) cells while the Ss cells correspond to non-specific IA cells, called in our earlier publications.

427, I G 1630

NEUROTOXIC EFFECTS OF α-AMINOADIPIC ACID IN THE CARP RETINA. SUGAWARA, K. AND KATO, S. Dept. Neurophysiol., Neuroinformation Res. Inst., Kanazawa Univ. Sch. Med., Kanazawa 920

We previously reported that α-aminoadipic acid (α-AAA) acts as a gliotoxin in the retina. To further explore whether or not α-AAA acts on other retinal neurons, we examined electrophysiological effects of the agent on horizontal and ganglion cells, which are representative neurons at the OPL and IPL, respectively. In perfusion experiments using isolated carp retinas, the agent with high concentrations (>2 mM) was found to rapidly hyperpolarize horizontal cells and to reduce S-potentials, while it with low concentrations (<0.8 mM) suppressed light-induced discharges of ganglion cell. Using retinas isolated from the eyes, which had been treated with intravitreal injection, α-AAA (8 μmol/eye) caused different effects on both neurons. Horizontal cells were at a depolarized state with reduced amplitude of S-potentials during a period from 30 min to one day but returned to a normal state 1-2 days after injection. However, light-induced discharges of ganglion cell were abolished for a longer period (>1 month) after injection. Therefore, α-AAA certainly affects neurons other than glial cells, and a significant difference between horizontal and ganglion cells may exist in the mechanism of α-AAA toxicity.

428, I G 1645

VOLTAGE-DEPENDENT MEMBRANE CURRENTS IN SOLITARY RETINAL CELLS OF CHICK EMBRYO. **YAMASHITA,E. & IGARI,T. Dept. Blind Study, Sch.Ed. Tohoku Univ.,Sendai,Miyagi**

Membrane properties of cultured chick embryonic retinal cells or those of visual cells dissociated from the enzym-treated chick embryo were studied under current- and voltage-clamp conditions with 'Giga-seal' suction pipettes (pipette solution 138 mM K). The identification between cultured cells was difficult under microscopic observation, but partially made in comparison with histologic pleparations of embryonic eye. The visual cell was easily identified by its autersegment microscopic observed. The voltage dependent membrane currents were observed in the both sorts of cells. The current in one of the cultured cells seen at >+10 mV and increased at higher voltage.

429, II G 0915

THE MÜLLER CELL HYPOTHESIS OF THE ORIGIN OF ERG B-WAVE AND SPREADING DEPRESSION POTENTIAL (SDP).

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Using the frog retina, Mori et al. in 1976 assigned the origin of the SDP to Müller cells acting as K^+ electrodes. The logic of the assignment is similar to the Müller cell hypothesis of the ERG b-wave. The polarity of the chick SDP is receptor-side positive which is opposite to the frog SDP, while the b-waves of these animals are both receptor-side negative. The fact that the Müller cells of the chick and frog are markedly different morphologically prompted us to compare the localization of the neutral zone by intraretinal K^+ injection. The neutral zone in the chick was found in the inner nuclear layer, far distal to that of the frog. The result, when combined with the previous observation that the maximum increase in K^+ is in the inner plexiform layer in both SDP and b-wave, justifies the opposite polarity of the SDP in the chick and frog, but not the same polarity of their b-waves. We conclude that the b-wave cannot solely be attributed to Müller cells without considering a contribution of the electrical activity of neurons.

430, II G 0930

THE OFF RESPONSE OF THE ELECTRORETINOGRAM.

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The off response of the electroretinogram (ERG) in the isolated bullfrog retina was studied by the addition of 2-amino-4-phosphonobutylic acid (APB) to the bathing medium. The application of 20 μM APB reversibly blocked the b-wave of the ERG and the off response was isolated by using a longer stimulus period. The off response consists of the early (d-wave) and the delayed (e-wave) components. In the dark adapted retina, the e-wave increased in both peak amplitude and peak latency when the stimulus intensity increased. The increase in the log of the stimulus intensity required to evoke the criterion response (20 μV) of the e-wave was sigmoidally related to the fraction of rhodopsin present, and this characteristic was very similar to that of the rod receptor potential. These results suggest a possibility that the information process of the off pathway in the vertebrate retina is different from that of the on pathway.

431, II G 0945

EFFECTS OF GABA AND PICROTOXIN ON C-WAVE AND LIGHT PEAK OF RETINAL POTENTIALS RECORDED IN THE CHICK.

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The retinal potentials were recorded from the chick eyes by a standard method of the DC recording. The chick was anesthetized and immobilized with Nembutal and curare. The stimulus light of 1000 lx was given in a duration of 10 sec for ERG recording and 15 min for recording of the light peak of the standing potential. The amplitude of the c-wave was measured at two points of 2 and 5 sec after the onset of the light stimulus, as indices of the fast c-wave (c_F) and the slow c-wave (c_S), respectively.

The intravitreal injection of GABA (10^{-9} - 10^{-7} M) resulted increase in amplitude of the c_S-wave, while there was no increase in the a- and c_F-waves and a slight decrease in the b-wave. Amplitude of the light peak was increased with GABA administration (10^{-7} - 10^{-4} M). By the intravitreal injection of picrotoxin (10^{-5} - 10^{-3} M), the polarity of the c_S-wave changed from positive to negative and a significant decrease and deformation in the light peak was observed. The amplitude of the a-wave, however, increased dose-dependently, while that of the b- and c_F-waves decreased markedly but polarity of the c_F-wave did not reverse. Present results may suggest that the GABA-ergic synapses are possibly involved in the generating mechanism of the c_S-wave and the light peak.

432, II G 1000

SYNAPTIC MECHANISM OF THE GENERATION OF THE SPREADING DEPRESSION IN THE FROG RETINA.
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The frog retina in low Cl media gives rise to spreading depression (SD) accompanied by large, receptor-side negative potential (SDP). The SD is caused by release of large amount of K from some neurons which have synaptic contacts in the IPL. Identification of the original cell and the synaptic mechanism of the generation of the SD has been investigated in the retina of the frog, Rana catesbieana.

Simultaneous recording of the intra- and extracellular potential shows that the amacrine and ganglion cells were strongly depolarized and the light responses were completely depressed during the SD. Moreover, in the ganglion cells, the membrane start to be depolarized preceding to the SDP, which suggests that the ganglion cells have an initiative role in the generation of the SD. The effects of some chemicals which are thought to be the inhibitory synaptic transmitters, on the SD generation have been studied. GABA and strychnine (an antagonist of glycine) decreased the SD generation and diminished the SDP amplitude. On the contrary, glycine and bicuculline (an antagonist of GABA) increased in the SD generation.

These results suggest that the SD might be initiated in the ganglion cells which are innervated with GABergic neuron, which is not identified.

433, II G 1015

RESPONSE PROPERTIES OF THALAMIC RETICULAR AND PERIGENICULATE CELLS IN THE CAT.
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Electrophysiological and visual properties were compared between thalamic reticular (TR) and perigeniculate (PG) cells in the cat anesthetized with N_2O in order to know whether there are any functional differences between them. Both TR and PG cells responded synaptically with a burst of spikes followed by postexcitatory inhibition and rebound discharges to stimulation of both optic chiasm (OX) and optic radiation (OR). However, the number and the proportion of TR cells driven by OX stimulation to those cells tested were smaller than those of PG cells. PG cells had significantly shorter mean OX- and OR-latencies than TR cells. The number and the proportion of TR cells activated by visual stimulation were small as compared with PG cells. In both TR and PG cells binocular cells were found more frequently than monocular cells. The receptive fields (RFs) were of ON-OFF, ON-OFF inhibited, and ON- or OFF-phasic types. The RF centers of TR and PG cells were always located near those of dorsal lateral geniculate cells just ventral to them. Simultaneous visual stimulation of both eyes induced binocular interaction such as facilitation, occlusion, and inhibition in some TR and PG binocular cells.

434, II G 1030

TOPOGRAPHICAL RELATIONSHIP BETWEEN THE SUPERIOR COLLICULUS AND THE VENTRAL LATERAL GENICULATE NUCLEUS IN THE RAT.
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Topographical relationship between the superior cilliculus (SC) and the ventral lateral geniculate nucleus (LGv) was studied in the rat. First, horseradish peroxidase was injected into various parts of SC and relation between the injection sites in SC and locations of retrogradely labeled cells in LGv was examined. Second, LGv neurons were activated antidromically by microstimulation of SC and the axonal projection of individual LGv neurons determined by threshold mapping in SC was correlated with the recording site of the LGv neurons. Results obtained from those two kinds of experiments coincided well with each other, being summarized as that neurons located in the dorsal, ventral, caudomedial and rostrolateral parts of LGv project to rostral, caudal, lateral and medial parts of SC, respectively. Those results suggest that LGv neurons project to SC neurons with closely related receptive field positions in the visual field.

435, II G 1045

INTRACORTICAL CONNECTIVITY STUDIED IN SLICE PREPARATIONS OF CAT'S STRIATE CORTEX USING TRIGGER AVERAGING TECHNIQUE.

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Single cortical (target) cells were recorded intracellularly in a slice preparation of striate cortex and their synaptic potentials were studied by averaging them triggered by activities of the other cortical (source) cell recorded extracellularly under chemical stimulation by glutamate. Seventy-five pairs of cells were sampled from layers II-IV. Two types of synaptic potentials were demonstrated. 1) Monosynaptic EPSPs (ME) with delays of 0.6-0.9 ms and peak amplitudes of 0.02-0.2 mV (n=8). 2) Monosynaptic IPSPs (MI) with similar delays and peak amplitudes (0.5-0.8 ms and 0.02-0.2 mV, n=8). Source cells for ME were localized at border region between layers III-IV, and those for MI at bottom of layer III. Target cells for ME and MI were located in layers II and III 0.1-0.4 and 0.05-0.3 mm above the source cells. Almost all source cells for ME (7/8) were monosynaptically excited by stimulation of white matter, while those for MI (7/8) were disynaptically excited. These results indicate that the former cells mediate disynaptic excitation evoked through white matter and the latter cells trisynaptic inhibition.

436, II G 1100

A FUNCTIONAL ROLE OF CHOLINERGIC INNERVATION IN THE CAT VISUAL CORTEX.

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The basal forebrain (BF), including the nucleus basalis magnocellularlis, is known as the main source of cholinergic projection to the cerebral cortex. To elucidate a functional role of this projection in the visual cortex (VC), we studied effects of microionophoretically applied acetylcholine (ACh) and its antagonists on activity of VC neurons in two groups of cats; cats with unilateral BF lesions and normals. In normal cats, an application of ACh enhanced visual responses and/or spontaneous activity of 77 % of the VC neurons tested while it suppressed those of 14 %. The suppressed cells were located in layers II+III, IVab and IVc of the VC. The application of muscarinic antagonists partially or strongly suppressed activities of 52 % of the cells tested and facilitated those of 16 %. In cats with BF lesions, about 40 % of neurons in the VC ipsilateral to the lesion were unresponsive or very weakly responsive to visual stimuli. Most of these cells became clearly responsive to visual stimulation during ACh application. The newly appeared responses had normal stimulus selectivity. These results suggest that visual responsivity of VC neurons is modulated by the cholinergic projection from the BF.

437, II G 1115

RESPONSES OF CAT'S VISUAL CORTICAL NEURONS TO MUSCIMOL AND BACLOFEN.

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Previously we reported that GABA applied in perfusion medium produced an initial depolarization followed by a hyperpolarization in many cells in cat's brain slice preparations. In the present experiments we used two GABA agonists, muscimol (a $GABA_A$ receptor agonist) and baclofen (a $GABA_B$ receptor agonist) to further study the depolarizing and hyperpolarizing GABA responses. Drugs were applied either in a droplet or by iontophoresis while intracellular recordings were continued. Baclofen, which is known to increase K^+ conductance, hyperpolarized the membrane and muscimol, which is known to increase Cl^- conductance, depolarized, although the input resistance was decreased in both cases. The muscimol response reversed at about -60 mV and the baclofen response was reduced in amplitude when the membrane was hyperpolarized. In Ca^{2+} deficient medium the muscimol response was almost unchanged, but the baclofen response was decreased, suggesting that Ca^{2+} dependent K^+ channels are relevant to the baclofen response.

438, II G 1130

ANALYSIS OF CONTOURS IN THE CAT'S AREA 19.

SAITO, H., TANAKA, K. AND FUKADA, Y. NHK Sci. & Tech. Res. Labs., Setagaya, Tokyo 157

To study the functional roles of the cat's area 19 on pattern vision, we compared receptive field properties of area 19 cells with those of area 17 cells using anesthetized, immobilized (N_2O, 70%; Nembutal, 1-2 mg/kg/hr; Flaxedil, 5 mg/kg/hr) animals.

The majority (70%) of cells in the area 17 were orientation-selective. By contrast, about 1/2 (125/243, 51%) of area 19 cells showed a good response to a non-oriented small stimulus moving in any direction (non-oriented cells). Two-thirds of them failed to respond when the moving stimulus was elongated beyond some length along any orientation. The majority of the end-stopped non-oriented cells, however, gave good responses when the end of a long bar passed through the discharge center, and a considerable number of them were activated by the elongated stimulus when a part of the discharge center was masked from stimulation. Thus their trigger feature can be assumed to be a discontinuous part of contours moving within the receptive field. Of the orientation-selective (oriented) cells in the area 19 (46%), 1/4 were end-stopped. Vertical and oblique penetrations showed that non-oriented and oriented cells form columns in the area 19.

In contrast with the area 17 which seems to decompose the visual world into oriented contours, the area 19 analyzes the visual pattern in its various aspects including detection of discontinuity, orientation and length of contours.

439, II G 1145

FUNCTIONAL CHARACTERISTICS OF ROTATION-SENSITIVE NEURONS OF THE POSTERIOR PARIETAL ASSOCIATION CORTEX OF THE MONKEY.

SAKATA, H., SHIBUTANI, H., ITO, Y., TSURUGAI, K., TAIRA, M. AND MINE, S. Dept. Neurophysiol., Tokyo Metrop. Inst. Neurosci. Tokyo, 183.

We made quantitative analysis of functional characteristics of 68 rotation-sensitive neurons in the posterior part of area 7a (PG) of alert monkeys. Each of these neurons had preferred vector of rotation which was determined by optimal plane, either frontal (20/68), sagittal (20/68), horizontal (10/68) or diagonal (18/68), and preferred direction of rotary movement. Most of these neurons had large (40 to 160 degrees in diameter) bilateral receptive fields. Majority of these neurons showed gradual increase of discharge rate by the increase of angular velocity, but some of them responded to a very slow rotation (upto 2 degrees/sec.). Most of them did not change their responses by the change of the size of the rotating stimulus, but some of them responded preferentially to a large object. Responses to the shearing movement(a pair of linear movements in oppsing direction) was usually much smaller than the rotary movement(less than half), and often transient and non-directional, suggesting that the continuous change in the direction of movement was essential to activate these neurons. Several depth rotation-sensitive neurons showed reversal of preferred direction with trapezoid plate in monocular viewing, just like the illusion of Ames' window.

440, II G 1300

THE CHARACTERISTICS OF THE CHANGE IN NEURONAL ACTIVITY RELATING TO SELECTIVE ATTENTION IN MONKEY'S INFERIOR TEMPORAL CORTEX.

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We reported previously that the response of inferior temporal cortical neurons to visual stimulus was suppressed while the monkey was watching a pattern stimulus which was presented at the center or a contralateral position in the visual field in a pattern discrimination task. Significant decrease in the response to visual stimulus was observed in more than half of the tested neurons. The effect did not depend on responsiveness of the neuron to the pattern stimulus. Because the effect disappeared in almost neurons when the pattern stimulus was presented in ipsilateral visual field, this effect was possibly dependent on stimlus-stimulus interaction but not on general activation nor on other behavioral factors. On the other hand, when irrelevant visual stimulus preceded the pattern stimulus, the response to pattern stimuli was not modified by it, although the two stimuli was present simultaneously. This indicated that this type of stimulus-stimulus interaction was intimately related to mechanisms of selective attention.

441, II G 1315

POSITRON EMISSION TOMOGRAPHIC MEASUREMENTS OF HUMAN CEREBRAL GLUCOSE METABOLISM AND BLOOD FLOW UNDER SENSORY DEPRIVED AND LIGHT ILLUMINATED STATES. TASAKI, K., TSUKAHARA, Y., TAMAI, M., FUKADA, Y., SUZUKI, H. AND SUGITA, Y. Dept. of Physiol. and Dept. of Ophthal., Tohoku Univ. Sch. of Med., Res. Center Appl Inf. Sci., Tohoku Univ., Sendai, NHK Sci. and Tech. Res Labs., Setagaya, Tokyo

Our previous study of positron emission tomography revealed that the regional cerebral metabolic rate for glucose is high in the frontal cortex, cingulate gyrus, basal ganglia and low in temporal and occipital lobes, thalamus and cerebellum under sensory deprived state (Tasaki et al., 1985). This was further confirmed in this study in several more normal and two visually handicapped subjects, and the results were compared with those obtained under light illuminated state. The regional cerebral blood flow (rCBF) was also measured in the dark adapted and light adapted states by injecting a bolus of ^{15}O-H_2O. An intense illumination cause a rapid increase in the rCBF in the visual cortex, thalamus, basal ganglia, cingulate gyrus, etc., and the high rCBF in these areas persisted long after the adapting light was turned off. Almost 30 min were required for full recovery of the rCBF to the dark adapted level.

442, II G 1330

MOTION STEREOPSIS IN NORMAL AND STRABISMIC SUBJECTS. KITAOJI, H., UMETANI, K., AND TOYAMA, K., Depts. Physiol. and Ophthal., Kyoto Prefectural Sch. Med., Kawaramachi-Hirokohji, Kyoto, 602.

Responsiveness to visual cues for motion stereopsis was studied in normal (n = 4) and strabismic subjects (n = 5). A pair of visual stimuli (square of 2°x 2°) moving in- or anti-phase was displayed on two CRT, and they were presented to the two eyes of the subjects through a display system using a pair of polarizing filters and a half-mirror. Motion cue was reproduced as a difference between motions of the two stimuli. Thresholds of motion cue for eliciting perception of motion in depth were determined by presenting weak stimuli at repetition interval of 3 sec. In normal subjects thresholds were 0.13°± 0.02°at the central visual field, 0.22°± 0.05°, and 0.46°± 0.02° at eccentricities of 10°and 20°. In strabismic subjects motion stereopsis was present only at the peripheral area, the thresholds were variable but at least 2-8 fold larger than those for normal subjects (1.6°± 0.6°). Preliminary study indicated that the threshold for single presentation of size cue did not differed appreciably between strabismic and normal subjects (7 and 5 % at an eccentricity of 10°), while that for combined presentation of motion and size cues was significantly larger in strabismic than normal subjects (0.4°and 0.2°).

443, II G 1345

PUPILLARY CONTRACTIONS REFLEXES ELICITED BY ELECTRIC MAGNETIC FIELDS. TSUKAHARA,S. Dept. Physiol., Fukushima Med. Coll.,Fukushima 960

Pupillary contractions could be observed by electro-magnetic stimulations. 1)The magnet had a coil of 100uH with laminated iron core. Current was supplied by discharging a electric condensers(10000uF,max,500Volts). The field strength assumed to be several thousands Gauss at the peek. The subject was seated with his temple close to the core of the magnet. 2)Sizes of pupil were measured by the visual recording of IR-TV camera. 3)Pupillary contractions observed in both side simultaneously 50msec after the stimulations. 4)Magnetophosphens aroused at the same time of the stimulation, and the sensations were limitted peripherally. 5)It is supposed that the magnetic field stimulate the Y cell of retina selectively.

444, II P (23) 1330

ULTRASTRUCTURES AND PHOTORESPONSES IN PINEAL ORGANS OF LARVAL AND ADULT CYCLOSTOMES. TAMOTSU, S. AND MORITA, Y. 1. Dept. Physiol., Hamamatsu Univ. Sch. Med., Hamamatsu 431-31

Since hyperpolarizing photoresponses were recorded intracellularly from pineal photoreceptors of the larval (body length, 5-10 cm) river lampreys, Lampetra japonica, as well as from the adult (body length, about 52 cm), larval pineal organs were compared morphologically with the adults using an electron microscopy. The pineal organ of the larval river lamprey is consisted of three major cell types: photoreceptor, supporting cells and ganglion cells, similar to the pineal of other lower vertebrates. Each photoreceptor cell of the larva and the adult has well-developed disks in outer segments, numerous mitochondria in ellipsoids of inner segments and ribbon synapses adjacent to the ganglion cells in the basal portion. These findings reveal that the larval pineal photoreceptors are well-developed in structure and function.

445, II P (24) 1330

CELL DISSOCIATION FROM THE PHOTOSENSORY PINEAL ORGAN. SAMEJIMA, M. AND MORITA, Y. 1. Dept. Physiol., Hamamatsu Univ. Sch. Med., Hamamatsu 431-31

Pineal photoreceptor cells are located inside the pineal vesicle, and their outer segments are protruded into the lumen. This structural feature makes it difficult to evaluate the results obtained from ion exchange experiment and pharmacological treatment of the pineal organ. Thus, the photoreceptors were dissociated from the pineal organ. Four to five pineal organs taken out of lamprey, Lampetra japonica, were incubated for 20 min at 28°C in 5 ml of oxygenated saline solution containing 10 U/ml papain. They were gently triturated with a glass pipette of 1 mm tip diameter. Two types of cells were predominantly obtained. One was round-shaped with guanine crystals which seemed to be a supporting cell. The other was a long and slender one with a ovoid terminal which seemed to be a photoreceptor cell. The latter was electron microscopically confirmed to be a photoreceptor cell with a basal process, a cell body and an ellipsoid. Dissociated cells were alive for several days in dishes.

446, II P (25) 1330

MINUTE MECHANICAL MOVEMENTS AS THE SIGN OF THE RETINAL PHOTORECEPTION. NAKAYE, T., TASAKI, I.* and TASAKI, K. Dept. Physiol., Tohoku Univ. Sch. Med., Sendai 980 and *National Institutes of Health, U.S.A.

By applying our mechano-electric transducers to invertebrate eyes, we found recently that isolated retinas of both squids and lobsters exhibit mechanical changes when they are excited by light. The mechanical responses are diphasic, a brief initial swelling of the retinular cells followed by a prolonged phase of shrinkage.

We report the results of light-induced mechanical changes in detail as following; (1) The peak of swelling in the mechanical response precedes the peak of electroretinogram. (2) The spectral sensitivity of the eye determined by taking mechanical responses as an index coincides with the absorption spectrum of rhodopsin. (3) The outer segments of squid retina mainly produced the mechanical forces evoked by light. (4) The mechanical changes detected by our transduction technique are rapid and quit distinct from the slow photo-mechanical responses known to physiologists.

The pharmacological and methodical experiments are now in progress to measure the direct mechanical response of vertebrate photoreceptors.

447, II P (26) 1330

ROD-CONE INTERACTION IN FLASH- AND FLICKER DETECTION

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Peripheral sensitivity to both cone-mediated flash- and flicker was assessed with a 20' diameter cone test probe (660 nm wavelength) in the presence of concentric background of 2° 20' diameter (490 nm wavelength). Modulation depth of flicker was fixed at 100%. For all normal observers, the flicker sensitivity is enhanced a little before the rod stimulation while the flash sensitivity is enhanced after the rod stimulation. These results indicate the existence of two functionally different cone pathways which receive different effects of rod stimulation.

448, II P (27) 1330

SYNAPTIC CONTACTS BETWEEN CONES AND HORIZONTAL CELLS IN THE TURTLE RETINA.

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Ribbon synaptic contacts between three chromatic types of cones and three spectral types of horizontal cells in the retina of the turtle (Geoclemys) were investigated by light and electron microscopy. According to the spectral responses, the horizontal cells (HCs) were classified into a luminosity, a biphasic chromaticity and a triphasic chromaticity HC (LHC, BHC and THC). These HCs were ionophoretically filled with horseradish peroxidase (HRP). Three chromatic types of cones within the dendritic field of HRP-filled HCs were identified by the presence and colors of oil droplets in the inner segments. LHC (n=3) made synaptic contacts with about 90 cones, including three chromatic types; two thirds with the cell body and the remaining with the axon terminal. BHC (n=2) contacted with about 30 cones; red-, green-, and blue-sensitive cones in the ratio of 3:4:1. One THC contacted with 20 cones; red- and blue-sensitive cones in the ratio of 2:1. All dendritic processes of HRP-filled HCs were found as the lateral element of the ribbon synaptic complexes. The present finding, different from the previous observations, suggests that both BHC and THC receive direct inputs from red-sensitive cones.

449, II P (28) 1330

GABA-SENSITIVITY OF ISOLATED BIPOLAR CELLS DISSOCIATED FROM THE GOLDFISH RETINA.

TACHIBANA, M. AND KANEKO, A. Department of Information Physiology, National Institute for Physiological Sciences, Okazaki 444

Radioautography has demonstrated GABAergic amacrine cells in a wide variety of vertebrate retina. Since amacrine cells are known to make feedback synapses on bipolar cell axon terminals, we examined the sensitivity to GABA of isolated bipolar cells. The cells were voltage-clamped by a patch electrode in the whole-cell recording configuration, and GABA was applied by ionophoresis. Most of the bipolar cells responded to GABA. Generally, cells with a huge bulbous axon terminal generated responses of large amplitude to saturating dose (>-300 pA at -60 mV; 120 mM $[Cl^-]_i$, 133 mM $[Cl^-]_o$). The GABA sensitivity was localized to the axon terminal. The GABA-induced current (I_{GABA}) was selectively carried by Cl^-, and I_{GABA}-V relation was linear. GABA hyperpolarized isolated bipolar cells (resting potential, -40 mV) whose $[Cl^-]_i$ was not disturbed by the recording patch pipette. E_{Cl} in these cells was estimated to be more negative than -45 mV. Prolonged application of GABA caused partial desensitization. Bicuculline and picrotoxin behaved as blockers, while muscimol as a potent agonist. Co^{2+}, which is a strong blocker of I_{GABA} in turtle cones, affected very weakly to I_{GABA} in bipolar cells. Our results indicate that most bipolar cells receive negative feedback inputs from GABAergic amacrine cells.

450, II P (29) 1330

SYNAPTIC TRANSMISSION FROM BIPOLAR CELLS TO AMACRINE CELLS IN THE CARP RETINA.

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Dept. Physiol. St. Marianna Univ. Sch. Med., Kanagawa 213

ON-OFF amacrine cells respond with transient depolarizations both at onset and termination of light. It has not been, however, clearly demonstrated how such unique response can be produced by convergence of the ON- and OFF-bipolar cells from which sustained ON and OFF amacrine cells receive inputs, respectively. We examined the direct effect of an bipolar cell polarized by extrinsic current injection on an amacrine cell while the intracellular recordings from the both cells were made simultaneously. Depolarization of an ON-bipolar cell elicited a transient depolarization at onset of current in an ON-OFF amacrine cell, while it elicited a sustained depolarization in an ON amacrine cell. Hyperpolarization of an OFF-bipolar cell elicited a transient depolarization at termination of current in an ON-OFF amacrine cell. These current-evoked responses are considered to be mediated by chemical synapses for the following reasons: the responses, (1) had a significant delay, (2) were abolished under light illumination, (3) were enhanced in amplitude as same as in that of the light responses by hyperpolarization of the amacrine cells.

451, II P (30) 1330

THE SHAPE OF THE CATECHOLAMINERGIC NEURONS IN THE RABBIT RETINA

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Dopamine is known as the primary catecholamine in the vertebrate retina. Although catecholamines are found in the inner retina, we do not know the dendritic morphology of the corresponding cells yet. Recently a technique has developed, by which aldehyde-fixed single neurons can be injected with diffusible dyes under visual control(Tauchi and Masland 1984). Since dopamine fluoresces by the treatment with aldehyde-mixture in water phase, the "fixed cell injection" should be applicable. I have used this technique to study the shape of the individual dopamine containing cells in the rabbit retina. The fluorescent cells were randomly injected at the locations on the retinal surface and they were found to be categorized into amacrine populations. In general, the dye injected cells appeared to have less complex dendritic branchings and their dendritic field shape was highly asymmetric. The cells were further classified into three subtypes depending on the locations of dendritic branchings within the inner plexiform layer(IPL). The dendrites of TypeI cells arborize at sublamina 1 within the IPL. TypeII cells are, on the other hand, multistratified, i.e., their dendrites are located in sublamina 1,3, and 5. TypeIII cells are similar to TypeII cells in respect to dendritic shape and pattern though their dendrites lie in a plane corresponding to sublamina 3.

452, II P (31) 1330

EFFECTS OF DOPAMINE ON GANGLION CELLS IN CATFISH RETINA.

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Okazaki, 444

Effects of dopamine on on-center and off-center ganglion cells in catfish retina were examined by measuring spatio-temporal receptive field and extracellular responses to flashing single bar of light before and after the application of dopamine. In on-center cells, both mean impulse frequency and incremental sensitivity were decreased without changing spatial profile of the receptive field. On the other hand, off-center cells showed the increase of mean impulse frequency and incremental sensitivity by dopamine application. Moreover, temporal dynamics was improved without altering the receptive field profile. Off-center cells with distinct localized surround showed the increase of the incremental sensitivity and improvement of temporal dynamics of the receptive field center accompanied with the disappearance of distinct surround component. These results suggested that dopamine plays the important role in the regulation of the sensitivity and temporal dynamics of ganglion cells in catfish retina.

453, II P (32) 1330

EVOKED POTENTIALS OF THE LOCAL RETINA OF INTACT RATS.

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We inserted a pencil type glass microelectrode into intact eyeball of urethane-anesthetized rats from the pars plana and performed intravitreous electroretinography and intraretinal recordings of potentials of ganglion cells. Light stimulation was guided to the cornea or directly to the retina through the glass electrode (OD: 100-400 μm) by plastic fibers.

Results obtained in this study were as follows;

1) When the electrode was flashed, ten or more oscillatory potentials (o.p.s) were recorded. The average of their frequencies was 64.2 Hz. On the contrary, when the cornea was flashed, only five or six o.p.s were countable even if so strong light source that evokes the early receptor potential was used.
2) When the electrode was flashed, the negative after-swing of the b-wave was larger than that when the cornea was flashed.
3) When the cornea was flashed, a phase shift of the electroretinogram was recorded. Then, when the electrode was advanced about 100 μm to the retina from the electrode position where the phase shift was elicited, fires of ganglion cells were recorded. While the electrode was flashed, the phase shift never occurred.

454, II P (33) 1330

EFFECTS OF BARIUM ON THE ERG C-WAVE OF ISOLATED BULLFROG RETINA.

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ERG c-wave arises from the pigment epithelial cells in response to the light-induced decrease of the extracellular K^+ concentration in the photoreceptor layer. Barium (Ba^{2+}) which was found to suppress the K^+ conductance of the Müller cells (Matsuura, 1984), was applied to the isolated bullfrog retina or to isolated pigment epithelium itself.

As the results, the transretinally recorded c-wave was completely abolished with little effect on the receptor potential by the application of 0.2 mM Ba^{2+}, whereas K^+ electrode detected normal extracellular K^+ change in the photoreceptor layer. The transepithelial potential in response to the K^+ concentration changes in the bathing solution, decreased in magnitude to about half of the control in the presence of 0.2 mM Ba^{2+} and to about 1/4 in 2.0 mM Ba^{2+}. These results indicated that the K^+ conductance of the pigment epithelial cells was suppressed by Ba^{2+} as observed in the Müller cells.

455, II P (34) 1330

BINOCULAR FUNCITON IN VISUAL CORTICAL NEURONS IN STRABISMIC (SIAMESE) CAT.

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Binocular neuronal function was studied in striate (area 17) and prestriate visual cortices (areas 18 and 19, Clare-Bishop cortex) in nine cats under Etomidate anaesthesia. They exhibited convergent strabismus of 12-29 (19 ± 7) degrees, as determined by corneal reflection method and all of them exhibited Boston type of abnormal retinotopic representation in area 17. Most majority of cells were monocularly responsive in areas 17 (133/154), 18 (47/47), and 19 (86/100), but a minorty of cells were binocular in areas 17 (21/154) and 19 (14/100). By contrast, binocular responsiveness was markedly different between the major part of Clare-Bishop cortex representing peripheral visual field and the posterior extreme representing the central visual field. More than two-thirds (115/168) in the former part and less than one-third (30/98) in the latter part were binocular cells. Retinal correspondence was investigated in these binocular cells as disparities between the centers of the receptive areas defined through the two eye. The disparities were not substantially different between strabismic and normal animals after compensation for strabismic visual axes, indicating that retinal correspondence in Siamese cats does not compensate for strabismus.

456, II P (35) 1330

CENTRAL PROJECTIONS OF RETINAL GANGLION CELLS IN JAPANESE MONKEYS (MACACA FUSCATA). FUKUDA, Y. AND SAWAI, H.* Dept. Neurophysiol., Osaka Univ. Med. Sch., Kita-ku, Osaka, 530

Using a method of retrograde labelling with HRP we studied the distribution and soma size of ipsilaterally or contralaterally projecting ganglion cells in whole-mounted retinas. The HRP-injection was confined to the optic tract of one side between the optic chiasm and the lateral geniculate nucleus. In general, contralaterally projecting cells were distributed in temporal hemiretina and ipsilaterally projecting cells in nasal hemiretina. Between the two hemiretinas there was an overlap region, so-called "naso-temporal overlap". It was about 1° wide around the central fovea but it extended 25-30° wide in lower and upper peripheries. Contralaterally projecting cells in the temporal half of the overlap consist mainly of large and small cells which probably correspond respectively to P-α (Y-like in physiology) and P-γ (W-like) cells, while ipsilaterally projecting cells in the nasal half of the overlap mainly consist of medium-sized cells which probably correspond to P-β (X-like) cells. This finding was interpreted to suggest some functional difference between Y-like and X-like cells in binocular stereoscopic vision.

457, II P (36) 1330

LOCALIZATION OF CALSPECTIN (FODRIN) IN VISUAL AREAS OF THE DEVELOPING CORTEX. KIMURA, F.[1*], TSUMOTO, T.[1] AND SOBUE, K.[2*] Depts. Neurophysiol.[1], and Neurochem. and Neuropharmacol.[2], Inst. Higher Nervous Activity, Osaka Univ. Med. Sch. Osaka 530

Calspectin (or fodrin) is a membrane-associated cytoskeletal protein which may control cell shape in association with actin and other calcium-activated proteins. Calspectin is found to be concentrated in postsynaptic densities (Kakiuchi, S. et al., 1982), and hypothesized to play a role in synaptic plastisity by changing the shape of postsynaptic structures (Lynch, G. et al. 1984). To test this hypothesis, we studied localization of calspectin stained immunofluorescently in the developing visual cortex (VC), in which the degree of plasticity is a function of age of animals.

Rats and cats, from birth to adults, were perfused with Zamboni's solution. Brains were removed and sections were incubated first with the anti-calspectin IgG, then with the fluorescein isothiocyanate (FITC)-labelled anti-rabbit IgG. In the adult VC, cells in layers II+III, V and lower VI were more intensely stained than those in the other layers. In rat pups, stained cells became clearly recognizable at postnatal day (PD) 4. In a PD 9 rat, the staining was diffuse throughout the cortex except layer I. At the 3rd postnatal week and thereafter, however, the fluorescence became rather faint in layers IV and upper VI. Analysis of a relationship between the degree of cortical plastisity and the intensity and localization of staining is in progress.

458, II G 1400

ENDOLYMPH CALCIUM ION CONCENTRATION IN THE GUINEA PIG COCHLEA. IKEDA, K., KUSAKARI, J., TAKASAKA, T., SAITO, Y.*, NISHIYAMA, A.* Depts.of Otolaryngol. & Physiol.*, Tohoku Univ. Sch. of Med., Sendai 980.

Ca ion of a suitable concentration in endolymph is known to be essential in the transduction by cochlear hair cells. Furthermore, Ca ion has been shown to have an effect on the cochlear micromechanism through the contractile mechanism associated with hair cell actin. In the present experiment, Ca ion concentration in the endolymph of normal guinea pig was determined by means of ion-selective microelectrode and its changes induced by anoxia or intravenously given furosemide or gentamicin were observed. The concentration of Ca ion in endolymph was 4.6 ± 2.0 ($\times 10^{-5}$ M, n = 12) in normal animals which was significantly higher than the equilibrium concentration with respect to the perilymph. Anoxia or furosemide administration (60 mg/kg) abolished the endocochlear potential (EP) and increased Ca ion concentration to 2.5 x 10^{-4} M and 3.6 x 10^{-4} M in 30 min, respectively. But the administration of gentamicin (100 mg/kg) exhibited no significant effect on the EP and Ca ion concentration.

459, II G 1415

COCHLEAR MICROPHONIC POTENTIAL AND DISTORTION PRODUCT. HASHIMOTO, T. and TANIGUCHI, I. Inst. Med. Dent. Engin., Tokyo Med. Dent. Univ., Tokyo 101; Med. Res. Inst., Tokyo Med. Dent. Univ., Tokyo 113.

Alternating current injected into the scala media of the guinea pig under the sodium pentobarbital anesthesia modulates the amplitude of the cochlear microphonic potential measured in the scala media. With an aid of the active bridge circuit simultaneous voltage recording and current injection were implemented by a single enamel coated wire electrode inserted into the scala media of the first cochlear turn. In the cochlear microphonic potential the distortion product of the frequency equal to the sum or difference of frequencies of the applied sound and current stimuli was detected. The sideband generation was consistent withe variabe resistance model of the cochlear transduction. It was nearly proportional to the product of the injected current and the sound-induced impedance change, which was synchronized with the acoustic waveform. Sinusoidal current as low as 0.05 μA across the basilar membrane could generate the distortion product at the level just recognizable in the spectrogram. The sideband of the second harmonic of the sound frequency was also observed.

460, II G 1430

SENSITIVITY TO THE MECHANICAL DISPLACEMENT OF THE CHICK VESTIBULAR HAIR CELL. OHMORI,H. National Institute for Physiological Sciences. Okazaki 444.

Input-output relationship was measured in the mechano-electrical transduction(m-e.t.) current of the dissociated chick vestibular hair cell. Amplitudes of 0 to 1.25 um displacement was applied to the hair bundle by a glass rod of which motion was controlled by a computer through a piezoelectric mechano-stimulator. The motion of the glass rod was monitored optoelectrically by using a photodiode with a resolution of 0.01 um. The exact motion of the hair bundle and the stimulating glass rod was monitored through a contrast enhanced video system, demonstrating a close coupling of the hair bundle with the stimulating glass rod, and no motions of the cell body even when the hair bundle was deflected 1.25 um by the glass rod. The spatial resolution of the video system is 0.1 um. Thus, the motion of the glass rod could be taken as the motion of the hair bundle relative to the cell body.

The m-e.t. current was measured under a whole cell voltage clamp condition. The amplitude of the m-e.t. current demonstrated a linear relationship to the hair bundle displacement up to 0.65 um. Further displacement demonstrated a saturation of the m-e.t. channel conductace. The minimum hair bundle displacement which could generate the m-e.t. current was 0.01 um. The average sensitivity was 40.5 pA/um displacement which was measured at the tip of the hair bundle.

461, II G 1445

BLOCKAGE OF THE Ca-DEPENDENT K CHANNEL WITH QUININE IN GOLDFIDSH SACCULAR HAIR CELLS. SUGIHARA, I. and FURUKAWA, T. Dept. of Physiol., Tokyo Med. & Dent. Univ. Sch. of Med., Yushima, Bunkyo-ku, Tokyo 113.

Quinine, an ototoxic drug, is also known as a K-channel blocker. Presently, effects of quinine on the Ca-dependent K channel of large conductance were studied with single-channel recording of inside-out patch-clamp mode on the basolateral membrane of enzymatically isolated goldfish saccular hair cells. The Ca-dependent K channel of the present material had faster open-close kinetics compared with reports on other cells, showing a mean open time of 0.13 ms in quinine-free medium. When 30 - 300 μM of quinine was applied, open time became extremely short, its mean being 0.03 ms with 300 μM of quinine. On the other hand, mean closed time was stretched from 0.15 ms under the control to 1.6 ms with 300 uM of quinine. These findings may be explained by assuming that quinine molecule enters the open channel to occulude it and that the rate of its release from the channel is slower than the rate of the entrance. However, there remains uncertainty about whether quinine enters the channel only during the open state of the channel or quite independently of the gating.

462, II G 1500

THE MECHANISM OF AMPLITUDE MODULATION IN THE COCHLEA OF THE GUINEA PIG TOSHIO MORIYAMA, YUTAKA HOSOKAWA, KEIICHI MURATA, and SADAO MINAMI. Dept. of Neurophysiol., Med. Res. Inst., Tokyo Med. & Dent. Univ., Kandasurugadai, Tokyo, 101, Japan

The animals were anesthetized with urethane (100mg/kg i.p.). An alternating current (AC) of a frequency of Fc was fed into the scala media at the 2nd turn through a microelectrode. A tone of a frequency of Ft was delivered to the ipsilateral ear canal with an earphone, and the sound in the ear canal was picked up with a probe tube microphone. During simultaneous application of the current and tone, the frequency spectrum analysis of the sound showed components at Ft±Fc in addition to Fc and Ft. The Ft±Fc powers were decayed reversibly by frosemide (20 mg i.v.) and disappeared irreversibly after loud noise exposure or cardiac arrest. The Ft±Fc powers could not be detected in kanamycin treated animals (400 mg/kg/day i.m. for two weeks) though the Fc power persisted. A model was proposed: an applied AC elicits an oscillation in the cochlea and a part of the oscillation amplitude-modulates the non-linear basilar membrane vibration due to a sound stimulation.

463, II G 1515

EFFERENT INNERVATION TO LABYRINTHINE ORGANS OF THE TOAD. SUGAI, T., OOYAMA, H., YANO, J. AND SUGITANI, M. Dept. Physiol., Kanazawa Med. Univ., Ishikawa 920-02

The vestibular organs and the amphibian papilla of toad receive efferent innervations. Effects of efferent fiber activation on spontaneous activity of both auditory and vestibular afferents were studied. Since some efferent fibers bifurcate in the eighth nerve and innervate at least two labyrinthine organs, a single branchlet of the eighth nerve, disconnected from its organ, was electrically stimulated. Spontaneous activity was recorded in other branchlets which were left connected to their organs. Electrical stimulation(ES) elicited either inhibitory(34.9%) or facilitatory(31.9%) effects on spontaneous activity of vestibular units. The remaining units showed no response. Spontaneous discharge was completely suppressed in the inhibited units, while in the facilitated units it was remarkably increased, during the ES period. Most of units insensitive to the ES had relatively regular spontaneous activity, and units having irregular activity used to change spontaneous activity in response to the ES. Of 50 amphibian papilla units, four units were inhibited and one facilitated in response to the ES of vestibular nerve. This result coincides with the observation that ES of any one of the vestibular branchlets elicited a small compound action potentials in the amphibian papilla nerve. Results indicate that the auditory and the vestibular organs are connected by a few divergent efferent fibers.

464, II G 1530

GLUTAMATE-INDUCED INHIBITION AND EFFERENT TRANSMISSION IN FROG AUDITORY ORGAN. YANO, J., OOYAMA, H., SUGAI, T. AND SUGITANI, M. Dept. of Physiol., Kanazawa Med. Univ., Ishikawa 920-02

In the bullfrog, Glu (50 mM) in Ringer's solution was injected into the cannulated occipital artery, and the effects on the afferent discharges of the eighth nerve fibers were studied. Injection of Glu (less than 0.8 ml) did not affect the firing rate in the fibers with the characteristic frequencies (CFs) from 1700 to 2000 Hz, supposedly the basilar papilla fibers. Within the fibers with the CF from 60 to 1000 Hz, supposedly the amphibian papilla fibers, the firing rate in high CF (400-1000 Hz) fibers did not change with injection of Glu, whereas Glu decreased the firing rate in sixty percent of low CF (60-400 Hz) fibers studied. Glu-induced inhibition have not been observed when the eighth nerve trunk was severed. This inhibition, therefore, seems to be exerted through the efferent fibers. Moreover, Glu-induced inhibition tended to diminish or delay when d-tubocurarine chloride (1 mM) was injected immediately before or after Glu injection. In order to clarify whether the efferent transmission is cholinergic or not, we are studying effects of carbamylcholine chloride, agonist of acetylcholine, on the afferent discharges.

465, II G 1545

SUBDIVISIONS OF PURE-TONE UNITS. MARUYAMA, N., KUDOH, M., FURUKAWARA, M. AND SHINZAWA, H. Dept. of Neurophysiol., Brain Research Inst., Niigata Univ., Niigata 951

As reported already, about 25% of auditory cortex units of cats responded best to pure-tone stimuli, which were called pure-tone units. For most pure-tone units, the effective range of the frequency was not restricted, and bands of noise and other complex sound stimuli were also effective. These pure-tone units, therefore, showed no selectivity for sound stimuli used. In the present experiment, we found 3 types of pure-tone units which showed some special selectivities for the stimulus. 1) The effective range of the frequency was restricted. 2) Medium bands of noise were not effective; the response decreased rapidly as the band width widened. 3) The selectivity was very similar to 2) for the band width and moreover, very similar to 1) for the effective frequency range.

466, II G 1600

SUPPLEMENTARY CHARACTERISTICS OF THE FORMANT DETECTOR. MARUYAMA, N., KUDOH, M., FURUKAWARA, M. AND SHINZAWA, H. Dept. of Neurophysiol., Brain Research Inst., Niigata Univ., Niigata 951

We have already reported on formant detectors (FDs), vowel sensitive neurons and vowel detectors in the primary auditory cortex of cats. FDs responded exclusively to synthesized formants. Each formant is characterized by the parameters of formant frequency, formant bandwidth and pitch. As reported already, the effective range of formant frequency of each FD was extremely restricted. In this experiment, we examined the response characteristic of FDs for bandwidths of synthesized formants generated by a terminal analog method. The Q-values of formants used were 10, 25 and 40. These were in the range of usual values of formants of human vowels and cat cries. In some of FDs, the difference in spike frequency of the response was very little for different Q-values, but in many of FDs, the difference was not negligible. The discharges of FDs, vowel sensitive neurons and vowel detectors were not phase-locked to the pitch period of synthesized formants or vowels.

467, II G 1615

FUNCTIONAL MAPPING OF THE BRAIN OF ECHOLOCATING BATS BY THE DEOXYGLUCOSE METHOD.
TANIGUCHI, I., SAITO, N. AND ARAI, O. Med. Res. Inst., Tokyo Med. and Dent. Univ., Tokyo 113, and Dept. Physiol., Dokkyo Univ. Med. Sch., Tochigi 321-02

Functional organization of the brain of echolocating Japanese horseshoe bats, Rhinolophus ferrumequinum nippon was visualized by the autoradiographic 2-[14C]deoxyglucose (DG) method. Bats were injected intraperitoneally with 2 μCi, while they were unanesthetized. After injection, each animal hung from a toe-hold in a small cage in a sound-proof room. To stimulate bats to echolocate, a train of tone bursts of 66 kHz was used as a mimetic echo. Eighty minutes after the DG injection, the animal was killed by an overdose of pentobarbital. The frozen brain was sectioned at 30 μ. The sections were exposed to an X-ray film for 4 days. Autoradiographs obtained from the brain of echolocating bats revealed a laminar structure in the central nucleus of inferior colliculus and the columnar organization in the auditory cortex. Furthermore, the remarkable DG uptake was observed also in the vocalization centers. However, the brain of resting bats as a whole showed a weak activity. These results suggest that the auditory centers are influenced by vocalization during echolocation.

468, II G 1630

EFFECTS OF TILT STIMULATION ON VESTIBULAR NERVE DISCHARGES IN CARP.
SATOW,Y.,TAKAGI, S., TAKABAYASHI,A., AND WATANABE,S. Gifu Coll. Med. Tech., Gifu 501-32, Res. Inst. Environmental Med., Nagoya Univ., Nagoya 464

Potential recordings from the vestibular nerve in carp were performed. During the experiments, a carp was supplied with running water through a mouth piece. Nerve bundle from each receptor organ can identify under a dissection microscope. In an immobilized carp, spontaneous discharges from single or multiple units of the vestibular nerves were recorded by a microelectrode filled with 1 M NaCl and the frequencies of spontaneous discharges were 10 to 40 spikes/sec under the horizontal position. The frequencies of spontaneous discharges from anterior ampullar nerve became lower or higher by the tilt stimulation (rolling or pitching). By the tilt stimulation, the discharges from a silent nerve under the horizontal position were sometimes appeared.

Twenty to thirty long cilia, 50 um in length or even longer, were observed in an ampullar hair cell through a scanning electronmicroscope, however the length of cilia on a macular hair cell was very short.

It is interesting to know how a receptor cell with long or short cilia affects the response pattern induced by the tilt stimulation.

469, II P (45) 0900

CONTRIBUTION OF IONIC PUMPS TO THE DC POTENTIAL AND RECEPTOR ACTIVITY OF PLOTOSUS ELECTRORECEPTORS.
SUGAWARA, Y. Dept. Physiol., Teikyo Univ. Sch. Med., Tokyo 173

Electroreceptors of Plotosus under I-clamp show a DC potential of c. -13 mV in the lumen, but are optimally biased in situ, i.e. near zero DC-level. Little is known, however, about origin of the biological emfs for the bias, nor about mechanisms which maintain the stable receptor operation in the face of a small continual Ca influx. Possible involvements of ionic pumps were examined. Under I-clamp, ouabain (5 μM) or zero Na depolarized the DC-level about 10 mV irreversibly, and induced regenerative receptor activity (RP) repetitively, but without much change in the peak amplitude. Addition of K (4 mM) to K-free saline induced reversible hyperpolarization in the DC-level (c. 10 mV) under I-clamp, and a DC outward current (c. 8 μA) under V-clamp, both of which were suppressed by ouabain, suggesting the presence of an electrogenic Na-K pump. A Ca pump blocker (KCN, 0.3 mM) indeuced repetitive RPs with decreasing amplitude, which ultimately reached a plateau level with loss of further responses, suggesting an involvement of Ca pump. In other acoustico-lateralis receptors, non-receptor cells are known to actively secrete K ions into the lumen, which generates a positive DC potential. The high K content in the lumen of Plotosus receptors is presumably secreted by the supporting cells. Thus, the biological emfs responsible for biasing Plotosus receptors appear to consist of several pump activities.

470, II P (46) 0900

OBSERVATIONS OF EYE MOVEMENTS EVOKED BY MICROSTIMULATION OF THE UTRICULAR MACULA OF THE CAT. JIJIWA,H., MOTOOKA,T. AND °WATANABE,S. Dept.Physiol.,Inst.Develop.Res., Aichi Pref. Colony,Kasugai 480-03, °5th Dept,Inst.Environ.Med.,Nagoya Univ.,Nagoya 464

The functional organization of the utricular macula of the cat was studied by means of vestibularly evoked eye movements in the present experiments. The left inner ear was explored and the spinal cord was dissected between C1 and C2 under Ketalar anesthesia. The head was fixed horizontally. All observations were performed without anesthesia except for a local analgesia. The utricular macula was microstimulated systematically with a train of electrical pulses which was delivered monopolarly through a glass micropipette electrode of 20-50 um in tip diameter. Eye movements were observed visually or recorded as multistobo photos using cross marks patched on both eyes. Ocular deviations induced were always tonic and conjugate. No nystagmus was noticed. The eyes deviated upwards or right-upwards when the anterior part of the macula was stimulated, whereas rotated anticlockwise with the posterior part stimulation. The stimulation of the outer margin of the middle part evoked a horizontal eye deviation toward the contralateral side. These results were well explained by the tangential force theory and together with by the well established distribution of the morphological depolarization of the sensory hairs, taking into account that the main axis of the macula displaced at approximately 60 degrees in caudal portion from the sagittal plane.

471, II P (47) 0900

INTRACELLULAR RECORDING OF RAT INFERIOR COLLICULAR NEURONS TO TONE BURSTS. YUTAKA HOSOKAWA, SUSUMU ITO, JUNSEI HORIKAWA, SADAO MINAMI* AND KEIICHI MURATA. Department of Neurophysiology, Medical Research Institute, Tokyo Medical and Dental University, Kanda-surugadai, Tokyo, 101 Japan

We studied intracellular membrane potentials in response to pure tone stimuli in the inferior colliculus of albino rats (250-350g) under Nembutal anesthesia (40mg/kg). The potentials were recorded by glass microelectrodes filled with 1 M K-citrate (40-100 megohm). To the contralateral tone bursts, the depolarization with a preceding or following preceding hyperpolarization was observed. The intensity and frequency of the stimulus changed both the hyperpolarization and the depolarization and modulated spike discharge pattern. Most of the inferior collicular neurons were excited contralaterally and inhibited ipsilaterally. The depolarization to the contralateral stimuli was inhibited by the simultaneous or preceding ipsilateral stimuli even when the sole ipsilateral stimulation elicited no observable hyperpolarization. We discussed the convergence of the contralateral and ipsilateral input on the inferior collicular neurons.

472, III G 0915

COMPARISON OF EFFECTS OF PROSTAGLANDIN-E_2 AND -I_2 ON ACTIVITIES OF THE CANINE VISCERAL POLYMODAL RECEPTOR. MIZUMURA, K., SATO, J. AND KUMAZAWA, T. Dept. Nervous & Sensory Functions, Res. Inst. Environ. Med., Nagoya Univ., Nagoya 464

Polymodal receptors are considered to play an important role in tansmitting noxious informations, especially from inflamed tissues, and are expected to be modulated by some of chemical mediators. Using testis-superior spermatic nerve preparations excised from anesthetized dogs, effects of prostaglandin (PG)-E_2 and -I_2 on activities of testicular polymodal receptors were studied in vitro.

PG-E_2 per se never induced discharges up to 1.4×10^{-7} M in preparations unchallenged by bradykinin (BK), while PG-I_2 induced excitations, though quite weak, in 3 out of 14 cases at the same concentration. At 1.4×10^{-9} M enhancement of the response to BK (9×10^{-8} M) was observed in 6 out of 14 cases with PG-I_2 while in only 1 out of 11 cases with PG-E_2, suggesting a slight higher potency of PG-I_2 in the enhancing effect. This effect became larger along the increase of the concentration. The effect of PG-E_2 lasted longer than PG-I_2, this might reflect a difference of metabolic process of these PGs. Consecutively applied PG of the same species and concentration often failed to induce any enhancement of the response to BK, suggesting an existence of tachyphylaxis to PG. Cross tachyphylaxis between PG-E_2 and -I_2 was also observed.

473, III G 0930

IDENTIFICATION OF THALAMIC NUCLEI RELAYING PULPAL INFORMATION TO SOMATOSENSORY CORTEX (SI). MATSUMOTO, N., SATO, T., OOE, M. AND SUZUKI, T. A. Dept. Oral Physiol., Sch. Dent., Iwate Medical Univ., Morioka, Iwate 020

Pulpal Input pathways in the thalamocortical projection were investigated in the cat. Applying the electrical stimuli to the tooth pulps, single unit activity was recorded in the thalamus. The PST-histograms were analyzed and compared with those of the cortical tooth pulp-driven (TPD) neurons. The thalamic TPD neurons were classified into two types by their response patterns; type I (fast cell) and type II (slow cell). Well correspondence was found between the thalamic and the cortical TPD neurons. However, the neuron which responded with an initial burst followed a prolonged afterdischarge was not found. The thalamic fast cells were mainly distributed in the caudal shell region of the nucleus ventralis posteromedialis (VPM), whereas the slow cells were found in the intralaminar nuclei. On the other hand, the effects of morphine on the pulpal evoked cortical responses in the oral area were examined. Morphine caused no observable changes in the fast wave but produced a significant decrease in amplitude of the slow wave. These findings suggest that there are a dual input pathways which convey the impulse from the tooth pulp to the SI through the thalamocortical projection: one for fast transmission of the pulpal information via the VPM, and another, being sensitive to morphine, for slow transmission via the non-specific nuclei.

474, III G 0945

TASTE AFFERENT SYSTEM FOR SOME AMINO ACIDS AND 5'-NUCLEOTIDES IN MICE. NINOMIYA, Y. AND FUNAKOSHI, M. Dept. Oral Physiol., Asahi Univ. Sch. Dent., Gifu 501-02

Taste afferent system for some amino acids and 5'-nucleotides was studied by examining behavioral responses to them and other taste substances by using a conditioned taste aversion paradigm and their neural responses obtained from single chorda tympani (CT) and glossopharyngeal(GL) fibers in mice. Behavioral experiments demonstrated that monosodium glutamate(MSG), representing prototypical "Umami" in man, generalized strongly to monosodium aspartate, 5'-IMP and 5'-GMP, and fairly to saccharin Na and NaCl, but only slightly if at all to L-glutamine, monoammonium glutamate, L-arginine, glycine, HCl, quinine-HCl and sugars. The section of bilateral GL nerve of the mouse reduced the behavioral discriminability between MSG and NaCl, although that of CT nerve did not. Single CT fibers sensitive to MSG usually more strongly responded to NaCl and/or sucrose than to MSG. On the other hand, there were several GL fibers which responded very strongly to MSG and other several amino acids and 5'-nucleotides but only slightly to sucrose and/or NaCl. Across-neuron correlations between MSG and the four basic taste stimuli calculated for the GL fibers were considerably lower than those for CT fibers. These results suggest that taste inputs from the GL nerve play relatively more important roles in qualitative discrimination between MSG and the four basic taste stimuli than those from the CT nerve does in mice.

475, III G 1000

TASTE RESPONSES TO AMINO ACIDS IN THE JAPANESE SEA CATFISH, Plotosus anguillaris.

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Over the past decade, a number of experiments clearly demonstrate that L-α-amino acids are an important class of chemical stimuli to the chemosensory systems of fishes, indicating that specific amino acids are suitable, high-affinity ligands for the fish taste receptors. Although North American ictalurid catfish have been and are continuing to serve as model organisms in the study of vertebrate gustation, the search for even better experimental organisms, based on relevant neuroanatomical features, continues. We report here the finding of amino acid sensitivity of the Japanese sea catfish, Plotosus anguillaris ("Gonzui"). In the present study, neural responses of the facial nerve of the fish to amino acids and their derivatives were investigated to determine the taste specificity. The stimulatory amino acids for the fish are L-Pro, Bet, L-Hyp, Gly, L-Ala, L-CysH and L-Arg-HCl tested at 0.1 mM. Cross-adaptation experiments show that Bet and Pro, and Ala and Gly may share their receptive mechanisms, respectively. These results support the contention that although L-Ala and L-Pro are especially stimulatory in all species of fish tested so far, electrophysiological taste recordings from fishes show highly species-specific spectra for amino acids.

476, III G 1015

CHARACTERISTICS OF THE TRANSEPITHELIAL POTENTIAL CHANGE PRODUCED BY WATER IN THE FROG TONGUE.

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After adaptation to Ringer solution, stimulation of the mucosal surface with water or weak NaCl solution produced a slow transepithelial potential change across the dorsal epithelium isolated from the bullfrog tongue. No response was elicited during serosal stimulation. The mucosal side during the response became positive to the grounded serosa, and its magnitude was dependent upon excluding NaCl amount out from Ringer solution. The response was depressed by addition of NaCl or its similar salts to stimulus solution, but not by sucrose. Ouabain had no significant effect on the response, but local anesthetics reversibly depressed it. The response was increased after adaptation to Na rich Ringer solution, while it was decreased after Na poor adaptation. The response after serosal adaptation to Na rich Ringer solution was increased but decreased following Na poor adaptation. The results indicate that the response is caused by a passive Na current from the serosa to the mucosa through the tissue.

477, III G 1030

CONTRIBUTION OF CALCIUM CHANNEL IN RECEPTOR MEMBRANE OF FROG TASTE CELL TO ACID-INDUCED RECEPTOR POTENTIAL.

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Previously we reported that both the diffusion potential of Ca^{2+} and Na^{+} and the phase boundary potential which occur at the frog taste receptor membrane are related to the receptor potential elicited by acids. In the present experiment, we examined whether or not Ca^{2+} and Na^{+} in the superficial fluid on the bullfrog tongue pass through the same channel during the acid response. When either Ca^{2+} or Na^{+} existed singly in the superficial fluid, the receptor potential increased proportionally with increasing concentration. The receptor potential in the presence of both ions was smaller than that in the presence of either ion. The competitive inhibition was found between Ca^{2+} and Na^{+}. The receptor potential was not changed by amiloride, but was reduced to 50% of the control by Cd^{2+}. The receptor potential increased in proportion to the concentration of Sr^{2+} and Ba^{2+}. These results suggest that during acid response Ca^{2+} and Na^{+} pass through the same channel, which may be called a chemically gated Ca^{2+} channel.

478, III G 1045

THERMAL SENSITIVITY OF TASTE NEURONS IN SOLITARY TRACT NUCLEUS OF RATS. OGAWA, H., HAYAMA, T. AND YAMASHITA, Y. Dept. Physiol., Kumamoto Univ.Med. Sch., Honjo 2-2-1, Kumamoto 860

We examined responsiveness of solitary tract nucleus (NTS) units to taste, mechanical and thermal stimulation of the oral cavity in anesthetized rats. Thermal stimulations were made by cooling or warming the whole oral cavity by 20°C. Of the 24 NTS units examined, 5 responded to all 3 modalities, 11 to 2 and 8 to one. Four of the 5 thermoreceptive (T) units and 2 thermosensitive mechanoreceptive (T+M) units responded to only cooling and one T to both cooling and warming. But 7 of the 13 thermosensitive gustatory (T+G) units responded to both cooling and warming, 4 to cooling and 2 to warming. T+G units, most excited by sucrose, responded to warming and those most sensitive to HCl produced massive responses to cooling, which is consistent with the previous results on the chorda tympani units (Ogawa et al. 1968). Most of the thermally activated units showed transient responses at the onset of temperature changes, except for 3 T and 4 T+G units with maintained discharges to a steady temperature. Mean thermal sensitivity of the T and T+M units was -4.30 spikes/°C /5s to cooling (n=5), while that of the T+G units was -0.70/°C/5s to cooling (n=10) and 0.67/°C/5s to warming (n=7). Spontaneous discharge rates were the largest in T units (18.0 $\pm$ 11.7 spikes/5s, n=4) and the smallest in thermally insensitive gustatory units (0.4 $\pm$ 0.7 /5s, n=4).

479, III G 1100

UNIT ACTIVITIES OF PRIMATE FRONTO-OPERCULUM DURING EATING AND DRINKING. ITO, S. AND OGAWA, H. Dept. Physiol., Kumamoto Univ. Med. Sch., Kumamoto 860. and Dept. Neurophysiol., Primate Res Inst., Kyoto Univ., Inuyama City, Aichi 484.

To examine the role of cortical oral representation areas on drinking and/or eating, unit activities were recorded from the fronto-opercular cortex of two awake Japanese monkeys, during chewing small pieces of potato or drinking fluid (the four basic taste solutions and water) delivered through a nozzle inserted in the mouth. EMGs were also recorded from the masseter. The event-related unit activities were classified into three types; onset-related (ON), movement-related (MO), and fluid-specific (FL). ON type units increased firing rates on the delivery of all the fluids. Some of this type had tactile receptive fields (RFs) on the tongue. MO type units changed the activity in relation to chewing, sucking, or swallowing, and some of them were activated by touching the teeth. FL units, not influenced by any oral movements detected, showed differential responses to four taste stimuli. Their response properties were similar to those found in gustatory units of the same area in anesthetized monkeys (Ogawa et. al. unpubl. obs.). This type probably included gustatory units. Thus, units were activated differentially, during eating and drinking, according to the location of the RFs or taste submodalities. It is suggested that the fronto-opercular cortex represents mechanical and chemical aspects of foods in the oral cavity.

481, III G 1115

SPECIFIC CARBOHYDRATE EXPRESSIONS BY SUBSETS OF PRIMARY AFFERENT FIBERS IN SOMATOSENSORY AND OLFACTORY SYSTEMS.
MORI, K. Dept. Physiol., Gunma Univ. Sch. Med., Maebashi, Gunma 371

Cell surface carbohydrate expressions by primary afferent fibers were examined histochemically using several kinds of FITC-conjugated lectins. The lectin Ulex europaeus agglutinin I specifically labeled a subset of dorsal root ganglion neurons and their axons which project to the superficial laminae of the spinal dorsal horn. It labeled also a subset of trigeminal afferent fibers which project to the superficial laminae of the caudal subnucleus of the spinal tract of the trigeminal nerve. Soybean agglutinin also labeled a subset of cutaneous primary afferent fibers. In the olfactory system, the soybean agglutinin specifically labeled vomeronasal nerve fibers which project to the accessory olfactory bulb. These results indicate that in both somatosensory and olfactory systems, functionally different subsets of primary afferent fibers express different carbohydrates on their cell surfaces.

482, III G 1130

DUAL OLFACTORY INPUT TO THE ORBITOFRONTAL CORTEX. MOTOKIZAWA, F. AND SHIMOMURA, F. Dept. Physiol., Nara Med. Coll., Kashihara, Nara 634

Neuronal connections of the orbitofrontal cortex(OFC) with the olfactory system were investigated using retrograde and anterograde tracing methods and electrophysiologically in the cat anesthetized with sodium pentobarbital. Following injection of horseradish peroxidase(HRP) into the OFC, labeled neurons are found in the amygdala(AMYG) as well as in the mediodorsal thalamic nucleus(MD), both of which receive olfactory afferents. Following WGA-HRP injection into the MD, dense labeling of axon terminals was found in the layers 1 and 3 of the gyrus proreus, and less dense labeling in the layer 3 of the gyrus rectus. Following WGA-HRP injection into the AMYG, dense labeling of axon terminals was found in the layer 1 of the gyri proreus and rectus and in the layers 1-3 of the transition zone between the two gyri. Neurons of the OFC responded orthodromically or antidromically both to MD and AMYG stimuli. The whole area(both gyri proreus and rectus) of the OFC were responsive both to MD and AMYG stimuli, and the convergence of inputs from the MD and AMYG were observed widely in the OFC. A columner organization was found both for MD and AMYG afferents. Thus the OFC receives a parallel olfactory input from different subcortical relays. Such a neuronal connection suggests that the OFC is an association cortex for olfaction rather than a specific olfactory cortex.

483, III G 1300

SLOW-ADAPTING RESPONSES OF PACINIAN CORPUSCLES OF THE CAT URINARY BLADDER. SAKADA, S., AEBA, A. AND HADA, R. Dept. Physiol., Tokyo Dent. Coll., Chiba 260

The presence of Pacinian corpuscles in the bladder wall of the cat was first noted in 1970 by Shehata. The structure of Pacinian corpuscles in the bladder wall is the same as that of Pacinian corpuscles in the planta and the mesentery. Impulses were recorded in single afferent fibres in the pelvic plexus during passive distension and active contraction of the cat bladder (Iggo, 1955). The receptors in the bladder were slowly adapting mechanoreceptors. But the structure of the receptor could not be determined. The Pacinian corpuscle is well known as a rapidly adapting mechanoreceptor that elicits one or two impulses to constant pressure stimulation. Recently we have found that Pacinian corpuscles taken from the cat planta and mesentery elicit slow-adapting responses to rectangular mechanical stimulation at the temperature of 28-33°C. The present study indicates that electrophysiological properties of single Pacinian corpuscles isolated from the bladder are identical with those of the corpuscles taken from the planta and the mesentery.

484, III G 1315

MAMMALIAN AND AMPHYBIAN MUSCLE SPINDLES STAINED IMMUNOHISTOCHEMICALLY USING ANTI-GLIAL FIBRILLARY ACID PROTEIN. FUNAHASHI, A., ITO, F. & SOKABE, M. Dept. Physiol., Nagoya Univ.Sch.Med., Nagoya 466.

The studies were made on muscle spindles in segmental caudal muscles of the rat and in semitendinosus muscles of the bull frog. Monoclonal antibodies to human glial bribrillary acid protein (DAKO Corp. CA, USA) react to the intrafusal muscle fibers and axon terminals, as well as the capsular cells, in muscle spindles of the both species. The glial immunoactivity was found through the whole length of the intrafusal muscle fibers without significant differentiation between nuclear bag and chain fibers. No reaction was demonstrated in the extrafusal fast and slow muscle fibers in both species. The results were compared with the known distribution of glial cells in the brain and spinal cord of both species. These findings were emphasized also by electron-microscopic observations.

485, ⅢG 1330

HISTOCHEMICAL CLASSIFICATION OF THE INTRAFUSAL MUSCLE FIBERS IN THE FROG MUSCLE SPINDLE. YOSHIMURA,A., FUJITSUKA,N. and ITO,F.* Dept. Educ., Nagoya Inst. Technol., Nagoya 466 and *Dept. Physiol., Nagoya Univ. Sch. Med., Nagoya 466.

Since we have found fusimotor innervation of the frog muscle spindle, the types of the intrafusal muscle fibers were attended in comparison with those in mammalian spindles. The muscle spindles, around which 30 - 50 extrafusal fibers were left, were excised from semitendinosus, iliofibularis or sartorius muscles of the frog Rana catesbeiana. The preparation was frozen in isopentan cooled with liquid nitrogen, and then a serial section of 20 μm thick was made using a cryostat. Myosin ATPase staining after alkali (pH 10.38) and acid (pH 5.00) preincubation made it possible to divide into four types of the intrafusal fibers in semitendinosus and iliofibularis muscles; two of which correspond to fast and slow fibers in the extrafusal muscle fibers, and the other two may be intermediate types as is the case in mammalian muscle spindles. A type of intrafusal fibers in sartorius muscle corresponds to one of the intermediate type.

486, ⅢG 1345

EFFECTS OF cAMP ON THE ENCODING PROCESSES IN FROG MUSCLE SPINDLE. ITO,F. and SOKABE,M. Dept.Physiol., Nagoya Univ.Sch.Med. Nagoya 466.

Muscle spindles isolated from semitendinosus muscles of the frog Rana catesbeiana were decapsulated by incubating in a Ca-free Ringer solution containing 0.2 % collagenase at 33°C for 20 - 30 min. The responses of the sensory nerve terminal during stretch of the receptor were recorded by an air-gap method from the isolated afferent axon. Application of a Ringer solution containing 0.1 - 10 mM dbcAMP or 10 - 100 μM forskolin resulted reversibly in an increase in the rate of spontaneous afferent discharges and also in a deteriorated response to stretch, without significant change in the amplitude of spindle potential. No effect of cGMP was observed. The results suggest that adenylate cyclase mediates encoding processes in the frog muscle spindle.

487, ⅢG 1400

FUSIMOTOR INNERVATION IN THE FROG MUSCLE SPINDLE. FUJITSUKA,N. and ITO,F.* Dept. Educ., Nagoya Inst. Technol., Nagoya 466 and *Dept. Physiol., Nagoya Univ. Sch. Med., Nagoya 466.

Fusimotor innervation of some spindles in semitendinosus muscles of the frog Rana catesbeiana was established using a histochemical technique besides electrophysiological studies, although beta innervation to the amphibian spindles has been received in general. A ramp-and-hold stretch during repetitive stimulation (1 ms in pulse duration, 10 - 50 /s) to a fine motor axon (9.8 m/s in velocity; 3.8 μm in diameter) in the ventral root produced a distinct increase in the static component in the afferent discharge rate without significant change in the dynamic component, while the dynamic one was increased by stimulation of a ß axon (38.5 m/s in velocity; 7.2 μm in diameter). The fine motor axons to innervate intrafusal muscle fibers alone were verified by PAS reaction, which revealed glycogen depletion in some of the fibers without any depletion in the extrafusal fibers when the spindle was frozen soon after repetitive stimulation of the motor axon at 75 Hz for 1 min.

488, III G 1415

SINGLE UNIT RESPONSE CHARACTERISTICS OF MECHANORECEPTIVE AFFERENTS IN THE CAT'S HAIRLESS SKIN TO VIBRATORY STIMULI

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From the signal-dynamical (SD) entropy point of view we propose an autoregressive model and a simple constant model of the signal transmission in the communication system including the nervous system, which requires a pair composed of a noise source and a signal source to encode or decode a message. The SD entropy of a transmitted signal is defined as $I = (1/2)\log P/N$, where P and N are the transmitted signal power and the noise power, respectively. Maximizing the SD entropy lays down a theoretically optimum criterion of coding and filtering. The following statement of signal dynamics is suggested, which has an inverse nature of the 2nd law of thermodynamics: The communication system can decrease or at best maintain the SD entropy.

We apply the concept of SD entropy to the neural signal transmission by the slowly and rapidly adapting, and Pacinian mechanoreceptive units innervating the pad of the cat, and analyze the spike series evoked by the sinusoidal and white-noise vibratory stimulation of the mechanoreceptors. The ordered pattern formation of spike firing, e.g. $Ic \simeq 40$ [dB], is observed in the phase-locked responses. Finally the physiological meanings of the variability of discharge patterns are discussed.

489, II P (38) 0900

CHANGES IN THRESHOLD OF NOCICEPTIVE WITHDRAWAL REACTION (NWR) TO PRESSURE STIMULUS ONTO CRANIOFACIAL AREAS AFTER SODIUM URATE (MSU) CRYSTALS INJECTION INTO TEMPOROMANDIBULAR JOINT.

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Variations in threshold of the NWR to the mechanical stimulation were investigated after injection of MSU crystals (an acute arthritis inducing substance) into the temporomandibular joint (TMJ) of the rabbit. The near-threshold stimulus was applied to 19 loci on the craniofacial skin by a pressure algometer. Following unilateral injection of 1.5 mg MSU crystal suspension (50 µl) into the TMJ, the threshold of NWR decreased maximally at about 4 h, continuing more than 8 h and then it recovered gradually to pre-injection level for one week. A magnitude of this threshold decrease was dose dependent. Besides at the TMJ area, a marked threshold decrease was similarly observed at areas of the ipsilateral tempolar and masseter muscles, but no significant change was found at the ipsilateral bony areas and all of the contralateral areas tested. In contrast to a marked threshold decrease by MSU alone, the injection of MSU crystals (1.5 mg) with lidocaine (1 mg) caused a slight decrease in the threshold, although a degree of swelling in the TMJ area was similar in both cases. Present results may suggest that inflammatory changes in the TMJ possibly produces hyperalgesia in this TMJ area and peripheral nerve dependent hyperalgesia in ipsilateral masticatory muscles.

490, II P (39) 0900

RESPONSE OF NEURONS IN RAT A_1 AND ADJACENT RETICULAR REGION TO ACUPUNCTURE STIMULATION.

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Single unit activity was recorded from neurons in the A_1 and adjacent reticular (A_1R) region of rats to clarify their functional roles in the descending inhibitory mechanisms involved in acupuncture analgesia. Spontaneuos discharge of about 60% A_1R neurons projecting to the nucleus raphe magnus (TYPE I) was significantly suppressed after electrical acupuncture stimulation of Ho-Ku point for 15 min (frequency 45 Hz, duration 0.1 ms, intensity ca. 0.5 mA). Generally, TYPE I neurons had a wide inhibitory receptive field for noxious stimuli. In contrast, a majority of A_1R neurons projecting to the spinal cord at least to the level of Th_{1-5} (TYPE II) showed an excitatory response to the same acupuncture stimulation. To test if these acupuncture-induced changes were directly evoked by endogenous opioid peptides, a specific opioid antagonist, naloxone-HCl (0.1 M) was iontophoretically applied to the A_1R neurons at an intensity of 60-100 nA. The activity of TYPE I neurons was strongly antagonized, while , that of TYPE II was scarcely changed. Histological study revealed that TYPE I and II neurons were located in the rostral and caudal portions of the A_1R region, respectively . The results suggest that there are at least two types of functionally different cells in the A_1R region which presumably play a modulatory role in endogenously activated descending analgesic mechanisms.

491, II P (40) 0900

RESPONSES TO ELECTRIC STIMULATION OF MECHANORECEPTOR AFFERENT UNITS IN THE FROG SKIN.
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We applied electric currents to the receptive fields of 4 types of mechanoreceptor afferent units, rapidly adapting type (RA) I & II and slowly adapting type (Ft) I & II, innervating the plantar surface of bullfrog's hindfoot by a Ringer-agar micropipette, while changing parameters of current electric stimulus to excite them. No differences was found in threshold currents and chronaxie among the 4 types. A double shock test revealed that recovery of the excitability was most rapid in RA I units but slowest in Ft I units. With an increased current strength, response latencies shortened in a stepwise in all the 4 type units as reported by Verveen (1963). When a current pulse of 1 sec was used, striking differences were found in the responses between Ft I and Ft II units. Ft I units produced irregular maintained discharges to an anodal current as with responses to a steady skin indentation, but a single spike each at the onset and offset of cathodal stimulation. Ft II units showed, however, regular maintained discharges in response to both cathodal and anodal currents without phasic discharges, and the threshold was lower in cathodal than in anodal. Since differential responses to anodal and cathodal currents have been reported in lateral line organs with secondary sensory cells (Katsuki et al.1952), Ft I units were suggested to make a functional contact with secondary sensory cells, e.g., merkel cells.

492, II P (41) 0900

SPECTRAL ANALYSIS OF INSTANTANEOUS FREQUENCY RESPONSE TO SINUSOIDAL STIMULATION IN MECHANORECEPTOR AFFERENT UNITS OF FROG SKIN.
TANIGUCHI,K. and OGAWA,H., Dept. of Physiol., Kumamoto Univ. Med. Sch., Kumamoto 860.

Four types of the cutaneous mechanoreceptor afferent units have been recognized in the frog; 2 types of the slowly adapting (SA) units, i.e. Frog type I (Ft I) and Frog type II (Ft II) units, and 2 types of the rapidly adapting (RA) units, i.e. RA type I and RA type II units. On the basis of the phase relation of the first spikes at each cycle of sine wave indentation, we previously reported that both the Ft I and Ft II units were displacement detectors, the RA I units velocity detectors and the RA II units acceleration detectors. Presently, we quantitatively examined the dynamic response of the cutaneous mechanoreceptor afferent units, while applying a Fast Fourier Transform to instantaneous frequency responses of the Ft I, Ft II and RA I. The original response could be reconstructed by adding the DC component, fundamental wave and 2nd - 5th harmonics in the spectra obtained. In the Ft I and Ft II units, the magnitude of the spectrum of the fundamental wave was the highest among others, but in the RA I units the magnitude of the 2nd harmonics was the highest. At sine wave stimulation of low frequencies and large indentation, however, the 2nd harmonics of SA units became larger in magnitude than the fundamental wave. Magnitudes and phases of the spectrum were studied in all 3 units by changing both the magnitude and frequency of sine wave indentation.

493, II P (42) 0900

CHANGES OF THE AFFERENT RESPONSES OF THE SNAKE MUSCLE SPINDLE TO RAMP-AND-HOLD STRETCH IN THE DILUTED K^+ BATHING SOLUTION.
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That Ca^{2+}-dependent K^+ channels($K_{(Ca)}$) were involved in regulating the afferent discharges in frog muscle spindles was reported(Ito,F. 1981), but in cat muscle spindles, such a role of $K_{(Ca)}$ was suspected(Hunt,C.C. 1978). On the role of this type of K^+ channels, changes of the afferent responses of snake muscle spindles were examined in the diluted K^+ bathing solution. The rate of the afferent discharges to dynamic phase of stretches increased in the solution of 1.5-2.0 mM K^+ unexpectedly with little changes of the latency. Static and spontaneous discharges also had the tendency of the increase. The application of APAMIN of 125nM to the solution caused the inhibitory effect on the afferents. Reducing $[K^+]_o$ may cause the level changes of the potencials in sensory terminals and the spike initiation sites and of the equilibrium potencial for K^+, exerting influences on various types of G_K. These results suggest that $K_{(Ca)}$ may exist in the reptilian muscle spindles and participate in controlling the rate of the afferent responses, together with other types of K^+ channels.

494, II P (43) 0900

ROLE OF ANIONS IN SALT TASTE RECEPTION OF THE FROG. KITADA, Y. Dept. of Physiology, Okayama University Dental School, Shikata-cho, Okayama 700

In salt taste reception, it has been generally accepted that cation has an excitatory action on taste receptors and anion has a supplemental role. However, role of anions in salt taste reception is still obscure. In the present study, the influences of anions on the salt taste responses of the frog glossopharyngeal nerve were investigated. The effect of anions on the salt response varied with cation species. For example, SCN^- inhibits the Ca response, whereas it greatly enhances the Na response. The kinetics of enhancement of the Na response by SCN^- was studied. The results indicate that the formation of cation-receptor site complex leads to excitation of the taste cell and anions alter the salt response by interference with a certain step of stimulation process without altering the dissociation constant for cation-receptor complex.

Choline-Cl did not excite the water fibers. Addition of choline-Cl to a $MgCl_2$ solution or a NaCl solution did not affect both the Mg response and the Na response. This indicates that Cl^- does not affect the Mg response and the Na response, and that the mechanism of taste stimulation by salt can not be explained in terms of surface potential on an outer membrane surface.

495, II P (44) 0900

RESPONSE CHARACTERISTICS OF CORTICAL TASTE AREA NEURONS IN HAMSTERS. YAMAMOTO, T. AND KITAMURA, R.* Dept. Oral Physiol., *Dept Oral Surg., Osaka Univ. Fac. Dent., 1-8 Yamadaoka, Suita, Osaka 565.

The responses of 42 cortical neurons to the four classical taste stimuli (sucrose, NaCl, HCl, and quinine hydrochloride) were recorded extracellularly in acute, urethane-anesthetized hamsters. The results were compared with the data previously reported for the lower order taste-responsive neurons. The magnitudes of cortical responses to the four stimuli were smaller, while their spontaneous rates of discharges were greater than those of the lower order neurons. About 14% of the cortical neurons were inhibitory in response to one or more of the four stimuli. The excitatory cortical neurons were broadly tuned to the four tastes: about half of the neurons responded to more than three of the four stimuli, and the mean entropy of the response profiles was 0.745. The across-neuron correlations of activity evoked by the four stimuli were similar and quite high, ranging from 0.56 for NaCl-quinine pair to 0.78 for HCl-quinine pair. The present study indicates that the taste stimuli are less discriminated at the cortical level than at the lower levels.

496, III D 0915

COMAPRISON OF ELECTRICAL PROPERTIES BETWEEN HUMAN AND GUINEA-PIG TRACHEAL SMOOTH MUSCLES. HONDA, K., BABA, K., AND TOMITA, T. The 2nd Dept. Int. Med. and Dept. Physiol., Nagoya Univ., Nagoya 466

The trancheal smooth muscles generally lack the muscle tone. In the guinea-pig and human trachea, however, a high muscle tone has been reported. It was found in these muscles that there was a rhythmic changes in membrane potential (slow wave) which was closely related to the development of muscle tone. In the present experiments, the mechanical and electrical activity were compared in human and guinea-pig tracheal muscles with intracellular microelectrodes. In guinea-pig, the mean values of membrane potential and slow wave amplitude were -51 and 12 mV, respectively. The similar results were obtained in human, and the pattern of slow wave was also similar, except that its frequency was higher in guinea-pig (about 40/min) than in human (about 17/min). The most significant difference was that indomethacin (1 μM) abolished the slow wave and muscle tone in guinea-pig, but not in human. The effects of carbachol (depolarization and contraction) and those of isoprenaline (hyperpolarization and relaxation) were essentially the same in both species.

497, III D 0930

BETA-ACTION ON THE GUINEA-PIG TRACHEAL MUSCLE IN THE PRESENCE OF BARIUM ION. BABA, K., HONDA, K. AND TOMITA, T. The 2nd Dept. Int. Med., Dept. Physiol., Nagoya Univ. Sch. Med., Nagoya 466

The tracheal smooth muscles contracted by carbachol (10 μM) were relaxed by isoprenaline or forskolin (an adenylate cyclase activator) dose-dependently. The response to carbachol was not significantly modified by an addition of Ba, but the effect of isoprenaline was markedly reduced by increasing Ba concentrations to 4.8 mM. The Ba effect was potentiated by decreasing Ca concentrations. Verapamil (3 μM) had a negligible effect on the tension development caused by carbachol and did not alter the effect of isoprenaline. On the other hand, in the presence of Ba (4.8 mM), the relaxation by isoprenaline was strongly potentiated by verapamil without affecting the carbachol response and the isoprenaline effect became even stronger than the control observed in the absence of Ba. The similar results were obtained for the relaxation produced by forskolin. Since an increrase in cyclic AMP level caused by these relaxants was not suppressed by Ba, it probably interferes with some other intracellular process involved in the relaxation mediated by beta-adrenoceptors.

498, III D 0945

PATCH CLAMP STUDY OF SINGLE CA CHANNELS IN MAMMALIAN VISCERAL SMOOTH MUSCLE CELLS. YOSHINO, M. AND YABU, H. Dep. Physiol. Sapporo Med. Coll. Sapporo, 060.

Recordings of single Ca channel currents from guinea-pig taenia coli smooth muscle cells were obtained using cell-attached patch clamp technique with the use of pipettes filled with 50 mM Ba^{2+}. Cells were prepared by enzymatic dispersion using collagenase (Obara, 1984). When the patch membrane was depolarized 60-100 mV above resting potential (RP), brief inward current pulses of unitary size (0.8-1.8 ms) and small amplitudes (0.5-1.1 pA) were observed during the period of depolarization. The opening probability increased with depolarization from 0.067 to 0.423. Modulation of Ca channels by the dihydropyridine Ca agonist Bay K 8644 was investigated. Applying the drug into the superfusate markedly increased the opening probability of Ca channels. This effect was found to be due to an increase in the mean open time of Ca channels and not to an increase in the single channel current. Due to this large prolongation, the mean current obtained by averaging individual current responses was markedly enhanced.

499, III D 1000

EFFECTS OF CATECHOLAMINES ON IONIC CURRENTS OF GUINEA-PIG VAS DEFERENS IN BARIUM KREBS SOLUTION. INOMATA, H. Dept. Appllied Physiol., Tohoku Univ. Sch. Med., Sendai 980

To analyze adrenergic modulation of calcium channels in vas deferens smooth muscle, effects of alpha- and beta-adrenergic agonists have been studied in current and voltage clamped preparations. Barium was used as the current carrier instead of Ca to suppress possible contamination from Ca-activated potassium channels. Noradrensline(NA) causes membrane depolarization and reduces the rate of rise of Ba-action potential, while isoprenaline(ISO) causes no detectable change in membrane, but enhances the rate of rise. Under voltage clamped conditions, on Ba current(I_{Ba}), NA decreases the maximum I_{Ba} and shifts the reversal potential(E_{Ba}) to more negative voltages. The time course of both activation and inactivation is slowed slightly. On other hand, ISO strongly enhances the maximum I_{Ba} and causes no change in E_{Ba}, with increasing the maximum conductance ($\bar{g}_{Ba}$). The activation is rapid, but the inactivation unaltered. On the steady state outward current(I_b) due to K, ISO enhances I_b in the preparation held to Ba-induced depolarization level, while in the other preparations held back to the original resting potential, ISO does not alter the reversal potential or the maximum conductance($\bar{g}_b$). The present results would suggest that inotropic function mediated through alph- and beta-receptors may be attributed to modulation of Ca from myoplasma binding site or/and K efflux rather than to modulation of transmembrane Ca influx.

500, III D 1015

CONTRACTILE RESPONSE OF PORTAL VEINS FROM CHRONIC PORTAL HYPERTENSIVE RATS TO EXTERNAL POTASSIUM AND CALCIUM CONCENTRATIONS. YOSHIMURA, T., KIYOSUE, T. AND ARITA, M. Dept. of Physiol. Medical College of Oita, Oita 879-56

We studied contractile properties of portal vein isolated from portal hypertensive rats(PHR) with liver cirrhosis, which was made by repeated subcutaneous injection of CCl_4(2mg/kg) twice a week for 40 weeks. Portal venous pressure in vivo was significantly higher in PHR (138.5±30.1 mmH_2O) than the control rats (78.2±2.9 mmH_2O). Longituidal strip of portal vein was mounted in an organ bath and perfused with Tyrode's solution with different K^+ and Ca^{++} concentrations. The isometric tention was measured by a straing gauge. In control solution, spontaneous contractile force was greater and the frequency was lower in PHR preparations than the control preparations. The contractile response of PHR preparations to different $[K]_o$(5.4-86.4mM) was the same to that of the control. However, the response to different $[Ca]_o$(0.45-5.4mM) measured in 86.4mM$[K]_o$ condition was significantly greater in PHR preparations. D-600(1μM) inhibitted $[Ca]_o$-induced increases in the tension more effectively in PHR preparations than the control ones. Results suggest that contractile force of portal vein from PHR is larger probably due to increased membrane permeability to Ca ions as compared to control preparations.

501, III D 1030

EFFECTS OF HYDROGEN PEROXIDE ON THE MECHANICAL RESPONSE IN THE LONGITUDINAL MUSCLE OF RAT MYOMETRIUM. UNO, Y. TAKAI, A. AND TOMITA, T. Dept. Physiol., Nagoya Univ. Sch. Med., Nagoya 466

Several smooth muscles can produce a sustained (Ca-independent) contraction in response to various agonists or fluoride even in the absence of the external Ca. However, the mechanism underlying this response is not clear. Since hydrogen peroxide (H_2O_2) is known to play a possible important role in many intracellular functions, we have studied the effects of H_2O_2 on the rat myometrium which produces the Ca-independent contraction by oxytocin. In the presence of Ca, H_2O_2 (0.5-5 mM) increased the frequency of spontaneous phasic contractions and this effect was blocked by indomethacin (1 μM). H_2O_2 was able to produce a slow contraction (indomethacin-insensitive) in Ca-free solution at higher than 0.1 mM. The tension development caused by 2 mM H_2O_2 applied for 4 min was about 30% of that caused by 20 nM oxytocin. Effects of H_2O_2 on the oxytocin response in Ca-free soltuion varied in different preparations, but there was a tendency that larger oxytocin responses are reduced, while smaller responses increased. The contraction induced by H_2O_2 became irreversible beyond 10 mM.

502, III D 1045

LIPID COMPOSITION RELATED TO Ca TRANSPORT BY PLASMA MEMBRANE ISOLATED FROM STOMACH SMOOTH MUSCLE.

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The accumulation of Ca^{2+} and phospholipids influencing Ca^{2+} incorporation in plasma membrane (PM) isolated from canine stomach smooth muscle was investigated. The major phospholipids in PM were phosphatidylethanolamine (PE, 26%), phosphatidylcholine (PC, 20%), and phosphatidylserine + phsophatidylinositol (PS + PI, 15%). The cholesterol/phospholipid ratio in the PM was 0.64. Accumulation of Ca^{2+} uptake was inhibited by exogenous PE, PC and PS, but increased by PI. In the absence of ATP, Ca^{2+} uptake was increased slightly by PE and significantly by PI, but was not affected by PC or PS. These phospholipids in the dilution medium tended to increase the release of Ca^{2+} from PM. Neomycin inhibited Ca^{2+} uptake by PM in the presence and absence of ATP. This inhibition by neomycin increased in the presence of PI. Results suggest that phospholipids are important in the Ca^{2+} transport system, and PI was the most active of the four tested. PI appears to increase Ca^{2+} binding to PM by either fusion or adsorption.

503, III D 1100

ACTIONS OF PGE_2 ON THE CIRCULAR MUSCLE OF GUINEA-PIG COLON

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The contractile and relaxant effects of PGE_2 on the circular muscle layer of isolated guinea-pig colon were investigated. PGE_2 (1nM - 1μM) dose dependently relaxed circular muscle, although PGF_{2a} contracted it. However, PGE_2 at high doses (0.1 - 1μM) produced a phasic contraction followed by a relaxation. This initial contraction, which stimulates spike activities, was not blocked by atropine, tetrodotoxin, methysergide or antihistamine, but was abolished by Ca blocker, verapamil. PGE_2-induced relaxation, which suppresses spike activities, was not blocked by adrenergic antagonists. When the temperature of bathing solution was lowered from 37°C to 22°C, PGE_2 produced only a contraction.

From these results, it is considered that PGE_2 have two opposite actions (contraction and relaxation) on the circular muscle of colon, and that the contraction may depend on an increase in Ca influx by spike generation and/or depolarization, and the relaxation may depend on an increase in Ca efflux and/or uptake of intracellular Ca ions to the store sites by energy-dependent process.

504, III D 1115

RELATIONSHIP BETWEEN THE FREQUENCY OF SPONTANEOUS CONTRACTIONS AND THE ACETYLCHOLINE CONTENT OF THE RABBIT SMALL INTESTINE.

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Using segments taken from three parts (duodenum, jejunum and ileum) of the rabbit small intestine, both the frequency of spontaneous contractions (pendular movements) and the acetylcholine content of the muscle layer were measured.

Both the measured values were the highest in duodenum and the lowest in ileum. There were the gradients of both values and there exists the significant correlation between both values, the higher the frequency of contractions the higher the acetylcholine content. One week after the vagotomy, the gradients of both the values were abolished, but they were restored three weeks later.

It was suggested that the automaticity of the small intestine muscle might be related with the content in acetylcholine.

505, ⅢD 1130

INFLUENCE OF CYCLOHEXIMIDE ON THE CHANGES IN PROPERTIES OF THE CIRCULAR MUSCLE OF PREGNANT RAT UTERUS. MARUTA,K., OGASAWARA,T. AND OSA,T. Dept. of Physiol., Yamaguchi Univ. Sch. of Med., Ube 755

A study was made of the effects of an inhibitor of protein synthesis (cycloheximide) on the changes in electrical activity and adrenergic response of the circular muscle of pregnant rat uterus. Membrane activity transfered from plateau type on gestation Day 18 to spike type on Day 22. Excitatory reaction of the contraction to noradrenaline (10^{-7}, 3×10^{-7}M) on Day 18 altered to inhibitory one on Day 22. When the pregnant rats were injected with 50 μg cycloheximide daily from Day 18, the changes in the circular muscle mentioned above were suppressed and parturition delayed by 12-48 hr. In the preparations obtained on Day 21, excitatory effect of 10^{-7}M noradrenaline changed to inhibitory one during prolonged in vitro incubation with Krebs solution. This transformation was prevented by the application of 2μg/ml cycloheximide into the incubation medium. The results suggest that the process of protein synthesis is involved in the alterations in electrical activity and adrenergic response of the circular muscle of rat uterus during late pregnant stage.

506, ⅢD 1145

COMPARISON OF PHOSPHOROUS METABOLITES BETWEEN STOMACH MUSCLE AND TAENIA OF GUINEA-PIG STUDIED WITH NMR. NAKAYAMA, S., TAKAI, A., TOMITA, T. SEO, Y. AND WATARI, H. Dept. Physiol., Nagoya Univ. Nagoya 466, Nat. Inst. Physil. Sci., Okazaki 444

Metabolic characteristics were compared between smooth muscles of the stomach (mainly a corpus region, mucosal layer removed, about 3 g in wet weight) and the taenia (about 4 g) of the guinea-pig utilizing ^{31}P-NMR technique with a Bruker WM-360 wb spectrometer operating at 145.8 MHz. The preparations obtained from 3 guinea-pigs were mounted in a test tube of a 10 mm outer diameter and perfused with physiological solution, saturated with oxygen, at a constant rate of 4-5 ml/min kept at 32°C. Radiofrequency pulses of 30° (pulse width: 10 μsec) were repeated at an interval of 0.6 sec and the signals were accumulated 500 times for 5 min. The spectra obtained from stomach muscle differed from taenia in the following points. (1) Sugar phosphate peaks were significantly larger and always separated into two. (2) ATP_{α} peak and its shoulder were clearly larger, probably reflecting a higher concentration of NAD and NADH components. (3) The ratio of [creatine phosphate/ATP] was lower (45-70% of taenia).

507, ⅡP (27) 0900

CHARACTERISTICS OF CALCIUM-DEPENDENT POTASSIUM CHANNELS IN THE RAT MYOMETRIUM. KIHARA, M., MATSUZAWA, K. TOKUNO, H. AND TOMITA, T. Dept. Gynaecol., Dept. Physiol., Nagoya Univ. Sch. Med., Nagoya 466

Ca-dependent K channels in single longitudinal muscle cells of the rat uterus were studied with excised membrane patch (inside-out). When pipette contained 100 mM K and 2.4 mM Ca and bathing (intracellular) solution 133 mM K, the probability of the channel being open was depending on the Ca concentration in the bath; it was nearly zero below pCa 7.3, and reached the maximum at about pCa 6.8. The single channel conductance was remained the same (approximately 205 pS) independent of Ca concentrations, but decreased to 80 pS by reducing intracellular K to 6 mM. As the K concentration was reduced the rectification appeared, the conductance being decreased in a depolarizing direction. The conductance decrease and the rectification were both partially compensated by increasing Na concentrations, indicating a relatively high permeability of the channel to Na. The open probability was slightly reduced on hyperpolarization and markedly reduced by Ba or Cs. TEA shifted the V-I curve toward hyperpolarization and slightly reduced conductance, without a significantly change in the channel kinetics.

508, II P (28) 0900

CALCIUM-DEPENDENT POTASSIUM CHANNELS IN THE TAENIA OF GUINEA-PIG CAECUM STUDIED BY PATCH CLAMP METHOD. TOKUNO, H., KIHIRA, M. AND TOMITA, T. Dept. Physiol., Dept. Gynaecol., Nagoya Univ. Sch. Med., Nagoya 466

Ca-dependent K channels in the taenia of guinea-pig were studied with the patch clamp technique. When pipette solution contained (mM) K 6, Na 127 and Ca 2.4 and bath solution K 100, Na 33 and Ca 2.4, the single channel conductance in the escised (inside-out) membrane was linear (about 120 pS) in an inside positive direction, but it gradually reduced in an inside negative direction to about 30% at -60 mV. When the ionic composition was reversed in the pipette and bath the rectification was also reversed; i.e. the conductance was constant in a hyperpolarizing direction and reduced in a depolarizing direction. The open probability of channels was increased by increasing Ca concentrations in the bath above 0.01 μM and reached the maximum at 1 μM. Distribution of open time could be described by single exponential, but that of closed time by double exponential. The VI curve was shifted in parallel to right by 10 mV by increasing Ca from 0.1 μM to 2 mM. The effects of reducing Na concentration in the bath and of TEA were essentially the same as those observed in the rat myometrium.

509, II P (29) 0900

EFFECTS OF GLYCOGEN DEPLETION ON Na-PUMP ACTIVATION IN THE TAENIA OF GUINEA-PIG CAECUM. TOMITA, T., TOKUNO, H. AND TAKAI, A. Dept. Physiol., Nagoya Univ. Sch. Med., Nagoya 466

In the taenia of guinea-pig, it is known that K-readmission following exposure to K-free solution for 10-20 min produces a transient hyperpolarization by activating the electrogenic Na-pump. However, when the preparation was depleted of glycogen by producing K contracture in the absence of glucose, the K-readmission failed to produce the hyperpolarization even though the membrane potential was nearly normal. The K-induced hyperpolarization recovered by applying β-hydroxybutyrate (βHB) or glucose, and βHB was as effective as glucose as a substrate in producing the K-induced hyperpolarization. A βHB application immediately after K-readmission produced a transient hyperpolarization, but this hyperpolarization became samller as the time of βHB application was delayed. These effects of βHB were blocked by ouabain (1 μM). It was concluded that a high rate of energy and accumulation of intracellular Na are necessary for a clear demonstration of the electrogenic pump activity and that the pump can be supported by oxidative phosphorylation without glycolysis.

510, II P (30) 0900

PROPERTIES OF THE MECHANICAL RESPONSE TO RAPID COOLING IN GUINEA-PIG TAENIA COLI. EMURA, A. AND SUGI, H. Dept. Physiol., Sch. Med., Teikyo Univ., Itabashi-ku, Tokyo 173

Physiological properties of the mechanical response to rapid cooling in guinea-pig taenia coli were studied with an apparatus to change the temperature of the surrounding medium within a fraction of a second. In normal Krebs solution, the magnitude of the mechanical response, which amounted to about 60% of the maximum K-contracture tension, did not change appreciably when the temperature was rapidly reduced from 33 to 27-10°C. The mechanical response to rapid cooling was eliminated after the removal of external Ca ions (3 mM EGTA present) or by the addition of Mn ions (5 mM), but was not affected in the presence of procained (2 mM). These results indicate that the inward movement of external Ca ions may be responsible for the initiation of the mechanical response to rapid cooling. The mechanical response to rapid cooling could also be produced in preparations, which had relaxed in a solution containing 120 mM-K, and the magnitude of the response increased as the magnitude of the step change in temperature was increased. If the preparation was returned to the standard temperature (33°C) and again subjected to rapid cooling, the magnitude of the mechanical response decreased as the time at the standard temperature was shortened.

511, II P (31) 0900

EFFECT OF IONIC STRENGTH ON THE CONTRACTION IN GLYCERINATED SMOOTH MUSCLE OF GUINEA-PIG TAENIA COLI. TORIDE, M. AND SUGI, H. Dept. Physiol., Teikyo Univ. Sch. Med., Tokyo 173

We have already reported that, in guinea-pig taenia coli, the maximum contracture tension (with 145 mM-K) and the maximum shortening velocity (Vmax) are reduced in both hypertonic and hypotonic solutions. To study the effect of hypertonic and hypotonic solutions in more detail, the tension development and Vmax were examined on glycerinated taenia coli smooth muscle preparations activated by Ca under various ionic strengths. The maximum Ca-activated tension decreased in both high (0.25 M) and low (0.06 M) ionic strengths, as with the K-induced contracture tension in the intact preparation. On the other hand, Vmax was found to decrease at the low ionic strength and to increase at the high ionic strength, in contrast with the result on the intact muscle. The above results on the Ca-activated glycerinated smooth muscle are qualitatively different from those on Ca-activated skinned skeletal muscle fibers.

512, II P (32) 0900

EFFECTS OF NICORANDIL ON SINGLE SMOOTH MUSCLE CELLS OF GUINEA PIG TAENIA CAECI. ITO, Y., OBARA, K. AND YABU, H. Dept. of Physiol., Sapporo Med. College, Sapporo 060

The effects of nicorandil on the contractile properties and ^{45}Ca fluxes in single smooth muscle cells were studied. The single cells were isolated from guinea pig taenia caeci by digestion with 0.3% collagenase. Nicorandil inhibited high K (71mM)- and carbachol (0.1mM)-induced contraction in a dose dependent manner. The inhibitory effects of nicorandil on these contractions were remarkable at concentrations of 1mM or more. The cells did not contract with the simultaneous application of high K and EGTA (7mM). They responded, however, when carbachol was added to the medium containing high K and EGTA, and this carbachol-induced contraction was inhibited by nicorandil. Nicorandil (5mM) did not affect ^{45}Ca uptake in carbachol-containing medium or high K-stimulated ^{45}Ca uptake. Spontaneous and carbachol-stimulated ^{45}Ca effluxes were not affected by nicorandil.

These results suggest that nicorandil inhibits the contraction by a mechanism which is independent of Ca fluxes.

513, II P (33) 0900

CHARACTERISTICS OF ENERGY METABOLISM IN THE GUINEA-PIG TRACHEAL SMOOTH MUSCLE. ITOH, M., TAKAI, A. AND TOMITA, T. The 2nd Dept. Int. Med. and Dept. Physiol., Nagoya Univ., Nagoya 466

The tracheal muscle and the taenia of guinea-pig produce sustained contraction in excess K solution. When oxidative phosphorylation was inhibited during the K-contracture by cyanide or anoxia, the tension was reduced by only about 20% in trachea, while by more than 90% in taenia. On the other hand, when glucose was omitted from the external medium, the contracture was progressively decreased, but the rate of decrease was much slower in trachea than taenia. This is likely to be due to the fact that trachea contained a larger amount of glycogen and developed smaller tension per unit cross area comapared with taenia. When glucose was substituted with β-hydroxybutyrate (under the glycogen-depleted condition), the oxygen consumption rate during the K-contracture was greater by about 50% in trachea and by about 20% in taenia than in the presence of glucose. It was concluded based on the estimation from oxygen consumption and lactate production that glycolysis has a relatively larger contribution to an energy demand for the K-contracture in the tracheal muscle than the taenia.

514, II P (34) 0900

CHANGES OF THE SERIES ELASTICITY DURING ACTIVATION AND RELAXATION IN THE ANTERIOR BYSSAL RETRACTOR MUSCLE OF MYTILUS. IWAMOTO, H. AND SUGI, H. Dept. Physiol., Sch. Med., Teikyo Univ., Tokyo 173

The elastic properties of the anterior byssal retractor muscle (ABRM) of Mytilus were studied during activation, phasic and tonic relaxations, by applying sinusoidal vibrations and ramp releases. The muscle was activated with 10^{-3} M acetylcholine (ACh) and made to relax by applying 10^{-6} M 5-hydroxytryptamine (phasic relaxation), or simply by removing ACh (tonic relaxation or catch). The stiffness of the muscle, as examined by the sinusoidal vibration (10Hz, 0.6%), showed higher values during the tonic relaxation than during activation or the phasic relaxation. The force-extension curves of the series elastic component (SEC) were determined by applying ramp releases (3%, complete within 4msec). The total amount of extension of the SEC increased with increasing force levels and amounted to ca. 2% of muscle length at maximal activation. Compared at the same prerelease levels of force, the curves for activation and for the phasic relaxation showed a striking resemblance, suggesting that the origin of the SEC is common in the two states. During the tonic relaxation, the curves became steeper with a reduced amount of extension. These results are discussed from the viewpoint of the force-bearing mechanism in the phasically or tonically relaxing muscle.

515, II P (35) 0900

ELECTRON MICROSCOPIC STUDIES ON THE STRUCTURAL CHANGES IN A MOLLUSCAN SMOOTH MUSCLE DURING ACTIVE AND CATCH CONTRACTIONS.
TAKAHASHI, I., AMAKAWA, Y*, TAKAMA, M* AND SUGI, H. Cent. Lab. Electron Microsc., and Dept. Physiol., Sch. Med., Teikyo Univ., Itabashi-ku, Tokyo 173

To give information about the catch mechanism in molluscan smooth muscles, the structural changes in the anterior byssus retractor muscle (ABRM) of Mytilus edulis during active and catch contractions were studied with the quick freezing and the freeze substitution methods.

Careful examination of the longitudinal and transverse sections indicated that the projections from the thick filaments formed two different kinds of cross-linkes; one was the linkings between the adjacent thick and thin filaments, while the other was those between the adjacent thick filaments. The number of both the thick to thin and the thick to thick linkages per thick filament in the ABRM fibers was of the order, resting < ACh-induced active contraction < catch. These results might suggest that the catch tension would be supported by not only the slow rate linkage breakings of the thick to thin but also those of the thick to thick.

516, II P (36) 0900

DIFFERENCES OF MECHANICAL PROPERTIES OF SMOOTH MUSCLE BETWEEN A STRIP PREPARATIONS AND A WHOLE TISSUE OF GUINEA-PIG VAS DEFERENS. MIZOBE, H., TSUCHIYA, T. AND SUGI, H. Dept. Physiol., Teikyo Univ. Sch. Med., Tokyo 173

Mechanical properties of smooth muscle are usually investigated by using strip preparations dissected out of tissues. It is, however, probable that these mechanical properties are different from those of a whole tissue. To examine this possibility, the length-tension relation of circular muscle and longitudinal one in guinea-pig vas deferens was determined in two methods. In one method, longitudinal strip preparations and circular ones were dissected and stimulated electrically in various length and the length-tension relation was obtained. In another method, a whole tubular tissue was mounted in a bath with one end connected to pressure gauge. The length and diameter was changed by changing the resting intraluminal pressure. The average longitudinal and circumferential wall tensions were calculated from the active pressure responses. The length-tension curves thus obtained were similar in shape to those in strip preparations but tension developed in much smaller range of length than in strip preparations.

517, II P (37) 0900

STRUCTURAL CHANGES OF INDIVIDUAL CELLS DURING ISOTONIC CONTRACTION OF GUINEA PIG SMOOTH MUSCLE STRIPS.

OOTA, I., MORIYA, M. AND YABU, H.
Dept. Physiol., Sapporo Med. College, Sapporo 060.

The relationship between the shortening of muscle strips and that of their constituent cells, and changes in cellular surface structure during isotonic contraction were examined using guinea pig taenia coli and stomach circular muscle. The strips were prefixed with 3% glutaraldehyde during isotonic contraction at various strip lengths ($0.45\text{-}1.0L_0$), and postfixed with 1% OsO_4. Isotonic contraction was induced in strips by electrical stimulation. The fixed tissues were treated with 8N HCl, in order to disperse individual cells from fixed strips. The dispersed cells were prepared for scanning electron microscopy and for measurement of cell length by a figure analysing system. The extent of cellular shortening was somewhat greater than that of the strip itself. Although the cells in each strip varied in length, the distribution pattern of cell length was equally represented at any shortening level of the strip. These results suggest that all the cells in the strip shortened to the same extent. The shortened cells showed a striated pattern of membrane folding throughout their entire lengths.

518, I F 0915

THE ORIGIN OF THE SERIES ELASTIC COMPONENT IN HORSESHOE CRAB SKELETAL MUSCLE FIBERS.
SUGI, H., GOMI, S. AND TANAKA, H. Dept. Physiol., Sch. Med., Teikyo Univ., Itabashi-ku, Tokyo 173

We studied the anatomical origin of the highly compliant series elastic component (SEC) in horseshoe crab skeletal muscle fibers. The force-extension relation of the SEC, obtained by applying quick releases to tetanized muscle fibers, indicated that the minimum amount of quick release required to drop the tetanic force to zero was about 6% of the fiber slack length. As the sarcomere length of the fibers at the slack length was 7-8 μm, the SEC in horseshoe crab muscle fibers is much more compliant than that in frog skeletal muscle fibers. High-speed cinematography (1,000 frames /sec) showed that the SEC was uniformly distributed in each sarcomere. The localization of the SEC in each sarcomere was further studied by use of thin bundles of glycerinated muscle myofibrils mounted on a polarizing microscope. When a very short segment of myofibrils, with both ends fixed in position, was activated with iontophoretically applied Ca ions, the A-band width was observed to increase by about 10% during the resulting nearly isometric contraction, and this A-band elongation amounted to about 6% of the sarcomere length. These results indicate that the highly compliant SEC in horseshoe crab muscle fibers is due to the elastic elongation and recoil of the A-band.

519, I F 0930

STUDIES ON ACTIN-LINKED REGULATION IN SCALLOP STRIATED MUSCLE.
ASADA, N. YAZAWA, Y. Division of Nutritional Physiology, Hokkaido University of Education, Hokumoncho 9, Asahikawa 070

Actin-linked calcium regulatory system in scallop striated muscle was studied with its thin filaments. When the thin filaments were added to scallop actomyosin reconstituted with scallop myosin and skeletal actin, the extent of superprecipitation(turbidity at 660nm) of actomyosin was enhanced in the presence of 10^{-4}M Ca^{2+}. Similar enhancement of superprecipitation was also observed when skeletal tropomyosin and troponin were added. Mg^{2+}-ATPase activity of the actomyosin was inhibited at low Ca^{2+} concentration(10^{-7}M) and activated at high Ca^{2+} concentration (10^{-4}M) when the thin filaments were added. When scallop thin filaments were added to rabbit skeletal myosin, superprecipitation and Mg^{2+}-ATPase activity were inhibited and the inhibition was independent of Ca^{2+} concentrations. These effects of the thin filaments were also reproducible by addition of the single protein in the thin filaments. It suggests that the actin-linked regulatory protein exists in scallop striated muscle and which may be different from tropomyosin-troponin system.

520, I F 0945

VARIATION OF STIFFNESS DURING AND AFTER RAMP LENGTH CHANGE IN FROG SINGLE MUSCLE FIBERS.
TSUCHIYA, T. AND SUGI, H. Dept. Physiol., Teikyo Univ. Sch. Med., Tokyo 173

Contractile tension in skeletal muscle is known to increase or decrease above or below isometric tension during and after ramp stretch or release respectively and the stiffness change in these phenomena were investigated on frog single muscle fibers. A small high frequency vibration was imposed to measure the stiffnes. During stretch, the stiffness rose steeply at first along with the tension and then began to decrease linearly, though the tension continued to rise slowly. After stretch the stiffness decayed exponentially and reached the same level as was produced during isometric contraction at the sarcomere length after stretch. The tension redeveloped after the release was lower than the isometric tension at the same sarcomere length as that after release. This tension difference, called tension deficit, was dependent on the magnitude and the velocity of the release and the stiffness during and after ramp release was nearly proportional to the tension.

521, I F 1000

LATTICE SPACING IN RADIALLY COMPRESSED FROG SKINNED MUSCLE FIBERS.
UMAZUME,Y., HIGUCHI,H. and TAKEMORI,S., Dept. Physiol., The Jikei Univ. Sch. Med., Minatoku Tokyo 105

The 1,0 lattice spacing (d) of mechanically skinned fibers of semitendinosus muscle were measured at various concentrations of polyvinylpyrrolidone K-30 (Mw = 40,000) or Dextran T-500 (Mw = 488,000). In a standard relaxing solution (MgATP 4, Mg 1, EGTA 4, ionic strength 150 mM at pH 7.0), d was 41.3 nm and decreased as the osmotic pressure (P) increased. At the sarcomere length (L) of 2.5 μm, the decrease in d with P was large until a definite 'break point' was reached (at about 35 nm). From the geometrical consideration, it is possible that there is contact of myosin heads with thin filaments at $d \leq 35$ nm. On the other hand, the break point was about 30 nm in the fiber stretched to L = 3.5 μm, where thin filaments do not exist in A-bands. This result suggests that myosin heads contact with adjacent heads at $d \leq 30$ nm. The radial stiffness (K) at smaller d than that at break point was not significantly different with that in rigor fibers. Above results suggest that K at smaller d reflects the force between the myosin head and thick filament backbone.

522, I F 1015

AN X-RAY DIFFRACTION STUDY OF FROG SKELETAL MUSCLES USING A TWO-DIMENSIONAL X-RAY DETECTOR.
N. YAGI AND I. MATSUBARA Dept. Pharmacol. Tohoku Univ. Sch. Med., Sendai 980

Two-dimensional detector of multiwire type was used to record X-ray diffraction patterns from bullfrog skeletal muscles during isometric contractions. Sartorius muscles with a sarcomere length of 2.4μm showed an increase in the integrated intensity of the 5.9-nm actin layer-line during contraction. This did not accompany a significant change in the intensity distribution along the layer-line. The 18-nm actin second layer-line also showed an increase in its intensity. Semitendinosus muscles with a sarcomere length of above 4.0μm, which developed very little tension, showed only a small increase in the intensity of the 5.9-nm layer-line whereas that of the second layer-line increased significantly. These results indicate that (i) the increase in the intensity of the 5.9-nm actin layer-line is mainly due to the actin-myosin interaction and not a result of a calcium-induced conformational change in actin molecules per se (ii) the increase in the intensity of the 18-nm actin second layer-line is mainly due to a calcium-induced structural change in the thin filaments.

523, I F 1030

THE EFFECT OF MUSCEL LENGTH ON ENERGY UTILIZATION IN FROG SKELETAL MUSCLES. A TIME-RESOLVED ^{31}P NMR STUDY.
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The course of changes of phosphocreatine(PCr) and inorganic phosphate (P_i) following brief isometric tetanic contractions was studied at 4°C by using a time-resolved phosphorus nuclear magnetic resonance (^{31}P NMR). Eight pairs of bullfrog semitendinosus muscles (total weight of muscles ~5 g) were used, and free induction decays phased with stimuli were accumulated during repeated contractions of up to 64. Each spectrum thus obtained has the time resolution of 100 ms. The results indicated the post-contractile PCr utilization as has been reported previously using sartorius muscles; the level of PCr continues to decrease for a few min after the muscles has relaxed from tetanic contractions while the level of P_i is maximal at the end of contraction and decrease exponentially (time constant, 15–25 min). The appearance of P_i without utilization of PCr, or post-contractile utilization of PCr, was strongly dependent on muscle length, being undetectable at the sarcomere lengths over 3.4 μm. The results strongly indicate that the phenomenon is closely associated with the actin-myosin ATPase cycle.

524, I F 1045

SARCOMERE LENGTH CHANGES DURING CONTRACTION IN MOUSE SKELETAL MUSCLES EXAMINED BY LASER DIFFRACTION METHODS.
MATSUMURA,M., OCHI,K., TOYOTA, H., MATSUKI,Y. AND SATO,Y. Dept. Physiol., Kawasaki Med. Sch., Kurashiki 701-01

Changes in sarcomere length during contraction in mouse EDL muscles are On-Line measured and controlled using laser diffraction methods. The first order diffraction line is focused and directed towards the photodiode array and its position is converted into the output voltage. At sarcomere length smaller than 3.2 μm, the average sarcomere length is shortened upto 0.3 μm during isometric tetanus. Under the controlled sarcomere isometric condition the tetanus tention rises more rapidly and attains larger peak than that under ordinary isometric tetanus. Sarcomere length fluctuates at the beginning of both contraction and relaxation. No tension development is observed at sarcomeres longer than 3.7 μm. The velocity of shortening and of lengthening of sarcomeres under 0.15 - 1.4 P_o is measured in afterloaded contraction. The force:sarcomere shortening velocity relation nearly fits to the hyperbolic curve and the maximum shortening velocity is 27 μm/sec at 28°C.

525, I F 1100

ROLE OF THE Ca-INDUCED Ca RELEASE MECHANISM IN COOLING CONTRACTURE OF FROG SKELETAL MUSCLE FIBRES.
K. HORIUTI AND M. ENDO. Dept. Pharmacol., Sch. Med., Univ. Tokyo, Tokyo, 113 and Dept. Physiol., The Jikei Univ. Sch. Med., Tokyo, 105.

In frog muscle fibres soaked in a Ringer solution containing a low concentration of caffeine, cooling the solution down from room temperature to ice-cold one liberates calcium (Ca) from the sarcoplasmic reticulum (s.r.) to the sarcoplasm to elicit muscle contracture. This Ca liberation with contracture has been considered to be ascribable solely to the suppressive effect of cooling on the Ca-pump ATPase of the s.r. In the present study, we examined the temperature dependence of the Ca-induced Ca release mechanism of the s.r. using skinned fibre preparations, substituting AMP-PCP for ATP to eliminate the s.r. pump activity during Ca-induced Ca release. It was found that the Ca release mechanism in the presence of a low dose of caffeine was more active at lower than higher temperature. The enhanced activity of the Ca release mechanism at lower temperature, as well as the suppressed function of the Ca pump, is probably essential to the cooling contracture of frog muscle fibres in a caffeine Ringer.

526, I F 1115

EFFECT OF CAFFEINE ON CALCIUM RELEASE FROM SARCOPLASMIC RETICULUM ISOLATED FROM FROG SKELETAL MUSCLE.
KOSHITA,M. AND HOTTA,K. Dept. Physiol., Nagoya City Univ. Med. Sch., Nagoya 467

The effect of caffeine on Ca release from and Ca uptake by sarcoplasmic reticulum isolated from frog skeletal muscle was studied. Ca uptake was started by adding ATP into a reaction solution containing ATP-regenerating system. It took from 1.5-3 min to reach the steady Ca level (about 200 nmol/mg of protein). In the presence of 10 mM caffeine,the rate of Ca uptake decreased, but the steady Ca level was similar to that in the absence of caffeine. One mM caffeine gave only little effect on Ca uptake. In the presence of caffeine,the rate of caffeine decreased, while ATPase activity increased. It is suggested that caffeine decreased the efficiency of Ca transport supported by ATP hydrolysis. Addition of caffeine(1-10mM) to the SR which Ca had been loaded induced transient Ca release (30-50 nmol/mg of protein). Released Ca was taken up again within 2 min. Repeated caffeine addition after Ca reuptake induced no or small Ca release from SR.

527, I F 1130

EACH EFFECT OF TN-C, TN-I AND TN-T TO THE Ca^{2+} SENSITIVITY OF GLYCERINATED SKELETAL MUSCLE FIBER. Nakayama, Y., Yamaguchi M.*, Watanabe Y. and Watanabe K.** Dept. of Physiol. & Anat. Kyoritsu Coll. of Pharm., Tokyo 105, *Dept. of Biochem and Nutri. Juntendo Univ., Chiba 275 and **Dept of Biol., Nihon Univ., Chiba 274.

We showed in the previous report that the extracted TN-T played an important role as a removing factor of TN-C and TN-I from glycerinated skeletal muscle fiber.

In this experiment, we investigated the effects of extracted TN-C or TN-I as well as TN-T. Moreover, it was examined also the effects of paired components, as TN-(C+I), TN-(I+T) and TN-(T+C), to the muscle contraction. From these observations, we obtained some interesting results that TN-C added to the muscle fiber did not change Ca^{2+} transmission system, though TN-I blocked it completely, nothing to do with whether Ca^{2+} will be present or not. On the other hand, the case of paired one, the one of each pair of two components inhibited another one in the muscle function, that is, TN-C for TN-I, TN-I for TN-T and TN-T for TN-C, respectively.

It was suggested that the each component of TN-complex inhibited reciprocally to maintain the sterical structure of the TN-complex on the tropomyosin.

528, I F 1145

EFFECTS OF EXTERNAL SODIUM ON THE EXCITATION-CONTRACTION COUPLING IN THE SKELETAL MUSCLE. KAWATA, H., HATAE, J. AND FUJISHIRO, N. Dept. Physiol., Fukuoka Univ. Sch. Med., Fukuoka 814-01

In a previous study we found that both twitch and tetanus were augmented when the external sodium was reduced. This occurred in spite of the reduction in the action potential amplitude. In order to clarify the mechanism of this potentiating effect further, we investigated the effect of either reduction or depletion of external sodium on both the electrically-induced and potassium-induced contracture. While the potassium contracture tended to decrease its amplitude during low sodium perfusion, the electrically-induced contracture was markedly increased in both phases, namely fast and slow ones. This potentiation was accompanied by a slight hyperpolarization and thus occurred in the opposite direction of what can be expected from the effects of conditioning hyperpolarization on the tension generation. On the basis of these results the role of external sodium in the E-C coupling was analyzed in these two types of contracture and the causal mechanism of inhibitory action of sodium was discussed.

529, I F 1300

ACTIVATION AND INACTIVATION MECHANISMS OF THE POTASSIUM CONTRACTURE IN FROG SINGLE TWITCH MUSCLE FIBERS. TAKAUJI, M. AND TSUTSU-URA, M. Dept. Physiol., Sapporo Med. College., Sapporo 060

We have recently reported that the tension development of the initial component of biphasic potassium (K) contracture is not accompanied by contractile inactivation, while the activation of the secondary component is followed by the inactivation (Jpn. J. Physiol., Takauji et al., 1984, 1985). In the present report, the effects of some agents, e.g., low concentration of caffeine (0.1-0.3 mM), organic calcium channel blockers and Bay K 8644 on the biphasic K contractures were examined, using single twitch muscle fibers of the frog. The changes, induced with these agents, of the peak tension and the time course of the two components of the K contracture and those of the activation and inactivation of the secondary component were measured. On the basis of the results obtained, the excitation-contraction coupling mechanisms of two components of the biphasic K contracture and the mechanism of the inactivation of the secondary component are discussed.

530, I F 1315

EFFECT OF SOME FLUOROGENIC SULFHYDRYL (SH) REAGENTS ON EXCITATION-CONTRACTION (E-C) COUPLING IN SINGLE SKELETAL MUSCLE FIBERS OF FROG, R. JAPONICA. M. FUJINO, Y. SATO, T. ARIMA. 1.Dept of Physiol., Natl. Def. Med. Coll., Tokorozawa.

1. NBD-F, NBD-Cl, SBD-F, SBD-Cl, the fluorogenic reagents, were tested. 2. The former two applied extracellularly inhibited E-C coupling of twitch fibers. The inhibition due to NBD-F (10μM, 30min) and NBD-Cl (20μM, 30min) treatments was irreversible. 3. Both ionophoretic injection of and extracellular application at pH 7.2 of SBD-F and SBD-Cl, negative ions, evoked no inhibition but potentiation; whereas, extracellular application of 10 mM at pH 9.8 evoked an inhibition, though reversible. 4. In NBD-F-paralyzed fibers, behavior of resting and action potentials was observed. 5. The inhibitory effect was weakened by hypertonicity and D_2O, but not influenced by hypotonicity, urea-treatment, low temperature, Cl-withdrawal, elevation of pH and various organic substances 6. Higher doses of NBD-F (0.1-2 mM) induced contracture, which was also observed in case of several SH-reagents. 7. PCMB exerts no effect on twitch (0.5-1.0 mM, pH 7.3). 8. PRM, DTNB, and DDD can potentiate twitch about twice the normal. 9. Conclusion: In a chain of processes for E-C coupling, a SH-radical takes an important part and exists not on so-called extracellular surface but intracellular portion which relates, however, intimately to extracellular medium. In a first step of the chain, there exists a positively charged site.

531, I F 1330

SITE RESPONSIBLE FOR EXCITATION-CONTRACTION (E-C) COUPLING ON T-TUBULAR MEMBRANE OF SKELETAL MUSCLE FIBERS OF FROG, R. JAPONICA. M. FUJINO, T. ARIMA, Y. SATO. 1.Dept of Physiol., Natl. Def. Med. Coll., Tokorozawa.

1.Both acrolein and phenylglyoxal, E-C uncouplers, were shown to react with amino-radicals of not only protein but also sugar. 2. Tension-K concentration-relation curve was shifted towards higher concentration of K by treatment of concanavalin A (con A) of 20μM, of which calculation basis was pH 7.2 (pH 7.2 calc.), slightly at pH 7.2 and distinctly at pH 5.6. The grade of shift seemed to be remained unchanged by 40 μM con A (pH 7.2 calc.) at pH 7.2. Resting potential and caffeine (15 mM) contracture were almost not influenced by the treatment. These results demonstrate that con A inhibits E-C coupling process through an extracellular mode of action. 3. In longitudinal electron-microscope sections of fibers immersed for 120 min in Ringer of 0°C containing 2.5 % ferritin at pH 7.2, ferritin particles were recognized within T-tubular lumen rather at random; while, in fibers immersed at pH 7.2 in Ringer containing con A-ferritin complex of the same concentration-level in point of ferritin particle, the particles were recognized in considerable cases in contact with luminal surface of T-membrane and in opposite to feet. These findings might suggest directly a large possibility that E-C coupling takes place through feet themselves.

532, I F 1345

On the mechanism of decoupling in skeletal muscle fibres. Isojima,C. Dept. Physiol.,St. Marianna Univ. Kawasaki 213

The effect of Mn ions on the electrically induced local contraction threshold of frog's skeletal muscle fibres is similar to that of Ca or Mg ions,while Mn ions exhibit a marked inhibitory effect on the twitch tension development. It is a matter of discussion whether the inhibitory effect of Mn ions be attributable to the blocking effect on the Ca influ -x during depolarization of the transverse tubule membrane or not. In order to elucidate this point , the minimum concentration of Mn ion in the external solutions necessitated to exhibit a given degree of inhibition of twitch tension development of isolated single muscle fibres was measured in the external solutions of various low Ca ion concentrations to which Mg ions were added to maintain the normal resting potential. The single muscle fibres were immersed in low Ca solutions for a relatively short period of time in order to prevent the depletion of Ca content within single muscle fibres. The dependency of the minimum concentration of Mn on the external Ca concentration is discussed from the standpoint of E-C coupling of skeletal muscle.

533, I F 1400

EFFECTS OF SCN AND Mn IONS ON THE LOCALIZED CONTRACTURE IN SKELETAL MUSCLE FIBERS: THEIR ANTAGONISM. TAMEYASU, T. AND TANAKA, M. Dept. Physiol., St. Marianna Univ. Sch. Med., Kawasaki 213

It is known that lyotropic anions such as SCN lower the mechanical threshold without changing the magnitude of maximal K-contracture, while Mn ions suppress the K-contracture. Mn ions have dual effects on the membrane; stabilizing action as a divalent cation and a blocker of Ca-influx. Since it is expected that the lyotropic anions exert their action by modifying the surface charges of the membrane, which is involved in the E-C coupling, it is interesting to examine the antagonism between the actions of SCN and Mn ions to see whether or not their sites of action are the same. Some experimental results will be presented on this line.

534, I F 1415

TEMPERATURE-DEPENDENCE OF QUININE CONTRACTURE IN RAT SKELETAL MUSCLE. Yoshioka*, T., Tamaki*, T., Nagami*, K., Nakahara**, Y., and Nakano*, S. (*Dept. Physiol., Tokai Univ. Sch. Med., Kanagawa 259-11, **Mie Univ. Fac. Educ., Mie 514)

In a manner similar to caffeine, quinine, and its optical isomer, quinidine, potentiate twitch tension of skeletal muscle at low concentrations and produce contracture at higher concentrations. Furthermore quinine has well-documented inhibitory effects on the sarcoplasmic reticulum (SR) Ca-ATPase and no effect on the passive leak rate of Ca from the SR. We present some observations on the effect of quinine on tension, the effect of temperature on the quinine contracture, and the structural change during quinine contracture in rat slow (soleus, SOL) and fast (extensor digitorum longus, EDL) muscles. Relative tensions of quinine contracture (10 mM) for tetanus tension were 27±7.2% (SOL, n=4) and 23±10.1% (EDL, n=4) when the quinine solution temperature was changed from 15°C to 25°C, 36±14.1% (SOL, n=10) and 26±9.1% (EDL, n=6) from 25°C to 35°C. In structural aspects, an irregularity in sarcomere lengths, ballooning in mitochondria, and irregular arrangement of thick and thin filaments were observed during quinine contracture. The triads showed normal in appearance. These structures are similar to those of caffeine contracture. Quinine contracture was always bigger in SOL muscle than EDL. The temperature-dependent variation in the SR membranes is not similar in quinine-treated SOL and EDL muscles.

535, I F 1430

BIPHASIC CONTRACTURE AND ATP HYDROLYSIS IN GLYCERINATED MUSCLE, A SPIN LABEL STUDY. TSUJIMOTO, T. AND NONAKA, Y. Dept. of Physiol., Wakayama Med. Coll., Wakayama 640

In an attempt to clarify the interactions between the SH groups of the glycerinated muscle fiber and the substrate binding site as was reported previously, a spin-labeled ESR study was performed on ATP-induced biphasic contracture at pCa>8.4. The glycerinated fibers (0.4 x 20 mm, two) was incubated isometrically in a photometer's cell containing spin-label solution (4-maleimido TEMPO) at 12.5°C. Tension and ATP hydrolysis were monitored during the incubation period. Reagents were added during the labeling reaction. Relative peak heights of the signal pairs appearing on the low field side of the spectra was designated as a/b and was used as an index of the mobility of attatched probe. Spin labeling (0.85 moles/mol of myosin, as determined by the method of Stone, 1973) reduced the initial and 2ndary components of Ca-induced tension to 40% and 5% of that of untreated fibers, respectively. ATPase rate accompanied with Ca_i was reduced to 50% of the control, while, the rate with Ca_s increased by 70%. Tension and ATP turnover rate decreased as the concentration of ATP was increased. The contracture became biphasic with high concentrations of ATP, and the greatest reversal was found with 0.27mM ATP. Maximum increase of a/b was also found at that concentration. The amount of bound label increased linearly with increasing concentrations of ATP, and reached the peak (1.2 moles/mol myosin). Results indicated the interaction between the SH- and ATP-site.

536, I F 1445

THE ROLE OF ALKALINE PROTEASE IN THE DEVELOPMENT OF MYOFIBRILLAR NECROSIS IN SEVERAL MURINE MUSCULAR DYSTROPHIES. TSUJI, S., SAWADA, H., KUSUMOTO, S., DOI, Y., AND MATSUSHITA, H. Dept. Physiol., Wakayama Medical College, Wakayama 640

The role of alkaline protease in the development of myofibrillar necrosis in several murine muscular dystrophies, such as dy, dy^k, myd, and the new mutant which was discovered in our laboratory, was studied.

There was abnormal elevation of alkaline protease in the hind-limb muscle of all dystrophic mice, associating with the progression of the disease. Corresponding elevation of histamine concentration in the muscle was observed in dy and dy^k mice but not in myd and the new mutant mice. The developmental changes of alkaline protease in the muscle of dy mice shows a lower level of the activity at early stage of the disease (3 weeks of age) compared with those of controls and then a rapid increase of the activity after 5 weeks of age, correlating with the severity of muscle degeneration.

We concluded from the results that alkaline proteolytic activity contains two types of activity, one is a protease from mast cell which appear to be associated with the late stage of the disease, and the other intramuscular protease which appear to act in the initial phase of myocytolysis.

537, I F 1500

PROPERTIES OF FRAGMENTED SARCOPLASMIC RETICULUM(FSR) FROM THE MYOGENEOUS ATROPHIC MUSCLE. NISHIJIMA,H.,TAKAHASHI,A. AND SAKAI,T. Dept.Physiol., Jikei Univ., Sch.Med.,3-25-8 Nishishinbashi.Minato-ku.Tokyo 105.

Pathogenesis of skeletal muscle from malignant hyperthermia(MH) and Duchene muscle dystrohy(DMD) patients has been considered to the myogenousdisease. And muscle from these disease has been shown to have a higher sensitivity of contraction induced action of caffeine. But the relation of Ca-uptake and release on FSR from muscle in these patients have not yet the accurate report. The maximum volume of Ca-uptake on normal FSR from a small pieces of manmalian skeletal muscle was shown at 30-45sec after the start of reaction by ATP. On FSR from muscle in MH patients, the Ca-uptake rate in the initial phase was same as normal FSR, but the maximum volume of Ca-uptake reached later than normal FSR, and was shown the steady state for 60sec at the least. This FSR was released to Ca of about 10% of maximum volume at 15sec after the addition if 1.0mM caffeine . Ohterhand, on FSR from muscle in DMD patients, the Ca-uptake in initial and after phases were markedly inhibited more than normal FSR, and the stably maximum volume was not shown.

538, I F 1515

MECHANICAL ACTIVATION AND INACTIVATION INDUCED BY SILVER ION IN FROG SINGLE MUSCLE FIBER. OBA,T. AND HOTTA,K. Dept.Physiol., Nagoya City Univ. Med. Sch., Nagoya 467

Chemical binding of Ag ions to transverse tubular membrane proteins led to a mechanical activation with a short lag time in bull-frog toe muscle placed in Ca- and Cl-free MOPS solution. The contracture was followed by abrupt inactivation. Therefore, we investigated to know the site(s) of action of Ag ions for evaluating the mechanism of excitation-contraction coupling in skeletal muscle. 1 mM ditiothreitol (DTT), a SH-protector, was applied at various times after the onset of tension development induced by 5 uM Ag ions. When DTT was added within 5 s, a contracture which is developing upon Ag ions was disappeared immediately. After washing DTT with MOPS solution for 3 min, the same fiber was fully activated in response to either the 2nd application of 5 uM Ag ions or 120 mM K ions. However, delay of DTT application(5-18s after the onset of contracture) caused decrease in tension amplitude as a function of application time. These results suggest that chemical binding site(s) of Ag ion for mechanical activation exists independently from inactivation site(s).

539, I F 1530

MECHANISM OF TWITCH POTENTIATION BY CAFFEINE IN FROG SKELETAL MUSCLE FIBERS.

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Low concentrations of caffeine (0.1-1 mM) are known to potentiate twitch tension without remarkable change of electrical properties of surface membrane. In order to explore the twitch potentiating mechanism of caffeine, aequorin was injected into single skeletal muscle fibers of frogs. Low concentrations of caffeine (0.2-0.4 mM) increased peak twitch tension with slight increase of peak light. Further increase of caffeine concentration (0.6-1 mM) enhanced twitch potentiating effect but diminished the peak light. Resting light level before stimulation was dose-dependently increased by caffeine (0.4-1 mM). Application of procaine (0.5-1 mM) to the fiber treated with caffeine lowered the resting light level but increased the peak light in the twitch. The peak twitch tension was further enhanced by procaine. These results were interpreted as follows: Twitch potentiation by caffeine cannot be explained only by the increased Ca^{2+} release from SR, and rise of $[Ca^{2+}]_i$ before stimulation might be important. In addition to it, caffeine might facilitate Ca^{2+} release from SR by depolarization, if Ca^{2+} release triggered by Ca-induced Ca release mechanism is inhibited by procaine.

540, I F 1545

THE EFFECT OF INTRACELLULAR pH ON THE REPRIMING OF THE LABILE MAINTENANCE HEAT OF FROG SKELETAL MUSCLES.

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We previously reported the effect of intracellular pH(pH_i) on maintenance heat production of frog sartorius muscles (Rana japonica), (J.Physiol.Soc.Japan, 47,522, 1985). The pH_i was lowered by increasing CO_2 partial pressure in Ringer solution. The maximal tension was decreased, and the relaxation phase was strikingly prolonged with a decrease in pH_i. The total heat was also decreased with pH_i, and this decrease was mainly caused by the decrease of the stable heat production (the part with a steady rate during tetanic contraction), whereas, the labile heat (the part with an exponentially declining rate), was not affected by pH_i change. It is known that the labile maintenance heat is affected by an interval between tetani; it is reduced in a second tetanus repeated immediately after the 1st tetanus and recovers according to the intervals between the two (repriming of the labile heat). To examine whether the reduced pH_i affects the course of the repriming of the labile heat, the two 5sec tetani at 4°C were studied at different intervals of 5s, 10s, 25s, 1min, 3min, 5min, 8min, 10min, and 15min at pH_i 7.2 and 6.7. No significant difference in the time course of the repriming between pH_i 7.2 and 6.7 was observed. The result suggest that chemical reactions which evolve the labile heat are independent of the pH_i range studied.

541, II P (21) 0900

A CALORIMETRIC STUDY ON CALCIUM-BINDING BY TROPONIN C FROM BULLFROG SKELETAL MUSCLE.

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Dept. of Physiol., Medical College of Oita, Oita 879-56

Troponin was extracted from bullfrog skeletal muscles. It was then separated into its components by DEAE-Sepharose column chromatography. Purified bullfrog troponin C (fTnC) was concentrated and decalcificated by TCA treatment. Microcalorimetric titrations were carried out at pH 7.0 and at 25°C in order to study the enthalpy changes (ΔH) of the Ca-binding by fTnC. In the absence of Mg^{2+}, the enthalpy titration profile of fTnC could be divided into three stages. The 1st stage of the titration was characterized by a large exothermic phase ($\Delta H \simeq -90$ kJ/mol fTnC). Then at the 2nd stage, the Ca-binding reaction gave rise to a weak endothermic phase. The 3rd stage was characterized by a weak exothermic phase. When 5 mM Mg^{2+} was present, the Ca-binding reaction of fTnC was a moderately exothermic reaction without apparent phase separation. Mg-binding reaction was exothermic, but when 1 mM Ca^{2+} was present, the Mg-binding reaction of fTnC was endothermic ($\Delta H \simeq 5$ kJ/mol fTnC).

The pH changes on mixing fTnC and Ca^{2+} were measured and the results were correlated with the Ca-binding enthalpy profile; in the 1st exothermic stage fTnC absorbed H^+, then in the 2nd endothermic stage fTnC released H^+. These results are nearly consistent with the results on TnC from rabbit skeletal muscle.

542, II P (22) 0900

31P-NMR STUDY OF THE ENERGY METABOLISM IN POISONED FROG SKELETAL MUSCLES. YAMADA, T. AND SUGI, H. Dept. of Physiol., Sch. of Med., Teikyo Univ., Itabashi-ku, Tokyo 173

The phosphate metabolism in poisoned frog skeletal muscles was studied by 31P-NMR. Sixteen sartorius muscles of bull frog were set in an NMR magnet which were irrigated with aerated Ringer's solution controlled at 10 C. Sixty four to 256 FIDs produced by 60 degree pulses with 5 s interval were accumulated in sequence after isometric tetani. When intact muscles were stimulated, phosphocreatine(PCr) decreased and inorganic phosphate(Pi) increased from the resting levels and returned to the resting levels with half time of about 10 min. When iodoacetate(IAA)-treated muscles were stimulated, PCr decreased and Pi increased followed by partial recovery of PCr and full recovery of Pi to the resting levels, and additionally sugar phosphates increased without any time-dependent changes. These are consistent with IAA inactivates one of the glycolytic enzymes (glyceraldehyde phosphate dehydrogenase). Further studies suggested that the rate of glycolysis drastically changes apparently depending on the level of Pi. When NaCN-treated muscles were stimulated, the decreased PCr and increased Pi levels showed no recovery to the resting levels, which is expected from the impairment of mitochondria by CN. When dinitrofluorobenzene(FDNB)-treated muscles were stimulated, Pi and sugar phosphate increased leaving PCr level unchanged, which is in accord with FDNB inactivates creatine kinase.

543, II P (23) 0900

EVIDENCE FOR COOPERATIVE INTERACTIONS OF MYOSIN HEADS IN THE FORCE GENERATION OF VERTEBRATE SKELETAL MUSCLE FIBERS. CHAEN, S., SHIMADA, M., AND SUGI, H. Dept. Physiol. Sch. Med., Teikyo Univ., Itabashi-ku, Tokyo 173

In order to examine the possibility of cooperative interaction between the two myosin heads in muscle contraction, we have investigated the Mg^{2+}-ATPase activity during isometric contraction and the mechanical response of p-phenylenedimaleimide (p-PDM) modified glycerinated rabbit psoas muscle fibers, and suggested that a cross-bridge can exert force only when both heads are not inactivated with p-PDM (Chaen et al., J. Mus. Res. Cell Motil. 6, 368 (1985)). In this study, we measured the K^+-EDTA-ATPase activity of fibers to determine the extent to which the myosin heads in the fibers are inactivated with p-PDM. It was found that the isometric force of p-PDM modified muscle fibers was proportional to the square of the K^+-EDTA-ATPase activity (both relative to the control value). Partially p-PDM modified muscle fibers contains a mixture of myosin molecule with zero, one and two of their heads inactivated, having the probability of $(1-q)^2$, $2q(1-q)$ and q^2, respectively (the quantity, q, is the fraction of inactivated head.). Since the K^+-EDTA-ATPase activity is considered to be a monitor of the quantity, (1-q), above results suggest that a crossbridge can exert force only when both heads are not inactivated.

544, II P (24) 0900

CHANGES IN THE X-RAY DIFFRACTION PATTERN OF TETANIZED FROG SKELETAL MUSCLE DURING SINUSOIDAL LENGTH CHANGES. TANAKA,H., KOBAYASHI,T., IWAMOTO,H. AND SUGI,H. Dept. Physiol., Teikyo Univ. Sch. Med., Tokyo, Japan 173

To study the dynamic behabiour of cross-bridges, sinusoidal length changes(1% at 17°C) were applied to isometrically contracting frog sartorius muscles, and the resulting changes in the X-ray diffraction pattern were examined at a 10 msec interval. Both the equatorial and meridional reflections showed distinct periodic changes in response to the muscle length changes. The equatorial 1,0 intensity increased during release phase and decreased during stretch phase of the sinusoidal length perturbation, while the reciprocal changes in the 1,1 intensity were seen. Thus, 1,0 and 1,1 intensities changed nearly in phase and antiphasic manner with the length change. The meridional 14.3 nm intensity decreased for both stretch and release phases. These intensity changes in response to the muscle length perturbation were seen in the frequency range from 2 to 20 Hz. The effect of perturbation on the 14.3 nm intensity was more evident, when the amplitude of the length change was increased from 1 to 3%. A marked temperature effect on the 14.3 nm intensity was also observed; the intensity decrease in the stretching phase was much more greater at 4°C than at 17°C.

These experiments were performed at Photon Factory(PF) in collaboration with Dr. Y.Amemiya(PF) and Dr. K.Wakabayashi(Oosaka Univ.).

545, II P (25) 0900

THE CHANGES OF THE PROTEIN COMPONENTS IN DISUSED ATROPHIED MUSCLE.
ATOMI, Y. AND S. YAMADA. Dept. Sports Sciences, College of Arts and Sciences, Univ. of Tokyo, Tokyo 153

We have studied the mechanism of disused muscle atrophy. In the present study, the disused muscle atrophy was induced by tail suspension, tenotomy and denervation in rats. Muscle protein was compared by means of SDS-polyacrylamide gel electrophoresis. One protein component of soluble fraction in atrophied soleus muscle induced by tail suspension, referred to 30k-Da protein in one dimentional electrophoresis, decreased in quantity. This decrease in 30k protein was observed in atrophied muscle induced by tenotomy and denervation. According to gel'filtration, this 30k protein was separated to two fractions. It appeared that 30k protein had the properties of two different proteins. The decrease of 30k protein observed in these models may be important factor to understand atrophy process.

546, II P (26) 0900

COMPENSATORY MUSCLE HYPERTROPHY IS NOT INDUCED IN ALBUMIN-DEFICIENT RAT.
YAMADA, S., TOMINO, S. and ATOMI, Y. Dept. Sports Sciences, College of Arts and Sciences, Univ. of Tokyo, Tokyo 153

We have studied the change in the muscle protein component associated with hypertrophy and found that a single protein component (64k protein) increased in muscle after compensatory hypertrophy. 64k Protein in the skeletal muscle is indistinguishable from rat serum with respect to its molecular and immunological properties. In the albumin-deficient rat, the work-induced muscle hypertrophy is hardly observed nor the increase in concentration of muscle albumin. The lowered inborn level of testosterone and growth hormone might also cause these effects in albumin-deficient rats. However the results of the experiments employing castration and hypophysectomy on the normal rat ruled out this possibility. These results are suggesting that albumin is an important factor in the work-induced muscle hypertrophy of mammaliam skeletal muscle.

547, I F 1600

CHANGES OF EVOKED POTENTIALS ON SURAL MUSCLE IN MAN BY MEANS OF THE MONOPOLAR LEAD
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In general, M-and H-waves in the dorso-ventral part of the leg in man were recorded by means of the bipolar lead, which was not always suitable to get these two responses from a homonymous muscle because of a mixture of the negative going M-wave from the gastrocunemius and the positive going one from the soleus.

We attempted to record M-and H-waves derived from a homonymous muscle by means of the monopolar lead. The indifferent electrode and the ground electrode were always placed at the skin in the contralateral lower extrimity. When the active electrode was placed at the skin over the middle part of the gastrocunemius, the polarities of the negative M wave and of the positive H wave were invariant with intensity of the electrical stimulation but the amplitudes of these two waves increased in increase of the stimulus. While when the active electrode moved on the skin below the point where the gastrocunemius joints the Achilles tendons, the M wave changed small wavelets in pattern and the one of the wavelets grew the typical M wave in increase of the stimulus. Remainder might be derived from another muscles. However, we failed to diminish the wavelets by making choice of the position of the active electrode. While the polarity and the wave form of the H wave were invariable in the lower part of the extrimity.

548, I F 1615

CONTRAST IN THE CHANGING PATTERNS OF SOLEUS MUSCLE POTENTIALS TO REPETITIVE SCIATIC STIMULATION IN YOUNG AND OLD RATS.
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It is well known that individual muscle fibers show different sensitivities under the so-called fatigue regime. More simply, we demonstrated in about 60-day-old Wistar rats that evoked muscle potentials were rapidly reduced to a notable extent in the medial gastrocnemius muscle while they were gradually potentiated in the soleus muscle when repetitive stimulation was given at 5 Hz for 10 min. In the present study, changing patterns of muscle potentials of soleus muscles induced by 5 Hz-stimulation were compared between young and aged Wistar rats (40-44 and 400-500 days in age, respectively). It was found that repetitive stimulation at 5 Hz for 10 min resulted in a gradual potentiation of muscle potentials from young rats, whereas muscle potentials from aged rats were rapidly reduced, reaching plateau levels 2 min or so after the onset of repetitive stimulation at 5 Hz. Moreover, a magnitude of this reduction was less than that seen in the medial gastrocnemius muscle.

549, I F 1630

EFFECT OF SENSORY STIMULATION AND NERVE BLOCKADE ON WRIST FLEXOR STRETCH REFLEX COMPONENTS.
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When mechanical perturbations are applied to a joint, the stretched muscle shows a series of EMG responses including both short (M1) and long (M2) latency components. We have attempted to clarify the receptors and peripheral afferent pathways mediating the two components of the stretch reflex by using vibration, ischemic nerve blockade and electrical cutaneous nerve stimulation. Wrist flexor muscle EMG activity was recorded following extension perturbations of the wrist produced by a torque motor. (1) Continuous vibration (100 Hz) suppressed M1 with no obvious effect on M2 (Hendrie and Lee, 1978) and also suppressed both H-reflexes produced by two electrical stimuli 30 MSEC apart. (2) Ischemic nerve blockade produced by a blood pressure cuff around the upper arm inflated to 200 mm Hg suppressed M2 more than M1. These results suggest that M2 may be mediated by group II afferent fibres. (3) Electrical stimulation (three pulses of 0.2 MSEC duration; 300 Hz) of digital nerves timed to inhibit either M1 or M2 reflex components inhibited M2 more than M1 in the normal arm of hemiplegic subjects. In the paretic arm, inhibition of M2 was reduced and equal to inhibition of M1. This difference in inhibition of M2 could be accounted for if M2 is normally mediated by a long loop transcortical pathway which was interrupted on the paretic side.

550, I F 1645

OBSERVATIONS ON F AND S WAVES DURING MUSCULAR VOLUNTARY CONTRACTIONS OF HUMAN.

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In this study, we observed F and S waves on various musclar conditions which eight healthy subjects were tested on rest, max. voluntary contruction (MVC), 20%~80% MVC, electrical stimulations, and fatigue. Those waves were evoked by the supramaximal electric stimulus (about 130 voltage and 0.6 msec duration) for the tibial nerve (motor fibers) and were recorded from the triceps surae by the surface single electrode method.

In these records, following results were appeared such as: Latencies (time lag) of F, S1 and S2 responce from stimulus were mean values of 37, 76, and 95 msec, respectively. Amplitudes of these waves were shown at 176.8, 123.0, and 104.8 μV. And then occurence rate of these waves were gotten 52.8, 46.7, and 12.2% from every stimulus trials, with duration time of 6 (F), 16 (S1) and 13 (S2) msec. Respectively, by either the intensity of voluntary contractions of the peripheral muscles or by a preceeding excitability on the central nerve, F and S waves could be generated into the evoked muscular reflex. But exhaustive conditions of muscles would inhibite the occurance of these waves during dorsal root blockade from fatigue.

551, II F 0915

EFFERENT NEURAL DISCHARGE PATTERNS DURING NOSTRIL-CLOSING REFLEX MOVEMENTS IN THE FROG.

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Skeletal muscle fibers in mammals and frogs are known to be classified into two or more types, suggesting that the neural activity of motoneurons are also classified into some types. In order to reveal this possibility, we examined efferent neural discharge patterns during the nostril-closing and tongue-folding reflex movements, both of which can be elicited by chemical stimulation of the tongue, in the frog. Experiments were carried out by recording unitary neural reflex discharges in the branches of the trigeminal and hypoglossal nerves innervating the submental and tongue muscles, respectively, following chemical stimulation of the tongue. The unitary reflex discharges recorded in the hypoglossal nerve did not appear to be classified into some types, but those in the trigeminal nerve could be classified into three types, phasic, intermediate and tonic ones. The phasic type was characterized by a short burst of discharge with an extremely long latency (more than 2-3 seconds) at threshold, the intermediate one by a relatively high frequency of discharge with a short latency and the tonic one by a low frequency of discharge with a short latency. Discharge patterns in the secondary sensory neurons did not appear to be classified into some types. Thus, this classification of efferent discharge may be caused by the relay or motoneurons.

552, II F 0930

ACTIVITY OF HUMAN SINGLE MOTOR UNITS DURING TREADMILL WALKING.

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The aim of the present study was to investigate the activity of human motor units(MUs) during treadmill walking. The experiment was carried out on a healthy subject. Action potentials of motor units of anterior tibial muscle were recorded using coil-shaped inserted electrodes. The e.m.g. activities were related to the signals from three foot switches attached on the heel, anterior and middle parts of the sole respectively. The speeds of treadmill ranged from 20m/min to 112m/min. Consequently, five single motor units were identified. The recruitment orders of MUs during treadmill walking were irregular without regard of the speeds of treadmill. The number of spikes of each single motor unit per step discharged at high speeds was less than the number at low speeds. This reduction in number of spikes per step was due to a decrease in burst duration. The interspike interval in each burst decreased, that is, the discharge rates of MUs were higher in fast speed than in slow speed. Furthermore, we found very shorter interspike intervals($\leq$10ms;probably, a "doublet") during treadmill walking. These finding suggest that rate modulation is a more important contributor to force regulation than recruitment of new MUs in human treadmill walking.

553, II F 0945

ANALYSIS OF MUSCLE SPINDLE DISCHARGES DURING ISOMETRIC VOLUNTARY CONTRACTION IN MAN. TOMA, S., NAKAJIMA, Y. AND HOMMA, S. Dept. Physiol. Sch. Med., Chiba Univ., Chiba 280

Single muscle spindle discharges were recorded with a tungsten microelectrode inserted percutaneously into the median nerve in 11 normal subjects. Single motor unit spikes were simultaneously recorded from the spindle bearing muscles. Discharge rates of the muscle spindle and motor unit spikes increased in accordance with augmentaion of the contraction force. Ia afferents discharged irregularly at low frequency, while II afferents fired more regularly. These suggest the presence of alpha-gamma co-activation with a dominant contribution of static gamma activity during the isometric voluntary contraction. A cross-correlation analysis showed no time-locked motor unit spikes to the spindle afferent discharges during the voluntary contraction, while a sharp peak of time-locked ones was observed at a latency of 26 ms during the tendon taps. It was concluded from these results that irregular and asynchronous Ia discharges only maintain the membrane potential of motoneurons at a certain level during isometric voluntary contraction.

554, II F 1000

MOVEMENT PATTERN AND RECIPROCAL INHIBITION DURING RAPID VOLUNTARY WRIST FLEXION MOVEMENTS IN MAN. SAWADA,Y., MIYAMOTO,S., AND *AOKI,M. Sch. of Allied Health Professions and *Dept. of Physiol., Sapporo Med. College , Sapporo 060.

During rapid voluntary wrist flexion movements, electromyographic(EMG) patterns are characterized by silent period in agonist with corresponding burst in antagonist. For revealing the mechanism of silent period in agonist, activity of the reciprocal Ia inhibitory pathway was examined in man. Subjicts were asked to flex the wrist to the target as soon as possible following an auditory cue. The joint position, and EMGs of wrist flexor and extensor muscles were recorded during the movements. Day's method with H-reflex were used for testing excitability of the wrist flexor motoneurons(MNs) and the Ia inhibitory interneurons which are activated by GIa afferents from the wrist extensors. The amplitude of H-reflex evoked by median nerve(Hc) during the movements was larger than its amplitude at rest, in accordance with the EMG of wrist flexor muscles. The amplitude of H-reflex evoked by both median and radial nerves(Ht) during the movements was smaller than the amplitude of Hc, especially in silent period, the amplitude of Ht being below the amplitude of Ht at rest. These results suggest a possibility that the Ia inhibitory pathway is activated in parallel with antagonist MNs by supraspinal motor center and this contributes to the reciprocal inhibition of agonist MNs during the silent period.

555, III P (42) 0900

THE FACTORS RESPONSIBLE FOR THE MAXIMUM TETANIC FORCE OUTPUT OF MOTOR UNITS IN THE RAT MEDIAL GASTROCNEMIUS. KANDA, K. and HASHIZUME, K. Dept. of Physiol., Tokyo Metropol. Inst. of Gerontol., Itabashi-ku, Tokyo 173

We measured the innervation ratio, fiber cross-sectional area (CSA), and specific tension of type-identified, individual motor-units in the rat medial gastrocnemius. Units in the MG were isolated by the stimulation of dissected ventral root filaments in the rat anesthetized with urethane and chloralose. These were characterized physiologically as S, FR, and FF, and subsequently depleted of their glycogen through repetitive stimulation. Quasi-serial cross-sectional specimens were stained for glycogen using a perodic acid-Schiff reaction to reconstruct the muscle unit portion. The CSA was measured directly from the specimens by means of the image processing system. Specific tension was calculated as the ratio of the maximum tetanic tension (Tet.T) : the total CSA, where total CSA equals the multiple of the mean CSA of fibers belonging to the muscle unit and the innervation ratio. The data suggest that type S units in the rat MG have a somewhat lower specific tension than type FR and FF units. The mean CSAs of muscle fibers and innervation ratios of type S and FR units are similar, but those of type FF units are larger and vary considerably. As for type S and FR units, the Tet.T is well correlated with the total CSA of muscle fibers belonging to the unit. The correlation between the Tet.T and innervation ratio is poor.

556, III P (43) 0900

EFFECTS OF STIMULATION OF THE UPPER BRAIN CENTRES ON THE SPINAL ACCESSORY MOTONEURONES IN THE CAT. HIGUCHI, K.*, ASAHARA, T., NISHIMURA, Y. AND TANAKA, T. Dept. Physiol. and Paediatr.*, Sch. Med., Mie Univ., Tsu 514

Evoked responses in spinal accessory(Acc) neurones of cats anaesthetized with Nembutal were recorded on stimulation of the precruciate gyrus(PCG), cerebral peduncle(CP), superior colliculus(SC), and red nucleus(RN). Stimulation of the contralateral pyramidal tract evoked EPSPs with latencies of 1.9-3.8 msec(N=39) from PCG and 1.4-3.7 msec (N=86) from CP. In 27 units of them the latencies of activation from both sites were obtained and the extrapolation method yield the values of 0.97-2.0 msec for the delay at the zero position, which may indicate a disynaptic connexion. The calculated conduction velocity of this pathway ranged from 26 to 83 m/sec. Stimulation of the nucleus reticularis gigantocellularis(RGC) in the medulla elicited monosynaptic EPSPs with latencies of 0.6-1.3 msec(N=42). The lesion experiments suggested that the pyramidal impulses produced disynaptic EPSPs in Acc neurones via interneurones located in or near RGC. Eighty-seven percent of 144 units were EPSPs and 13 percent exhibited IPSPs. Stimulation of the contralateral SC and RN evoked EPSPs with latencies of 1.4-3.2 msec(N=38) and 1.6-3.5 msec(N=37) respectively, and the extrapyramidal activation also produced disynaptic exitatory action upon Acc neurones. No IPSPs were observed from SC and RN.

557, III P (44) 0900

EYE MOVEMENTS EXAMINED BY THE CORNEAL REFLECTION IMAGE. Sasaki, Y. and Suzuki, H. Dept. Physiol., Hirosaki Univ. Sch. Med., Hirosaki 036

The corneal reflection image, or the first Purkinje image is generated by a light placed in front of the eye and its position in the space depends on eye positions. In this report, we measured quantatively the displacements of the image on gaze shifts of the human eye by the use of a camera with a photodiode array. We thereby found that the gradient of its displacement was larger in horizontal gaze shifts than in vertical ones. We also measured the radii of the corneal curvature of various directions and found that they were almost constant. Then, the difference of image displacement on gaze shift did not depend on the corneal surface. It may be due to the difference of eye movement patterns on gaze shift directions. In order to get more detailed information about the eye movement patterns, we took each Purkinje image from two different directions with the camera, and calculated its coordinates in the space. The geometric loci of the images on gaze shifts made a convex surface toward the anterior direction with small horizontal curvature and large vertical one. From the loci, we obtained the center of rotation and the radius of rotation for each eye position, and made a model of eye muscle action on the eye movements.

558, III P (45) 0900

CHARACTERISTICS OF PRECISE BALLISTIC FORCE EXERTION. KIMURA,M.,YONEDA,T.,MISATO,E. & ISHIDA,A. Dept. of Physiol., Sch. of Physical Edu. Juntendo Univ. Narashino, Chiba.

The accuracy of performing a ballistic force matching task by thumb adduction and its trainability was investigated. Subjects were 16 healthy adult men. Subjects were instructed to exert force as fast and precisely as possible at three target force levels (10%,30% and 50% of MVC), and they were trained to performe a ballistic force matching task for 20 to 30 days. Values of four indices, hit percentage, error distribution, contraction time and e.m.g. dwell time before training were compared with those after training respectively.

Contraction time and e.m.g. dwell time, which were time factors of ballistic contraction decreased after training. However, hit percentage and error distribution, which were accurate factors of ballistic contraction after training,differ unclearly from those before training. The results derived from the same experiment concerning foot dorsiflexion were similar. It is suggested that in ballistic training it might be difficult to change the accurate factors although it might be possibled to alter the time factors in this condition.

559, III P (46) 0900

SYMMETRY AND ASYMMETRY OF BALLISTIC FORCE EXERTION.
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Physiological properties during ballistic force exertion by thumb adduction were studied using 12 healthy adult men. Force exertions were carried out in a reaction time(RT) experiment using auditory stimulus. Following stimulation,they performed thumb adduction to the isometric bar in single hand or in both hand movement. Subjects were instructed to respond to exert rapid and transient force, but not instructed as to any force levels.

On single hand response, significant differences between two hands were shown in RT, force, contraction time(TPF) and e.m.g. dwell time(EDT) in almost all subjects. On both hand response, values of EDT and TPF between two hands showed significant differences. However, a difference between RTs in both hands was not found. RT response and ballistic contraction were performed in a sequence, and they both were found to show a time factor of rapidity. However, it is suggested that the neuronal mechanism performing ballistic contraction might not be related to mechanism setting reaction time.

560, III P (47) 0900

OBSERVATIONS OF FILAMENT STRUCTURES AND CROSS-BRIDGE MOVEMENT IN THE SKELETAL MUSCLE FIBERS BY THE FREEZE-FRACTURE METHOD.
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To examine the cross-bridge behaviour during muscle contraction, freeze-etch replicas of mechanically skinned frog semitendinosus muscle fibers frozen rapidly with a liquid-helium or a propane-jet freezing device at various states were observed. During the freezing, the mechanical change of fibers was monitored using a strain-gauge. In the replicas, the helical arrangement of the cross-bridge heads (major and minor axes, about 20 and 13 nm with a Pt-thickness) on the thick filaments and the component of G-actins (about 5.5 nm in diameter) of the thin filaments were clearly observed, indicating a good preservation of their structures. The number of cross-bridges attached to the thin filaments (per 1 μm of the thick filament) was about 9 in relaxed fibers, and it increased to about 33 in contracting fibers and to about 27 in rigor fibers. The angle between the major axes of attached cross-bridges and the thick filament axis was 71.1 ± 15.1° (n=73) in relaxed fibers, 74.1 ± 13.6° (n=124) in contracting fibers, and 80.9 ± 8.5° (n=118) in rigor fibers. Further analysis of these results continues in our laboratory with the main goal of elucidating cross-bridge behaviour during mechanical activity.

561, II B 0915

EFFECT OF ISOPROTERENOL AND BETA-ADRENERGIC BLOCKER ON THE SLOW RISING PHASE OF THE ACTION POTENTIAL OF CANINE VENTRICULAR MUSCLE.

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we have been working on the action potential(AP) of canine right ventricular papillary muscle, with a partition chamber. The level of AP at the end of 5msec after the beginning of the fast upstroke was defined as PP_5. Maximum dV/dt(Vmax) of the fast upstroke was also recorded.

Isoproterenol(ISO) augmented the depolarization of the slow rising phase. Effects of ISO on PP_5 were measured at the same level of Vmax. We plotted the inverse of effect($1/\Delta PP$) against the inverse of ISO concentration. From such Lineweaver-Burk's plot, we obtained the value of Km, i.e., the dissociation constant of the drug-receptor complex. The value of Km was 5.1×10^{-7} g/ml.

Metoprolol(beta-adrenergic blocker) partially inhibited the effect of ISO in the manner of competitive inhibition, and the value of Km was 6.2×10^{-7} g/ml. These results support, partially, the validity of the previous investigation from this laboratory that ISO produced depolarization of the slow rising phase of the propagated AP.

562, II B 0930

RELATIONSHIP BETWEEN THE MAXIMUM RATE OF RISE OF THE ACTION POTENTIAL AND THE Na CONDUCTANCE IN MAMMALIAN VENTRICULAR MYOCYTES.

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We have obtained the relationship between the maximum rate of rise of the action potential ($\dot{V}_{max}$) and the available sodium conductance ($h\bar{G}_{Na}$) in ventricular myocytes by investigating the effects of latency on the $\dot{V}_{max}$. Myocytes were enzymatically isolated from guinea pig or rat hearts, perfused with Krebs (36°C), and stimulated with current pulses. Latency was defined as the interval between the end of stimulus artifact and the occurrence of $\dot{V}_{max}$. First, we established the $\dot{V}_{max}$-latency relation in the control condition ($h\bar{G}_{Na} \simeq 1$): at 15 and 30 ms latency, the $\dot{V}_{max}$ was 97±3% and 87±5% (mean±SD) of the value at the shortest latency (<1 ms), respectively. Then, we examined the hypothesis that the latency has the same effect on the $\dot{V}_{max}$ at lower $h\bar{G}_{Na}$ as that in the control condition, if the $\dot{V}_{max}$-$h\bar{G}_{Na}$ relation is linear. TTX at concentrations between 0.3 and 30 μM depressed the short latency $\dot{V}_{max}$ and accelerated the rate of decay of $\dot{V}_{max}$ with latency in a dose-dependent manner. These results indicate that the $\dot{V}_{max}$-$h\bar{G}_{Na}$ relation is highly non-linear.

563, II B 0945

DEVELOPMENTAL CHANGE OF FAST INWARD CURRENT IN CELLS ISOLATED FROM CHICK EMBRYONIC VENTRICLE AT EARLY STAGE.

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Voltage command steps(Vcomm) -120 to +80mV were applied to single 12-14um embryonic chick ventricle cells with patch electrodes in the whole cell clamp configuration. Cells isolated from embryos incubated 2,3,4 or 7days were maintained in culture medium for 5h,12h or 24h after dissociation in 10^{-5} M Ca buffer with or without collagenase.Time to peak,peak amplitude and time const. of inactivation phase were measured at 23°C from a constant holding potential(Vh) -80mV. h-inactivation relation and TTX-sensitivity was determined from Vh of -50mV to -130mV to Vcomm=-20mV. Cells from all stages exhibited a fast inward sodium current(Ina) that showed similar properties of time- and voltage-dependency and TTX-sensitivity. Amplitude of Ina increased during development from 20uA/uF at 2d+5h to 224uA/uF at 7d+1 cell. We conclude that functional Ina channels are present in the ventricle after 2d of incubation(stage 12-13),and that channel density increases without change of it's properties with future development.

564, II B 1000

TRANSIENT OUTWARD CURRENT IN RABBIT VENTRICULAR MYOCYTES.

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The presence and the role of transient outward current (I_{TO}) in ventricular action potentials were examined using a whole cell patch clamp method applied to an isolated myocyte from rabbit heart. While action potentials evoked at a frequency of 0.1 Hz revealed a distinct phase 1 followed by a small notch and plateau, those at diastolic intervals shorter than 1 sec displayed absent phase 1 and notch, but reached the higher level of the plateau. Depolarizing voltage pulses from holding potential of -60 mV produced an activation of I_{TO} above +30 mV in normal Tyrode solution. In the presence of TTX (6.26 uM) and Co^{2+} (2 mM), I_{TO} appeared at potentials positive to about -20 mV. Its amplitude increased with the higher depolarizations reaching a plateau above +70 mV. I_{TO} was inactivated with depolarizing prestep voltages and complete inactivation was obtained above 0 mV. The recovery of I_{TO} was accomplished with a time constant about 1.2 sec, which was much slower than that of I_{Ca}. This slow reocvery of I_{TO} causes a transient increase in I_{Ca} during shorter diastolic intervals than 1 sec. These results suggest that I_{TO} significantly contributes to the repolarization of ventricular action potentials and its contribution is more prominent in slow heart rate than in fast one.

565, II B 1015

SPONTANEOUS OSCILLATION POTENTIALS INDUCED AFTER AN INHIBITION OF Na-K PUMP ON SINOATRIAL NODE CELL.

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Spontaneous oscillation potentials induced by removal of $[Ca]_o$ were observed in rabbit sinoatrial node cells exposed to 10^{-5} M ouabain or K-free solutions. The oscillations increased from spontaneous voltage fluctuation of less than 2 mV to a peak amplitude of 46 ± 3 mV in the ouabain solution and 67 ± 3 mV in the K-free solution. These oscillations were more easily seen in ouabain recovery solution, i. e. Ca-free, EGTA solution after 5 mm exposure to a solution containing low $[Na]_o$. In the other words when $[Na]_o$ was lowered from 162.1 to 25.2 mM or 117.1 mM, and then restored to 162.1 mM, the oscillations markedly appeared in Ca-free EGTA solutions. Upon restoration of $[Na]_o$ from 25.2 to 162.1 mM, oscillations developed in the normal Ca solution. Restoration of $[Na]_o$ after pretreatment with 25.2 mM Na solution caused an increase in peak frequency ($P < 0.001$) and total number of signals ($P < 0.001$) of the oscillations induced by Ca removal on the ouabain-treated preparation.

On the other hand, twitch and tonic tensions of the cells with these oscillation were recorded simultaneously. Both twitch and tonic tension decreased upon the appearance of the oscillation potentials. The above results suggest that the Na-Ca exchange mechanism plays a significant role in the genesis of oscillation.

566, II B 1030

NA-CA EXCHANGE CURRENT IN SINGLE GUINEA PIG VENTRICULAR CELLS.

KIMURA, J., NOMA, A., IRISAWA, H. Natl. Inst. Pysiol. Sci. Okazaki 444

Na-Ca exchange is a major mechanism for Ca extrusion in heart cells. Although this process is known to be electrogenic, a membrane current generated by the exchange had not been isolated. Combining the methods of whole cell voltage clamp and intracellular perfusion, Ca current, K current and Na-K pump were blocked by appropriate blockers. Under these conditions, superfusing 1 mM Ca in the presence of Na in the cell induced a marked outward current. In contrast, loading 0.5 uM Ca internally and changing external solution from Li to Na induced a significant inward current. These currents were Na and Ca concentration dependent with Hill coefficient 3 and 1 respectively and blocked by La and Ni. Thus we concluded that this current is Na-Ca exchange current with the stoichiometry of 3:1. The exchange current showed exponential voltage dependence with saturation kinetics.

567, II B 1045

OUTWARD CURRENTS THROUGH THE INWARDLY RECTIFYING K CHANNELS OF SINGLE CELLS ISOLATED FROM GUINEA-PIG HEARTS.

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Depolarization to voltages positive to the equilibrium potential for K ions (E_K) evoked a decaying outward current, which is attributed to the inwardly rectifying K channels from the following findings. (1) This current was blocked by external Ba or internal TEA, and disappeared in K-free external solution. (2) Prolongation of the hyperpolarizing prepulse increased the amplitude of the decaying outward current with a time course identical to the activation of the inward current during the prepulse. The relation between the activation (deactivation) kinetics shifted along the voltage axis as E_K shifted with changing the external K concentration between 20 and 80 mM. At 15°C, the deactivation time constant was ∿8 ms at around E_K and decreased for potentials more positive than E_K. Steady-state activation was ∿40% at E_K and reduced to zero at E_K+30 mV. Instantaneous I-V curves were linear up to the potential examined (E_K+50 mV). This finding suggests that the rectification is due to the gating kinetics of the channel.

568, II B 1100

PROPERTIES OF SINGLE DELAYED RECTIFIER K CHANNELS IN PACEMAKER CELLS OF RABBIT HEART.

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A novel voltage-dependent K channel was found in pacemaker cells of rabbit heart by cell-attached patch recording. When the patch membrane was depolarized above -40mV, inward-going single channel currents of less than 1 pA were observed using the pipette solution contained 100-300 mM K concentration (K_o). The voltage range of activation was independent of K_o. The ensemble average of the single channel currents decayed with a time constant of 40 ms on repolarization from 0 mV to -70 mV, depending on the membrane potential. The single channel conductance for the inward current was 11 pS in 150 mM K_o, depended on the square root of K_o and was voltage-independent. The instantaneous inward current of the averaged current on hyperpolarizing voltage jumps decreased when the holding potential was altered from -10 mV to +20 mV. On hyperpolarizing clamp pulses from +20 mV to potentials negative to -40 mV, the inactivation was removed quickly and then deactivation occurred. These conductance and kinetic properties of the channel coincided well with those of delayed rectifier K current which were examined using the whole cell current recording.

569, II B 1115

Mg^{2+} as a "fast blocker" of adenosine-5'-triphosphate (ATP)-regulated K-channel in guinea-pig ventricular cells.

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Using a modified open-cell attached inside-out patch preparations of guinea-pig ventricular cell membrane, we studied the effects induced by Mg ions on a K-selective channel that opens at low intracellular ATP concentrations. Micromolar concentrations of internal Mg ions (Mg_i) produced marked fluctuations in the outward current through the channel which were relieved by raising the external K ions (5.4 → 140 mM). Higher Mg_i (-5mM) reduced its unitary amplitude. External Mg ions, on the other hand, did not affect the channel. Since these effects by Mg_i were attributed to a "fast" ionic blockade, the Mg kinetics on the outward current was investigated by introducing a blocking model based on Eyring rate theory. The results were consistent with the views that Mg ions can enter the channel only from the inner mouth, overcome the energy barrier, and bind the receptor site within the aqueous channel pore, partway across the electrical membrane (electrical distance 0.32), preventing K ions passage.

570, II B 1130

MODULATION OF THE CARDIAC Ca CHANNEL ACTIVITY BY PROTEIN PHOSPHORYLATION.
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In cardiac tissues, the amplitude of the Ca current (I_{Ca}) is enhanced by ß-adrenergic stimulation, presumably due to the phosphorylation of a Ca channel-related protein by cAMP-dependent protein kinase (Reuter, 1983; Kameyama et al. 1985). A question whether Ca channels in the dephosphorylated state are available to open on depolarization was examined in single ventricular cells of guinea pig. Internal dialysis of the cell with 1.0 µM protein kinase inhibitor (PKI) completely abolished isoproterenol-induced enhancement of I_{Ca} (n=6), but failed to suppress the basal I_{Ca} markedly (22 ± 9 %, n=8). PKI abolished the increasing effect of ATPγS on the basal I_{Ca} (cf. Kameyama et al. 1985), suggesting most of the channels being in the dephosphorylated state. These results were consistent with the idea that the Ca channel is available even in the dephosphorylated state and that phosphorylation by the protein kinase increases the probability to open.

This work was carried out in collaboration with J. Hescheler, F. Hofmann, and W. Trautwein and was supported by DFG, SFB38 and H0579/6-2.

References

Kameyama M, Hofmann F and Trautwein W (1985) Pflügers Arch 405: 285-293
Reuter H (1983) Nature 301: 569-574

571, II B 1145

VOLTAGE AND TIME DEPENDENCE OF NULL MODES OF CARDIAC CALCIUM CHANNEL GATING.
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The single Ca channel measurements in cardiac myocytes have shown that the percentage of blank sweeps (nulls) on stimulations increases with depolarized holding potentials as expected from steady-state inactivation (f_∞)- voltage relationships of macroscopic Ca currents (Cavalié et al., 1983). The channel currents were recorded in cell-attached membrane patches in isolated guinea pig ventricular myocytes as Ba currents. A constant large depolarizing step was applied repetitively from different holding potentials. The currents appeared in bursts during some depolarizing steps (success) but completely failed to appear in others in excess of those expected from C1-C2-O kinetics. In histograms the number of nulls between two successes showed an approximately double exponential distribution with time constants of 0.5s and 2s, while that of successes between two nulls distributed single exponentially with time constants of 1-2s at the holding potential near resting potential. With depolarizing the holding potential by 30-40 mV the mean time for nulls was markedly increased, while that for successes was slightly decreased. The results suggest that there are two kinds of null modes and that the slow transition from one null mode is primarily responsible for the small f_∞s at low holding potentials.

572, II B 1300

THE REPLACEMENT OF POTASIUM BY CESIUM IN THE RABBIT SINOATRIAL NODE CELLS. (2)
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Small specimens of tissue were isolated from the rabbit sinoatrial node, and superfused with Tyrode solution (5.4 mM-K, pH 7.4, 37°C). When external K was replaced by Cs (20 mM), an electrogenic automaticity transiently disappeared within 15 min and thereafter, restored within 30 min. An arrythmia appeared during the later phase of disappearance. This reaction of Cs can be divided in three phases, that is, the earlier phase of disappearance, the later phase of disappearance (arrythmia) and the phase of restoration (Cs-automatism). The arrythmia was not developed by the addition of lidocaine (0.3 mM), propranolol (6.6 µM) and phentolamine (1-10 µM). Lidocaine also blocked the generation of Cs-automatism. Although verapamil (0.2 mM) did not affected on the arrythmic phase, it suppressed the restoration of Cs-automatism. Adrenergic agonists of isoproterenol (0.04-0.4 µM), epinephrine (0.5-1 µM) and norepinephrine (0.6 µM), were not effective on these three phases. But the Cs-automatism appeared to be restored more earlier under the presence of these agonists. These results suggest that the arrythmia might not be essential to the development of Cs-automatism and the disappearance phase is transient reaction.

573, II B 1315

EFFECT OF ACETYLCHOLINE ON THE INTRACELLULAR POTASSIUM ACTIVITY OF FROG ATRIAL MUSCLE.
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Although it has long been known that acetylcholine (Ach) increases potassium conductance, there is no evidence of actual change in intracellular K activity (a_K^i) during the application of Ach. The recent use of double barrel K^+-sensitive microelectrode has made both potential and intracellular K^+ measurements in the same cell. We studied the effect of Ach on aconitine-induced delayed afterdepolarization (DAD) and a_K^i in frog atrium. The membrane potential and a_K^i in normal solution and in Ca^{2+}-free solution did not show significant differences. Aconitine did not change a_K^i untill the appearance of DAD in Ca^{2+}-free solution. Intracellular Na^+ activity increased during the application of aconitine. Ach (10^{-5} g/ml) inhibited aconitine-induced DAD with a transient hyperpolarization followed by later recovery. a_K^i also decreased during the period of this hyperpolarization followed by later recovery. These changes were dependent on the membrane potential level before the application of Ach. Atropine (10^{-6} g/ml) inhibited the effect of Ach. These results indicate that Ach reduced intracellular K^+ activity in the presence of aconitine and at decreased membrane potential.

574, II B 1330

KINETICS OF SODIUM CHANNEL INACTIVATION IN ISOLATED FROG VENTRICULAR CELLS.
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As the inflow of Na^+ (I_{Na}) mainly constitutes the cardiac action potential, the availability of I_{Na} in the succeeding excitation could become one of the determinant factors in the generation of arrhythmia. This experiment was therefore designed to characterize I_{Na} with special reference to the inactivation process using isolated frog ventricular cells. The beneficial features of this preparation are as follows: (1) low I_{Na} density ($1mA/cm^2$),(2) lowering of temperature to keep the preparation in physiological condition, and (3) lack of T-tube. The voltage clamp method using a suction pipette was employed throughout the experiment. The main ionic composition (in mM) for isolating I_{Na} were 113.5 Na^+,3.6 Mg^{++} without K^+ and Ca^{++} in the external medium and 130.0 Cs+,8.0 Na+ having no K+ in the internal medium. I_{Na} changed its polarity at 70 mV, which is near the value predicted by Nernst's equation. Administration of 2uM tetrodotoxin abolished I_{Na}. The time constants of the inactivation process were obtained by two methods: curve fitting to the falling phase of I_{Na} and conditioning pulse methods. The finding that the time constants at the same membrane potential obtained by these two different methods were not identical implies inconsistency with H-H formalism, indicating need for further modification of the model.

575, II B 1345

EFFECTS OF COENZYME Q_{10} ON ACTION POTENTIALS AND IONIC CURRENTS OF GUINEA PIG VENTRICULAR CELLS.
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The effects of Coenzyme Q_{10} (CoQ_{10}) on action potentials and ionic currents of single ventricular cells were studied using a "giga-seal" patch electrode filled with 150mM KCl, 1mM $CaCl_2$, 11mM EGTA, 2mM $MgCl_2$, 2mM Na_2-ATP and 10mM HEPES (pH 7.2). The cells were stimulated at 0.2 Hz. Under normal conditions, CoQ_{10} (50μg/ml) significantly prolonged the APD from 483±54 ms to 580±68 ms (mean and SD, n=8). In the presence of a metabolic inhibitor, DNP (5-50μM), APD was decreased from 374±44 ms to 307±43 ms. CoQ_{10} significantly recovered the APD to 377±29 ms (mean and SD, n=5). In voltage clamp studies, it was shown that the main ionic current which is altered by CoQ_{10} either in the presence or absence of DNP is the steady state outward current measured at the end of depolarizing pulse. As CoQ_{10} decreased the augumented outward current which would be carried by the ATP-regulated K channels, it was suggested that CoQ_{10} prolonged the APD mainly by blocking the ATP-regulated K channels.

576, II B 1400

AN X-RAY DIFFRACTION STUDY OF CHEMICALLY SKINNED CARDIAC MUSCLE. MATSUBARA, I. AND YAGI, N. Dept. Pharmacol., Tohoku Univ. Sch. Med., Sendai 980

A papillary muscle, isolated from the right ventricle of the rat, was treated with saponin to make the sarcolemma permeable to the solutes of the bathing medium. The sarcomere length was adjusted to about 2.2 μm by the laser diffraction method. The isometric tensions produced at various calcium concentrations were measured at room temperature. The threshold concentration for tension production was around pCa 6.2, and the maximum tension was reached at pCa 5.0. The X-ray diffraction pattern was recorded during contraction. From the intensities of the 1,0 and the 1,1 equatorial reflections, the fraction of myosin heads transferred to the vicinity of the actin filaments was calculated. During the maximum contraction at pCa 5.0-4.4, about 80 % of myosin heads were found in the vicinity of the actin filaments. An unexpectedly large fraction of myosin heads was transferred to the actin filaments at lower calcium concentrations; at pCa 6.2-5.8, where the average tension was less than 20 % of the maximum, the average fraction of myosin heads transferred was 40 %, almost a half of that during the maximum contraction. These results suggest that, at low calcium concentrations, a significant number of myosin heads may be attached to actin without producing tension. Earlier results, obtained in collaboration with Dr. D. W. Maughan, University of Vermont, have already been published.

577, II B 1415

REAL-TIME OPTICAL MAPPING OF SPONTANEOUS ELECTRICAL ACTIVITY IN THE EARLY EMBRYONIC CHICK HEART. KOMURO, H., HIROTA, A., SAKAI, T. and KAMINO, K. Dept. Physiol., Tokyo Ika-Shika Daigaku, Sch. Med., Tokyo 113.

Although we have previously reported that in the embryonic chick heart spontaneous action potential would be initially generated at the middle period of the 7-somite stage of development, corresponding to the time of beginning of fusion of the paired right and left cardiac primordia, additional experiments indicated that this result was not reliable: in experiments using a multiple-site optical recording method with a 100-element photodiode array, we have achieved to detect spontaneous electrical activity in the prefused cardiac primordia at the stage earlier than the middle period of the 7-somite. Furthermore, to see regional development of spontaneous electrical activity in the early embryonic precontractile chick hearts at the 7- to 9-somite stages, we have also monitored optical action signals from the entire regions of the heart using the 100-element photodiode array. The data represent the following natures: (i) the electrical activity increased and the active area gradually widened as development proceeded, (ii) the activity differed among the various regions in one heart, and (iii) there are two peaks of the activity in the right and left side of the conoventricle, in the every stage of development.

578, III B 1430

ASSESSMENT OF PACEMAKING AREA IN THE EARLY EMBRYONIC CHICK HEART USING MULTIPLE-SITE OPTICAL RECORDING OF ACTION POTENTIALS. SAKAI, T., KOMURO, H., HIROTA, A. and KAMINO, K. Dept. Physiol., Tokyo Ika-Shika Daigaku, Sch. Med., Tokyo 113.

Spatial-temporal organization of pacemaker function in the early developing embryonic chick heart was investigated. First we have developed a method to quantitatively assess the pacemaking area by means of multiple-site optical recording of spontaneous action potentials. The measuring system with a 100-element photodiode array had a time resolution of milliseconds and a spatial resolution in the micrometer order. The spontaneous action potentials were recorded simultaneously from 100 contiguous areas involved the pacemaker in the embryonic precontractile chick heart stained with a voltage-sensitive merocyanine-rhodanine dye, at the 7- to 9-somite developmental stage. Hence we have obtained the following results: (i) both the area and location of the pacemaker are very variable in the early embryonic heart; (ii) the pacemaking area generally narrowed as development proceeds to the 9-somite developmental stage; and (iii) at the 9-somite stage, the pacemaking area is characterlized by a few pacemaker cells: roughly estimated to be 50-5 cells. In addition, we have found that one kind of early embryonic arrhythmias is caused from a periodic change in the location of pacemaking area.

579, ⅡB1445

CHARACTERISTICS OF TWITCH AND AFTERCONTRACTION OF DEPOLARIZED VENTRICULAR MUSCLE UNDER THE INFLUENCE OF CATECHOLAMINE. ITO, T. AND EHARA, T. Dept. Physiol., Fac. Med., Kyushu Univ., Fukuoka 812

Catecholamine induces biphasic twitch tension and oscillatory aftercontraction in guinea-pig ventricular muscles depolarized by K-rich (27 mM) Tyrode solution. We investigated the mechanism of these phenomena. In the presence of $\sim 10^{-8}$ M isoproterenol, twitch tension was biphasic, the initial peak (initial tension component, C_1) being followed by a sustained tension (late tension component, C_2). The action potential was followed by an oscillatory afterpotential (OAP). There was also an aftercontraction (AC). These phenomena were more pronounced at higher $[Ca]_o$ and at higher isoproterenol concentrations, and were depressed by Ca channel blockers. C_1, OAP and AC were increased by increasing the stimulation rates. Caffeine (5 to 10 mM) reduced OAP and AC, but increased C_2. Thus, the properties of OAP and AC in this preparation are very similar to those of the electrical and mechanical oscillations in the digitalis-intoxicated myocardium. We conclude that OAP and AC result from an oscillatory release of Ca from the sarcoplasmic reticulum (SR). The tension component C_1 is considered to be related to the triggered release of Ca from SR. This preparation appears to be feasible for studying the role of Ca oscillations in the cardiac excitation-contraction coupling.

580, ⅡB1500

MECHANICAL PROPERTIES AND ATPase ACTIVITY IN GLYCERINATED MYOCARDIUM OF HYPERTHYROID RABBIT. SAEKI, Y., KATO, C. AND YANAGISAWA, K. Dept. Physiol., Tsurumi Univ. Sch. Dent. Med., Tsurumi, Yokohama 230

Isometric tension, tension transients in response to rapid step stretches in length and ATPase activity were measured at constant levels of various Ca^{2+} activations in glycerinated right-ventricular papillary muscle preparations of L-thyroxine-treated (14 daily injections of 0.2 mg/Kg) and control rabbits. The isometric tension increased as Ca^{2+} was varied from slightly below pCa 7 to about pCa 6 both in the thyroxine and control preparation. The maximum isometric tension in the thyroxine preparation was, however, only about 64% of that in control. The tension transients were characterized by three distinct phases; an immediate tension increase coincident with the stretch, a rapid exponential tension decrease (time constant, $t1_{63\%}$) and a delayed exponential tension rise ($t2_{63\%}$). In the thyroxine preparation, relative to control, $t1_{63\%}$ decreased from 39.3 ± 2.8 ms (mean $\pm$ SD, n=5) to 20.2 ± 2.0 ms ($P<0.001$) and $t2_{63\%}$ decreased from 483.9 ± 14.3 ms to 298.5 ± 15.9 ms ($P<0.001$). The ATPase activity increased in a sigmoid fashion with increasing Ca^{2+} from slightly above pCa 7 to slightly bellow pCa 6 both in the thyroxine and control preparations. However, the tension cost (ATPase activity/tension) was 2.5 times greater in the thyroxine preparation than in control.

581, ⅡB1515

DEVELOPMENT AND RECOVERY OF ANOXIC CONTRACTURE IN RAT VENTRICULAR MUSCLE. OKADA, T. Dept. Physiol., Sch. Med. Juntendo Univ., 2-1-1 Hongo, Bunkyo-ku, Tokyo 113.

The anoxic contracture was induced by superfusing the isometrically contracting rat right ventricular muscle with N_2-saturated Krebs solution. The contracture tension was elevated to 50-100% of the twitch tension within 10-15 min after the induction of anoxia. 10 μM of diltiazem significantly suppressed the development of anoxic contracture. On superfusing with oxygenated Krebs solution, the muscle recovered from the anoxic contracture but it took 10-15 min for complete recovery. When rapid cooling contracture (RCC), induced by rapidly cooling the muscle to 4 °C for about 10 sec, was superimposed on the anoxic contracture during the early period of reoxygenation, the recovery from anoxic contracture was significantly accelerated ($p<0.01$). RCC similarly accelerated the recovery from contracture which was induced by lowering the extracellular Na^+ concentration but showed no effect on the recovery from CN^--induced contracture.

These results indicate that the anoxic contracture is developed both by excess entry of Ca and the depletion of ATP. On the other hand, RCC facilitates the recovery from anoxic contracture by removing or redistributing the excess Ca ions.

582, II B 1530

CONTRACTILE REBOUND AFTER REMOVAL OF ACETYLCHOLINE ON CANINE ATRIAL MYOCARDIUM. INATOMI, K. AND IMANAGA, I. Dept. of Physiol., Sch. of Med., Fukuoka Univ., Fukuoka 814-01

Exogenous Acetylcholine (ACh) has a negative inotropic effect on canine atrial myocardium. But after removal of ACh contractile force was increased above the control value (rebound). In the previous study, we reported the rebound was brought about via muscarinic ACh receptor (m-AChR) without any interaction with intrinsic catecholamine. Amplitude and duration of the transmembrane action potential and resting membrane potential were not altered during the rebound. The rebound was abolished by $[Ca^{++}]o$-free or $[La^{+++}]o$ (2×10^{-4}M), but not Ca^{++}-channel antagonists (10^{-6}M). Low $[Na^{+}]o$ or Strophanthidin (10^{-7}M) enhanced the robund and Quinacrine (10^{-5}M) abolished it. Low $[K^{+}]o$ (1.35 mM) increased the rebound. On the contrary, high $[K^{+}]o$ (5.4-8.1 mM) decreased it. High $[K^{+}]o$ may stimulate Na^{+}-K^{+} active transport in presence of ACh. These results suggest that ACh increases uptake of Ca^{++} into intracellular store sites by an activation of Na^{+}-Ca^{++} exchange via m-AChR and an inactivation of m-AChR releases Ca^{++} from them. This may be a possible mechanism of the rebound phenomenon.

583, II B 1545

ASSESSMENT OF THE MECHANICAL EFFICIENCY OF CONTRACTILE MACHINERY IN DOG LEFT VENTRICLE. SUGA, H., GOTO, Y., AND IGARASHI, Y. Dept. Cardiovasc. Dynamics, National Cardiovascular Center Research Institute, Suita, Osaka 565

We developed a method to assess the total mechanical energy generated by ventricular contraction. This total energy is equivalent to the area within the end-systolic pressure-volume (P-V) curve, the systolic segment of the P-V trajectory, and the end-diastolic P-V curve in the P-V diagram. This specific area is called "systolic P-V area (PVA)" and 1 mmHg ml of PVA is equivalent to 1.33×10^{-4} J. The total energy (enthalpy) input to myocardium is equivalent to myocardial oxygen consumption (Vo_2) under aerobic conditions and 1 ml O_2 is equivalent to 20 J. In the excised, cross-circulated dog heart, we determined both Vo_2 and PVA under various conditions. The Vo_2-PVA relation of variously loaded contractions in a given contractile state was linear: $Vo_2 = A \times PVA + B$, where A = 2.5 - 3.0 (dimensionless) and B = 0.34 - 0.46 (J/beat/100 g). B increased to 0.64 - 0.70 with epinephrine or calcium which doubled Emax, but A remained unchanged. Theoretically, 1/A (= 0.3 - 0.4) indicates the energy conversion efficiency from Vo_2 available for contractile machinery (Vo_2 - B) to the total mechanical energy (PVA) generated by contraction, and this efficiency (30 - 40%) was not affected by the inotropic interventions. Since the efficiency from Vo_2 to ATP is 60-70%, we assessed the mechanical efficiency from ATP to PVA to be 60-70%.

584, I P (24) 1330

CHANGE OF Na-Ca EXCHANGE TRANSPORT AND DEVELOPMENT OF TETANIC TENSION IN FROG VENTRICULAR MUSCLES. NISHIYE, H. AND TANAKA, S. Dept. Physiol., Sch. Med., Juntendo Univ., Hongo, Tokyo 113

The full tetanic tension can be developed by AC field stimulation in 9 mM Ca containing Ringer's solution. Whereas, the tetanic tension is very small and seems to be incomplete in the normal Ringer's solution. We report here that the large full tetanic tension can be developed even in the presence of 1.8 mM Ca if the appropriate portion of Na in the solution is substituted with sucrose. In 45% or 56% Na substituted Ringer's solution, the tetanic tension was respectively increased to 3 or 9 times of the control. Its rising and falling phases were both rapid as those of the full tetanic tension in the 9 mM Ca Ringer's solution. Similar results were also observed in 2.7 mM or 3.6 mM Ca containing Na substituted Ringer's solutions. The full tetanic tension could be developed in 25%, 45%, 56% Na substituted Ringer's solutions. The increase of tetanic tension depended on the concentratins of Ca as well as the percentages of Na substitutions. We conclude that most of Ca entered into the cardiac cells are uptaken into the intracellular Ca store sites under the decreased Ca extrusion by decreased Na-Ca exchange transport and the large amounts of Ca released from the store sites on the stimulation results in the full tetanic tension.

585, II P (25) 1330

Ba^{2+}-INDUCED AUTOMATICITY IN GUINEA-PIG VENTRICULAR MYOCYTES. Hirano, Y., Sawada, K. and Hiraoka, M. Dept. Cardiovasc. Dis., MRI, Tokyo Med. and Dent. Univ., Tokyo 113

Guinea pig single ventricular cells developed automatic activity in the presence of Ba^{2+} (0.2-1 mM). A whole cell patch clamp method was used to record membrane potentials and currents. Automaticity from slow diastolic depolarization in five examined cells developed from Emax near -70 mV. When repolarizing pulses were given from the holding potential near 0 mV, a decaying outward current was observed at -40--80 mV with an increased amplitude than the control. The current reversed its polarity near presumed E_k with a time course depending on voltage and concentration of Ba^{2+}. These effects were consistent with the time- and voltage-dependent blocking action of Ba^{2+} on inward rectifier K^+ currents known in many excitable tissues. Voltage dependence of the steady state block on I_{k1} and the time constant of the blocking-unblocking action was estimated from these experiments and incorporated into a computer model of the ventricular action potential, based on the Beeler and Reuter's formulations. In this model, simple reduction in I_{k1} (without time-dependence) hardly produced repetitive firing if there were no involvement of the delayed outward K^+ current (I_k). When the time-dependent nature was given to I_{k1} through the blocking-unblocking process, however, the combination of inward currents (I_{Na} or I_S) and I_{k1} was sufficient to evoke automaticity. The contribution of the two inward currents depends on the level of Emax.

586, I P (26) 1330

THE VOLTAGE-DEPENDENT EFFECT OF 1,4-DIHYDROPYRIDINE ENANTIOMERS ON Ca CHANNELS IN CARDIAC CELLS. S.KOKUBUN Dept. Physiol. Jikei Univ. Sch. Med.,Nishishinbashi Minato-ku Tokyo 105

Voltage-dependent binding and action of 1,4-dihydropyridine enantiomers (Sandoz (+)-(S)&(-)-(R)-202-791) was studied in cardiac cells. Drug action was studied by patch clamp method. (+)-enantiomer primarily prolonged open time of Ca channel,thus enhancing Ca currents, while (-)-enantiomer predominantly favored closed state of the channel, reducing the currents. Electrophysiological study also revealed steady-state inactivation was greatly enhanced by both enantiomers. Therefore, it seems that botn enantiomers have a capability of activating and blocking effects. Strongly voltage-dependent binding affinity of these enantiomers was revealed by displacement of H-(+)-PN200-110 with each enantiomers. Binding affinity of both enantiomers in depolarized cells was much higher than in polarized cells. These results indicate that both enantiomers have higher affinity when Ca channels are inactivated.

587, I P (27) 1330

EFFECTS OF BETA RECEPTOR STIMULATION ON INTRACELLULAR CALCIUM TRANSIENTS AND TENSION IN RAT VENTRICULAR MUSCLE. KONISHI, M., KURIHARA, S. AND SAKAI, T. Dept. Physiol., The Jikei University of Medicine, 3-25-8 Nishi shinbashi, Minato-ku, Tokyo 105.

Effects of β-receptor stimulation on Ca sensitivity of a contractile apparatus in mammalian cardiac muscle were examined. Aequorin was injected into 50-80 cells of papillary muscles dissected from right ventricle of rats, and aequorin light signal and tension were recorded.

Replacement of extracellular Na^+ with Li^+ produced slow rise of light and tension (Na withdrawal contracture). Isoproterenol (1 μM) inhibited Na withdrawal contracture tension with little decrease (or sometimes increase) of light signal. This effect of isoproterenol was antagonized by 30 μM propranolol. Qualitatively same results were obtained in the similar experiments repeated in the presence of 1 μM ryanodine, an inhibitor of Ca release from cardiac sarcoplasmic reticulum, to exclude the possibility of cell-to-cell inhomogeneity in the preparation.

These results suggest that Ca sensitivity of a contractile apparatus in mammalian cardiac muscle is decreased by β-receptor stimulation, probably via intracellular cyclic AMP.

588, I P (28) 1330

DETERMINATION OF SLOPE OF END-SYSTOLIC PRESSURE-VOLUME LINE (Emax) BY END-DIASTOLIC VOLUME CLAMP IN DOG HEART. IGARASHI, Y., GOTO, Y., YAMADA, O., AND SUGA, H., Department of Cardiovascular Dynamics, National Cardiovascular Center Research Institute, Osaka 565

The purpose of this study was to establish a new method of assessment of the slope (Emax) of the end-systolic pressure-volume line (ESPVL) of the in situ heart. In nine anesthetized open-chest dogs, an isovolumic contraction was produced by an aortic occlusion after steady-state ejecting contractions in the left ventricle. We plotted ventricular pressure against time integral of aortic flow of the last ejecting and the first isovolumic contraction assuming the same end-diastolic volume. ESPVL was drawn from the peak isovolumic pressure-volume point tangentially to the left upper corner of the pressure-volume loop of the ejecting contraction. We found that Emax sensitively reflected acute changes in contractile state and was constant despite heart rate change by pacing. Utility of this aortic occlusion method for assessment of left ventricular contractility was corroborated in other eleven excised dog hearts. We conclude that Emax by aortic occlusion method is useful for assessment of left ventricular contractility of the in situ dog heart.

589, I P (29) 1330

REGULATION OF JUNCTIONAL CONDUCTANCE BY H^+, Ca^{2+} AND Mg^{2+} IN CARDIAC PAIRED CELLS OF GUINEA-PIG. TSUBOI, N.*, NOMA, A.** AND IRISAWA, H. Nat. Inst. for Physiol. Sci., Okazaki; *Nagoya Univ., Nagoya; **Kyushu Univ., Fukuoka

We developed a new method for measuring the gap junctional conductance (Gj) between paired myocytes dissociated enzymatically from the guinea-pig ventricle. Non-junctional membrane of one of the pair was perforated while clamping voltage of the other cell using two patch pipettes. The method allowed us to apply test solutions to one aspect of the junction and to measure the Gj. Control Gj was 1038±830nS (mean±SD, n=98). An increase in H^+, Ca^{2+} or Mg^{2+} decreased the junctional conductance in a dose-dependent manner and the effect was reversible. The half maximum concentrations of H^+, Ca^{2+} and Mg^{2+} were 6.1 (pH), 6.4 (pCa) and 2.5 (pMg), respectively. The pCa-Gj curve shifted toward higher Ca^{2+} concentration range at lower pH. It was suggested that Ca^{2+} plays a major role in regulation of the cardiac Gj under physiological conditions and that there might be two kinds of receptor sites for modulation of Gj, one for divalent cations and the other for H^+.

590, I P (30) 1330

MAPPING OF SPREAD OF SPONTANEOUS EXCITATION IN THE FROG ATRIUM USING MULTIPLE-SITE OPTICAL RECORDING OF ACTION POTENTIALS. HIROTA, A., SAKAI, T., KOMURO, H. and KAMINO, K. Dept. Physiol., Tokyo Ika-Shika Daigaku, Sch. Med., Tokyo 113.

A complete understanding of the conduction pattern of excitation in the atrium is necessary to answer major questions in cardiac physiology. With reference to the spread of excitation in the atrium, the question "Is the spread of excitation waves radial or nonradial?" has arisen. However, investigations into such a problem have been hampered, because of a technical limitation in the use of microelectrodes for simultaneous recording of action potentials from many sites of the preparation. In the present work, we investigated electrical propagation in the bullfrog atrium, using a voltage-sensitive merocyanine-rhodanine dye together with a multiple-site optical recording system to monitor action potentials simultaneously from 100 different contiguous areas. Isochrone curves of conduction obtained by timing the initiation of the action potential-related optical signals, and we constructed maps of the spread. Hence it is concluded (i) that basically, electrical excitation generated in a narrow pacemaking area where lies close to the sinus venosus, and conducts radially over the atrium, (ii) that the conduction velocity in the left atrium exceeds that in the right atrium, and (iii) that the location of the pacemaking area somewhat varies with every preparation.

591, I P (31) 1330

COMPARISON OF EPICARDIAL ACTIVATION MAPS OF LEFT VENTRICLE BETWEEN NR AND SHR

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Epicardial isochonic activation maps of the left ventricle (left lateral view of the heart) were compared between spontaneously hypertensive rats (SHRs) and normotensive rats (NRs). Each five males of 30 weeks old NR and SHR were used. Isolated heart was perfused by the Langendorff method, and was mounted on the cardiac muscle chamber filled with 35ml and 37°C of normal oxygenated Tyrode's solution. It was stimulated by a bipolar electrode with rectangular pulse wave of 4 msec duration and 2 Hz, which was placed in the atrial septum of right atrium site after the sinus node was crushed. In mapping procedure a fixed reference bipolar electrode was applied on the surface of left ventricular epicardium, and a roving electrode was run by conventional microelectrode method. The result and conclusion are as follows : 1) The earliest site of activation occur around the base of anterior interventricular sulcus, and the lastest site of activation around the middle base of free wall in all NR. 2) In the earliest and lastest sites of activation maps, they occur in various positions of free wall in SHR.

592, I P (32) 1330

TWO TIME-DEPENDENT PLATEAU OUTWARD CURRENTS IN GUINEA-PIG PURKINJE FIBERS.

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In guinea-pig Purkinje fibers, Cs (20 mM) completely blocked I_{K1} and a plateau outward current (I_K), both of which reversed around -95mV in 4mM (K)o. I_K showed inward rectification with negative slope region as I_{K1}. Activation of I_K consisted of fast (completed within 100msec) and very slow components. Cd (0.3 mM) completely blocked the fast activation component, suggesting Ica dependent activation of this component. A Cs (20mM) resistant deleyed outward current (Ic) reversed around -55mV and showed inward rectification above its reversal potential. Ic developed slowly (τ= 500msec) during depolarization but the amplitude of its inward tail current did not changne. It is suspected that the development of Ic during depolarization is not due to activation but to the removal of the inward rectification of the current. The decay of the inward tail of Ic was greatly retarded with prologation of the depolarizing clamp pulse. The kinetics of Ic and I_K well explains the slow final repolarization and automaticity when the voltage clamp was released during depolarizing pulse to plateau potentials.

593, I P (33) 1330

DELAYED OUTWARD CURRENT IN ISOLATED SINGLE VENTRICULAR MYOCYTES OF GUINEA-PIG.

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The reversal potential or ion selectivity of the delayed outward current (I_{out}) in cardiac cells is still a matter of controversy. We investigated the property of I_{out} in isolated guinea-pig ventricular myocytes. In order to facilitate the analysis, I_{out} was enhanced by application of isoproterenol, and Ca was omitted from the bathing solution. Under this condition, depolarizing pulses elicited I_{out} whose activation showed a sigmoid onset. The threshold voltage for activation was about -40 mV. Analysis of the tail currents revealed fast and slow current components, their time constant at -40 mV being about 100 msec and 400 msec, respectively. Both components appeared to have the same reversal potential (E_{out}), and it was near -70 mV in 5.4mM-K Tyrode solution. This value was about 20 mV less negative than the reversal potential of the anomalous rectifier K current. A linear fitting of the E_{out}-log$[K]_o$ relationship showed a slope of 44 mV per 10-fold change in $[K]_o$. E_{out} was little influenced by changes in the duration of depolarizing pulses or those in the holding potential, suggesting that any effect of extracellular K accumulation on the E_{out} determination was negligible. These results indicate that I_{out} in this preparation is not a pure K current. Na-removal markedly reduced the slow component of I_{out} without affecting E_{out}.

594, I P (34) 1330

THE EFFECTS OF MAGNESIUM ON THE EXCITATION-CONTRACTION COUPLING OF VENTRICULAR MUSCLE.

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Catecholamine-treated, depolarized guinea-pig ventricular muscle generates biphasic twitch tension consisting of the initial and late components, aftercontraction (AC) and oscillatory afterpotential (OAP). AC and OAP are related to an oscillatory release of Ca from the sarcoplasmic reticulum (SR), while the initial component of twitch (C_1) reflects the triggered release of Ca from SR (paper 579 in this volume). High $[Mg]_o$ (3 to 12 mM) was found to depress OAP and AC. However, C_1 was markedly enhanced at high $[Mg]_o$. This effect of Mg was more pronounced at higher driving rates, and the rested state contraction was only slightly enhanced by Mg, suggesting that Mg modifies the amount of releasable Ca in SR in a time-dependent manner. The experiments of extrasystoles, in which the extrasystoles with various coupling intervals were inserted during a regular driving at 0.2 Hz, suggested that Mg substantially slows the rate of decrease of the releasable Ca in SR during rest period. Thus, Mg appears to increse the amount of Ca releasable during twitch, which can be due to inhibition of the Ca oscillation at SR. Such an action of Mg on the excitation-contraction coupling can also be detected in the muscles perfused with normal Tyrode solution.

595, I P (35) 1330

INFLUENCE OF THE OSMOLARITY ON THE SPONTANEOUS ACTIVITY OF THE GUINEA-PIG SINOATRIAL NODE.

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The effects of various osmolarity of bathing solutions on the rate of spontaneous beating and on action potentials of the guinea-pig sinus node were studied. Increasing the osmolarity to 1.5 times that of isotonic solution by adding sucrose reduced the rate by 18%. At this stage, the slow diastolic depolarization (SDD) was depressed. When the osmolarity was increased twice the spontaneous beating was arrested. Decreasing the osmolarity by 30%, increased the rate by 6% and accelerated the SDD. However, further reduction of the osmolarity to half of the normal arrested the spontaneous activity. These effects were not altered by TTX, atropine, phentolamine and propranolol. When $[Ca^{++}]_o$ was lowered to 0.9 mM, it could reactivate the spontaneity which has been arrested in the hypertonic medium, however, adding the same amount of Mg^{++} to this medium stopped the beating. Adding K^+, Rb^+, or some K^+ channel blockers of 6 mM could initiate the beating. These results suggested that the hyperosmolarity may increase the threshold potential and the K^+ permeability of sinus nodal cells.

596, II B 1600

INFLUENCES OF -BLOCKER UPON ECG AND CORTEX EEG IN NON-ANESTHETIC SHR.
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In this study,influences of injecting various concentrations of propranolol, upon simultaneous recording observations of cortex EEG and ECG in non-anesthetic SHR with implanted electrodes, were investigated. From ISA by stabilizing membrane activities of propranolol, bradycardia was shown if a usual amount of propranolol was injected. However, no abnormal ECG wave was shown. The PQ interval was prolonged if high concentrations of propranolol were injected II° AV block and intra-ventricular conduction defect were seen if a rat LD50 was injected. Concerning central nerve activities, no abnormal finding caused by propranolol was shown in EEG.

597, II B 1615

RELATIONSHIPS BETWEEN ADRENERGIC INNERVATION AND PHARMACOLOGICAL CHARACTERISTICS OF ALPHA ADRENERGIC RECEPTORS IN CANINE MAJOR CEREBRAL ARTERIES.
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Innervation densities of adrenergic fibers in canine major cerebral arteries were studied histochemically by the glyoxylic acid method. Adrenergic fluorescent fibers were most abundant in the proximal portions of the anterior, middle (MCA) and posterior cerebral arteries as well as in the posterior communicating artery. The basilar artery (BA) contained a moderate number of adrenergic fibers while the internal carotid artery lying in the cavernosus sinus (ICA) had a very sparse innervation. Relationships between the innervation density and pharmacological characteristics of alpha adrenergic receptors in the MCA, BA and ICA were examined by recording isometric tensions in the isolated helical strips of these arteries. Neither cocaine, nor hydrocortisone, nor propranolol affected the noradrenaline-induced contractions in the strips of ICA. In addition, pharmacodynamic analyses were used to clarify the subtypes of alpha adrenergic receptors in ICA. The results suggested that there existed α_1- and α_2- adrenergic receptors on the plasma membrane of smooth muscles in ICA, α_2 adrenergic receptors being effective in relatively lower concentrations of noradrenaline and α_1 in higher concentrations.

598, II B 1630

INTEGRATION OF BAROSENSORY AND NON-BAROSENSORY INPUTS BY NEURONS IN THE VENTROLATERAL MEDULLA.
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In urethane-anesthetized rabbits, spontaneously active barosensory neurons in the ventrolateral medulla (BVLM neurons) were analyzed for their responses to various non-barosensory inputs. Activity of 90% of BVLM neurons was augmented by stimulation of the contralateral carotid chemoreceptors by an injection of NaCN. Although 60% of BVLM neurons were also excited by stimulation of the ipsilateral carotid chemoreceptors, the magnitude of the response was much smaller. Electrical stimulation of the posterior hypothalamus excited 89% of BVLM neurons tested. Stimulation of group II afferent fibers of the sural nerve inhibited spontaneous activity of BVLM neurons. On additional activation of group III fibers, the inhibition was preceded by a brief excitation in about half of BVLM neurons. A response of the same temporal pattern was elicited by stimulation of the spinal trigeminal tract. Stimulation of aortic nerve C-fibers usually resulted in an inhibition, often accompanied by an excitation, of spontaneous activity of BVLM neurons. Thus, the ventrolateral medulla is a site of confluence of various reflexes including those arising from arterial baro- and chemoreceptors, somatic and trigeminal afferents and the posterior hypothalamus.

599, II B 1645

THE TRANSFORMATION OF THE PRESSURE WAVE TRAVELING ALONG THE AORTA.
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The transformation of the pressure wave as it travels down the aorta was observed in 30 patients clinically.The pressure waves were recorded by the Millar cather-tip transducer inserted from the femoral artery up to the aortic root and progressively withdrawn at 10 cm intervals.
The amplitude of the wave increased linearly in the aorta as it traveled.The ratio of amplitude of the pressure wave from the aortic root to that from the common iliac(peaking ratio)was measured as a indicator of peaking.The mean value of PR was 1.32 and PR declined with age.The max dp/dt of the wave became progressively greater as the wave traveled down the aorta,the relation between the max dp/dt and the distance of the recorded site from the aortic root was roughly exponential.The mean value of the ratio of max dp/dt of the wave from the root to that from the common iliac was 2.38 and the ratio as a indicator of steepening was not corelated with age.Fourier analysis of the pressure showed that the amplitude of the second and third harmonics increased relatively with the distance.
The factors influence on the change of the pressure wave were discussed.

600, III B 0915

HAEMODYNAMICS AND LEFT VENTRICULAR WALL MOTION CHANGES WITH VARIOUS HEART RATE IN RIGHT VENTRICULAR PACING (VVI MODE).
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The cardiac performance in 12 patients with VVI pacing (complete A-V block and sick sinus syndrome) were assesed by ECG gated blood pool scinthigraphy (GBPS) using Tc-99m labelled red blood sell, then pacing rate were changed from 40 to 90 (evry 10 bpm). Cardiac output (CO) was measured by dye dilution method. Left ventricular ejection fraction (EF) and phase images was culculated from GBPS images. Left ventricular stroke volume (SV), enddiastolic volume (EDV) and endsystolic volume (ESV) were also culculated, and moving images were analysed. In the result, the higher heart rate produced decreased EF, SV, EDV, slightly increased CO, and slightly decreased ESV. The asynchronous left ventricular wall motion also observed in higher pacing rates.

601, III B 0930

MORPHOLOGICAL AND FUNCTIONAL STUDIES OF VASA VASORUM IN CANINE THORACIC AORTA.
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We have designed and constructed a new preparation to study the physiological regulation of blood flow through vasa vasorum in the isolated canine thoracic aorta. Vasa vasorum to the descending aorta originated primalily from intercostal arteries. Segments, 50-70 mm long, were prepared from the isolated aorta. A catheter was inserted reversely into an intercostal artery with vasa vasorum and then the artery was ligated at the adventitial surface of the descending aorta. Both vasa vasorum and intraluminal space of the descending aorta were separately perfused with Krebs solutions under a constant flow. Colloidal carbon and Evans blue dye were injected into the intercostal artery and then were demonstrated in the outer third of media in cryostat sections of the aorta. The perfusion pressure of vasa vasorum through the descending aorta was increased dependently with an increase of intraluminal pressure of the aorta. These findings suggest that our new preparation may be suitable for measurements of changes in the flow rate through vasa vasorum.

602, ⅢB 0945

NERVOUS CONTROL OF THE PORTAL VEIN DURING DEPRESSOR REFLEXES IN RABBITS.

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Increase of the portal venous volume (PVV) during depressor reflexes evoked by electrical stimulation (ES) of the aortic (AN) and/or carotid sinus (CSN) nerves was recorded with the plethysmographic method in anesthetized rabbits. Increase of the PVV caused by ES of the AN (10-80Hz, 0.5msec, 4V) on the left side was nearly twice as large as that on the right side. PVV increased by 11.3% (mean) and systemic arterial pressure (SAP) decreased by 48.6% during bilateral ES of the AN with 80Hz, respectively. Large dilatatory responses of the portal vein were produced by separate or combined ES of the CSN (5-50Hz, 0.1msec, 10V) and AN (5Hz, 0.5msec, 4V) on the left side. The PVV increased by 9.2% during ES of the CSN at 20Hz and increased by 15% during combined ES of the CSN at 20Hz and AN at 5Hz. SAP fell by 20.0% and 30.0% during the respective ES. In contrast, the PVV increased only by 2.3% and SAP reduced by 4.4% during ES of the AN at 5Hz. It is suggested that the dilatatory response of the portal vein during the depressor reflex promotes the venous blood pooling and participates in reducing SAP.

603, ⅢB 1000

RENAL NERVE ACTIVITY (RNA) DURING EXPERIMENTAL HEMORRHAGIC SHOCK.

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We assessed time course changes in RNA during a long-lasting hemorrhagic hypotension in the anesthetized dogs. Systemic blood pressure was maintained at 50 mmHg for 2 hours, withdrawing arterial blood to the blood reservoir. Hemorrhage caused an initial rapid increase in RNA, which was dependent on activation of baroreceptor-reflex system, followed by a secondary increase in RNA (mean onset time was 9.5 ± 2.2 min; maximal, 32 ± 5 min). This was mediated through disturbances of cerebral circulation. Following this secondary increase in RNA, even in animals either with sinoaortic denervation and vagotomy or with neuraxis intact, RNA declined to near zero level of discharges. These decreases in RNA were also protected by maintaining cerebral cerculation. These reductions of efferent sympathetic nerve activity during severe hemorrhagic hypotension may induce systemic vasodilation, resulting in irreversible circulatory disturbances in this experimental model.

604, ⅢB 1015

EFFECT OF VAGAL STIMULATION ON SMALL PULMONARY VESSELS IN THE RABBIT.

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Using a new X-ray TV system, we analysed effect of vagal nerve stimulation on internal diameter (ID) of small pulmonary arteries and veins ranging from 100 to 700 μm in anesthetized rabbits. Angiograms were taken before (control) and after electrical stimulation of the cervical vagus nerve with 1 msec duration, 10 V and 4-30 Hz. With stimulations, significant vasoconstriction occurred in selective sites of small arteries (100-700 μm in ID). The number of vasoconstrictive sites increased in a frequency-dependent manner, whereas the magnitudes of constriction seemed to be independent with stimulus frequencies in a given site. On the other hand, with small veins, there were no significant changes in ID to the stimulations. We concluded that vagal stimulation nonuniformly and selectively constricted the small arteries, but not the veins of the rabbit lungs.

605, ⅢB1030

AORTIC BAROREFLEX BRADYCARDIA IN EXPERIMENTAL HYPERCHOLESTEROLEMIA OF RABBITS.
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We showed previously that aortic nerves are the main afferent fibers for the brain ischemic reflex bradycardia elicited by interrupting completely the blood supply to the brain in rabbits. To confirm that the bradycardia is induced via aortic baroreceptors, we examined the effect of sclerotic changes of the aortic wall on the magnitude of this particular bradycardia. The aortic sclerosis was induced by giving a special diet contained 1% cholesterol for more than 8weeks in rabbits aged 20 to 24weeks. These animals had histologically typical atherosclerosis in the wall of the aortic arch and was 20 times as great in total plasma cholesterol as the rabbits fed on a commercial rabbit food. The brain ischemia experiments were performed under urethane anesthesia and the arterial pressure, heart rate and respiratory movements were simultaneously recorded. The heart rate during the brain ischemia decreased by 40 to 75% when the arterial pressure rapidly increased to its maximal level in the normal rabbits. This marked bradycardia was significantly inhibited in the atherosclerotic rabbits. The results support that the brain ischemic bradycardia is related to the wall structure as well as baroreceptors of the aortic arch.

606, ⅢB1045

INTERPRETATION OF CARDIAC PERFORMANCE CURVE AND VENOUS RETURN CURVE IN THE RIGHT HEART BYPASS EXPERIMENT.
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In our previous experiments we have shown that a flow-pressure relationship in the right heart bypass experiments does not represent either cardiac function or vascular properties alone, but a mixture of these parameters. (J. Physiol. Soc. Japan 47:552, 1985). We attempted in this study to estimate the cardovascular parameters as separately as possible based on the left and right heart and systemic and pulmonary networks.

In the right heart bypass experiments with mongrel dogs, cardiac output(Q) and pressures at systemic and pulmonary arteries and veins (Pas, Pvs, Pap, Pvp) were measured by changing the pump output with the circulatory blood volume kept at constant. The flow-pressure relationships were fitted by linear regression and the slopes(dP/dQ) and intercepts (Po at Q=0) were calculated. Pvso and Papo were interpreted as mean circulatory pressure (Pm) whereas Pvpo were about 1/4 of Pm. It was derived from the model that Pvpo = 1/Kl*Pm, dPap/dQ = (1 + hl*Ras)/kl and dPas/dQ = Ras, where hl,kl and Ras are afterload, preload sensitivity, and systemic arterial resistance. hl is much less than kl. The parameter changes by the cardiovascular drugs were in the direction as expected by their pharmacological principles.

607, ⅢB1100

DETERMINANT OF PERIOD OF BLOOD PRESSURE OSCILLATION.
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Blood pressure oscillation were elicited by the "side pressure exertion procedure" in rabbits. The procedure consists of restricting cerebral blood supply routes to one common carotid artery and then compressing the carotid with a constant pressure higher than control mean systemic arterial pressure of the animal. During the oscillation two groups of medullary vasomotor neurons which discharged reciprocally were already discriminated. The cardinal point of the mechanisms of the oscillation is considered to be the reciprocity combined with a clock mechanism having emerged in the medulla. This clock mechanisms is raised, strengthened and sustained by the medullary chemoceptive and peripheral baroceptive feedback mechanisms. With the establishment of the clock mechanism, it commands the oscillation instead. The periods of the clock mechanism are not continuous but quantum in nature. What is in the neighborhood of the resonant period of the feedback circuits is chosen. In order to examine the hypothesis the time constant of the feedback circuit was changed and its effect was studied. The change did not make a gradual shift of period histogram of the waves. Shorter resonant period made a new peak in shorter side and longer one made the same in longer side in the histogram.

608, ⅢB1115

EFFECTS OF CO_2 ON CIRCULATING BLOOD DISTRIBUTION. SHIGEMI,K., ITOH,T., NATSUYAMA,T., SOHMA,A., TANAKA,Y., MORIMOTO,T., AND MIYAZAKI,M. Depts. of Anesthesiol. and Physiol., Kyoto Pref. Univ. of Med., Kyoto 602

Carbon dioxide is known as one of the most effective vasodilator on cerebral and coronary vessels. In this experiment, the effects of carbon dioxide on whole body cardiovascular dynamics was examined on five splenectomized dogs by loading infusion of Ringer's solusion. Analyses were made on transvascular filtration coefficient, compliances of vascular and interstitial spaces, and blood volume distribution by computer simulation. Elevation of $PaCO_2$ to 65 mmHg from 35 mmHg caused significant increases of cardiac output, pulse pressure, and blood volume in central circulation (cardiopulmonary circulation), while circulating blood volume in hypercapnia was not different from in normocapnia. Significant decreases of total peripheral resistance and delayed compliances of vascular and interstitial spaces were also observed. Transvascular filtration coefficient and instantaneous compliances of vascular and interstitial spaces showed no significant differences each others.

These results suggest that hypercapnia causes redistribution of circulating blood from the space of unstressed volume, such as liver and kidneys, to central circulation in order to maintain arterial blood pressure by counteracting the direct vasodilating effect of hypercapnia on systemic vessels, such as brain and heart.

609, ⅢB1130

OXYGEN TRANSFER PROCESS IN CAPILLARY BLOOD FLOW.
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There are two methods of oxygen transport in capillary blood flow. One is molecular diffusion in the plasma and the other is convection resulting from the motion of the plasma. The latter factor not received attraction , but recent rheological studies of capillary blood flow suggests the important role of plasma motion in the oxygen transfer between capillary and tissue. We investigated how the motion of plasma could influence the oxygen transport from red cells to the pericapillary tissue. By considering the two transport methods in the plasma, we simulated the dynamical process of the oxygen transport from a moving red cell to the capillary wall. It was found that the convective motion of the plasma could maintain constant oxygen transport from a train of moving red cells to the capillary wall and further it could enhance the mean level of the oxygen transport when the red cell velocity increased.

610, ⅢB1145

DISTRIBUTION OF BODY FLUID AT EARLY STAGE AFTER RAPID BLOOD TRANSFUSION.
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We have reported that rapid transfusion of blood into aorta of rabbit produced a considerable drop of arterial pressure (AP) after its transitory passive rise. AP again gradually rised and reached a steady higher level. It is the object of the present paper to investigate distribution of body fluid in whole body during such changes of AP. Changes in body fluid of different regions of the body were continuously recorded by electrocapacitography, a versatile noninvasive method for measuring change in volume of living body (Hatakeyama, 1959). With the drop of AP just after the transfusion, venous pressure rised and thereafter it gradually returned to the original level. ECPG of hindleg showed an initial increase of its volume followed by decrease of the volume which again tended to decrease and finally reached a steady level that is somewhat lower than the original. Volume of lower part of trunk (waist and hypogastrium) gradually increased and after a while it tended to decline to a steady level. Volume of upper part of trunk (breast and abdomen) gradually increased to a steady level.

It is concluded that the transfused blood initially inclines to distribute in caudal part of body but finally the body fluid moves from caudal to cranial region.

611, ⅢB1300

BASIC STUDIES ON ARTERIAL BLOOD PRESSURE CHANGES CAUSED BY HEAD-UP TILT.
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In the present report, the mechanisms of the arterial blood pressure changes caused by tilting from supine and horizontal position to 10-60° head-up position were studied from the standpoint of the systemic hemodynamics reflected by cardiac output(C.O.) and total peripheral resistance(T.P.R.). Stroke volume(S.V.), heart rate(H.R.), C.O., and T.P.R. in addition to the blood pressure were measured by the pulse wave and Korotkoff sound graph recorder (GP-303S,PARAMA). Furthermore, ballistocardiogram, plethysmogram, etc. were also traced simultaneously. In many subjects the systolic blood pressure was observed to be changed less than 10 mmHg by 10,20 and 40° head-up tilt, while diastolic blood pressure was increased significantly. S.V. and T.P.R. were decreased and increased respectively. In the group whose systolic blood pressure was decreased more than 12 mmHg (average-S.D.) by 60° head-up tilt, the ascending rate of the diastolic blood pressure was lower than that in the group with systolic blood pressure increased more than 5 mmHg (average+S.D.). In the former C.O. was decreased slightly, although S.V. and H.R. were markedly decreased and increased respectively. In the latter S.V. and H.R. were respectively decreased and increased moderately, and C.O. was increased slightly.

612, ⅢB1315

CLINICAL STUDIES ON ARTERIAL BLOOD PRESSURE CHANGES CAUSED BY TILTING FROM HORIZONTAL TO HEAD-UP POSITION.
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In the pediatric field, orthostatic dysregulation(OD) is designated as pathologic conditions with dizziness, faint, etc. without known organic disorders by standing from lying position. In the present report the generating mechanism of OD from the standpoint of hemodynamics was studied. As the control subjects were selected children without any organic disorder and symptom of vegetative dystonia. The arterial blood pressure changes of the control and OD subjects caused by tilting from supine and horizontal to 20° head-up position were measused by the pulse wave and Korotkoff sound graph recorder(GP-303S,PARAMA). Furthermore, stroke volume(S.V.) heart rate, cardiac output (C.O.) and total peripheral resistance(T.P.R.) in addition to the blood pressure were measured simultaneously. In OD subjects, systolic blood pressure, S.V.,C.O. were decreased slightly and diastolic blood pressure and T.P.R. were increased moderately. In the healthy subjects, on the other hand, systolic pressure was usually not so changed or increased slightly, wheseas S.V. and C.O. were decreased slightly. From the above results it was suggested that the main symptoms of OD patients were provoked by the decrease of S.V. and C.O. and the following fall of systolic blood pressure.

613, ⅢB1330

RADIAL DISTRIBUTION OF SOME STATISTICAL CHARACTERISTICS OF TURBULENCE MEASURED IN THE CANINE AORTA.
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Turbulence in the canine ascending aorta was measured with a hot-film anemometer. Obtained data were analyzed using an ensemble averaging technique. The radial distribution of some statistical parameters of turbulence, such as mean velocity, turbulence intensity, the first and the second order characteristic frequency of turbulence spectra, was measured. Unsteady autocorrelation function of turbulent velocity fluctuations was also measured at the centerline of the aorta. The width of the autocorrelation coefficients were shown to be a potential measure to characterize the time course of unsteady turbulence spectra. It was shown in the present study that the development and the decay of unsteady turbulence should be examined using spectral analysis. This was true in spatial terms as well as in temporal terms.

614, ⅢB1345

NONINVASIVE MEASUREMENT OF VOLUME ELASTIC MODULUS IN FINGER ARTERIES: COMPARISON STUDY WITH PULSE WAVE VELOCITY.

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A mehtod for the noninvasive measurement of the volume elastic modulus (Ev) in the finger arteries was developed. The volume change ratio and pulse pressure in the arteries were simultaneously determined by a infrared photoelectric plethysmograph and a volume oscillometric sphygmomanometer using an occluding cuff. The Ev values were obtained at the desired transmural pressure levels.

To evaluate the accuracy of this method, the pulse wave velocity (PWV) values were also simultaneously measured at the same part of the finger artery by detecting the time lag between a couple of photoelectric plethysmographs placed at each side of the occluding cuff. Using Moens-Korteweg equation, the indirect Ev valuse were rewritten to the indirect PWV values. Thus the correlation between these two types of PWV's obtained in the finger arteries were studied.

The linear regression equation was $Y = 1.31X - 0.60$ (Y;indirect PWV , X;direct PWV) and the correlation coefficient 0.962. Although there is a slight difference between these two values, there shows a fairly well linear correlation. Thus this method will be practically useful for the indirect determination of Ev in human finger.

615, ⅢB1400

THEORETICAL INVESTIGATION ON PULSE WAVE PROPAGATING TIME.

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Pulses originating at the left ventricle are modified as they propagated towards the periphery. This arterial pulse wave propagating velocity has been shown to be associated with several factors including aging and hypertention. Increased pulse wave propagating velocity associated with aging apparently accompanies an increase in arterial regidity due to changes in decreasing diameter of the artery and increasing viscosity. These were confirmed experimentally using mongrel dogs, either sex weighing 10 to 15 kg anesthetized with penthobalbital (25 mg/kg). Pulse wave propagating time PWPT were measured from the upward deflection of aortic flow measured at the ascending aortic root to that of blood pressure taken at the bifercation of the femoral artery. We established an equation of PWPT using an arterial three component model with the least square method from the data under the conditions induced by infusion with noradrenarine (NADR), isoproterenol (ISP) and acethycholine (ACH). From these the results indicated that when viscous effects of the arterial wall became greater in the case of infusion with ISP and ACH, PWPT increased whereas PWPT decreased when elastic effect of the wall became greater in the case of infusion with NADR.

616, ⅢB1415

THE DIFFERENTIAL DIGITAL PLETHYSMOGRAM DURING STATIC FINGER EXERCISE.

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The differential digital plethysmogram(ΔDPG) during and after static finger exercise was measured continuously in eleven, healthy male subjects. ΔDPG was obtained by the differentiation of digital plethysmographic wave using AC preamplifier with the time constant of 0.03 sec. A modified Mosso-type ergograph was used for the measurement of static finger work in supine position, and the loads applied were 30%, 50% and 70% of maximal finger flex work, respectively. Immediately after the onset of 1 min exercise in the rhythm of a contraction per sec, ΔDPG-P wave decreased rapidly and the level was maintained during exercise. In the recovery the decreased ΔDPG-P wave returned to the control within 30 sec. The heavier the load was, the smaller the amplitude of ΔDPG-P wave was observed. Heart rate which was measured simultaneously reached only to about 110% of the control in 50% and 70% loads. It is considered that the initial decrease in ΔDPG-P wave reflects the local effect of sympathetic vasoconstrictor nerve on arteriolar resistance vessels, and the subsequent lower amplitude during exercise depends on the concomitant effects of sympathetic nerve activity on cardiac output and peripheral vessels.

617, ⅢB1430

A CAMERA-TYPE PLANIMETER GAUGE WITH A NEW MONITORING SYSTEM AND ITS PHYSIOLOGICAL APPLICATIONS.
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We have designed and constructed a planimeter gauge utilizing an area image sensor which has attracted special interests recently as a new photoelectric transducer. The gauge was stable, and easy to assemble.

A combination of this gauge with a monocular reflex camera and microscope enabled us to record continuously changes in the projected area of an in vivo or in vitro arteriol on the focal plane. The arteriolar image is able to display both on a TV-monitor and an oscilloscope, simultaneously. A new monitoring system with memory circuits also caused a three-dimensional demonstration of the changes in the projected area and outer diameters. Taking into consideration an optical magnification of the microscope (x25), the device can detect the diameter changes of about 1.1 μm. The measurement of the arteriolar projected area and diameters can be monitored digitally and recorded in the analog form. By using the new experimental device, we have studied effects of various vasoactive substances on the isolated canine and rat arteriolar smooth muscle.

618, ⅢB1445

ANALYTICAL METHODS FOR RESPIRATORY ARRHYTHMIA.
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It is well known that heart rate is modulated by respiration. However, there are many arguments about the mechanism of the respiratory arrhythmia (R.A.). We tried to analyze the R.A. from the standpoint of the theroy of control system. Volunteers were asked to breathe in various respiratory patterns. The Bode plots on amplitude and phase as well as mean level of cardiotachogram (cardiac interval curve) against respiratory frequency were drawn from sinusoidal respiration. Breath-hold, impulse, step and ramp of either inspiratory and expiratory directions were also examined on cardiotachogram. The transient R.A. in step respiration was easily discernible from background fluctuation, and could be explained qualitatively from the frequency characteristics. In order to look into the black box, we designed an artificial respirator which could generate the any desired wave form for animal experiments. This was done by regulating the cylinder movement by a computer using the step-motor of a XY-plotter. It would make us possible to open the loop of the control system.

619, ⅠP(1)1330

EFFECTS OF SODIUM PENTOBARBITAL ANESTHESIA ON BAROREFLEX CONTROL OF RENAL SYMPATHETIC NERVE ACTIVITY AND HEART RATE IN THE RABBIT.
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Sodium pentobarbital (PB) remains one of the most widely used anesthetics for experimental cardiovascular studies. To study effects of PB on the cardiovascular system, we examined changes in renal nerve activity (RNA) and heart rate (HR) in response to arterial pressure (AP) changes elicited by phenylephrine (PE) and nitroglycerin (NTG) before and after PB (25 mg/kg, iv) administration in six chronically instrumented rabbits. PB produced initial transient decrease in AP by 38±5 mmHg and increases in RNA and HR by 154±16 % and 59±9 beats/min, respectively. The steady state effects 15-60 min later were characterized by no changes in AP and RNA and a significant increase in HR by 64±16 beats/min. AP elevation by PE decreased RNA and HR, while AP reduction by NTG increased RNA and HR. Sensitivity of baroreflex control of RNA and HR were estimated by $\Delta RNA/\Delta AP$ and $\Delta HR/\Delta AP$, respectively. After PB, $\Delta RNA/\Delta AP$ was significantly suppressed from -5.9±0.4 to -4.7±0.4 (determined by PE injection) and from -9.8±1.0 to -6.7±0.7 (by NTG). PB also suppressed $\Delta HR/\Delta AP$ from -3.2±0.2 to -1.3±0.2 (by PE) and -4.4±0.3 to -0.8±0.1 (by NTG). Thus, PB anesthesia does not alter basal level of RNA, while PB significantly impaires baroreflex control of RNA and HR.

620, I P (2) 1330

NEURAL MODULATION OF SECRETION OF ATRIAL NATRIURETIC PEPTIDE CAUSED BY VOLUME EXPANSION

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The aim of this experiment was to determine whether secretion of atrial natriuretic peptide (ANP) caused by volume expansion was modified by the cardiac nerves. We performed cardiac denervation on dogs (CD-group) following the modified Randall's method and the sham operation on a different group of dogs (sham-group). Pressure catheters were placed at the descending aorta and the left atrium. After two weeks recovery period, isotonic saline or 3% dextran (20% of estimated blood volume) was infused intravenously within 5 minutes to each dog in conscious state, and plasma ANP level, heart rate (HR), mean arterial pressure (MAP) and mean left atrial pressure (MLAP) were measured. The volume expansion on the CD-group caused statistically significant increase in plasma ANP level, HR, MAP, and MLAP. The volume expansion on the sham-group also caused significant increase in every measurements. Increase in plasma ANP level caused by the volume expansion on the CD-group was significantly smaller than that on the sham-group. Increase in MLAP on the CD-group, however, was significantly larger than that on the sham-group. These findings suggested that secretion of ANP caused by the volume expansion was enhanced by the cardiac nerves.

621, I P (3) 1330

EFFECTS OF RAPID SODIUM CHLORIDE INJECTION ON SECRETION OF ATRIAL NATRIURETIC PEPTIDE.

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We examined whether atrial natriuretic peptide (ANP), which has been speculated to control the sodium balance of the body fluid, was secreted in response to rapid sodium injection in conscious dogs. Pressure catheters were placed at the descending aorta and the left atrium and an electric magnetic flow probe was instrumented at the ascending aorta. 20% sodium chloride solution (0.3ml/kg body weight) was rapidly injected intravenously under conscious state more than two weeks after the operations. Plasma sodium level was increased by about 10 mEg/L 15 sec after the injection, then returned to the control level. Mean arterial pressure and left atrial pressure decreased 15-30 sec and increased 60 sec after the injection. Cardiac output increased slightly. Plasma ANP level did not increase significantly after the injection. In order to eliminate possible modification by the cardiac nerves, we performed the same experiment on cardiac denervated dogs. Plasma ANP level did not change in respose to the injection. These results indicated that ANP secretary system did not respond to rapid and short lasting increase in plasma sodium level.

622, I P (4) 1330

JUNCTIONAL ADRENOCEPTOR SUBTYPES OF CAT'S PIAL ARTERY.

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It is established that the extrajunctional adrenoceptor is classified as an $alpha_2$-subtype in the cat's pial artery. The present study was undertaken to investigate whether of not the junctional adrenoceptor subtype is either $alpha_2$. A major branch of the middle cerebral artery was dissected and mounted on the isometric tension transducer as a ring segment in the Krebs-Ringer buffer solution. Transmitter norepinephrine was forced to be released by tyramine at concentration of 3×10^{-4} M from the sympathetic nerve fibers which innervate the pial artery. It was found that $alpha_2$-blocker yohimbine at concentration of 10^{-5} M only moderately inhibited the tyramine-induced contraction of the pial artery by 22 $\pm$5 % (mean $\pm$SE; n=9). In contrast, $alpha_1$-blocker prazosin at concentration of 10^{-5} M inhibited the tyramine-induced contraction by 73 $\pm$6 % (n=10). The results obtained in the present study may imply that the major proportion of the junctional adrenoceptors of cat's pial artery is classified as the $alpha_1$-subtype.

623, I P (5) 1330

Effect of Cardiac Sympathetic Nerve Activity on Coronary Cathecholamine in Anesthetized Cats.

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Arterial norepinephrine(ANE), coronary sinus norepinephrine(CSNE), coronary sinus plasma flow(CSPF) and cardiac sympathetic nerve activity (CSNA) were measured simultaneously before and during posterior vena cava ligation. With ligation, ANE and CSNE increased from 1.42 ± 0.83 and 1.19 ± 0.73 to 11.67 ± 7.05 and 5.89 ± 5.25 ng/ml,respectively. Norepinephrine(NE) uptake from and release to coronary blood plasma were estimated by a formula, i.e.,net NE = CSPF x (CSNE-ANE). Positive and negative values indicate release and uptake of NE, respectively. In both before and during ligation, net NE was -0.83 ± 1.38 and -9.66 ± 10.54 ng /min, respectively. Net NE decreased significantly with increase in ANE (r=-0.85). On the other hand, with ligation CSNA increased to 302 +101 % of the control level. The positive correlation between CSNA and net NE (r=0.63) showed that the NE released in parallel with increase in CSNA. It is suggested that cardiac uptake and release of NE depended on interaction of ANE and CSNA.

624, I P (6) 1330

NEURAL MECHANISMS RESPONSIBLE FOR ARRYTHMIA DURING CORONARY OCCLUSION IN CONSCIOUS CATS.

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Responses in efferent cardiac sympathetic nerve activity (CSNA), heart rate (HR) and arterial pressure (AP) to a 100-s anterior descending coronary artery occlusion were measured under conscious, atropinized or anesthetized states. In the awake state, immediately after occlusion a transient bradyarrythmia occurred frequently without changes in CSNA and AP, but it disappeared after administration of atropine. The bradyarrythmia was induced reflexly by enhanced cardiac vagal nerve activity (CVNA). During occlusion, HR and AP were decreased with the enhanced CVNA. When CSNA increased dramatically associating with emotion and/or behavioral changes, a transient tachyarrythmia was produced. In atropinized or anesthetized states, however, the initial HR was high and such tachyarrythmia was not induced with occlusion. We suggested that the transient tachyarrythmia occurred during occlusion was produced directly by the increase in CSNA due to activation of the higher center under the enhanced CVNA in conscious cats.

625, I P (7) 1330

SPINAL ASCENDING PATHWAYS MEDIATING SOMATOSENSORY INHIBITION ON BAROREFLEX VAGAL BRADYCARDIA.

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Somatosensory nerve stimulation inhibits baroreflex vagal bradycardia. A study was conducted in chloralose-urethane anesthetized rats to determine spinal pathways mediating this inhibition. A vagus nerve contralateral to the aortic nerve (ADN) to be stimulated was cut to confine the target vagal structure to one side. Using this model, effects of hemitransection of the spinal cord ipsi- and contralateral to the ADN and subsequent cordotomy on the other side at C_1 were studied. In any combination, inhibition by sciatic nerve (ScN) stimulation on vagal bradycardia provoked by ADN stimulation was not abolished unless the lateral funiculus (LF) was extensively lesioned. Spinal ascending system mediating ScN inhibition on ADN-induced vagal bradycardia was found to consist of four pathways mostly coursing in the LF: First one, crossing the midline in the spinal level to ascend contralaterally and project to the contralateral cardiovagal center; second one, ascending ipsilaterally to reach the center of the same side; third one, ascending ipsilaterally and upon reaching the medulla, crossing the midline to project to the contralateral vagal center; fourth one, crossing the midline in the spinal level to ascend contralaterally and upon reaching the medulla, crossing the midline once again to project to the ipsilateral vagal center. These multifold projections ensure powerful inhibition of baroreflex vagal bradycardia by somatosensory input.

626, I P (8) 1330

EFFECTS OF PHENYLEPHRINE ON PRESSURE TRANSDUCER FUNCTION OF THE CAROTID SINUS BARORECEPTOR. YOSHIDA, H., KAWATA, M., NAKAMURA, J., TSUCHIYA, K., NISHIDA, Y., MORITA, H., KOYAMA, S. AND HOSOMI, H. Dept. Physiol., Kagawa Med. Sch., Kagawa 761-07.

The aim of this experiment was to examine effects of phenylephrine (PE) on pressure transducer function of the carotid sinus baroreceptor. We sectioned the vagus nerves at the cricocartilage level and vascularly isolated the carotid sinus baroreceptors in dogs anesthetized by intravenous injection of Nembutal. Intracarotid sinus pressure (ICSP) was changed in steps of 20 mmHg over the 20-180 mmHg pressure range, and changes in mean systemic arterial pressure (ΔAP) and heart rate (ΔHR) were measured. Open-loop gains of carotid sinus baroreflex control of arterial pressure (Gap) and heart rate (Ghr) were estimated as follows, Gap=ΔAP/ΔICSP and Ghr=ΔHR/ΔICSP. The peak values of Gap and Ghr were -1.7±0.8 and -0.6±0.2, respectively. These peak gains were obtained at the pressure region of 120-140 mmHg. After the control experiment, the carotid sinus baroreceptors were perfused with Ringer's solution with PE (0.025μ/ml), and the same experiment was repeated. The peak values of Gap and Ghr after administration of PE were -2.0±0.8 and -0.7±0.2, respectively. These values were also obtained at the same pressure region. There were no significant differences in Gap and Ghr before and after administration of PE. These findings suggested that PE did not affect pressure transducer function of the carotid sinus baroreceptor.

627, I P (9) 1330

THE ROLE OF BARORECEPTOR REFLEXES IN THE HEPATIC CIRCULATORY REGULATION DURING RAPID CHANGE OF BLOOD VOLUME IN THE ANESTHETIZED DOG.
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This investigation was designed to study the role of cardiac receptor and arterial baroreceptor reflexes in the hepatic circulatory regulation during rapid change of blood volume in the anesthetized dog. Right atrial pressure, arterial pressure, heart rate, cardiac output, portal vein pressure, and hepatic tissue blood flow (HTF) were measured during rapid change of blood volume over the range from +20% to -20%, in steps of 5%. The experiment was done under the following four conditions :with both reflexes present, only the arterial baroreceptor reflex present, only the cardiac receptor reflex present, and with both reflexes absent. We concluded that during graded depletion of circulatory blood volume, HTF was reflexly maintained in a constant value mainly through arterial baroreceptors and slightly by cardiac receptors. In contrast, during graded volume expansion, HTF was reflexly regulated in a constant value mainly through cardiac receptors and partly by arterial baroreceptors.

628, I P (10) 1330

INCREASES IN THYROID BLOOD FLOW AND VASOACTIVE INTESTINAL PEPTIDE (VIP) EVOKED BY ELECTRICAL STIMULATION OF SUPERIOR LARYNGEAL NERVES (SLN) IN RATS. ITO, H.[*1], MATSUDA, K.[*], SATO, A., SHIRAKI, M.[*1] AND TOHGI, H.[*2] Dept. Physiol., Tokyo Metropol. Inst. of Gerontol., Tokyo 173,

The present experiment was performed to investigate the effect of SLN (parasympathetic) stimulation on thyroid blood flow in anesthetized rats. Blood flow was measured with a drop method through a thin catheter inserted into the thyroid vein. SLN were cut bilaterally and their peripheral portions were electrically stimulated. Weak (1 V, 0.5 ms) and strong (10 V, 0.5 ms) stimulations of SLN with stimulus frequencies above 10 Hz produced marked increases in blood flow in a frequency dependent manner. Intravenous administration of atropine partially reduced these responses. VIP in thyroid venous blood at resting condition was not detectable with our present VIP assay procedures (less than 20 pg/ml). However, after SLN stimulation (10V, 40 Hz) VIP concentration was increased to detectable levels(about 30 pg/ml). These results suggest that SLN stimulation increases thyroid blood flow by dilating thyroid vessels via activation of two fiber types i.e., cholinergic and an atropine-resistant substance (probably VIP) fibers. (Present address: 1 Dept. Endocrinol., Tokyo Metropol. Geriatric Hosp., Tokyo 173, 2 Dept. Neurol., Iwate Med. Univ., Morioka 020)

629, I P (11) 1330

RESPONSE OF INTRACRANIAL PRESSURE (ICP) INDUCED BY STIMULATING BRAINSTEM PRESSOR AREA AT DIFFERENT LEVELS OF PERFUSION PRESSURE.
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Dept. Physiol., Osaka City Univ. Med. Sch., Osaka 545

Changes of ICP and blood pressure (BP) responses at different levels of perfusion pressure (BP - ICP) were quantitatively examined by the activation of sites in the pressor area of cat's brainstem where electrical stimulation produces an increase in ICP in association with pressor response. Cats anesthetized with chloralose were used and CPP levels were decreased by applying trimetaphan camsilate at different levels of ICP that were induced by injecting saline solution into lateral ventricle. ICP responses less than about 7 mmg were ususally evoked in association with about 50 - 100 mm Hg of pressor response at the conditions without the artificial changes of base line levels of ICP and BP. However, the largest amplitude of ICP response was more than 50 mm Hg at the levels of ICP increased to about 30 - 50 mm Hg and BP decreased to about 90 - 100 mm Hg. Even when amplitude of BP responses decreased to an amplitude less than 20 mm Hg by the application of trimetaphan camsilate, ICP responses larger than the control response were frequently observed at the condition of decreased PP. The ratio of ICP response size to BP response size roughly showed a linear increase with the reduction of PP when PP was larger than about 50 mm Hg.

630, I P (12) 1330

IDENTIFICATION AND CHARACTERIZATION OF ANGIOTENSIN II RECEPTORS IN THE FOWL AORTA.
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Angiotensin II (AII) causes a unique vasodepressor response in the conscious domestic fowl. This depressor response may be a direct action on the vascular smooth muscle because AII produces dose-dependent, reversible relaxation of the fowl arotic ring precontracted with phenylephrine but AII alone did not cause contraction (K. Yamaguchi, personal communication). Thus we aimed to determine whether specific AII receptors exist in the fowl aortic smooth muscle. Membrane fraction of the aortic smooth muscle was collected by differential centrifugation between 12,000 and 57,000 g in buffered 0.25 M sucrose. Degradation of the ligand (^{125}I-[Asp^1, Ile^5] AII) was effectively inhibited by a combination of EGTA (10^{-3} M), phenanthroline (10^{-4} M) and bacitracin (10^{-5} M). Binding of labeled AII (0.5 nM) to the above fraction (15-30 μg protein) in 50 mM Tris (pH 7.2), 10 mM $MgCl_2$, 0.2% BSA and the inhibitors at 12°C was rapid, saturable and reversible, and increased with time, temperature or ligand or membrane concentration, and was specifically and competitively displaced by angiotensin analogs. Analysis of saturation binding data yielded 2 classes of binding sites with high (Kd1=0.80 nM, N1=132 f moles/mg protein) and low (Kd2=9.78 nM, N2=1085 f moles/mg protein) affinities.

631, I P (13) 1330

NON-UNIFORM ELEVATION OF VASCULAR RESISTANCE IN HYPERTENSIVE RATS.
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Regional distribution of vascular resistance in various kinds of experimental hypertensive rats was studied by observing peripheral flow and arterial pressure in the conscious state. In each rat, flow was measured at the common carotid, superior mesenteric, or renal artery or terminal aorta (for the hindquarters) with a chronically implanted electromagnetic flow probe. In spontaneously hypertensive rats (Okamoto and Aoki), hindquarter resistance was elevated especially markedly due to an increase in sympathetic tone to this area. In two-kidney, one-clip renovascular hypertensive rats, elevation of superior mesenteric resistance was especially marked. In one-kidney, one-clip renovascular hypertensive rats, the key vascular area which contributed most to the elevation of total peripheral resistance was the renal area itself. In DOCA-salt hypertensive rats, although sympathetic vasoconstrictor tone was elevated in all the vascular areas investigated, calculated peripheral resistance was not greater than the corresponding value in normal rats in any area. Hemodynamically, the hypertension in DOCA-salt hypertensive rats was sustained mostly by an increase in cardiac output.

632, I P (14) 1330

THE ROLE OF ENDOTHELIAL CELLS IN ACETYLCHOLINE AND ISOPROTERENOL-INDUCED VASODILATIONS IN CANINE RENAL ARTERY. ITOH, S. AND OHHASHI, T. Dept. of Physiol., Shinshu Univ. Sch. of Med., Matsumoto 390

The present studies were designed to evaluate the role of endothelial cells in the vasodilatory responses of the isolated normal and everted cylindrical preparations of canine renal arteries. The lumen and extraluminal space of the preparations were separately perfused with Krebs-bicarbonate solution. The change of the outer diameters in the preparations was recorded continuously by means of hand-made photoelectric devices. The administration of acetylcholine (ACh) from the intimal side in the normal and everted preparations caused more marked increase of the outer diameter than did that from the adventitial side. The dose-response curve of ACh with the latter was shifted to the left by pretreatment with 10^{-7} M physostigmine. The atropine sensitive ACh-induced vasodilatory response was completely abolished and was changed to a vasoconstrictive response by rubbing the endothelial cells. The vasodilatory response produced by low concentrations of isoproterenol was also significantly reduced by the rubbing. The isoproterenol-induced relaxation was competitively antagonized by treatment with 10^{-9} M propranolol.

These results suggest that endothelial cells, when exposed to ACh and isoproterenol, may initiate an inhibitory signal for the smooth muscles of the media in canine renal arteries.

633, I P (15) 1330

CORONARY BLOOD FLOW RATE DETERMINED OXYGEN CONSUMPTION AND UPTAKE OF CATECHOLAMINES IN ISOLATED CANINE HEART. AZUMI,T., SADA,K., SHIRAI,M. AND NINOMIYA,I. Department of Cardiac Physiology, National Cardiovascular Center Research Institute, 5-7-1 Fujishiro-dai, Suita, Osaka 565, JAPAN.

To analyse the influences of the coronary blood flow rate on the oxygen consumption and on the uptake of catecholamines (epinephrine and norepinephrine) in the canine heart, we measured the oxygen content and the concentration of the catecholamines on the coronary inflow and outflow in the control and the augmented coronary blood flow rate, and we estimated the oxygen consumption and the uptake of catecholamines in the six isolated blood perfused left ventricles, in which the volume were controlled with servo system. The oxygen consumption for a given work, expressed as the pressure-volume area, increased in proportion to the ccronary blood flow rate. The uptake of catecholamines also increased according to augmenting the coronary blood flow rate. These results suggested that increasing the coronary blood flow rate impaired the efficiency (a given work/oxygen consumption) in the left ventricle owing to increasing the uptake of catecholamines.

634, I P (16) 1330

EFFECTS OF REGIONAL ALVEOLAR HYPOXIA AND HYPERCAPNIA ON INTERNAL DIAMETER OF SMALL PULMONARY VESSELS IN CATS. SHIRAI, M., SADA, K. and NINOMIYA, I. Department of Cardiac Physiology, National Cardiovascular Center Research Institute, Fujishiro-dai, Suita, Osaka 565, Japan

Using an X-ray TV system, we analyzed responses in internal diameter (ID) of the small pulmonary vessels (100-600 μm ID) during unilobar hypoxia and hypercapnia in the cat. In the hypoxic and hypercapnic lobes, we found that the ID was reduced in proportion to the degree of hypoxia and hypercapnia, respectively. The ID reduction was larger in the arteries than in the veins for a given stimulus. In the arteries, the ID was reduced nonuniformly in the series-arranged vessels in response to both stimuli. The mean percentage reduction in ID was maximal in the arteries of 200-300 μm in ID, in which it was 21, 26, 28 and 36% with 5% O_2, 0% O_2, 5% CO_2 and 10% CO_2 inhalations, respectively. On the other hand, in the veins, uniform ID reduction was recorded for a given stimulus. In the contralateral normoxic lobe, no significant ID change was observed. We concluded that with regional alveolar hypoxia and hypercapnia, a local vasoconstriction was induced chiefly in the small pulmonary arteries, particularly those of 200-300 μm in ID.

635, I P (17) 1330

CONTINUOUS MEASUREMENT OF BLOOD VOLUME AND PLASMA SODIUM CONCENTRATION AND THE ANALYSIS OF DRINKING IN DEHYDRATED RATS.

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We developed a method of continuous measurements of blood volume(BV) and Na concentration([Na]) of plasma and used for the analysis of recovery process from thermal dehydration in rats. At least 5 days prior to the experiments, rats were splenectomized and cannulated into both the jugular vein and descending artery. After thermal dehydration (DBT:36°C, RH:20%) amounting about 6% of body weight, catheters were connected to the system for continuous monitoring of BV and [Na]. Water was made available and water intake, BV and [Na] were recorded at 30 s interval for 4 h. The rats took 2-3 ml of water/100g of body wt in the first 10 min and then drank 1 ml at 30-60 min intervals to reach an equilibrium in 2-3 h. The relation between water intake and BV and also between water intake and [Na] were analyzed. BV was unchanged until 18.9±3.6 min after the first access to water, whereas [Na] started to decrease after 3.6±0.6 min. The retention ratio of ingested fluid in the vascular space was 20.8±2.8 %, and the decrease of [Na] was 1.5±0.2 mEq/l per 1 ml of ingested fluid per 100g body wt. These results suggest that the change of [Na] affects drinking more rapidly than that of blood volume. In addition, responses were compaired providing 0.45 or 0.9 % NaCl solution and tap water.

636, I P (18) 1330

CHANGES IN PLASMA CATECHOLAMINE LEVELS IN RAT'S TRANSPOSITION RESPONSE.

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Transposition response is a cardiovascular response induced by transposing the rat from the home cage to a new cage, in which hindquarter flow is markedly increased. Arterial blood samples were collected from rats before and during this response for radioenzymatic assay of catecholamines. On the average, plasma adrenaline concentration increased about 6-fold and noradrenaline concentration about doubled during transposition response. In rats in which the adrenals had been removed, neither adrenaline nor noradrenaline in the plasma increased significantly in transposition response. Changes in plasma catecholamine concentrations were also observed during continuous intravenous infusion of adrenaline at constant rates. Although the variations were large, the concentration of adrenaline during transposition response was comparable with that attained by infusion of adrenaline at a rate to approximate the increase in hindquarter flow in the response. It is concluded that beta-adrenergic vasodilation, presumably in skeletal muscles, due to adrenaline secreted from the adrenal medulla is the main cause of the increase in hindquarter flow in transposition response.

637, I P (19) 1330

HEMODYNAMIC CHARACTERISTICS OF THE RABBIT MESENTERIC SMALL VASCULAR BEDS DURING MANIPULATION OF THE SYSTEMIC BLOOD PRESSURE.

HANAI,S. AND MINAMIYAMA,M., Dept. of Vascular Physiol., National Cardiovascular Center Research Institute, Suita, Osaka 565.

In randomly selected small arterioles of the mesenteric microcirculatory network, red cell velocity was measured and then volume flow rate (IAF) was calculated. The blood pressure in the small intestinal artery (IABP) and that in the intestinal vein (IVBP) were also recorded simultaneously. IAFs were changed in parallel with the differences of IABP and IVBP during systemic pressure change induced by injection of noradrenalin or acetylcholin. This tendency was also observed during depressor reflex. To estimate the pressure-flow relationship in the small segment of vasculature, a simple model consisting only of vascular resistance was assumed. It is difficult to estimate accurately the pressure difference between the feeding arteriole and the collecting venule in the target network. This is because major portion of the blood fed through the artery whose pressure was measured escaped to small intestine wall. However, the results of iterative calculation for the vascular resistance based on the experimental data suggested that pressure-flow relationship in the network could be explained by geometoric factors of vascular architecture and non-Newtonian behavior of blood rather than regulation mechanisms in microvessels.

638, I P ⑳ 1330

NUMERICAL ANALYSIS OF BLOOD FLOW AT THE BRANCH OF VESSEL. TANIFUJI,S.,UYEDA,M.* AND INOUYE,A.** Dept. of Applied Physics,Fac. of Eng.,Osaka City Univ.,Osaka 558, Dept. of Physiol.,Sch. of Med.,Gifu Univ.,Gifu 500 and Dept. of Physiol.,Hyogo Coll. of Med.,Nishinomiya 663

Blood flow calculation was done solving numerically two or three dimensional Navier-Stokes equation at the branch of blood vesseles. The need for such studies arises from known relation to certain types of vascular injury which arises from the shearing stress at endtherium. The formation of atheromatous deposit which occurrs frequentry at site of blood vessel branch also depend on flow patterns. Navier-Stokes equation was solved numerically by finite element method. The time dependent solution of flow were obtained by method based on explicit numerical integration schema in time. We first applied the method to singly bifurcated blood vessel. Secondary flow patterns,reverse flow or separation region at outer side edges of bifurcation were observed. We then applied the method to internal carotid and circle of Willis. In this case flow in trifurcation was involved.

639, I P ㉑ 1330

THE EFFECT OF LOCAL HEAT STIMULATION ON THE PERIPHERAL BLOOD FLOW. HATAMOTO, H. Dept. Physiol., Fac. Med., Kyoto Univ. Kyoto 606

Local heat stimulation (moxa, middle size 4 mg) was given 7 times to various parts of the rabbit's body surface, and the peripheral blood flow near the stimulating site was measured by sphygmograph for 30 minutes. At the anterior portion of the lower leg, at the elbow joint, at the top of the head and at the auricle, the blood flow of each place near the stimulating site increased from immediately or 1 minute after the 7th stimulation, and the increase continued for 5 to 20 minutes. Local heat stimulation (moxa, rice grain size) was given 10 times to the left sole (point YUSEN) of the human subject, and the blood flow near the stimulating site and at the 2nd toes and 2nd fingers of the both sides was measured by sphygmograph for 30 minutes. The blood flow near the stimulating site decreased immediately after the 1st stimulation, and it decreased or increased immediately after the 10th stimulation, but it had a tendency to increase after 30 minutes. The blood flow of the left toe decreased immediately after the 1st stimulation. After the 10th stimulation, it had a tendency to increase after 5-30 minutes. The skin temperature of the left sole and the left toe, and the temperature of the deep tissue at the left foot increased for 30 minutes after the 10th stimulation. Thus, the local heat stimulation has an effect to increase the blood flow not only near the stimulating site but also of some other peripheral parts of the body.

640, I P ㉒ 1330

THE CHANGE OF OXYGEN TENSION IN THE MEDULLA DURING SYSTEMIC ARTERIAL PRESSURE OSCILLATION IN RABBITS. KANAI, K. AND MIYAKAWA, K. The 2nd Dept. Physiol., Shinshu Univ. Sch. Med., Matsumoto 390

By extracellular recording technique two types of medullary vasomotor neurons were discriminated during the systemic arterial pressure oscillation elicited by the side pressure exertion procedure. They were identified as type-II and type-I vasomotor neurons, and discharged almost reciprocally during the oscillation. Each ascent of the oscillation has been assumed as the result of excitation of the type-II neurons which is caused by cerebral ischemia. Although relationship between the cerebral blood flow and the systemic arterial pressure oscillation has been already investigated, it is necessary to know more exact relationship between the oxygen tension in the medulla and the activity of the type-II neuron in order to understand the mechanism of the oscillation. In this report, the oxygen tension around the medulla vasomotor center during the systemic arterial presssure oscillation was messsured with an silver or platinum electrode which has a quick response and compared with the activity of the type-II vasomotor neuron.

641, I P (23) 1330

RECORDING SYSTEM FOR THE INDIRECT MEASUREMENTS OF BLOOD PRESSURE AND Q-K TIME IN RATS.

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In order to investigate the effect of the sentral nervous system on the cardiovascular function, as a first step, development of methods to determine the blood pressure and Korotkoff sounds was designed.

Five male Wistar rats, aged from 8 to 20 weeks, were used in this study. Animals were anesthetized with urethan (1.0-1.2 g/kg, i.p.), and placed in a stereotaxic instrument in the prone position. Conventional ECG from leadII was used for the detection of the Q wave. The method for determing the systolic and diastolic pressures is the auscultatory method introduced by Korotkoff. The annular occluding cuff was placed at the root of rat tail and a condenser microphone, connected to an amplifier, was placed at the distal position. In order to obtain the definite record of Korotkoff sounds, 2,3 and 5 cm of cuff width were used. The Q-K time was measured from the onset of the QRS to the onset of the Korotkoff sound . Namely, the systolic value (Q-Ks) of this time was determined from the first recorded Korotkoff sound , and the diastolic value (Q-Kd) was determined from the last one.

In this study, correlation between heart rate and the Q-K time was investigated.

642, II D 0915

MECHANISM OF ERYTHROCYTE AGGREGATION BY MACROMOLECULES.
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The aggregation of human erythrocytes induced by various kinds of macromolecules was quantitatively examined in isotonic phosphate-buffered saline, pH 7.4, at 25°C by using a low shear rheoscope combined with a television image analyzer and a computer.

(1) High-molecular-weight macromolecules (Ig G, fibrinogen, dextran of 70 kDa, poly (glutamic acid) of 66 and 50 kDa) induced erythrocyte aggregation, while low-molecular-weight macromolecules (albumin, dextran of 40 and 10 kDa, poly(glutamic acid) of 20 and 8 kDa) did not. (2) Ig G-induced aggregation was inhibited by albumin and poly (glutamic acid) of 20 and 8 kDa. (3) Fibrinogen-induced aggregation was curiously accelerated by albumin, but was not affected by poly(glutamic acid) of 20 and 8 kDa and dextran of 40 kDa. (4) Aggregation induced by dextran of 70 kDa was inhibited by dextran of 40 and 10 kDa and by glucose, but was not affected by albumin and poly (glutamic acid) of 20 and 8 kDa. (5) Aggregation induced by poly(glutamic acid) of 66 and 50 kDa was accelerated by poly(glutamic acid) of 20 kDa, but was inhibited by that of 8 kDa. And, albumin and dextran of 40 and 10 kDa did not affect the aggregation.

Conclusively, the stereochemical structure-dependent interaction of macromolecules with the surface of erythrocytes was proposed for the mechanism of erythrocyte aggregation.

643, II D 0930

EFFECT OF PLASMA PROTEIN ON SURFACE CHARGE OF RED BLOOD CELLS.
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Surface charge of red blood cells (RBCs) is regarded as one of the major factors which influence microcirculatory configulations such as RBC agglutination and cell lodging due to its electrostatic force.
By Ambrose's microelectrophoretic method, we measured electrophoretic mobility (EM) of RBC which reflects directly on its surface charge. RBCs were well washed with saline after separation from fresh human blood and then incubated in veronal buffer solution (pH: 7.0) containing 0 - 5 % of plasma protein (A/G : 1.4) for 30 min before measurement.
In protein free solution, EM was -1.31 ± 0.04 μ/sec/V/cm (equivalent to -12 mV of Zeta potential). In protein solution the mobility increased drastically to -1.57 ± 0.05 in 1 % protein solution, -1.81 ± 0.05 in 2%, -1.92 ± 0.07 in 3 % and -2.01 ± 0.07 in 5 %.
The rise of net negative charge depending on protein concentration can be resulted from adsorption of some proteins to RBC, and consequently it brings a sort of anti-agglutinating effect to RBCs in microcirculation.

644, II D 0945

THE EFFECT OF IOHEXOL AND OTHER RADIOGRAPHIC CONTRAST MEDIA ON THE ERYTHROCYTE MEMBRANE.
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Dept. of Radio., Physiol., Nippon Medical School,Sendagi,Bunkyo-ku,Tokyo Dept. of Radio., Nippon Medical School,First Hosp.,Iidabashi,Chiyoda-ku,Tokyo

The measurement of osmotic fragility, volume change, shape change and viscosity of red cell suspension were carried out taking osmolality, viscosity and iodine contents into account. Radiographic contrast media (RCM) caused decrease in osmotic fragility and in cell volume. These results suggested that the permeability of RCM across membrane was lower than that of NaCl. Under the iso-osmolar condition there was little substantial difference between Iohexol, Iothalamate and NaCl solution in blood viscosity and erythrocyte morphology. Increase in blood viscosity and several stage of echinocytic shape change were found out as the osmolality of Iothalamate solution increased. Iohexol, which osmolality was lower than that of Iothalamate, had smaller rheological and morphological effect on erythrocyte than Iothalamate under the condition of equal viscosity and of equal iodine content. Metrizamide solution caused remakable shape change and increase in blood viscosity and in yield stress even under the physiological condition. This experiment showed that the red cell deformability was more damaged by the osmotic change of contrast media than the viscous change, and that Iohexol was the better contrast medium than Iothalamate and Metrizamide.

645, II D1000

ULTRASONIC MEASUREMENTS OF RED BLOOD CELL COMPRESSIBILITY BY A CONTINUOUS PULSE OSCILLATION METHOD. HASEGAWA, M.[1], SAKANISHI, A.*[2], TERADA, N.[3] AND DOBASHI, K.*[2] [1]Dept. Vas. Physiol., Nat. Cardiovas. Center Res. Inst., Suita 565, [2]Dept. Poly. Sci., Fac. Tech., Gunma Univ., Kiryu 376, [3]Dept. Physiol., Yamanashi Med. Coll., Nakakoma-Gun 409-38

A continuous pulse oscillation method was devised modifying the sing-around method to measure the ultrasonic velocity V of rabbit red blood cell(RBC) diluted in 60% glycerol solution in the temperature range from 20°C to 40°C. The density ρ of the sample was simultaneously determined by a vibrational density meter(DMA 602, Anton Paar). Compressibility B was given by the relation $B = 1/(\rho V^2)$. Continuous pulse waves were transmitted to the transducer in a sample cell sending an ultrasonic wave of 3 MHz. The other transducer received and converted it into an electrical signal. The time interval T between the initial pulse and the final signal was measured by a universal counter and related to V by the equation $T = T\varepsilon + L/V$($T\varepsilon$:electrical delay, L:effective cell length). The ultrasonic velocity difference between the RBC suspension and the medium decreased with rising temperature, while the density difference between the RBC suspension and the medium increased with rising temperature. The compressibility of the RBC suspension was smaller than that of the medium over the whole temperature range and approached to the compressibility of the medium with rising temperature. This is mainly due to higher rate of increase in the compressibility of RBC as compared to the medium.

646, II D1015

THE EFFECT OF RED CELL SHAPE CHANGE UPON PRESSURE-FLOW RELATION OF ERYTHROCYTE SUSPENSION IN PERFUSION OF BULLFLOG'S HIND LIMB. UYESAKA, N., KIKUCHI, H. and SHINAGAWA, Y. Dept. of Physiol., Nippon Medical School, Sendagi, Bunkyo-ku, Tokyo

Using the conventional Laewen-Trendelenburg's method, perfusion of the hind limb was carried out by cannulating the abdominal aorta, outflow being accomplished through a cannula inserted into the abdominal vena. The pressure-flow relationship was constructed by the vertical-tube method (Nichol et al Amer. J. Physiol.164 1951) with a slight modification. The bullflog's hind limb was fixed by perfusion with 1% glutaraldehyde solution during 90min and then washed out. The pressure-flow rate curve was consisted of a smooth curve convex to the pressure axis, tending to a straight line at a high rate of flow. A reciprocal of slope at a high rate of flow indicated the resistance of flow. The echinocytic shape change caused striking increase in resistance of flow though change in viscosity measured by cone-plate viscometer was not able to detected. On the other hand slight increase in the resistance of flow was observed with stomatocyte transformation. Red cell showed no morphological changes after perfusion of hind limb comparing with before perfusion. These results shows more considerable implications in understanding the effect of red cell deformability on blood flow through microvascular network than other deformability test such as screen filtration method.

647, II D1030

ANALYSES OF THE STRUCTURE OF t-PA (TISSUE PLASMINOGEN ACTIVATOR) WITH MONOCLONAL ANTIBODIES. SUGAWARA, Y., MAKINO, Y., TAKADA, Y. AND TAKADA, A. Dept. Physiol., Hamamatsu Univ., Sch. Med., Hamamatsu-shi, Shizuoka-ken 431-31

Polyclonal and three monoclonal anti-tissue plasminogen activator (a-t-PA) antibodies were characterized by using enzyme immunoassay in which β-D-galactosidase was coupled to a-t-PA antibody. Monoclonal antibodies called 2:2 B10 and 1:3 G5, specific for both one-chain and two-chain t-PA, strongly bound to one-chain t-PA purified from cultured melanoma cell lines, but 1:3 C5 antibody bound weakly to such t-PA. When polyclonal t-PA antibody was used as the first reaction antibody immobilized on silicone pieces, few determinants were available for monoclonal antibody used in the second reaction due to previous interaction of these determinants in the first reaction. When t-PA levels in the plasma were determined, the presence of EDTA enhanced the sensitivity of t-PA determination by the present enzyme immunoassay technique. Plasma concentrations of t-PA were measured to be higher with 2:2 B10 monoclonal antibody than with polyclonal antibody as the first antibody. Since the calibration curves of one-chain t-PA were similar using 2:2 B10 monoclonal and polyclonal antibodies in the first step reaction, the results seem to indicate that some of t-PA molecules in the plasma were not detected by polyclonal antibody.

648, II D 1045

EFFECTS OF pH ON SECONDARY AND TERTIARY STRUCTURE OF HUMAN PLASMINOGEN. MAKINO, Y., SUGAWARA, Y., TAKADA, Y. AND TAKADA, A. Dept. Physiol., Hamamatsu Univ., Sch. Med., Hamamatsu-shi, Shizuoka-ken 431-31

Glu-plasminogen (plg) or Lys-plg solution was kept at pH 2.0 for various time intervals, and then readjusted to pH 7.0. The activation rate and conformational changes of such acid-treated plg were measured using the hydrolysis of S-2251, spectrofluorometry and spectropolarimetry (circular dichroism). The activation rate of acid-treated Glu-plg increased after readjustment to pH 7.0. The increase was not reversible even after keeping acid-treated Glu-plg for 24 hr at neutral pH. The activation rate of acid-treated Lys-plg rather decreased. The fluorescence intensity at 340 nm of acid-treated plg decreased, and the intensity of fluorescence induced by the interaction of plasminogen with ANS (1-anilino-8-naphthalene sulfonate) increased after keeping plasminogen for longer than 24 hr at pH 2.0. Circular dichroism spectra indicated that the secondary and tertiary structure of Glu-plg changed after acidification, and that only tertiary structure of Lys-plg changed.

649, II D 1100

Detection of a latent proteinase-like activity in the human plasma by SDS-PAGE containing a substrate. HORIE,N., YAMAMOTO,J. AND OKAMOTO,U., Fac. Nutr., Kobe-Gakuin Univ., Kobe 673.

In order to examine the existence of a latent proteinase in the human plasma, the electrophoretic method by using polyacrylamide-gel containing SDS and substrate was adopted in this study.

The proteinase-like substance in the human plasma hydrolysed the fibrinogen, the gelatin and the α-casein, but did not the serum albumin, the hemoglobin and the γ-globulin. The fibrinogenolytic activity in the human plasma was detected in all of six healthy subjects. The activity was disappeared at 50°C for 30 min, and inhibited by DFP and by anti-human plasminogen IgG. The proteinase-like substance was bound on lysine Sepharose and eluted with 0.2M EACA. The examination by gel filtration indicated that the fibrinolytic activity existed in the fraction coresponding to the molecular weight of 90kDa. By the immunoblotting method, a mobility of the substance was shown to be similar to that of human plasminogen.

These data demonstrated that the fibriongenolytic activity in the human plasma was derived from plasmin-like proteinase.

650, II D 1115

MEASUREMENT OF PLASMA ERYTHROPOIETIN BY ERYTHROID COLONY FORMING ASSAY. SAKATA, S., ENOKI, Y., SHIMIZU, S., KAWASE, M., KOHZUKI, H. AND OHGA, Y. Second Dept. Physiol., Nara Med. Univ., Kashihara, Nara 634

Effective methods were examined to eliminate an inhibitor(s) of erythroid colony formation from plasma in an attempt to measure genuine plasma erythropoietin (Epo) with an erythroid colony forming assay using fetal mouse liver cells. Acid-boiling-chloroform (ABC) treatment was concluded to be the best method because the plasma thus treated stimulated the colony formation most and contained proteins least. The dose-response curve for the plasma was parallel to that for the standard Epo preparation. The 'erythroid colony stimulating activity' in the plasma was completely additive to that in the standard Epo, and appeared to be a heat-stable and acid protein with isoelectric point of less than 5.0. These results suggest that the activity in the plasma is identical to that in the standard Epo. Stability of the plasma Epo activity was dependent on the storage temperature and was enhanced by adding 1 % bovine serum albumin (BSA). Average Epo titers for normal adult, full-term cord and murine plasmas, all ABC-treated and 1 % BSA-added, were 192.4, 184.5 and 150.6 mU/ml, respectively.

651, II D1130

PLASMINOGEN ACTIVATOR DERIVED FROM TONSILLAR LYMPHOCYTE OF RABBIT.
KOSUGI, T., HAMAI, Y., NAKAMURA, M. AND KINJO, K. Dept. Physiol., Sch. Med., Univ. Ryukyus., Okinawa, 903-01

In Arthus tonsillitis of rabbits, it has been reported that a fibrinolytic activity increased in locus of tonsillitis. In this paper, it was studied wether plasminogen activator (PA) did exist in tonsillar limphocytes or not. At first, lymphocytes were isolated from tonsil of rabbits and then isolated lymphocytes were cultured. After cultured, the medium and cultured lymphocytes were sonicated, then centrifuged at 1500 r.p.m. for 15 minutes. The fibrinolytic activity of supernatant was estimated by fibrin clot lysis method. In the addition of T cell growth factor to the cultured medium of tonsillar lymphocytes from non- treated rabbits, this sonicated cultured medium and lymphocytes did show PA activity at 10 days after cultured. However, in the addition of B cell growth factor it did not show PA activity. On the other hand, the cultured medium of tonsillar lymphocytes from rabbit with Arthus tonsillitis did show PA activity at 24 hours after the injection of sensitized antigen to tonsil. From these results, it was clarified that PA did exist in tonsillar lymphocytes of rabbits.

652, II D1145

CHARACTERIZATION OF THE ERYTHROID PRECURSOR CELLS (BFU-E) IN PATIENTS WITH PAROXYSMAL NOCTURNAL HEMOGLOBINURIA BY THE COMPLEMENT LYSIS SENSITIVITY TEST. MATSUDA, M. AND TERASAWA, T. Dept. Physiol., Tohoku Dent. Univ., Koriyama 963

Paroxysmal nocturnal hemoglobinuria (PNH) is an aquired chronic hemolytic anemia. The red cells in PNH consist of at least two populations which show the different susceptibility to complement mediated hemolysis : one is the complement sensitive cells which show highly sensitive to complement and the other is complement insensitive cells which exhibit slightly sensitive to complement than normal cells. To clarify the regulation of erythropoiesis of these two cell populations with different chracteristics of complement sensitivity, we try to investigate the distribution of PNH cells in individual erythroid bursts by complement lysis sensitivity test (CLS test) developed Rosse and Dacie (1966). Erythropoietic cell culture of bone marrow was performed for 14 d using methylcellulose clonal assay. Bursts formed in the culture were collected individulally and the CLS test in the bursts was carried out using anti-I and feshly prepared human serum. The results indicated that PNH cells were heterogenouly distributed in individual bursts.

653, II D1300

STUDIES ON THE CLEARANCE MECHANISM FOR FOREIGN SUBSTANCES BY RETICULO -ENDOTHERIAL SYSTEM (RES) OSHIBA,S.,TAKAO,K.,IMAI,H.,TAKAORI,M. Dept.Physiol., Nihon Univ. Sch. Med. Tokyo

The RES plays a role mainly for removing foreign substances in vivo. Investigation have been made to know whether or not the some kinds of serine protease participate in this mechanism.

Carbon particles and ^{125}I fibrin coated latex particles were used as foreign substances. Their disappearance rate from the circulating blood and the uptake by the RES in rats were examined. The uniform carbon particles prepared by centrifugation gave a reproducible disappearance curve. Organ uptake of the particles was found to take place in the liver and the spleen without any interferance by serine protease inhibitors (EACA , t-AMCHA , aprotinine). The disappearance rate of ^{125}I fibrin coated latex particles, and the mode of uptake in the organs was similar to those of carbon particles. However, it was observed that serine protease inhibitors strongly suppressed the initial phase of the disappearance curve, suggesting that serine proteases are taking part in the clearance mechanism for fibrin particles by RES.

654, II D1315

EFFECTS OF LOCAL VIBRATION ON BLOOD FIBRINOLYTIC ACTIVITY. Higashi,T.[1], Watanabe,M.[2], Takashima,N.[2]*, Sagawa,S.[2]*, Isomoto,A.[2], Tyuma,I.[2] and Tsuji,K.[3]* Dept. Med. Tech. Lab., Col. Biomed. Tech., Osaka Univ., Toyonaka, Osaka 560[1], Dept. Physicochem. Physiol., Med. Sch., Osaka Univ.[2] and Dept. Cardiol., Hanwa Memorial Hosp.[3]

The effects of local vibration exposure on blood and vessel were studied concentrating on the factors of thrombosis and hemostasis. (I) The palms of 10 healthy males were exposed to vibration (35Hz, 5G, 5mm p-p) for 5 minutes keeping the normal blood flow in the forearms. The euglobulin fractions were separated from the pre- and post-vibration blood samples. The fibrinolytic activity was measured with the fibrin plate method. It increased after vibration in spite of no hemoconcentration as follows; fibrinolytic areas (pre/post) = 4.89±3.89/7.17±5.21 mm^2. (II) The fibrinolytic activity was kept at high level even 30 minutes after vibration. In case of rabbits with hypercholeste rolemia, the activity did not increase. They suggest that the vascular plasminogen activator from the endotherial cells functionally takes part in the increased fibrinolytic activity. (III) In patients with arteriosclerosis (myocardial infarction and cerebro-vascular accident, n = 36), the fibrinolytic activity (pre/post) were 19.2±8.1/20.4±10.5 mm^2 though 22.2±18.2/28.2±18.2 mm^2 in controls (n = 30). A possibility of vibration load test is anticipated as a method for the physiological diagnosis of arteriosclerosis.

655, II D1330

PLASMA FIBRINOLYSIS IN ALCOHOL DRINKING: INCREASE OF UROKINASE(UK)-TYPE PLASMINOGEN ACTIVATOR IN PLASMA. SUMI, H., YOSHIDA, E., YAMAMOTO, T., IKEDA, R., HAMASUNA, S., MORIMOTO, N., TSUSHIMA, H., MARUYAMA, M. AND MIHARA, H. Dept. Physiol., Miyazaki Med. College, Kiyotake, Miyazaki-gun, 889-16

After 78 normal persons had ingested alcohol (Shochu, Sake and beer), almost no change in plasma enzyme parameters (pyro-Glu-Gly-Arg-pNA (S-2444) amidolytic activity, euglobulin fibrinolytic activity, euglobulin lysis time, and thromboelastography) was observed using the plasma sample directly. The plasma tissue plasminogen activator (TPA) determined by the ELISA method was also in the normal range (6.4 ± 0.8 ng/ml). However, after isolation of the serine-protease fraction by affinity chromatography on [N^{α}-(ε-aminocaproyl)-DL-homoarginine hexylester]-Sepharose, increases of S-2444 amidolytic, fibrinolytic and also Glu-plasminogen activating activities were confirmed. The maximal activity was in the Shochu drinking group, followed by the Sake and beer drinking groups, with approximately 2.1-, 1.7- and 1.5-fold increases in fibrinolytic activity. The double immunodiffusion and fibrin overly zymography methods indicated that UK-type plasminogen activator was the responsible enzyme for the effect. The main molecular form of the active enzyme had a calculated mol. wt. of about 30,000, while the minor components showed mol. wts. of about 50,000 and 100,000, respectively.

656, II D1345

EFFECTS OF STANDARD AND NICOTINELESS CIGARETTE SMOKE INHALATION ON CHANGES IN THE ADHESIVENESS OF LEUKOCYTES DURING DEVELOPMENT OF DIETARY-INDUCED ATHEROSCLEROSIS IN THE RABBIT. OHKUBO, C. AND ASANO, M. Dept. of Physiol. Hygine, the Inst. of Publ. Health, Tokyo 108

Rabbits of both sexes whose ear lobe had a transparent chamber for vital-microscopic observation were fed a regular diet(control gruop) or that supplemented with 1.5% cholesterol(CH gruop) in parallel with inhalation of standard or nicotineless cigarette smoke. Changes in the adhesiveness of leukocytes were measured with an in vitro assay, utilizing the hematocrit glass capillary, concurrently with vital-microscopic observation. Increased leukocyte adhesiveness in the microcirculatory vessels during cholesterol feeding enhanced remarkably by the parallel smoke inhalation of both types of cigarette, although no change was observed in control group of both sexes and no appreciable changes were observed in groups inhalating smoke of both types of cigarette in females. The in vitro leukocyte adhesiveness also increased in CH groups, especially in the combination with smoke inhalation of both types of cigarette, though no effect on the adhesiveness in control groups. The results showed that the in vitro assay well corresponded with vital-microscopic observations on the intramicrovascular leukocytes and that the increasing adhesiveness of leukocytes due to cholesterol feeding was remarkably enhanced by the concurrent smoke inhalation of both types of cigarette.

657, I P (39) 0900

THE DEFORMATION OF RED CELLS UNDER SHEAR FLOW.—THE EFFECT OF HEMATOCRIT ON THE DEFORMATION—

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The deformation of red cells from discocyte to ellipsoidal disk was studied by rheoscope under shear flow varing hematocrit. For the microscopic observation of cell deformation, partially hemolyzed cells were prepared to reduce MCHC, while maintaining biconcave shape and avoiding decrease of intracellular viscosity by introducing dextran into cells. The cells were suspended in plasam, 6% and 10% dextran solutions for rheoscopic observation. We deduced an empirical formula to evaluate the contribution of suspending medium viscosity to the deformation. By using the empirical relationship, it was shown that, when cells were suspended in 6% dextran, the increase of suspension viscosity by raising hematocrit progressively induced ellipsoidal deformaion at the hematocrit range of 4%-25% as in the case of suspending cells in more viscous medium. On the other hand, cells in plasma deformed irregularly at the same hematocrit range. However, at the physiological hematocrit range, cell in plasma deformed to the same extent of ellipsoidal deformation as cells in 6% and 10% dextran solutions. These results suggest that the degree of ellipsoidal deformation is determined by the available space for cell deformation regardless of the suspending medium viscosity.

658, I P (40) 0900

EMPIRICAL EQUATIONS FOR THE ESTIMATION OF INTRAERYTHROCYTIC pH.

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We have shown some basic relations among intra-(pHi) and extra-cellular pH(pHe) and Donnan effect in human whole blood at the 59th annual meeting. The present report is an extension of the previous one and deals with the estimation of pHi from extracellular parameters, pHe, pCO_2, temperature, and oxygen saturation(So_2), by empirical equations.

At the standard condition(37°C, pCO_2=40mmHg, pH7.40, So_2=100%), the relation between pHe and pHi or Donnan ratio(r) is usually described by a simple linear equation. In the other conditions, however, r(or pHi) depends upon So_2, pHe, pCO_2, and temperature in a complex manner. To determine empirical equations describing the relation among the above parameters, we have measured ΔpH=pHe-pHi of human blood at different So_2 and temperatures. pHe was changed by CO_2- and fixed acid titrations. The results were analyzed by least-squares fitting procedures. Following equations are proposed for open system.

For So_2 = 100% $r = -0.392(pHe-7.40)-0.00057(pCO_2-40)-0.00774(T-37)+0.72$

So_2 = 50% $r = -0.400(pHe-7.40)-0.00057(pCO_2-40)-0.00686(T-37)+0.70$

So_2 = 0% $r = -0.436(pHe-7.40)-0.00057(pCO_2-40)-0.00749(T-37)+0.69$

659, I P (41) 0900

BINDING OF ANTI-HUMAN T LYMPHOCYTES MONOCLONAL ANTIBODIES (OKT-3, -4 AND -8) ON QUANTITATIVE FLOW CYTOMETRY.

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The fluorescence mesurement on flow cytometry is confined to the cell-bound material, so it is not necessary to remove the co-existing unbound material, which may interfere with ligand-receptor interactions. Recently we have developed a new standard fluorescence microsphere for quantitative flow cytometry and have been able to determine the amount of FITC-conjugated molecules bound to the cell surface (J. Immunol. Methods 84:143,1985). Using this standard fluorescence microsphere, the binding reactions of FITC-conjugated anti-human T lymphocyte monoclonal antibodies (OKT-3, -4 and -8) were investigated. Increasing concentrations of these monoclonal antibodies with peripheral blood mono-nuclear cells showed saturation kinetics, and dissociation constant (Kd) and Hill coefficient (n) of each monoclonal antibody were estimated. On investigation of the effect of temperature, Kd of OKT-8 at 12°C was greater than that at 36°C and n value was the same at either temperature, whereas in case of OKT-3, Kd at 12°C was smaller than that at 36°C and n value changed from 1.5 at 12°C to 1.1 at 36°C. Binding of OKT-4 was not affected by the temperature within experimental accuracy.

660, I P (42) 0900

POPULATIONS OF RABBIT RETICULOCYTES USING SCANNING ELECTRON MICROSCOPY (SEM). KITAHARA, M., SAITO, H., O'HATA, S., Dept. Physiol., Tokyo Med. Coll., Shinjuku-ku, Tokyo 160

Reticulocytes due to hemolysis was induced subcutaneous injection of phenylhydrazine hydrochloride into rabbit, and the reticulocytes were studied morphologically and biochemically. The large reticulocytes contained more ribosomes, and there were Met-Hb positive cells among large reticulocytes. The small reticulocytes had processes, but they contained less ribosomes, and Heinz bodies were seen using neutral red staining. The shapes of reticulocytes were varied considerably including, echinocytes, stomatocytes, spherocytes, target cells and discocytes using SEM. The stomatocytes and discocytes had many pittings on the membrane. Heinz bodies were documented in the processes of echinocytes using TEM. The concentration of Met-Hb in reticulocytes were increased to about 9-fold compared with erythrocytes. These results indicate that morphology of population of reticulocytes varies considerably.

661, I P (43) 0900

STUDIES ON THE FIBRINOLYTIC ENZYME IN THE HEPATOBILIARY SYSTEM(XIV) -THE PRIMARY CULTURED RAT HEPATOCYTES AND PLASMINOGEN ACTIVATOR RELEASE- OSHIBA,S.,YOSHIDA,M.,IMAI,H.,SAWAI,H.,OGASAWARA,Y.,ENDOH,E.Dept.Physiol., Nihon Univ.Sch.Med.,Tokyo

Investigations were made on the conditions of primary culture for rat hepatocytes necessary for plasminogen activator (PA) release. The new type of culture method using collagen coated dish (CCD-method) and the ordinary culture method using plastic culture dish (PCD-method) were tested in a comparative way. The following results were obtained. 1) The isolated rat hepatocytes formed a monolayer with pavement-like morphology 24-48 hours after seeding. No difference was observed in the morphology of hepatocytes during the culture period between the two methods, although CCD-method allowed to keep 120 hours culture, whereas PCD-method allowed 72 hours. 2) The cultured hepatocytes released PA into the medium continuously as long as the viability and morphology of the cells were maintained in good state. When EGF is discontinued in the culture medium, the release of PA was reduced in association with the occuring of morphological disintegration of hepatocytes.

662, I P (44) 0900

THE ELEVATION OF PLASMA THIOL PROTEINASE INHIBITOR IN VITAMIN E DEFICIENT RAT. WATANABE, K., ARIGA, T. AND OSHIBA, S*. Dept. Agr. Chem., Sch. Agr. Vet. Med., Nihon Univ., Shimouma, Setagaya 3, Tokyo 154 and *Dept. Physiol., Sch. Med., Nihon Univ., Oyaguchi-Kamimachi 30, Tokyo 173

Proteinase inhibitor levels in the vitamin E deficient rat plasma were measured. The plasma and liver α-tocopherol levels in the rats fed on the vitamin E deficient diet for 2 months decreased by 88% and 95% of the control levels respectively. The plasma from the deficient rats showed stronger inhibition against the thiol proteinases, ficin, papain, bromelin and cathepsin B_1, at various substrates than the control plasma. The inhibitory activity of the deficient rat plasma against plasmin, a serine proteinase, was not changed if compared to the control plasma. Since, thiol proteinases were reported to be enhanced due to vitamin E deficiency, the elevation of the inhibitory activity in plasma against thiol proteases are considered to be of importance for minimizing inflammatory reactions.

663, I P (45) 0900

MOUSE HEMOPOIETIC COLONY FORMATION BY POKEWEED MITOGEN-STIMULATED SPLEEN CELL-CONDITIONED MEDIUM. NAGASAWA, T., OKADA, T. AND KINOSHITA, Y. Dept. Physiol., Osaka City Univ. Med. Sch., Osaka 545

Mouse hemopoietic colony formation in methylcellulose culture was investigated using medium conditioned by pokeweed mitogen-stimulated mouse spleen cells (PWMSCM). PWMSCM was prepared by incubating $2x10^7$ spleen cells (BDF_1 mouse)/10 ml α medium containing a 1:300 dilution of pokeweed mitogen (GIBCO) and 10% fetal bovine serum (Flow). PWMSCM[0-2] and PWMSCM [0-8] were prepared by incubating for 2 and 8 days, respectively. PWMSCM [2-4], PWMSCM[4-6] and PWMSCM[6-8] were prepared by ibcubating for 2, 4 and 6 days with medium containing pokeweed mitogen and fetal bovine serum, respectively, and then incubating washed cells for more two days with same medium. For colony formation, one ml of culture medium contained $6x10^5$ spleen cells from 5-fluorouracil-treated mice, α medium, 0.8% methylcellulose, 30% fetal bovine serum, 1% deionized bovine serum albumin, 10^{-4}M mercaptoethanol and 10% PWMSCM. Colonies were counted on day-14. PWMSCM[0-2] formed no colony and dispersed erythrocytes in dish. Maximum colony number was seen in PWMSCM[0-8] and multilineage hemopoietic colonies were most seen in PWMSCM[4-6].

664, I P (46) 0900

PATHO-PHYSIOLOGICAL IMPORTANCE OF MECHANICAL FRAGILITY OF ERYTHROCYTE MEMBRANE UYESAKA,N., HASEGAWA,S., KIKUCHI,H. and SHINAGAWA,Y. Dept. of Physiol.,Nippon Medical School,Sendagi,Bunkyo-ku,Tokyo, Dept. of Hematol.,The Kanto Teishin Hosp.,Higashi-Gotanda,Shinagawa-ku,Tokyo

In order to make patho-physiological meanings of mechanical fragility of erythrocyte membrane clear, abnormal red cells were investigated. Mechanical fragility was studied by impact-force method developed in our labaratory. The studied patients were myelodysplastic syndrome [MDS], unstable hemoglobin disease (Hb Yokohama) associated with abnormal hemoglobin [β31(B13) Leu→Pro] and congenital high erythrocyte membrane phosphatidylcholine (PC) hemolytic anemia which showed abnormality due to the elevation of membrane PC content despite of normal content of other membrane lipid. It was found out that these patient's erythrocytes showed several stage of shape change, for example, erythrocytes from MDS revealed echinocyte, darcocyte, schizocyte and fragmentation. An increase in membrane fragility of abnormal cell was expected from shape change mitioned above. But membrane fragility these abnormal erythrocytes investigated by osmotic fragility test resulted in decrease in fragility. On the contrary mechanical fragility of the abnormal cell studied by impact-force method showed maked increase in fragility. These results showed patho-physiological importance of mechanical fragility of red cell membrane in understanding hemolysis in vivo.

665, I P (47) 0900

RELEASE OF PLASMINOGEN ACTIVATOR BY EXTRACTS OF BOVINE ANTERIOR PITUITARY SAKAI,J.,SANADA,S.,ITO,A.,NAKASHIMA,A.,SUGISHITA,E. AND SUGIE,I. Dept. of Physiol., Aichi Med. Univ., Nagakute, Aichi, 480-11.

Extracts of pituitary were investigated in order to clarify the mechanism of humoral control of fibrinolysis. Bovine pituitary glands were homogenized and extracted with phosphate buffered saline. The release of plasminogen activator (Plg. Act.) from vessel wall was studied on the rat hindlegs perfused with oxygenated Krebs-Ringer bicarbonate solution (pH 7.4, 37°C, 3ml/min). Activity of Plg. Act. was examined on the fibrin plate method. The Plg. Act. in the perfusate was detected immediately after the administration of whole pituitary extracts (1.5ml), and the flow rate of perfusion unchanged. However, the administration of neural pituitary extracts, Plg. Act. in the perfusate was not detected and the flow rate decreased significantly. In the experiments of anterior pituitary extracts-administration, the release of Plg. Act. was detected and the same response was observed although the pretreatments of extracts were performed by either DFP or heating (56°C for 30 min). After the separation of heat denatured-anterior pituitary extracts by Sephadex G-25, releasing activity was hold in the low molecular fraction (< MW 5,000). From these results, it is suggested that Plg. Act. releasing factor would be existed in the extracts of bovine anterior pituitary gland.

666, II C 1515

NMR BEHAVIOR OF THE URINE COMPONENT CREATININE.

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Using Bruker's WP80SY-WG, the urine component creatinine solutions of 2 to 8 g/dl were examined on the chemical shifts and relaxation times of OH, CH_3 and CH_2 only by single scanning.

In all cases were found the highest peak of OH signal at 4.72 $\pm$ 0.01 ppm with a band width of 4 Hz. And, with an increase of concentration, it changed in T_1 from 3.18 to 2.90 sec and in T_2 from 0.72 to 0.26 sec. Then, however, the 2nd and 3rd peaks in height of CH_3 and CH_2 with a ratio of 3/2 in the area changed in the chemical shift from 2.99 to 2.95 and 3.99 to 3.95 ppm, respectively.

And the CH_3 showed little change in the T_1 and T_2, but the CH_2 decreased in T_1 from 2.3 to 1.8 sec and increased in T_2 from 1.0 to 1.8 sec.

Furthermore, using the water suppression method by homogated decoupling and some accumulations of FID, a dilute creatinine solution of 0.1 g/dl similar to the human urine were examined.

667, II C 1530

ACID STABLE TRYPSIN INHIBITOR IN THE BILE.

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Acid stable trypsin inhibitor having the same antigenicity as urinary trypsin inhibitor (UTI) was first identified in the bile (BTI) of patients with malignant tumors (biliary tract carcinoma or pancreas head carcinoma) and gallstones.

BTI could be partially purified by DEAE ion-exchange column chromatography. BTI was adsorbed and eluted with a salt gradient between 0.14-0.71 mol/l NaCl. The main molecular form had a molecular weight of about 86,000 (HMW BTI) and the minor one, a molecular weight of about 31,000 (LMW BTI) by gel filtration. HMW BTI revealed a pI of 2.0 and LMW BTI had a pI of 5.1 by isoelectric focussing. The isolated HMW BTI was found to migrate on the slightly cationic side of human serum albumin by analytical gel electrophoresis.

The isolated HMW BTI strongly inhibited trypsin, as well as chymotrypsin and plasmin to a lesser extent, but exerted no inhibitory effect on urokinase. It was found to be relatively stable at various pHs and temperatures. HMW BTI resembled UTI in its molecular weight, pI and some other properties. The presence of BTI implies that the biliary tract may play an important role as one of the excretory pathways of plasma acid stable trypsin inhibitor in addition to the urinary tract.

668, II C 1545

EFFECT OF SITS ON Na^+ AND HCO_3^- APPEARING IN PLASMA DURING PASSAGE OF CO_2-RICH GAS THROUGH HUMAN WHOLE BLOOD

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Kiyoji ASANO, Seiichi SHIMABUKURO, Akitoshi OGAWA, Toshiki OHIRA, Taro MINAGAWA and Senri HIRAKAWA

We have previously reported that "transport" of Na^+ and HCO_3^- from erythrocytes into plasma occurred in one-to-one relation as well as the well known chloride shift, during passage of CO_2-rich gas mixture through dog's or human whole blood. In the present study, in order to see whether the "transport" of Na^+ and HCO_3^- in question would be independent from chloride shift, CO_2-rich gas mixture was passed through human whole blood in the presence or absence of pretreatment with SITS, an anion transport inhibitor, and changes in the plasma electrolytes concentration was studied. In addition, an approximate net "flux" of Na^+ (F_{Na^+}), Cl^- (F_{Cl^-}) and HCO_3^- ($F_{HCO_3^-}$) was calculated and the relationship among F_{Na^+}, F_{Cl^-} and $F_{HCO_3^-}$ was studied. As a result, it was found that SITS decreased F_{Cl^-} significantly and $F_{HCO_3^-}$ slightly without any effect on F_{Na^+}. Parenthetically, pH, PCO_2 and PO_2 were roughly 7.23, 56 mmHg and 120.4 mmHg, respectively.

669, II C 1600

CONTRIBUTION OF ALBUMIN AND NON-ALBUMIN FRACTIONS TO PROTEIN OSMOTIC PRESSURE.
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The purpose of present study is to measure protein osmotic pressure of albumin and albumin-depleted plasma in sheep directly, and to determine the change of protein osmotic pressure following changes of albumin fractions. Albumin and albumin-depleted plasma were separated from pooled plasma of sheep through Cibacron Blue dye and gel-filtration columns. We measured protein osmotic pressure of serial dilutions of sheep plasma protein preparations from 0-10 g/dl with 5 different albumin fractions, with a WESCOR and a needle osmometer at room temperature(24-27 °C), and corrected to 37 °C. Two osmometers gave the same results. The best fit cubic regression equation for albumin at 37°C was: Π(mmHg, 37°C)= $2.98C+0.23C^2+0.005C^3$. For the non-albumin fraction, we extrapolated to zero albumin concentration: Π(mmHg, 37°C)=$1.06C+0.083C^2$. There was no cubic term up to 10 g/dl. Protein osmotic pressure of plasma and lymph was calculated from the relationship, i.e., Π(mmHg, 37°C)=$a(2.98C+0.23C^2+0.005C^3)+(1-a)(1.06C+0.083C^2)$. a is albumin fraction and C is protein concentration. From comparing measured and calculated protein osmotic pressure, we confirmed that our nomogram allows one to accurately compute the protein osmotic pressure of sheep plasma and lymph for any total protein concnetration up to 10 g/dl and any albumin fraction.

670, II C 1615

FLUID SHIFTS DURING HEAD-OUT WATER IMMERSION (WI) IN DOGS.
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The WI causes diuresis in humans, primates, and dogs. However the source of the fluid excreted via urine is not known. In the present study, blood volume (BV, Cr-51 erythrocyte space), hematocrit (Hct), plasma volume (PV, calculated from BV and Hct) and extracellular fluid space (ECF, I-125 iothalamate space) were measured continuously in 7 splenectomized and acutely nephrectomized dogs to determine kinetics of the fluid movement between plasma, interstitial, intracellular compartments during 60 min in air and 120 min of WI at 38 °C. PV rose immediately after WI and increased almost linearly by 12 ± 2 (SE) ml/kg above the control level. ECF also increased linearly during WI to 10 ± 2 ml/kg above the control level by 120 min of WI. Interstitial fluid volume, calculated from ECF and PV, did not change significantly during WI. These results indicate that WI leads a sustained fluid shift of the intracellular fluid compartment toward the plasma. We conclude therefore that WI causes acute increase in plasma volume and cellular dehydration in the nephrectomized dog.

671, I P (56) 1330

ANGIOTENSIN II (AII) AND VASOPRESSIN (AVP) CAUSE MEMBRANE DEPOLARIZATION AND CONTRACTION OF CULTURED RAT MESANGIAL (M) CELLS.
Toshihiro Okuda*, Naohide Yamashita, and Kiyoshi Kurokawa*. Fourth Dept Int Med, Univ Tokyo Sch Med, Tokyo 112.

M cell contraction induced by AII and AVP plays an important role in the regulation of glomerular hemodynamics. We examined electrophysiological properties of M cells obtained by culturing isolated rat glomeruli. The membrane potential was monitored by a glass microelectrode containing 4M K acetate. The hormones were administered by pressure from a capillary containing either 100 nM AII or AVP positioned near the impaled cell. The resting potential was -53 ± 5 mV and depolarized by about 15 mV for 1-5 min in response to AII or AVP. The depolarization was accompanied by an increase in membrane conductance. The reversal potential of the response by AII was -29 ± 3 mV and changed according to the extracellular Cl concentration indicating that the increased ion permeability depends mainly on an increased Cl conductance. The time course of membrane depolarization-repolarization closely corresponded to that of visually observed cell contraction-relaxation. Calcium ionophore A23187 caused cell contraction and similar membrane potential change with the reversal potential of -26 ± 7 mV. These results suggest that AII, AVP and A23187 cause membrane potential depolarization of M cells with an opening of Ca-activated Cl channel and that the membrane potential change and contraction may be related.

672, I P (57) 1330

ANALYSIS OF INTESTINAL WATER ABSORPTION WITH CONTINUOUS MONITORING OF BLOOD VOLUME IN RATS. MORITA, M., NOSE, H. AND MORIMOTO, T. Department of Physiology, Kyoto Prefectural University of Medicine, Kamigyoku, Kyoto 602, Japan.

To analyze the effect of water absorption on blood volume, changes of circulating blood volume were continuously monitored after injecting various solutions into rat's intestine. At least 24 hrs prior to the experiment, rats were splenectomized and cannulated into proximal portion of duodenum. After anesthesia with sodium pentobarbital, rats were cannulated into jugular aorta, jugular vein and bladder. The arterial and venous catheters were connected with the system for continuous monitoring of blood volume by dilution method of ^{51}Cr-labeled erythrocytes. Test solutions (Tap water, 0.45%, 0.9%, 1.8% NaCl, 0.45% NaCl with 2% Glucose and 5% Glucose) amounting 1 ml/100g body wt. and maintained at 37°C were injected for 10 min through the intestinal tube, and blood volume and urine volume were measured. Blood volume increased gradually after the injection, while only in 1.8% NaCl group, transient decrease in blood volume was observed. The rate of blood volume increase was higher in both 0.45% NaCl groups. The retention ratio of injected solution in vascular spase was about 18-28% on an average in all groups. These results indicate that water absorption through intestinal tract is modified by the osmotic gradient.

673, II H 0915

FACTORS AFFECTING HYPOXIC VENTILATORY DEPRESSION IN THE ANESTHETIZED RAT.

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Changes in breathing pattern and threshold end-tidal O_2 concentration ($F_{ET}O_2$, %) for ventilatory depression during isocapnic progressive hypoxia test were studied in the halothane anesthetized rat. Progressive reduction in $F_{ET}O_2$ from hyperoxia ($F_{ET}O_2$>35%) initiated hyperbolic increase in ventilation which was followed by depression due to reduction in respiratory frequency (f) with an elevated tidal volume at $F_{ET}O_2$ levels lower than 8-10% (moderate hypoxia). Depression occurred with similar changes in breathing pattern and at almost the same $F_{ET}O_2$ level after bilateral vagotomy. The threshold $F_{ET}O_2$ for depression shifted to 5-7% (severe hypoxia) when the $F_{ET}CO_2$ was increased, or the rat was pretreated with naloxone or when the decrease in systemic arterial pressure during hypoxia was prevented by continuous infusion of phenylephrine. After bilateral carotid sinus nerve section there was no appreciable respiratory stimulation, and the ventilation was progressively decreased even by slight hypoxia ($F_{ET}O_2$< 15-16%). In all cases studied, reduction in f with prolongation of expiratory time was the primary cause of depression. The results suggest that hypoxic ventilatory depression in the rat is derived from disturbance of expiratory breaking (or expiratory-inspiratory phase switching) mechanism probably due to medullary tissue hypoxia.

674, II H 0930

HYPERCAPNIC AND HYPOXIC VENTILATORY RESPONSES DURING GROWTH.

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Cross-sectional studies on hypercapnic and hypoxic ventilatory chemosensistivities were performed in 73 children ranging in age from 7 to 18 yrs. The subjects were classified into 6 successive 2-yr age groups. Normalized ventilatory responses to CO_2 by body surface area (S/BSA) were progressively decreased from the 7-8 through the 11-12 yr groups, and then tended to decrease further in a more gradual manner with increasing age. This trend was very similar to the normalized CO_2 output ($\dot{V}$/BSA), but did not parallel so closely the normalized O_2 in take ($\dot{V}$/BSA). When ventilatory and metabolic parameters were normalized by body weight (BW), or the lean body mass (LBM), qualitatively similar relationships between CO_2 sensitivities and metabolic parameters were also obtained. Contrary to hypercapnic response, hypoxic ventilatory chemosenssitivities were not siginificantly different among the 6 different age groups. We concluded that normalized hypercapnic chemosensitivities decreased during growth and corresponded well with decreased CO_2 output per unit body mass.

675, II H 0945

EFFECTS OF CEASING THE BLOOD FLOW TO THE UPPER PART OF THE BRAIN STEM ON THE INSPIRATORY ACTIVITY DURING STIMULATION OF THE CAROTID SINUS NERVE IN CATS.

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Inspiratory output responses, measured as integrated phrenic nerve activity(PNA), to ceasing the blood flow to the upper part of the brain stem were studied in anesthetized, vagotomized and paralyzed cats. The phrenic nerve activity was increased by electrical stimulation of the carotid sinus nerve. During stimulation of the carotid sinus nerve, occlusion of the basilar artery at the rostral end of the medulla did not alter the PNA. However, subsequent bilateral occlusions of the external carotid arteries suppressed markedly the PNA which finally disappeared within one minute. The PNA did not recover during the period of occlusion(from 1 to 6 min.). After release of the occlusion, the PNA appeared in a short delay and recovered completely. These results indicate that the peripheral chemoreceptor inputs would be processed in some areas of the upper part of the brain stem, which appear to have an intrinsic and important function of the respiratory control system.

676, II H1000

INFLUENCE OF OXYGEN DELIVERY ON OXYGEN CONSUMPTION ($\dot{V}o_2$) OF THE ISOLATED PERFUSED CANINE GRACILIS MUSCLES.

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Blood oxygen delivery (oxygen capacity X blood flow) is argued to be an important limiting factor for tissue oxygen consumption, but the quantitative aspect has not been fully understood. We studied this problem by perfusing the isolated canine gracilis muscles with blood of varied hematocrits (Ht) and at different flow rates. A surgical improvement has also been attempted to assure a complete and equal perfusion of all portions of the muscles. In the normal Ht (45%) series (n=5), a constant $\dot{V}o_2$ (0.31±0.06ml/min·100g muscle) was maintained at the oxygen deliveries above 0.4ml/min·100g muscle, but below the critical level the $\dot{V}o_2$ was delivery-limited. The same relationship was observed in the low Ht (25%) series (n=6), too. Mean lactate efflux by the muscles was almost nil, although two of the eleven experiments indicated an extent of the influx during perfusion.

677, II H1015

REGIONAL INHOMOGENEITY OF CONVECTIVE AND DIFFUSIVE GAS MIXING IN TERMINAL AIR WAY.

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We had shown possible existance of stratified inhomogeneity in symmetrically branched terminal air way at the meeting last year. For the analysis of gas mixing of terminal bronchial tree,Navier-Stokes equation and convective diffusion equation of two dimension were coupled and solved numerically by finite element method. The time dependent solution of flow,pressur and concentration distribution are obtained by the method based on explicit numerical integration shema in time. We applied this method to ansymmetrically branched terminal air way. The existance of anisotropy of flow and gas flux and uneven distribution of concentration in the time of one breath had been shown by this model. The inhomogeneity was dependent on the branching angles. The angle of branch where the difference of diffusion velocity from convection velocity were small seemed to be most effective on the regional inhomogeneity. Our model of terminal air way deduced that possible existence of both regional inhomogeneity and stratified inhomogeneity caused solely by convective diffusion.

678, II H1030

MICROSTEPS IN THE OXYGEN DIFFUSION PROCESS IN THE LUNG

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Inhaled oxygen molecules diffuse through alveolar membrane, blood plasma, erythrocyte membrane and hemoglobin solution in erythrocytes. Several diffusion barriers based on different microstructures in tissues, therefore, are distinguished on the passage for oxygen. To obtain detailed information for oxygen diffusion barriers, microviscosity (MV) and wobbling diameter (WD) of the phospholipid bilayers of enzymatically isolated lung cells and erythrocyte ghosts were measured in bullfrogs by means of the nanosecond fluorescence depolarization technique by the use of rodlike shaped fluorophore, DPH. MV of lung cells was 0.34 poise at 30°C, which was significantly smaller than MV in erythrocyte ghosts. WD was 12.6 A in lung cells at 30°C. The viscosity of the blood plasma was 0.019 poise by means of a cone plate viscometer. Diffusion coefficients were calcuated from viscosity values by the assumption that the oxygen molecule is a sphere whose diameter was 2A and the Einstein-Stokes equation is valid to MV; 0.78 in erythrocyte ghosts, 3.26 in lung cells and 58.4 in blood plasma, each in the unit of $\times 10^{-7}$ cm^2/sec at 30°C. These results are useful for the analysis of non-uniform distribution of diffusion coefficient for oxygen. The relatively small WD of lung cell membranes seems to be advantageous as the boundary between the inhaled air and circulating blood.

679, ⅢH1045

ENTRAINMENT OF BREATHING RHYTHM TO LOCOMOTION RHYTHM. MIYAMOTO,Y., KAWAHARA,K., AND NAKAZONO,Y. Dept. Information Eng., Fac. Eng., Yamagata Univ. Yonezawa 992

For the purpose of clarifing the influence of locomotion rhythm to breathing rhythm, experiments were carried out on eight healthy volunteers. First, the subject was ordered to step spontaneously on a treadmill moving at a constant speed of 3.2 Km/h. Breathing and stepping rates were monitored. Secondary, the subject stepped in such a way to synchronize his stepping rate to sound beats which reflected his free walking rhythm monitored previously. It was then observed that the ratio,breathing period/ stepping period, approached closely to 1 or 2 during synchronized stepping. No such a phenomenon was observed during free stepping, though breathing rate tended to close to a half of stepping rate. Breathing rhythm may be modified via two pathways, one via reflex originating from moving limbs, and the other via command originating from central nervous system. The present observation would suggest that both of the central command and peripheral reflex are important as a factor to modify breathing rhythm during locomtion.

680, ⅡH1100

VENTILATORY RESPONSES TO BICYCLE EXERCISE AT TWO PEDALLING RATES IN WOMEN. TAKANO, N. Dept. of School Health, Fac. of Education, Kanazawa Univ., Kanazawa 920

Ventilatory responses to progressive bicycle exercise were studied at two pedalling rates of 30 and 60 rpm. Work load at each pedalling rate was progressively increased by 15W every min to the point of exhaustion. Twelve sedentary women volunteered as the subject. There were linear relationships in $\dot{V}CO_2$-$\dot{V}E$, $\dot{V}CO_2$-VT/TI (mean inspiratory flow) and $\dot{V}CO_2$-f (resp. freq.). The slopes of these relationships were steeper at the pedalling rate of 60 rpm than at 30 rpm. The result suggests that a multiplicative interaction between two stimuli of $\dot{V}CO_2$ and rate of limb movement takes part in ventilatory control during bicycle exercise. TI/TT (inspiratory duty cycle) increased progressively and then attained to steady levels of 0.45-0.46, with increasing $\dot{V}O_2$ during the exercise. The turning point appeared at the point of 60% $\dot{V}O_{2max}$, which corresponded to a respiratory gas exchange anaerobic threshold. The change in TI/TT was similar at the two pedalling rates studied. Ventilatory timing, primarily controlled by neurogenic factors, seems to be modulated by metabolic factors but not by rate of limb movement during bicycle exercise.

681, ⅡH1115

ARTERIAL BLOOD pH DURING HATHA-YOGA AND CONTROL BREATHING. MIYAMURA,M. AND HIRUTA,S. Lab. Work Physiol. Res. Cent. Hlth. Phys. Fit. Sports, Nagoya University, Chikusa-ku, Nagoya 464

To examine effects of hatha-yoga breathing on the ventilatory response to hypercapnia, arterial blood pH, P_{CO_2} and P_{O_2} were determined during hatha-yoga and control breathing. It was found in this study that during hatha-yoga breathing arterial pH, P_{CO_2} and P_{O_2} oscillated simultaneously with respiration cycle and arterial pH in one subject, who can breath with a frequency about one per minute, decreased until 7.319. From these results, it was suggested that lower hypercapnic ventilatory drive in subject particing hatha-yoga may be related to adaptation to low pH and/or high P_{CO_2}.

682, II H1130

ATTENUATION OF HYPOXIC VENTILATORY DEPRESSION BY A SYNTHETIC PROGESTERONE. KIMURA, H., KOBAYASHI, T. AND FUKUDA, Y. Dept. Chest Med. and Physiol., Chiba Univ. Sch. Med., Chiba 280

We examined whether a synthetic progesterone, chlormadinone acetate (CMA), could affect ventilatory control in the anesthetized rat.

Twelve rats were anesthetized with halothane throughout experiments. The animal inhaled gas mixtures containing various concentration of O_2, N_2 and CO_2 through a trachial cannula. Six rats were orally pretreated with CMA (4 mg/kg in emulsifying solution) for 7 days (CMA group), and other 6 were pretreated with emulsifying agent only (control group). Resting ventilation ($\dot{V}_E$, V_T, f), metabolic rate ($\dot{V}o_2$, $\dot{V}co_2$), airway occlusion pressure ($P_{0.1}$), functional residual capacity (FRC) and ventilatory responses to hypercapnia (HCVR) and isocapnic hypoxia (HVR) were determined on the 8th day.

$\dot{V}_E$, V_T, f, $\dot{V}o_2$, $\dot{V}co_2$, $P_{0.1}$, and FRC were not affected by CMA. Administration of CMA augmented the HCVR and HVR although differences in response parameters were not statistically significant between CMA and control groups. The threshold F_{ETO_2} for ventilatory depression during isocapnic hypoxia test was, however, lower in the CMA group (5.8±0.6%) than in the control group (8.2±1.5%, $p<0.01$). We conclude that CMA attenuates hypoxic ventilatory depression under halothane anesthetized rats.

683, II H1145

THE EFFECT OF SYNTHETIC PROGESTERONE ON VENTILATION IN NORMAL MAN : COMPARISON BETWEEN CHLORMADINONE ACETATE (CMA) AND MEDROXYPROGESTERONE ACETATE (MPA). MORIKAWA,T., TANAKA,Y., MARUYAMA,R., NISHIBAYASHI,Y. AND HONDA,Y. Dep. Orthopaedic Surg., Chiba Univ. Sch. Med., Chiba 280

We administered CMA,MPA and placebo to 16 normal males for 7 days using a randomized double-blind crossover study. Arterial blood gas tension, resting ventilation, ventilatory and mouth occlusion pressure responses to hypoxia, and ventilatory and occlusion pressure responses to hypercapnia with and without flow-resistive loading were measured. During CMA administration, arterial P_{CO_2} decreased with an increase in minute ventilation. Metabolic rate increased but the change was not significant. During MPA administration, the changes of blood gas tension, ventilation and metabolic rate were in similar degree to those of MPA. Normocapnic ventilatory and occlusion pressure responses to hypoxia were significantly elevated by both CMA and MPA, and the increments by both agents were not significantly different. Both CMA and MPA shifted the ventilatory and occlusion pressure response curves to CO_2 to the left,significantly with loading but not significantly without loading. But the slope of both response curves did not change. Thus, the difference of the hypercapnic responses between CMA and MPA was not detected. We conclude that the effect of CMA on ventilation is almost similar to that of MPA although the luteinizing activity is about ten times stronger than MPA.

684, II H1300

VENTILATORY RESPONSES TO STIMULATION OF CENTRAL CHEMOSENSITIVE AREA BY INJECTION OF A HIGH CO_2 SOLUTION INTO THE VERTEBRAL ARTERY. KOGO,N., KOSHIYA,N., ARITA,H. and KUMADA,M. Inst. of Basic Med. Sci., Univ. of Tsukuba, Ibaraki 305.

We studied the response of respiratory activity to stimulation of central chemosensitive area by injecting a high CO_2 solution into the vertebral artery in decerebrated, spontaneously breathing cats. A catheter was inserted into the vertebral artery at the C_1 level, and its tip was located about 8 mm distal to the basilar artery. One ml of the loading solution (saline saturated with 100% CO_2 gas) was injected rapidly (0.3-0.4 ml/sec) during various respiratory phases. Respiratory activity was assessed by phrenic nerve activity, intrapleural pressure and respiratory flow. With a few sec delay after injection, the stimulation consistently evoked new inspiratory activity (NIA) independent of the preceding rhythmic activity, followed by rapid and deep inspiratory activity (RDIA). These responses were quite different from those to peripheral chemoreceptor stimulation. Intraventricular injection of acetazolamide abolished the NIA response, whereas the RDIA response remained qualitatively unchanged. We conclude that stimulation of central chemosensitive area affects the mechanism underlying respiratory rhythm generation, as evidenced by the NIA response, and that a rapid increase in $[H^+]$ of brain extracellular fluid is responsible for the NIA response, but not for the RDIA response.

685, II H1315

INFLUENCES OF MORPHINE AND PROGLUMIDE ON REFLEX RESPIRATORY SUPPRESSION INDUCED BY THIN-FIBER MUSCULAR AFFERENTS.
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In anesthetized, vagotomized, glomectomized, paralyzed and artificially ventilated cats, electrical stimulation of thin-fiber muscular afferents causes naloxone-reversible respiratory suppression a few minutes after cessation of stimulation("after suppression"). However, this phenomenon is attenuated after repeated stimulation at intervals of 15 min. It has been reported that the activity of opiate systems is influenced by various neuropeptides, and that endogenous cholecystokinin(CCK) may antagonize opiate analgesia and be involved in opiate tolerance. The effects of proglumide, a CCK antagonist, and morphine on respiratory suppression were investigated. At doses of 0.02 and 0.2 mg/kg i.v., proglumide per se did not cause any change on respiration, but significantly potentiated "after suppression". The attenuation of "after suppression" induced by repeated stimuli disappeared after continuous infusion of proglumide(0.08 mg/kg/h). However, respiratory suppressive effect of exogenously applied morphine(0.05 mg/kg i.v.) did not attenuate when repetitively applied at intervals of 10 min. These results suggest that endogenous CCK driven by stimulation of thin-fiber muscular afferents may be involved in the attenuation of "after suppression".

686, II H1330

CORRELATION OF INSPIRATORY RETICULAR UNIT ACTIVITY IN THE BRAIN STEM TO PHRENIC HIGH FREQUENCY OSCILLATIONS OF RABBITS.
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In aiming to study the physiological meanings of the high frequency oscillations (HFO) in terms of the respiratory rhythmogenesis in the medulla oblongata, the correlation of inspiratory neuronal activity to the HFO in the phrenic nerve activity was quantitatively investigated in vagotomized and paralyzed rabbits. HFO component in the phrenic nerve activity was averaged for 200 times using the "spike-triggered averaging"technique by inspiratory unit spike. The amplitude of the spike-triggered averaging wave was normalized with the amplitude of self-triggered averaging of the phrenic HFO. The value of normalized amplitude ratio varied (0.04-1.08, N=35) among each reticular inspiratory neuron in the brain stem. The value of the bulbar inspiratory unit activity was larger than that of pontine ones (medulla; mean$\pm$SE, 0.38$\pm$0.04, N=32: pons; 0.15$\pm$0.01, N=3: $p<0.001$). The value of unit activity of primary inspiratory neurons, which are thought to be the possible members belonging to the respiratory rhythm generating mechanisms, was smaller than that of the other inspiratory neurons (primary; 0.15$\pm$0.04, N=4: others; 0.41$\pm$0.05, N=28: $p<0.001$). These results suggest that HFO in the phrenic nerve activity correlates in lesser degree to the respiratory rhythm generating process in the medulla oblongata.

687, II H1345

VARIATION OF HIGH FREQUENCY OSCILLATIONS IN PHRENIC NERVE ACTIVITY IN THE COURSE OF ONE RESPIRATORY CYCLE.
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Sequential changes in the quantitative properties of high frequency oscillations (HFO) in the phrenic nerve activity during the whole span of single respiratory cycle were studied. Paralyzed and vagotomized rabbits were maintained under normocapnia (respiratory period; 1.57$\pm$0.2sec: mean$\pm$SD, n=6) by artificial ventilation monitoring end-tidal CO_2 level. Consecutive 160msec data of the digitally sampled phrenic nerve activity were transformed to the auto-power spectral density function at every 50msec step from the onset of inspiration(I-onset) to the terminal of expiration. The peak-frequency(FREQ), peak-area power(AREA) and the half-value width(WIDTH) of HFO were estimated by the non-linear least squares method(Kato et al. 1985). At I-onset, FREQ and WIDTH were 112.5$\pm$6.8 and 7.8$\pm$1.8Hz, respectively, and they rapidly decreased to their lowest values of 110.4$\pm$7.3 and 3.7$\pm$0.5Hz, respectively, at about 100msec from I-onset. Afterwards, they gradually increased and gained thier highest values of 121.0 $\pm$10.9 and 10.2$\pm$3.0Hz, respectively, at the terminal of inspiration. While, AREA increased gradually from I-onset and grew largest after about two thirds of inspiratory phase had passed, then gradually decreased to zero. These results suggest that the degree of synchronization of HFO varies gradually throughout a respiratory cycle.

688, II H1400

PRE-INSPIRATION NEURONAL ACTIVITY IN VENTRAL MEDULLA OF ISOLATED BRAIN STEM-SPINAL CORD OF NEONATAL RAT. ONIMARU, H., ARATA, A., HOMMA, I. AND ICHIKAWA, S. Dept. Physiol., Showa Univ. Sch. Med., Hatanodai, Tokyo 142

We studied respiratory neuronal activity in rostral and ventral medulla of rat (0-5 day-old) brain stem-spinal cord preparations in vitro. The brain stem, without the pons, was transected at the VIth cranial nerve root level. Potential change recorded from ventral C4 or C5 root was used to monitor inspiratory activity. Most neurons that fired with respiratory rhythm in the ventrolateral surface of the medulla (80-250 μm deep) at the level of the Xth cranial nerve root fired preceding inspiration (Pre-I neuron). This Pre-I neuron activity usually stopped during, and then continued again for a short time after inspiratory activity. Vagus stimulation at 5Hz blocked the C4 inspiratory activity, but not the Pre-I neuron activity, which merged into continuous bursts at intervals slightly shorter than the inspiration intervals before stimulation. C4 inspiratory activity reappeared following the first and subsequent medullary Pre-I neuron activity after stopping vagal stimulation. The results strongly suggest that inspiratory rhythmic activity is triggerd by the Pre-I neuron activity.

689, II H1415

THE RESPIRATORY REFLEX INDUCED BY HIGH FREQUENCY AIRWAY DEFLATION (HFD) IN RABBITS. HOMMA, I., ISOBE, A., ONIMARU, H., OOUCHI, M. AND ICHIKAWA, S. Dept. Physiol., Showa Univ. Sch. Med., Hatanodai, Tokyo 142

Respiratory responses to high frequency airway deflation (HFD) applied to the air in the trachea of rabbits were studied. Experiments were performed on 10 rabbits, weighing 2.5-3.5 kg, anesthetized with urethane-chloralose (initial dose, 450 mg urethane + 45 mg chloralose/kg, i.v.). Mass phrenic efferent nerve activity and unitary vagal afferent activity were recorded. Intratracheal pressure was monitored and the peak pressure produced by HFD was -7cm H_2O to -10cm H_2O. In two different vagal afferents, HFD depressed spontaneous slowly adapting receptor (SAR) activity and enhanced rapidly adapting receptor (RAR) activity. HFD pulses blocked one or two pulses of each SAR burst, but induced short bursts of RAR pulses. HFD facilitated inspiration, and induced tonic discharges seen in phrenic recordings. HFD decreased expiratory time by inducing the next inspiratory burst earlier. This effect also occurred when inspiratory activity ceased during apnea induced by hyperventilation.

690, II H1430

RECOVERY OF MOTOR BEHAVIOR FOLLOWING CROSS-REINNERVATION OF FORELIMB MUSCLES BY THE PHRENIC NERVE IN CATS. FUJITO, Y., KAWASAKI, H. AND AOKI, M. Dept. Physiol., Sapporo Med. College, S.1, W.17, Chuo-ku, Sapporo 060

Electromyographic (EMG) recordings from forelimb muscles following cross-reinnervation of elbow flexors by the phrenic nerve were made simultaneously with cinematographic analysis of forelimb movements. The proximal stump of the cut right phrenic nerve was cross-united to the peripheral stump of the right musculocutaneous nerve. In all surgical procedures, cats were anesthetized with pentobarbital sodium. Bipolar EMG recording electrodes were chronically implanted in the right M. biceps brachii, M. triceps brachii and the left diaphragm. EMG activities of M. biceps synchronized with those of the diaphragm for several months after the cross-union. In a cat cross-united 11 months previously, EMG activities of M. biceps were occasionally dissociated from those of the left diaphragm. During voluntary goal directed movements, cats could reach their right forepaw to the target smoothly using elbow flexors after the completion of reinnervation. This indicates functional compensation of forelimb movement disorders by voluntary control of respiration. Effects of cerebral peduncle (CP) stimulation on respiratory neural activities were also examined in intact cats. Phrenic nerve discharges were mainly suppressed by stimulation of the contralateral CP. Activities of medullary respiratory neurons were depressed or unaffected by CP stimulation.

691, II H 1445

BRAINSTEM CONTROL OF THE CERVICAL RESPIRATORY NEURONS IN THE CAT. AOKI, M., FUJITO, Y., KUROSAWA, Y. AND KAWASAKI, H. Dept. Physiol., Sapporo Med. College, Chuo-ku, Sapporo 060

In the present study, brainstem projections to the cervical inspiratory neurons (C1-C2) were examined. Cats were anesthetized with Nembutal (pentobarbital sodium, initial dosage of 20 mg/kg i.v.) or decerebrated at the precollicular level. Spontaneous respiratory neuron activities were maintained. Using extracellular microelectrodes, medullary and cervical inspiratory neuron discharges were simultaneously recorded, and then a medullary recording electrode was switched to a stimulating electrode. Most of the cervical inspiratory neurons were antidromically activated by microstimulation (10-50 μA) of the lower cervical (C5) cord with the latencies of 2-8 msec. Contralateral stimulation of N. retroambigualis activated 93% of the cervical units examined, while ipsilateral stimulation activated 55% of them. Contralateral and ipsilateral stimulation of N. tractus solitarius activated 65% and 55% of them, respectively. Electrical stimulation (200 Hz, 10-50 μA) of N. raphe magnus (P4-P10) was found to inhibit both the cervical inspiratory neuron activities and phrenic motor discharges. In contrast, stimulation of Locus coeruleus (P2-P4) and nearby structures was found to facilitate the cervical neuron activities and the phrenic discharges.

692, III H 0915

RESPIRATORY NEURONS IN THE NUCLEUS RETROAMBIGUALIS (NRA): ELECTROPHYSIOLOGICAL AND MORPHOLOGICAL ANALYSES. KOSHIYA, N., KOGO, N., ARITA, H. and KUMADA, M. Inst. of Basic Med. Sci., Univ. of Tsukuba, Ibaraki 305

Role of NRA neurons on respiratory rhythmogenesis was evaluated in decerebrated, spontaneously breathing cats. We recorded intracellular potentials from the respiratory neurons in the caudal NRA, examined the synaptic inputs by current injection, and then studied the morphology of those neurons by the method of intracellular injection of HRP. Expiratory neurons (ENs) were found to be densely packed in the caudal NRA, most of which could be activated by antidromic stimulation at the contralateral spinal cord. Inspiratory neurons (INs) were intermingled with the ENs, though less frequently. Current injection demonstrated that ENs had IPSPs during inspiration; the IPSP was similar in configulation to the intracellular potential of the neighbouring INs. In contrast, the INs did not show any IPSPs. The ENs (n=8) possessed a long axon which crossed the midline within the medulla. Most of them (n=5) passed through the ipsilateral hypogrossal nucleus. None of ENs examined had any axon collaterals. The results indicate that the ENs in the caudal NRA do not affect other respiratory neurons in the brainstem, but function only as premotor neurons projecting to the spinal cord. Rhythmic activity of the ENs is caused mainly by synaptic inhibition during inspiration. The neighbouring INs possibly provide inhibition inputs to the ENs.

693, III H 0930

INHIBITION OF RESPIRATION CAUSED BY MICROINJECTION OF MORPHINE OR REPETITIVE ELECTRICAL STIMULATION IN THE REGION OF THE NUCLEUS PARABRACHIALIS OF CATS. Eguchi, K., Simbulan, D., Tadaki, E. and Kumazawa, T. Dept. of Nervous and Sensory Function, Res. Inst. of Environ. Med., Nagoya Univ., Nagoya 464.

In anesthetized, vagotomized, paralyzed and artificially ventilated cats, morphine (2.66 nmol in 0.1 μl) microinjected in the dorso-lateral portion of the nucleus parabrachialis(PBN) caused suppression of respiration indicated by the phrenic nerve activity. This effect appeared within 1 min after application of morphine and lasted for more than 20 min. In the marginal area of the PBN and the reticular formation ventral to the PBN, repetitive electrical stimulation delivered in the periods of expiration, but not inspiration, of 20 successive respiratory cycles also induced suppression of respiration lasting for a long period. These respiratory-depressant effects were reversed by naloxone(0.5 mg/kg i.v.). The pattern of the respiratory suppression induced by both methods was quite similar to that obtained by thin-fiber muscular afferent activation. These results suggest an involvement of the PBN region in the latter phenomenon.

694, III H 0945

EFFECT OF HIGH FREQUENCY VENTILATION ON RESPIRATORY NERVE DISCHARGES IN THE CAT.
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High frequency ventilation(HFV) has been reported to inhibit spontaneous breathing. We examined the effect of HFV on phrenic nerve discharge and pulmonary stretch receptor activity to analyze the mechanism of this inhibition. Experiments were performed in cats anesthetized with urethane-chloralose (initial doses, ure-440mg/kg, chl-35mg/kg I.V.). The C5 branch of the right phrenic nerve was cut for recording efferent nerve discharge. The strand of ipsilateral cervical vagus was dissected for recording single unit afferent nerve discharge. HFV was applied with piston pump with stroke of 7ml and the tracheostomy tube was attached to a T-piece(air flow 6-8 l/min). Airway pressure and end-tidal CO_2 were measured. HFV pump frequency was tested from 10 Hz to 30 Hz. HFV led to an apnea or slow breathing with inhibition of phrenic nerve discharge and prolongation of expiration. During HFV(above 25 Hz) an apnea was accompanied by a weak maintained phrenic nerve discharge. The unit discharges from slowly adapting pulmonary stretch receptor were synchronized with positive air flow during HFV. After bilateral vagotomy, HFV produced no observable change in breathing pattern. These results suggest that activation of slowly adapting pulmonary stretch receptor contributes to HFV-induced inhibition of spontaneous breathing.

695, III H 1000

AN ORIGIN OF INSPIRATORY INHIBITION OF EXPIRATORY NEURONS IN THE BÖTZINGER COMPLEX.
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In Nembutal anesthetized cat, the expiratory (E) neurons in the Bötzinger complex (BöT) were analyzed by intracellular recording. They were shown to receive synaptic inhibition during the inspiratory (I) phase. Looking for the origins of this inhibition, I neurons of burst decrementing type in and around the BöT were tested electrophysiologically for projection to the BöT E region. More than seventy per cent of the I neurons tested were activated antidromically from the contralateral BöT area. Axons of some of them were systematically mapped by moving stimulus electrodes and were suggested to have branches in the contralateral BöT. Furthermore, membrane potentials recorded from BöT E neurons were averaged, using spikes of simultaneously recorded I neurons as triggering sources. Revealed hyperpolarizations locked to the trigger strongly suggested that the inhibition observed in BöT E neurons was originated, partly at least, from these I neurons.

696, III H 1015

ACTIVITY OF PULMONARY VAGAL AFFERENTS INNERVATING CO_2 SENSITIVE RECEPTORS OF THE TORTOISE.
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By recording afferent impulses the existence of 2 sorts of CO_2 sensitive intrapulmonary receptors was demonstrated in the tortoise, Testudo hermani Gmelin. Afferent impulses were recorded from fine strands split from the vagus trunk.

IPC. In an artificially well ventilated tortoise very regular discharge was recorded. When the animal was ventilated by CO_2-enriched air, impulse frequency decreased markedly. In lung-vagus preparations, where the other internal organs were removed, it was demonstrated that this type of afferents did not respond to lung inflation and to hypoxia, but its frequency decreased in dependence on CO_2-fractions in the lung.

CO_2 sensitive mechanoreceptors. In artificially ventilated animals afferent impulses synchronous with the ventilatory movement decreased when the animals were ventilated with CO_2-enriched air. In lung-vagus preparations frequencies of impulses adapting slowly to lung inflation decreased in dependence on CO_2-fractions in the lung.

697, III H1030

DIFFERENCES OBSERVED IN PHASE RESPONSE CURVE BETWEEN THE MIDDLE AND THE CAUDAL EXTERNAL INTERCOSTAL NERVE STIMULATION IN RABBITS. SHIN-ICHIRO KITANO, H. SUZUKI, M. FUJITA※, A. KOMATSU* and K. WATANABE*, Dept. of Anesthesiol. and Physiol.*, Tokyo Wemen's Medical College, Tokyo

It has been known that the middle (Th5-8) and caudal (Th9-11) external intercostal nerve (M.E.I.N. and C.E.I.N.) are different in function, e.g., inspiratory for the former and expiratory for the latter. Phase response curves (PRC's) were obtained from phrenic discharges by stimulating the above nerves in anesthetized, artificially ventilated, immobilized and bilaterally thoraco- as well as vago-tomized rabbits. Perturbations by electrical stimulation in inspiratory phase affected the PRC's in all-or-none fashion (phase advance or no phase shift) and those in expiratory phase caused graded phase delay irrespective of the nerves stimulated. It has come out that the PRC is continuous from inspiration to expiration but is discontinuous conversely. The average slope 1.0 of PRC is obtainable but it seems harder by C.E.I.N. stimulation than by M.E.I.N.. Perturbations in expiration by M.E.I.N. stimulation did not affect duration of the succeeding inspiration whereas those by C.E.I.N. slightly shortened it.

698, III H1045

TEMPORAL RELATIONSHIPS BETWEEN BOTH NEURAL DISCHARGES RELATING TO RESPIRATORY MOVEMENTS AND STRAINING IN DECEREBRATE DOGS. FUKUDA, H. AND FUKAI, K. Dept. Physiol., Kawasaki Med. Sch., Kurashiki 701-01

Activation of pelvic afferent fibers elicits rhythmic straining which is manifested by simultaneous increases of nervous outflows to inspiratory and expiratory muscles. The straining is usually induced immediately after inspiratory phase. Reflex center of the straining exists in K-F nucleus. However, the neural mechanism forming the temporal relationship is not known. To resolve the problem, behaviors of respiratory neurons in the lower bulb were observed during the reflex straining. All inspiratory units (76 involving 16 bulbo-spinal units) except 2 did not discharge during the straining, however, 20 (involving 7 bulbo-spinal units) out of 46 expiratory units and a half (4) of inspiratory-expiratory units did simultaneously with the straining. No difference was observed between such behaviors in member units of the dorsal and ventral respiratory groups. These observations show that the bulbar inspiratory neurons do not produce the increase which appears on nervous outflows to the inspiratory muscles simultaneously with the straining.

699, III H1100

RESPIRATORY REFLEXES FROM THE UPPER AIRWAY OF THE RABBIT. MIYAOKA, Y. AND SHIMADA, K. Dept. Oral Physiol., Niigata Univ. Sch. Dent., Niigata 951

Influences of airflow stimulation to the upper airway on respiratory activity were studied in anesthetized vagotomized rabbits by recording electromyograms from the diaphragm, geniohyoid (inspiratory) and pharyngeal constrictor (expiratory) muscles. After anesthesia with urethane (0.75 g/kg, i.v.), a cannula with a side arm was inserted into the trachea. Shifting from tracheostomy breathing to upper airway breathing, which was produced by closure of the side arm, increased activity of both inspiratory and expiratory muscles and prolonged duration of inspiratory phase. Furthermore, the upper airway of the animals was stimulated by artificially simulated respiratory airflow. The simulated inspiratory (from nose to trachea) or expiratory (from trachea to nose) airflow also increased activity of these inspiratory and expiratory muscles and prolonged duration of inspiratory phase. These observations indicate that mechanical stimuli arising from inspiratory and expiratory airflow in the upper airway facilitate respiratory activity.

700, I P (48) 0900

RELATIONSHIPS AMONG PANIC-FEAR PERSONALITY, AGING, AND VENTILATORY ACTIVITY. TANAKA, Y., MORIKAWA, T., MARUYAMA, R., NISHIBAYASHI, Y. AND HONDA, Y. Dep. Phisiol., Chiba Univ. Sch. Med., Chiba 280

We have studied 204 healthy male subjects ranging in age from 20 to 59 yrs. They were divided into 4 10-year age groups. Each age group was further divided into 2 subgroups with high and low Panic-Fear scores. The ventilatory activities of all the groups were compared. In the younger generation (20-39 yrs), the low PF group revealed a higher slope in CO_2 response curve than the high PF group ($p<0.05$). This result was considered to be related to the difference in CO_2 production between the two groups. In the older age groups, however, the high PF subjects exhibited a tendency to increase the CO_2 response slope with increasing ages. This contradictory result was thought to be due to the age dependent changes in biogenic amine activity.

701, I P (49) 0900

EFFECTS OF SEASON ON THE METABOLIC RATE IN THE BULLFROG. SAKAKIBARA, Y., Dept. Physiol.,Chiba Univ. Sch. Med., Chiba 280

The oxygen consumption in 30 bullfrogs were measured for five consecutive days indirectly by using the metabolism chamber consisting of CO_2 absorber, pressure sensor, and an automatic O_2 supplying system, to investigate the daily changes in the metabolic rate associated with light and dark cycle(light: 6 to 18:00) under different temperatures(5, 15, and 25 C), as well as under different seasons(spring, March-May; summer, July-September; winter,November-February). Animals have been accustomed to quasi-natural photoperiodic and thermal conditions until examination started.

Only summer frogs exhibited higher metabolic rate during early phase of light period, compared with that during the preceding dark period in all the temperatures examined. This increase in metabolic rate had an tendancy to start before the light was switched on. These results suggest that a photoperiod can influence metabolic rate in the bullfrog.

702, I P (50) 0900

EFFECT OF OCCLUSION OF ARTERIES IN THE VENTRAL SURFACE OF MEDULLA ON CO_2-PHRENIC NERVE ACTIVITY RESPONSE IN CATS. KUWANA, S. and NATSUI, T. Dept. of Physiol., Sch. of Med., Teikyo Univ., Itabashi-ku, Tokyo 173.

Effect of the occlusion of the arteries in the medulla on CO_2-respiratory response was examined quantitatively in anesthetized cats. After vagotomy and sinus nerve neurectomy, cats were paralyzed and artificially ventilated. Integrated phrenic nerve activity, as an indication of the output of the respiratory center, was transiently increased by the injection (3.1 ml/min, 10 sec) of hypercapnic blood ($pCO_2 > 160$ mmHg) into the vertebral artery (CO_2 injection response). This response was reduced by the occlusion of the branches of the vertebral-basilar artery, mainly bilateral occlusion of the anterior inferior cerebellar arteries. Whereas, phrenic nerve activity response to systemic hypercapnia (steady-state CO_2 response) was not largely affected by the occlusion of the branches of the vertebral-basilar artery. Although these two types of CO_2 responses were seemed to be due to the stimulating effect of CO_2 on the central chemoreceptors, they differed in the effect of occlusion of the medullary artery. Thus, it was assumed that the area perfused by the anterior inferior cerebellar arteries was at least a part of the central chemoreceptors.

703, I P (51) 0900

CHARACTERISTICS OF FIRST AND SECOND STAGES OF EXPIRATION IN PATIENTS WITH TRANSFERRED INTERCOSTAL NERVES M. Sibuya, I. Homma, Dept. of Physiol., Showa Univ. T. Hara*, Hiroo Hosp. and N. Tsuyama*, National Rehabilitation Center, Tokyo and Saitama, Japan

Six patients with bracheal plexus injury of the root avulsion type were examined 5 years (average) after an intercostal transfer operation. The activity of M. biceps brachii reinnervated by the internal intercostal nerves of the third and fourth thoracic segments (IC-biceps) was recorded with surface electrodes. During quiet breathing, involuntary IC-biceps activity was seen in the latter part of the expiratory phase. Thus, the expiratory phase could be divided into 'first stage (E1)' and 'second stage (E2)' by the onset of IC-biceps activity. When ventilation was enhanced by air rebreathing, the IC-biceps activity gradually increased. At the same time, the duration of E1 stage (T_{E1}) shortened and that of E2 (T_{E2}) was prolonged, even though there was no significant change in the duration of inspiratory or expiratory phases, or respiratory frequency. There was a significant positive correlation between the IC-biceps activity and T_{E2} and a significant negative correlation betweeen the activity and T_{E1}. Similar results were found in the expiratory muscle of rabbits. Our result indicated that there is a mechanism that controls the activity of internal intercostal muscles, basically independant from the inspiratory mechanism.

704, I P (52) 0900

FLOW PATTERN AT THE BIFURCATION OF BRONCHIAL AIR WAY. UYEDA,M.*,TANIFUJI,S.**, IWAI,T.**, AND INOUYE,A. *Dept. of Physiol.,Sch. of Med.,Gifu Univ.,Gifu 500, **Dept. of Applied Physics,Fac. of Eng.,Osaka City Univ.,Osaka 558 and Dept. of Physiol.,Hyogo Coll. of Med.,Nishinomiya 663

flow profiles were calculated in typical junction of bronchial trees. Three dimensional Navier-Stokes equation was solved numerically by finite element method. The time dependent solution of flow were obtained by method based on explicit numerical integration schema in time.The geometry of air way were based on Weibel's data. Inspiratry and expiratry flows were studied with either flat or parabolic profile as the initialy entering flow. Secondary flow patterns were observed the patterns were different depending on directions of flow. The calculated flow patterns were neither parabolic nor flat depended on flow velocity. The reverse flow or separation region usually observed at outer side edges of tapered bifurcated tube was obscure because of low Reunolds number of our calculation. All the calculated flow profiles described the characteristics of experimentary observed flow patterns well.

705, I P (53) 0900

VAGAL AND NONVAGAL ROLES ON THE PATTERN OF BREATHING INDUCED BY AIRWAY OCCLUSION(AO) IN RABBITS. SASAKI,K.,UCHIDA,H.,NEMOTO,H. AND KINOSHITA,M. The 4th Depart. of internal Med.,Toho Univ. School of Med.,Meguro-ku,Tokyo. #153

Experiments were performed on 5 rabbits anesthetized intravenously with chloralose and urethane, tracheostomized and spontaneously breathed with pure oxygen. Vagi were prepared and right phrenic nerve dissected and desheated to record the action potentials(AP). We put the catheter into the right thorax to measure intrapleural(Ppl) transpulmonary(Ptr) and tracheal pressure. We also measured time of inspiration(Ti) and expiration(Te) by the integration of AP. We occluded the airway at end-expiration(FRC) or after introducing 10,30,and 50ml of air intrapulmonarily and intrapleurally. With vagi intact,the elongation of Ti diminished and that of Te increased with intrapulmonary volume above FRC,but these elongations were blocked by the section of vagi. Pneumothorax shortened Te by AO significantly with vagi intact and not significantly with vagi cut. We conclude AO-induced elongation of Ti and Te are dominantly controlled by intrapulmonary volume via vagus.

706, I P (54) 0900

EVALUATION OF UNEVEN DISTRIBUTION OF $\dot{V}A/\dot{Q}$ RATIO FROM DATA ON EXCHANGE OF RESPIRATORY GASES. DOI, K., NIIZEKI, K., KAGAWA, T. AND TAKAHASHI*, K. Dept. Physiol. and *Dept. Internal. Med., Yamagata Univ. Sch. Med., Yamagata, 990-23

A new approach has been developed for evaluating uneveness of ventilation/perfusion ratio, $\dot{V}A/\dot{Q}$, based on a two-compartment model with a reciprocal $\dot{V}A/\dot{Q}$ relation. The $\dot{V}A/\dot{Q}$ ratios were expressed by $\mu\cdot(1-\rho)/\rho$ and $\mu\cdot\rho/(1-\rho)$, where μ and ρ were referred to as overall $\dot{V}A/\dot{Q}$ and uneveness factor, respectively. During steady state breathing arterial Po_2 and Pco_2, and end-tidal Pco_2 as well as gas exchange ratio, R, were measured. Then, arterial-venous O_2 and CO_2 content differences were obtained from a rebreathing experiment. Referring to these values the mixed venous Po_2 and Pco_2 were estimated from arterial Po_2 and Pco_2, using the O_2 and CO_2 dissociation curves. The $\dot{V}A/\dot{Q}$ and iso-R lines were drawn on O_2-CO_2 diagram, and further, total arterial and alveolar Po_2 and Pco_2 of two-compartment model were computed by changing both ρ and lung gas volume factor, Φ. The Φ value was determined so as to make the above Po_2-Pco_2 locus pass through the measured arterial Po_2 and Pco_2. The ρ value was estimated so that the computed alveolar Pco_2 fitted to the end-tidal one. The experiments were performed on 8 normal subjects in normoxia and hyperoxia with PIo_2 245 Torr. The mean Φ values in normoxia and hyperoxia were 0.50 and 0.56, and ρ, 0.438 and 0.428, respectively. The $\dot{V}A/\dot{Q}$ was decreased in hyperoxia because of a decrease in $\dot{V}A$ value.

707, I P (55) 0900

ANALYSIS OF PULMONARY GAS EXCHANGE DURING REBREATHING BY A SIMULATION TECHNIQUE. SHIBUYA, I., NIIZEKI, K., UCHIDA, K., AND MOCHIZUKI, M. Dept. Physiol., Yamagata Univ. Sch. Med., Yamagata 990-23.

An O_2 injection method was first applied to the measurement of O_2 uptake ($\dot{V}o_2$) during rebreathing by Mochizuki et al. (1984). The method has the advantage in being less influenced by air contamination. We used it for the measurement of $\dot{V}o_2$ during hyperoxia. First, a new equation was derived for calculating $\dot{V}o_2$: (1) $\dot{V}o_2 = VJ/\Delta t\cdot(1-Fo)/(1-(1-R)\cdot Fo)$, where VJ and Fo are the injected O_2 volume and O_2 concentration just before the O_2 injection, respectively, and Δt and R are the time interval during which O_2 concentration returns to Fo and the gas exchange ratio during Δt, respectively. In hyperoxia, however, as Fo in Eq.(1) getting higher, $\dot{V}o_2$ was rather influenced by the error in estimating R. Therefore, a simulation technique was developed to confirm the accuracy of the $\dot{V}o_2$ value during hyperoxia. The decay of O_2 concentration ($\Delta F(i)/\Delta t$) is expressed by (2) $\Delta F(i)/\Delta t = \dot{V}o_2/VL(i-1)\cdot(1-(1-R)\cdot F(i))$, where VL(i-1) is the lung gas volume at (i-1)'th inspiration. The increasing rate in CO_2 concentration ($\Delta G(i)/\Delta t$) is expressed by (3) $\Delta G(i)/\Delta t = \dot{V}o_2/VL(i-1)\cdot(R+(1-R)\cdot G(i))$. According to Eqs.(2) and (3), $\dot{V}o_2$ was determined so that the calculated O_2 and CO_2 concentrations were consistent with the measured data. Thus calculated $\dot{V}o_2$ was significantly incresed as given by $\dot{V}o_2$ (ml/min) = $0.202\cdot P_Ao_2$ (Torr) + 300.

708, ⅢD1300

INHIBITORY EFFECT OF GYMNEMIC ACID ON GLUCOSE ABSORPTION IN THE RAT SMALL INTESTINE. YOSHIOKA, S., TAKEUCHI, T.*+, IMOTO, T., KASAGI, T. AND HIJI, Y. Dept. Physiol., Int. Med.+, Tottori Univ. Sch. Med., Yonago 683

Gymnemic acid (GA), a triterpene glycoside extracted from the leaves of Gymnema sylvestre, R. Br. (Asclepiadaceae), has been known as a potent inhibitor of sweet taste sensation in man. In the present study, its effect on the intestinal glucose absorption was investigated on the rat in vivo by measuring glucose evoked transmural potential difference (ΔPD) and by a circulating method. It was shown that the ΔPD for 5 mM glucose was strongly suppressed in the presence of 1 mg/ml GA and the inhibitory effect lasted over about two hours even after GA was washed out. When 20 mM glucose was perfused through the intestine together with both GA and 1 mM phlorizin, added GA showed no further inhibitory effect compared to that of phlorizin alone, suggesting that GA worked to inhibit predominantly the active transport of glucose. Oral sucrose tolerance test (2 g/kgbody weight) revealed that the raise of blood glucose level was significantly suppressed when GA was administrated with the amount of one-tenth of sucrose.

709, ⅢD1315

STUDIES ON PHENOMENA THROUGH INTESTINAL MEMBRANE AND ITS DISTURBANCE(II). Nakano, S., Terao, T., Miyoshi, M., and Yoshioka,T. (Dept. Physiol., Tokai Univ. Sch. Med., Kanagawa 259-11)

We have investigated a series of experiments on penetration of L-Phenylalanine (Phe.), L-Tryptophane (Try.) and Insulin (Ins.) as activepolypeptides in everted intestine. In the present studies, by use our devised circulation apparatus, intestinal penetration phenomena were investigated under each following conditions. The obtained experimental results are as follows; 1) In 30 sec's pretreatment of surface mucosal membrane with 0.1N HCl and 0.1N NaOH, Phe., Try. and Ins. penetration were enhanced. On the contrary, in 2 min's pretreatment with 0.1N HCl, Phe. and Try. penetration were inhibited, but Ins. penetration were hardly influenced. In 2 min's pretreatment with 0.1N NaOH, Phe. and Ins. penetration were enhanced, but Try. penetration were inhibited. As the results it will be considered that selective structure change of such the components on intestinal brush border cell membrane and glycocaryx. 2) In the next experiment, when Asparatame as dipeptides of Asparatic Acid and Phe. penetration were virtually no difference observable according to the penetration of Phe.. In addition to PAL (phenylalanine-ammonia lyase), Phe.and Asparatame penetration decreased. These obserbation suggest that the addition of PAL, the resolved in Phe. in to cinnamic acids and other substances.

710, ⅢD1330

PERMEABILITY CHANGES OF TIGHT JUNCTION IN RAT SUBMANDIBULAR GLAND AFTER SYMPATHOMIMETICAL STIMULATIONS. UCHIHASHI, K., TAKAI, N., YOSHIDA, Y. and KAKUDO, Y. Dept. Physiol., Osaka Dent. Univ. Osaka 540

In glandular tissue tight junctions play an important role in the maintenance of the barrier functions of the intercellular spaces. Previous studies of salivary glands have suggested that under certain conditions the tight junctions become permeable to various substances. In this study, we examined, using horseradish peroxidase (HRP) as a tracer, the permeability of the tight junctions in rat submandibular glands stimulated by various sympathomimetic drugs.

Male Wistar rats were anesthetized with sodium pentobarbital. The HRP and drugs were administered by a micro-infusion technique(20μl/min, 5 min.). The α1-agonist phenylephrine, α2-agonist clonidine, β1-agonist dobutamine, β2-agonist pirbuterol, β1β2-agonist isoproterenol were used. The β1β2-antagonist propranolol and β1-antagonist acebutolol were also used.

In the α1-, α2- and β1-stimulated glands, the tight junctions were impermeable to HRP penetration. But the tight junctions of β2-stimulated glands were permeable to it. Additionally, this effect was blocked by antagonists.

This study suggests that stimulation of the β2-receptor increases the permeability of tight junctions in the rat submandibular gland.

711, ⅢD1345

THE EFFECT OF PROGLUMIDE ON LUMINAL FEEDBACK REGULATION IN THE CONSCIOUS RAT.

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In a previous experiment in vitro, a glutaramic acid derivative, proglumide was reported to be a specific and competitive antagonist for the CCK receptor of the pancreas. In the present study, we examined the effect of proglumide on pancreatic exocrine function in the conscious rat, in situ. Rats were prepared with cannulae draining pure pancreatic juice(PJ), bile(B), the duodenum and the jugular vein. After three 30-min basal collections with BPJ returning, BPJ were diverted from the duodenum, and was replaced by 0.15M $NaHCO_3$. Since pancreatic secretion was stimulated by BPJ diverseion(the luminal feedback mechanism), 100mg proglumide was injected bolus, followed by a 4-hr infusion of proglumide(300 or 60mg/kg/hr). The effect of proglumide on basal secretion was also examined. Results: Both 300 and 60mg/kg/hr proglumide infusions significantly inhibited the protein output stimulated by BPJ diversion, while the hypersecretion response to BPJ diversion was not completely abolished. In contrast, during basal secretion, 300mg proglumide increased protein output. Fluid and bicarbonate outputs were unaffected during either stimulated or basal secretion. Conclusions: Proglumide inhibits protein output during stimulated secretion but increases protein output during basal secretion in the conscious rat in situ.

712, ⅢD1400

EFFECTS OF HYPOTHALAMIC STIMULATION ON THE PANCREATIC EXOCRINE SECRETION OF DOGS.

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Effects of hypothalamic electrical stimulation on the pancreatic secretion were studied in hemispherectomized 34 dogs anesthetized with chloralose, in which the pyloric sphincter was occluded by submucosal ligature. Hypothalamic stimulation was performed about 10 minutes with rectangular pulses (30 Hz, 0.1-0.2 mA, 3 msec) through the unipolar needle electrode. The marked increased response (601% increase) was obtained from the stimulation of two areas of the anterior hypothalamus (A.H.); ventromedial area closed to the optic chiasma and dorsal area (paraventricular nucleus and perifornical area). The moderate increased response (330% increase) was obtained from mainly ventrolateral and partly dorsolateral hypothalamic area, caudal portion of ventromedial nucleus (V.M.H.), a part of dorsomedial nucleus (D.M.H.) and the mamillary body. The inhibitory response was obtained from the defence area of A.H., V.M.H., a part of D.M.H. and the posterior hypothalamus. The increased volume outflow was accompanied with the increased protein and bicarbonate outputs without an increase of plasma secretin, and abolished by cervical vagotomy and i.v. injection of atropine. The inhibitory response was mediated by both roots of splanchnic and vagal nerves. Inhibition via the latter was probably due to the decreased activity of the vagus nerve.

713, ⅢD1415

MOTILE ACTVITY OF ISOLATED GASTROINTESTINAL TRACT OF STREPTOZOTOCIN DIABETIC RATS.

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In order to elucidate the physiological mechanisms of diabetic gastrointestinal disorders, such as gastric retention, constipation and diarrhea, we studied the spontaneous intraluminal pressure waves of isolated gastrointestinal tract of streptozotocin-induced diabetic rats. Diabetic rats, 1-2 months after single i.v. injection of streptozotocin 60 mg/kg, were characterized by body weight loss of 50 % to the control, high plasma glucose level of 500 mg/dl and diarrhea. In diabetic rats, pressure waves of the isolated intestinal segments of 4-5 cm were often irregular, in comparison with normal regular ones. Normal frequncy of pressure waves of 33/min in duodenum was characteristically lowered to 21/min. No differences in motile frequencies between normal and diabetic ones were detected in stomach, jejunum, ileum and proximal colon. These characters were confirmed by power spectral density analysis(FFT) of pressure waves. Insulin treatment(5 U/day for 1 month) lowered the plasma glucose level to normal and gained body weight(80 % to the control), but could'nt recover the normal motile rhythms in duodenum. Neither the treatment with an aldose reductase inhibitor, Ono 2235(per os,50 mg/kg/day for 1 month), recovered the normal rhythms in duodenum. It seems to be suggested that pacemaker activity in intestinal tract is specifically disturbed in diabetic rats.

714, ⅢD1430

THE NUTRITIONAL ROLE OF UREA NITROGEN IN PROTEIN DEFICIENCY. TANAKA, N., KAWASAKI, I., HORI, S. AND YOSHIMURA, H.* Dept. of Physiol., Hyogo Coll. of Med., Nishinomiya 663, *Dept. of Home Economics, Kobe Women's Univ., Kobe 654

We have showed that urea was hydrolized to ammonia in the intestine and was utilized for the synthesis of amino acids as a result of bacterial action in low protein diet (LPD) fed rats. As the next step of the above experiments, two experiments were conducted, the first to estimate how much urea nitrogen can be utilized for protein synthesis and the second to clarify a nutritional role of urea, using adult rats fed LPD (5% casein diet). At first, the ^{15}N incorporated into the total body protein was measured in LPD fed rats, given 50 mg ^{15}N-urea/100 g B.W., when urea utilization for protein synthesis attained to the maximum value. It was found that the ^{15}N utilized for protein synthesis corresponds to 5% of total dietary N intake. Next, the growth test was done with the effectiveness of the urea supplement. The weanling rats fed LPD alone showed that the average gain of 24 g during 4 weeks, while the rats fed LPD with 1.2% and 6.0% urea manifested the average gain of 36-38 g. Thus, it is concluded that urea nitrogen can be effectively utilized for synthesis of amino acids and protein in rats fed LPD.

715, ⅢD1445

THE EFFECT OF RBOWN RICE DIET ON ABSORPTION OF NUTRIENTS ON LOW PROTEIN INTAKE.
MIYOSHI, H., OI, Y., YAMAMOTO, Y.*, OKUDA, T. and KOISHI, H. Fac. of the Sci. of Living. Osaka City Univ., Sumiyoshi-Ku, Osaka 558

We intended to know the effect of rice dietary fiber on the absorption of nutrients such as protein and lipid in male students on low protein intake. They were fed daily 500g of well milled rice(WMR) for 2 weeks, then changed the diet containing brown rice (BR) and changed the diet containing floured brown rice(FBR) for 8 days. Three diets contained 0.5g protein/kg body weight and enough energy for maintaining their body weight. The BR and FBR contained the DF approximately 4 times than that on WMR. The wet weight of feces of the students fed on BR and FBR were about 2 times compaired with those fed WMR. The absorption rate of protein was 83% on WMR, 64% on BR and 51% on FBR. And the nitrogen balance was -0.7gN/day on WMR, -1.1gN/day on BR and -1.5gN/day on FBR. But the absorption rate of lipid on BR was the lowest in 75%, and was each 94% on WMR, 89% on FBR. The blood status were similar in three diets.

716, IP(43)1330

EFFECTS OF INHIBITORS ON MEMBRANE DIGESTION AND ABSORPTION OF SUGARS BY EVERTED INTESTINE OF GUINEA PIG. HIMUKAI, M., Div.Bas Nutr.,Natl.Inst.Nutr., Tokyo 162

Comparisons were made for the effects of BAYg 5421 and phlorizin on membrane digestion and absorption of carbohydrates. BAYg 5421 (acarbose, M.W.645) is a complex tetrasaccharide of microbial orizin. The addition of acarbose into the mucosal solution at the final concentration of 0.1 mM markedly suppressed the amylose-, maltose-, and sucrose -evoked changes in transmural potential difference(PD). But, it did not inhibit the lactose(β-galactoside) -evoked PD even at 2 mM. Unexpectedly, trehalose -evoked PD was also unaffected by acarbose. Glucose- evoked PD was not affected by acarbose at all. On the other hand, the addition of phlorizin to the mucosal solution at 0.4 mM completely abolished the changes in PD evoked by all sugars tested. These observations indicate that acarbose is a potent inhibitor of α-glucosidases with an exeption of trehalase, and that the processes of membrane digestion and absorption of sugars can be easily discriminated by the two drugs. Using the kinetic equation derived from the analysis on well type local pool model(Igarashi et al.,1976), the value of Ki for acarbose against the activities of membrane digestion of maltose and sucrose was estimated to be 1.2×10^{-6} and 0.7×10^{-6} M, respectively. These values were quite similar to the value of Ki(0.9×10^{-6} M) for phlorizin obtained from the inhibition kinetics of glucose-evoked PD.

717, I P (44) 1330

SECRETION PATTERN OF HUMAN PAROTID SALIVA. SHIMATANI, Y., KATAGIRI, Y., AND ABE, H*., Dept. Physiol., Dept. Oral & Dental Surgey*, Tokyo Women's Medical College, Tokyo 162

Salivary outflow of human parotid gland was measured with a device using a pressure transducer and an electric circuit. Besides secretion curves, a tiny increment of volume in unit time, i.e. secretion velocity, could simultaneously be displayed by an ink-recorder. Refelx secretion in response to gustatory stimulation (5% citric acid), appeared not steady but irregular. We found, however, by observing the secretion curves in detail that several transient outflows with a regular pattern were intermittently superimposed on a rather continuous secretion. Each transient salivary outflow, though its quantity is not the same, is composed of an initial rapid rise reaching a maximum and a gradual decay. Mechanism of this transient secretion is unknown but it may be related to the myoepithelial activity of the parotid gland.

718, III A 0945

THE EFFECTS OF CA-AGONIST AND -ANTAGONIST ON ELECTRICAL ACTIVITY INDUCED BY GLUCOSE, QUININE AND TOLBUTAMIDE IN B-CELLS OF PANCREATIC ISLETS. SAKAMOTO, Y., MATTHEWS, E. K.* AND IMANAGA, I. Dept. of Physiol., Sch. of Med., Fukuoka Univ., Fukuoka 814-01, *Cambridge Univ., England

It is well known that there is a close relationship between electrical activity and insulin release in B-cells of pancreatic islets. Glucose-induced burst activity, which consists of regularly occuring slow waves with fast spikes superimposed on the plateau level, is observed at 11 mM D-glucose in the Krebs solution. The effects of new Ca-agonist (CGP)/antagonist (PY) on the slow waves induced by D-glucose, quinine and tolbutamide were examined. The dihydropyridine derivative, CGP-28392 (10^{-6}M), induced an increase in an amplitude and a rate of rise of spike and prolonged a plateau duration, but in some cells it reduced the amplitude of spike. The similar results were observed in tolbutamide-induced activity, but not in quinine-induced one. The PY blocked the spike activities. The CGP may be acting by enhancing Ca^{++} influx but it might also enhance the action of a Ca^{++}-activated K channel. However CGP is not likely to be stimulating directly the operation of the Ca/K channel, since it does not oppose quinine action.

719, III A 1000

SPECIES DIFFERENCE IN THE SECRETORY RESPONSE OF ADRENOCORTICAL CELLS TO PLATELET ACTIVATING FACTOR AND HISTAMINE. SHIMADA, T., MATSUMOTO, I., HIROSE, T., TANAKA, Y. AND AIKAWA, T. Dept. Physiol., Nagasaki Univ. Sch. Med., Nagasaki 852

Platelet activating factor (PAF) and histamine (H) are chemical mediators of anaphylaxis and inflammation. We previously reported that PAF and H increase the secretion of cortisol and aldosterone from the perfused canine adrenal gland. Glucocorticoid production by dispersed adrenocortical cells in response to PAF and H was compared in dogs, guinea pigs and rats. PAF and H significantly increased cortisol production by dispersed adrenocortical cells of dogs and guinea pigs. In the case of rats, both agents did not increase corticosterone production by dispersed adrenocortical cells although serotonin increased it. The result suggests that there is species difference in the secretory response of mammalian adrenal cortex to chemical mediators and that PAF and H may cause feedback inhibition of anaphylaxis and inflammation via glucocorticoid release in dogs and guinea pigs.

720, III A 1015

ADRENAL MEDULLARY SECRETORY RESPONSE TO STIMULATION OF THE ZONA INCERTA, AMYGDALA AND HIPPOCAMPUS IN THE RAT. Matsui, H. Dept. Physiol., Nagasaki Univ. Sch. Med., Nagasaki 852

In rats anesthetized with sodium pentobarbital, adrenal secretions of epinephrine and norepinephrine were evaluated by collections and fluorometric analyses of adrenal venous blood samples. A significant increase in epinephrine secretion was produced by stimulation of the lateral areas of the zona incerta. A significant increase in epinephrine secretion as well as in norepinephrine secretion was observed following stimulation of the medial amygdala nucleus and the ventral part of the hippocampus. A significant decrease in epinephrine secretion with or without significant decrease in norepinephrine secretion was found following stimulation of the dorsolateral areas of the zona incerta and the medial, basomedial and basolateral nuclei of the amygdala. These findings suggest that in the zona incerta and limbic system structure there exist excitatory and inhibitory central nervous system mechanisms for the control of the adrenal medullary secretion.

721, III A 1030

EFFECT OF ANTI-ALLERGIC DRUG ON THE SECRETORY RESPONSE OF THE PITUITARY-ADRENAL AXIS TO INTRAVENTRICULAR ADMINISTRATION OF COMP.48/80.
MATSUMOTO, I. AND AIKAWA, T. Dept. Physiol., Nagasaki Univ. Sch. Med., Nagasaki 852

The effect of ketotifen,which stabilizes mast cell, on the secretory response of pituitary-adrenal axis to the intraventricular administration of comp.48/80 was examined in pentobarbital anesthetized dogs in order to explore the possibility that brain mast cells play a role in stimulating hypothalamo-pituitary-adrenal axis. Adrenal venous blood samples were collected and the secretory rate of cortisol was measured as an index of ACTH secretion. The secretory rate of cortisol significantly increased after the intraventricular infusion of comp.48/80 (7.5 μg/kg/min for 5 min) and the increase was not affected by the intraventricular infusion of ketotifen. However, in 8 dogs to which ketotifen had been administered orally for one week before the experiment, the increase was almost completely depressed in 3 dogs, fairly depressed in one dog and amplified in 4 dogs.

722, III A 1045

STIMULATORY ACTION OF OXYTOCIN ON NEURONS IN THE SUPRAOPTIC NUCLEUS OF RATS IN VITRO.
OKUYA, S.[1], KANNAN, H. AND YAMASHITA, H. [1]Dept. of Internal Medicine, Yamaguchi Univ., Sch. of Med., Ube 755 and Dept. of Physiol., Univ. of Occup. Environ. Health, Sch. of Med., Kitakyushu 807

The oxytocin (OXT) sensitivity of neurons in the supraoptic nucleus (SON) was investigated using extracellular recording in the rat hypothalamic slice preparation by adding OXT (10^{-10}-10^{-6} M) to the perfusion medium. Ten (91%) of 11 fast continuous firing neurons (putative oxytocin neurons), 22(81%) of 27 slow irregular firing neurons (including putative oxytocin neurons) and, by contrast, only two (8%) of 26 phasic firing neurons (putative vasopressin neurons) were excited by OXT. The remaining cells were unaffected. The threshold concentration to evoke the responses was approximately 10^{-9} M. The excitatory effect of OXT was reversibly antagonized by a synthetic analogue and persisted after synaptic blockade in medium with low $[Ca^{2+}]$ and high $[Mg^{2+}]$. These results suggest that OXT exerts the direct excitatory effect predominantly on oxytocin cells in the SON and that OXT can constitute a direct positive feedback system.

723, III A 1100

PARAVENTRICULAR AND PERIVENTRICULAR NUCLEUS NEURONS WITH PROJECTION TO THE MEDIAN EMINENCE.
KANNAN, H., KASAI, M. AND YAMASHITA, H. Dept. Physiol., Univ. of Occup. Environ. Health Med., Kitakyushu 807

In male rats anesthetized with urethane-chloralose, extracellular recordings were made from neurons in the paraventricular (PVN) and periventricular (PeV) nucleus that were antidromically activated with stimulation of the median eminence but not the neurohypophysis and were classified as tuberoinfundibular neurons. Baroreceptors activation induced by i.v. administration of phenylephrine inhibited about two-third of the tuberoinfundibular neurons tested (n=32). Discrete electrical stimulation of the A1 area in the ventrolateral medulla produced excitation in half of the tuberoinfundibular neurons (n=28). No inhibitory effects were observed. The mean latency to onset of the effect measured from peristimulus time histogram was 46.1±8.1 ms (mean±S.D., n=14). About one-third of the tuberoinfundibular neurons (n=40), mainly located in the PeV, were orthodromically influenced by neurohypophyseal stimulation; ten neurons were excited with variable latencies (13-65 ms) and 4 inhibited with latencies of 15-25 ms. The results show that tuberoinfundibular neurons in the PVN and PeV receive similar synaptic inputs from the baroreceptors and the A1 area to those for PVN neurohypophyseal neurons and may also imply a close functional association between tuberoinfundibular and neurohypophyseal system via local recurrent pathways.

724, ⅢA1115

RESPONSES OF PARAVENTRICULAR NEUROSECRETORY CELLS TO OSMOTIC STIMULI APPLIED LOCALLY TO THE ANTEROVENTRAL WALL OF THE 3RD VENTRICLE.
HONDA.K., NEGORO,H., HIGUCHI,T. AND TADOKORO,Y. Dept. of Physiol., Fukui Medical School, Fukui 910-11

The anteroventral wall of the 3rd ventricle (AV3V) has been implicated in the osmotic control of neurosecretory cell activity. However, no direct evidence had been shown yet. We investigated the effect of locally applied osmotic stimuli to the AV3V on the activity of paraventricular (PVN) neurosecretory cells in urethane anesthetized lactating rats. Injection of 0.6 M-NaCl (0.1 or 0.2 μl) into the AV3V excited 66% of neurones tested, while the same volume of hypertonic saline injected into the 3rd ventricle or near the recording site did not excite them. An inverse correlation was found between distance from the AV3V-injection site to the organum vasculosum lamina terminalis (OVLT) and magnitude of the response of neurosecretory cell to the hypertonic saline injected into the AV3V. Injection of distilled water (0.2 μl) into the AV3V after i.p. injection of 1.5 M-NaCl reduced the activity in 67% of neurones tested. These results strongly suggest that the OVLT is an osmoreceptor site for the osmotic control of PVN neurosecretory cells.

725, ⅢA1130

GROWTH HORMONE RELEASE INDUCED BY ELECTRICAL STIMULATION OF THE BASOLATERAL AMYGDALA, OBSERVED IN PENTOBARBITAL ANESTHETIZED RATS.
KOIBUCHI, N., KATO, M. AND SUZUKI, M. Dept. Physiol., Institute of Endocrinology, Gunma Univ., Maebashi 371

The aim of this study was to clarify the neural pathway leading to the growth hormone (GH) release when the basolateral amygdala (ABL) was electrically stimulated. Concentric bipolar stimulating electrode was implanted in the unilateral ABL. Blood samples were taken from a cannula implanted into the right atrium via the right external jugular vein. Electrical stimulation of the ABL for 10 min caused a significant increase in plasma GH level from resting value 27.5±5.7 ng/ml (mean±SE) to 62.2±7.5 ng/ml at the termination of stimulation. This increase in plasma GH level was markedly augmented to 152.0±23.0 ng/ml after lesion of the periventricular hypothalamic nucleus (Pe), where somatostatinergic neurons send their axons to the median eminence. Lesion of the stria terminalis (st) fully or partly abolished GH release induced by ABL stimulation. These results suggest that stimulation of the ABL accelerates GH secretion. The st is essential pathway for this release, whereas the activity of Pe-neurons were rather inhibitory to this release.

726, ⅢA1145

QUANTITATIVE ANALYSES OF PLASMA VASOPRESSIN LEVEL AFTER FOOTSHOCK : INTENSITY EFFECTS AND TIME COURSE.
ONAKA, T., HAMAMURA, M. AND YAGI, K. Dept. Physiol., Jichi Med. Sch., Tochigi 329-04

Footshocks (FS) have been shown to potentiate vasopressin (VP) secretion (bioassay; Mirsky et al 1982) but to unalter (radioimmunoassay; Knepel et al 1982). Our previous radioimmunoassay study has shown to increase plasma VP to an extremely high level after continuously applied FS but not after intermittently applied FS (Yagi et al 1985). Thus the present study aimed to analyse quantitatively time course and stimulus intensity effects of FS-induced VP secretion. Plasma VP level was highest immediately after 50 Hz-FS for 60 s and became lower with a half decay time of far less than 1 min. Plasma ACTH also elevated and reached at the maximum 5 min after the onset of FS. Both hormone levels increased as shock intensity increased. The minimum effective intensity for significant elevation was 1 mA for ACTH and 2 mA for VP. VP level after intermittently applied FS for 10 min was not significantly high though ACTH level was extremely high and rats exhibited 'freeze' behaviour. These data show that noxious stimulus potentiates VP secretion and suggest the possibility that psychological stress inhibits FS-induced VP secretion.

727, III A 1300

ROLE OF FETUS EXPULSION REFLEX IN PARTURITION OF THE RAT. HIGUCHI, T., TADOKORO, Y., HONDA, K. & NEGORO, H. Dept. Physiol., Fukui Medical School, Fukui 910-11

To clarify the origin of the dystocia in pelvic-neurectomized (PN) rats and normal process of parturition in the rat, the uterine activity during late pregnancy and parturition was examined. PN rats started to show the regular uterine contractions of similar strength to those observed in control rats within day 23 of gestation, but lacked the straining movements which preceded expulsions of each pups in controls. The dissection of PN rats revealed that an unborned fetus was retained in the expanded upper vaginal cavity. Urethane-anesthetized PN rats did not show fetus expulsion reflex which was induced in control rats in response to mechanical stimulation to the cervix or upper vaginal cavity. This reflex induces a rise of intraabdominal pressure by facilitation of the abdominal muscles and the diaphragm and by inhibition of respiratory movements and may correspond to the straining movements during normal parturition. These results suggest that the dystocia in PN rats appears to be caused by the lack of fetus expulsion reflex which may play a physiological role in expelling a fetus from upper vaginal space.

728, III A 1315

AGE-RELATED CHANGES IN AMOUNT OF NUCLEAR ANDROGEN BINDING IN THE MURINE SUBMANDIBULAR SALIVARY GLAND. Katsukawa,H. and Funakoshi,M. Dept. Oral Physiol., Asahi Univ., Sch. Dent. Gifu 501-02.

Androgen responsiveness of the murine submandibular gland has been reported to vary with age. Mechanisms for development of androgen responsiveness of this gland were studied by measuring the activity of nuclear androgen binding at various ages and by investigating effects of sex hormones on this activity. Male and female ICR mice of 1-10 weeks of age were used in this study. The cell nuclei were isolated by a modification of the method of Schibler and Webber. The activity of nuclear androgen binding was measured by ^{3}H-5α-dihydrotestosterone exchange assay. The activities of nuclear androgen binding were very low from 1 to 3 weeks of age, which was followed by gradual increases to 10 weeks of age. When data were analyzed according to the method of Lineweaver-Burk, nuclei from mice at any age contained a single class of high affinity binding sites. Although there was no sex difference in the number of binding sites, binding activities in males showed a tendency to be higher than those in females. Circulating androgens may have cumulative effects on the activity of nuclear androgen binding.

729, III A 1330

EFFECTS OF ANTI-ESTROGEN (TAMOXIFEN) ON THE EMBRYONIC GONAD OF THE JAPANESE QUAIL. ITO, Y. and YAMAMOTO, N. Dept. of Physiology, Gifu University, School of Medicine, Tsukasamachi 40, Gifu 500.

A single injection of tamoxifen and double treatment of estradiol benzoate and tamoxifen were carried out through a minute opening hole directly into the yolk sac on zero (before incubation) day stage. (1). Treatment of the eggs with tamoxifen affects strongly this morphogenesis. As a consequence of a very restricted cortical proliferation, the ovary appears partially reduced, while the right gonad is much more prominent. (2). In the males treated with estradiol benzoate, the right testes are reduced and left ovotestes have on ovarian cortex. These effects, however, are mainly inhibited by simultaneous treatment with an anti-estrogen (TAM + E); the cortexes of ovotestes are reduced and the right testes are increased in size. Tamoxifen which is known to act at the level of estrogen receptors, is thus able to inhibit proliferation of the germinal epithelium into an ovarian cortex. Therefore this drug exerts opposite effects to those of estradiol benzoate which reversely favours cortical proliferation.

730, III A 1345

INFLUX OF EXTRACELLULAR Ca^{2+} OR MOBILIZATION OF Ca^{2+} FROM INTRACELLULAR STORE SITE —— WHICH IS ESSENTIAL FOR HUMAN PANCREATIC GROWTH HORMONE RELEASING FACTOR (hpGRF)-INDUCED GROWTH HORMONE (GH) RELEASE FROM DISPERSED RAT PITUITARY CELLS ?

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Rat anterior pituitary was removed under pentobarbital anesthesia and was dispersed with 0.5% trypsin. Dispersed pituitary cells were mixed with Biogel-P-2 and packed in 2.5 ml-syringe, connected to the peristaltic pump, for perifusion experiment (flow rate, 1.2 ml/min). One min-application of 1 nM hpGRF produced a rapid rise in GH release, which is parallel to the concentration change of hpGRF, although the response reached maximum around 2 min after the application, then gradually decreased to the basal value by 15 min after the application. Decreasing extracellular Ca^{2+} or addition of 2 mM Co^{2+} completely blocked hpGRF-induced GH release. However, GH release could be observed for 1 min-application of hpGRF without extracellular Ca^{2+} if normal Ca^{2+} concentration was recovered by 10 min after hpGRF application. In this case, prompt rise in GH release was seen right after the introduction of Ca^{2+} to extracellular space. Thus, extracellular Ca^{2+} is essential for GH release itself but not for the interaction between hpGRF and its receptor and probably subsequent intracellular biochemical processes. Mobilization of Ca^{2+} from intracellular store site may not be involved in hpGRF-induced GH release as a major process.

731, III A 1400

ROLES OF SOMATOSTATIN NEURONS IN THE REGULATION OF GROWTH HORMONE IN THE RAT.

PRAPUTPITTAYA, C., MITSUGI, N., ARITA, J. AND KIMURA, F. Dept. Physiol., Yokohama City Univ. Sch. Med., Yokohama 232

The study was undertaken to determine whether the surgical cut to destroy the hypothalamic periventricular (PV) region, in which somatostatin (SS)-containing neurons are mainly located, affect growth hormone (GH) secretion in the rat. The PV-cut was placed stereotaxically by means of a modified Halasz's knife. At 2-, 4- and 6-week periods after operation serial blood samples were taken at 10-min intervals for 10 h via an intracardiac cannula. In 17 PV-cut animals the pulsatile pattern of GH secretion was maintained with unaffected surge periodicity as well as its basal sacretion but over-all mean amplitude of GH secretory peaks was significantly increased. However, amplitude of GH peak levels did not show a significant fluctuation over the 10-h sampling period, which was in contrast to an afternoon elevation observed in sham-controls. This suggests that SS plays a significant role in the modulation of GH peak amplitude.

732, III A 1415

EFFECTS OF NEWBORN CATECHOLAMINERGIC TISSUE TRANSPLANTED IN THE THIRD VENTRICLE ON CYCLIC OVULATION IN RATS.

HASHIMOTO, R., and KIMURA, F. Dept. Physiol., Yokohama City Univ. Sch. Med., Yokohama 232

The involvement of catecholamine in the regulation of ovulation has been established, but is still in confusion about details. Experiments were designed to see how the transplantation of newborn norepinephrine (NE) neurons (A-6 groups) or dopamine (DA) neurons (A-10 groups) in the third ventricle at the level of preoptic region affected the cyclic ovulation in the female rat. Cerebellum was transplanted as the control transplant and an empty cannula was inserted and pulled out for the sham control. Sixty-two rats that had tissues in contact with the preoptic region were evaluated as having surviving transplants by the histological examination after sacrifice. The rats that had surviving NE-neuron transplants became to show frequently prolongation of estrus in their vaginal smears during 70-days period examined. There were no significant changes in the rats with DA-neuron transplants, as well as in the cerebellum and sham controls. It seemed that the NE transmission at the level of preoptic region exerted an inhibitory influence on the operation of CNS mechanisms for the ovulatory secretion of gonadotropin.

733, I P (36) 1330

TURNOVER OF BIOGENIC AMINE IN THE VENTROMEDIAL HYPOTHALAMIC, PARAVENTRICULAR, AND SUPRACHIASMATIC NUCLEUS IN RATS SUBJECTED TO RESTRICTED DAILY FEEDING. *NAGASAKA, T., HONMA, K., KATSUNO, Y. AND HIROSHIGE, T. Dept. Physiol., Sch. Med., *Dept. Pediat. Dent., Sch. Dent., Hokkaido Uni., Sapporo, 060

Restricted daily feeding has been demonstrated to elevate the circulating corticosterone level in rats prior to meal (prefeeding peak). In order to know whether or not changes in the metabolism of brain biogenic amine are involved in the hormone peak formation, the turnover of norepinephrine (NE) was measured in the rat brain. Materials and Methods Male rats were subjected to restricted daily feeding (meal time from 10:00 to 12:00 h) under the light-dark cycle (lights from 06:00 to 18:00 h). Two weeks later, rats were injected with α-methyl-p-tyrosine intraperitoneally and decapitated 2 hours after the drug injection. The ventromedial hypothalamic (VMH), paraventricular (PVN), and suprachiasmatic nucleus (SCN) were punched out according to the Palkovits method, and NE in each nucleus was measured by HPLC. Results The NE concentration (pg/μg protein) prior to meal was not different from that measured after meal, except for that in SCN which was reduced after meal. The NE turnover, which was estimated from the decrement of NE concentration after α-methy-p-tyrosine injection, increased after meal in VMH and PVN and covariated with changes in plasma corticosterone level.

734, I P (37) 1330

RELEASE OF OXYTOCIN ESTIMATED WITH PUSH-PULL CANNULAE FROM THE PARAVENTRICULAR NUCLEUS OF LACTATING RATS. TADOKORO, Y., NEGORO, H., HONDA, K. AND HIGUCHI, T. Dept. Physiol., Fukui Medical School, Fukui 910-11

Recently, we demonstrated that stimulation of the neurohypophysis evoked milk ejection-related bursts of oxytocin cells in the urethane-anesthetized lactating rat (Neurosci. Lett. 59, 21-25, 1985). And we assumed that oxytocin released within the magnocellular nuclei was responsible for the effect.

In the present study, we tested the hypothesis by examining the in vivo release of oxytocin from the paraventricular nucleus (PVN) after stimulation (1 mA, 50 pulses/s, 30 s on off for 10 min) of the neurohypophysis by means of a push-pull perfusion system in urethane-anesthetized lactating rats. The basal oxytocin levels averaged 21.80 $\pm$ 3.31 pg/ml in the control samples. The stimulation induced rapid and peak-shaped responces of perfusate oxytocin levels averaged 56.15 $\pm$ 9.20 pg/ml. While, venous injections of the synthetic oxytocin (2-4 mU) did not affect the oxytocin levels in the perfusate. These results indicate that oxytocin could be released within the PVN by stimulation of the neurohypophysis and thus support the aforementioned hypothesis.

735, I P (38) 1330

cAMP STIMULATES DOPAMINE SYNTHESIS IN THE MEDIAN EMINENCE OF RAT HYPOTHALAMIC SLICES. ARITA, J. AND KIMURA, F. Department of Physiology, Yokohama City University School of Medicine , Yokohama 232

Dopamine synthesis in tuberoinfundibular dopaminergic (TIDA) neurons was estimated by the rate of in vitro DOPA accumulation in the median eminence of rat hypothalamic slices after incubation with a DOPA decarboxylase inhibitor. Addition of dibutyryl cAMP (db-cAMP) into medium caused an increase in the rate of DOPA accumulation in the median eminence in a dose- and time-dependent manner. An increase in the concentration of endogeneous cAMP achieved by addition of isobutylmethylxanthine or forskolin was associated with an increase in the rate of DOPA aacumulation in the median eminence. The stimulatory effect of db-cAMP on DOPA accumulation was not dependent upon the presence of extracellular Ca2+ and was not blocked by tetrodotoxin. Furthermore, the stimulation of DOPA accumulation induced by db-cAMP was additive with that induced by high potassium depolarization, which was Ca2+-dependent, suggesting the distinct regulation of dopamine synthesis in TIDA neurons by the cAMP and Ca2+ systems.

736, I P (39) 1330

INHIBITION OF PULSATILE LUTEINIZING HORMONE SECRETION AND HYPOTHALAMIC UNIT ACTIVITIES BY INTRAVENOUS ESTROGEN ADMINISTRATION IN FREELY-MOVING OVARIECTOMIZED RATS. AKEMA, T. and KIMURA, F. Dept. Physiol., Yokohama City Univ. Sch. Med., Yokohama 232.

To examine whether the CNS mechanism is involved in the negative feedback effect of circulating estrogen on pulsatile luteinizing hormone (LH) secretion, the effects of an i. v. administration of estradiol (E2) on serum LH profiles and medial basal hypothalamic unit activities were examined in freely-moving ovariectomized rats. An i.v. bolus injection (2μg/100g b.w.) or a constant rate infusion (2 or 10μg/100g b.w./12min for 1hr) of E2 effectively reduced the amplitude and/or frequency of existing pulsatile LH secretion, while administration of the vehicle did not. E2 injection also reduced spontaneous firing rates of some medial basal hypothalamic neurons recorded through chronically-implanted multiple platinum-iridium microwires within 16-30min; i.e., prior to or simultaneously with the inhibition of pulsatile LH secretion. These results suggest that the CNS mechanism may be at least in part involved in the negative feedback action of circulating estrogen on pulsatile LH secretion in the ovariectomized rat.

737, I P (40) 1330

EFFECTS OF ESTROGEN ON THE CHEMOSENSITIVITY OF THE RAT PARAVENTRICULAR NEURONS IN VITRO. AKAISHI, T. AND SAKUMA, Y. Dept. Physiol., Niigata Univ. Sch. Med., Niigata 951

In superfused slices of the hypothalamus (frontal section, 400-500 μm thick) taken from ovariectomized female rats, extracellular action potentials were recorded from 126 neurons in the magnocellular region of the paraventricular nucleus (PVN). Effects of 17β-estradiol (E_2)(10^{-8} M) were observed on their spontaneous as well as induced discharges, the latter followed infusion of either noradrenaline (NA), dopamin (DA) or acetylcholine (ACh). Biologically inactive 17α-E_2 was used as control. Twenty-one among the recorded cells were antidromically identified from the PVN-neurohypophyseal tract. Estrogen altered spontaneous activity in 19 of 26 PVN neurons, including the 4 identified cells. Ninteen cells were consisted of those responded with excitation (n=7, latency 82.3±11.6 sec) and those with inhibition (n=12, latency 89.3±7.4 sec). None of 5 cells in this group responded to 17α-E_2. In other PVN neurons, perfusion of 17β-E_2 containing medium modified the magnitude of excitatory responses induced by NA (n=5), DA (n=3) or ACh (n=1). These data suggest that estrogen specifically exerts an immediate action on the activity of some of the PVN neurons either directly or through modification of the efficacy of other chemical agents.

738, I P (41) 1330

CHANGES IN SYMPATHO-ADRENAL MEDULLARY FUNCTIONS DURING AGING. ITO, K., SATO, A., SATO, Y. AND SUZUKI, H. Dept. Physiol., Tokyo Metropolitan Institute of Gerontology, Tokyo 173.

It is known that concentrations of noradrenaline (NA) and adrenaline (A) in the adrenal medulla and NA concentration in the peripheral blood increase during aging, but it is not clear if their secretion rates from the adrenal gland are also increased. The present experiment was conducted primarily to investigate changes in secretion rates of both NA and A from the adrenal gland during aging, and secondly, changes in efferent nerve activity of the sympathetic nerves innervating the adrenal glands. Urethane-chloralose anesthetized Wistar rats of different ages (from about 100 to 900 days after birth) were used. Secretion rates of NA and A from the adrenal gland of 100 day old rats were 4.0 ± 0.8 (mean ± S.E.) and 26.7 ± 2.9 ng/kg/min, respectively. Both secretion rates began gradually increasing after 300 days of age and were 2-4 times higher of 800-900 days of age. Sympathetic efferent nerve activity at resting condition was 1.4 ± 0.2 Hz for 100 day old rats. The magnitude of increases in the nerve activity with aging were similar to the increases observed in catecholamine secretion rate. The present results suggest that during aging adrenal sympathetic efferent nerve activity increases, resulting in increases in both adrenal NA and A secretions.

739, I P (42) 1330

SELECTIVE RESPONSES IN PLASMA ACTH, PROLACTIN AND TSH LEVELS AFTER NOXIOUS AND HYPOVOLEMIC STIMULI. HAMAMURA, M., ONAKA, T. AND YAGI, K.
Dept. Physiol., Jichi Med. Sch., Tochigi 329-04

Both footshocks (FS) and hypovolemia (HV) have been shown to elevate plasma ACTH and prolactin (PRL) levels but to lower TSH level in conscious rats. Our previous study with anesthetized rat has shown that noxious stimuli elevate ACTH and PRL levels and unalter TSH level while HV elevates these hormone levels. To examine the discrepancy among these data we ananylsed time course and stimulus intensity dependency of hormone level after noxious stimuli and HV. In anesthetized rats HV elevated all these hormone levels as shed blood volume increased. HV for 3, 5, 15 and 30 min increased levels of all these hormones. Saphenous nerve stimulation (3 mA, 4 Hz) for 3 min elevated mean ACTH and PRL levels but not mean TSH level under a condition of elevated TSH level after HV. In conscious rats FS (50 Hz, 1 min) elevated ACTH and PRL levels in intensity-dependent manner but unaltered in TSH level. Intermittent FS for 10 and 30 min increased ACTH and PRL levels but lowered mean TSH level. These data show that noxious stimuli potentiate ACTH and PRL selectively to TSH secretion while HV potentiates secretions of all these hormones.

740, II F 1300

PATTERN DIFFERENCES IN THE EXPERIMENTAL FEVER. WATANABE, T., NAKAMORI, T.*, MORIMOTO, A. AND MURAKAMI, N. Dept. Physiol., Yamaguchi Univ. Sch. Med., Ube, Yamaguchi 755

We have investigated the febrile responses induced by intravenous (IV), intracerebroventricular (ICV) and intra-preoptic/anterior hypothalamic (POA) administration of endotoxin (lipopolysaccharide: LPS), endogenous pyrogen (EP) and prostaglandin E_2 and $F_{2\alpha}$. A small dose of IV injection of LPS or EP produced monophasic fever and a large does biphasic fever. The latency to the onset and the time to the first peak of fever induced by IV injection of LPS or EP were almost the same as those by ICV or POA injection of PGE_2. Fever induced by ICV or POA administration of LPS, EP or $PGF_{2\alpha}$ had a long latency to the onset and a prolonged time course. There were significant differences between the latencies to fever onset exhibited by the groups of ICV or POA injection of LPS, EP or $PGF_{2\alpha}$ and by the groups of IV injection of LPS or EP and of ICV or POA injection of PGE_2. These results permit us to consider the possibility that there are several mediators or multiprocesses underlying the pathogenesis of fever.

741, II F 1315

THE INVOLVEMENT OF BIOGENIC AMINES ON PGE_1-INDUCED FEVER IN THE RABBIT. IWAMOTO, J., FUJIWARA, M., OHWATARI, N. AND KOSAKA, M. Dept. of Environment. Physiol., Inst. for Trop. Med., Nagasaki Univ., Nagasaki 852

The interactions of prostaglandin E_1 (PGE_1) and tolazoline, as well as noradrenaline (NA) and dipyron on fever induction were studied in rabbits through intraventricular microinjection technique. Monitorings of febrile responses were made on rectal temperature, ear skin temperature and respiratory rate. Pre-injected tolazoline, an alpha-adrenoceptor blockade diminished febrile responses elicited by PGE_1, whereas post-injected tolazoline didn't induce any antagonistic effects on PGE_1-fever, rather it facilitated febrile responses, especially drop of ear temperature, or in a few cases it induced shivering. So that it is assumed that post-injected tolazoline may not act on the receptor sites on which PGE_1 has already occupied, and would inhibit other receptors which are responsible for the antagonism of fever induction. An antipyretic drug dipyron was antagonistic to all the responses elicited by PGE_1 and NA. It also depressed febrile responses exaggerated by tolazoline. The results would permit us to conclude that PGE_1 may act on presynaptic adrenoceptor which modulate synaptic transmission onto cold responsive units, and the effect of dipyron might be involved in such synaptic transmission.

742, II F 1330

THE MECHANISM OF BIPHASIC FEVER INDUCTION. MORIMOTO, A., NAKAMORI, T.* AND MURAKAMI, N. Dept. Physiol., Yamaguchi Univ. Sch. Med., Ube, Yamaguchi 755

We have examined the effect of intravenous (IV) or intracerebroventricular (ICV) administration of indomethacin (Indo) on febrile responses induced by endotoxin or endogenous pyrogen (EP). IV injection of Indo attenuated the first peak but not the second peak in the biphasic fever induced by IV endotoxin. The second peak in the biphasic fever was significantly attenuated by ICV administration of Indo but the first peak was not. On the other hand, the monophasic fever induced by IV injection of EP was attenuated by IV Indo but not by ICV Indo. However, fever induced by ICV administration of EP was suppressed by ICV Indo but not IV Indo. These results indicate that there exist at least two steps mechanism, regarding inside and outside of blood-brain barrier, for producing the biphasic fever with endotoxin.

743, II F 1345

RESPONSIVENESS OF HYPOTHALAMIC NEURONS TO INTERLEUKIN-1, SALICYLATE AND MEPACRINE.

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The effects of electrophoretic application of purified human interleukin-1 (IL-1) and its related substances on the single-unit activity of preoptic and anterior hypothalamic (PO/AH) thermosensitive neurons in rats were studied. Out of 17 warm-units, 13 units decreased and one unit increased the firing rate following application of IL-1. Ten of 12 cold-units increased the activity and two did not change it after IL-1 application. IL-1 did not affect the activity in 37 of 48 thermally insensitive units, depressed 9 units and excited 2 units. No units tested were influenced by application of heat-treated IL-1 or the solvent. Simultaneous application of sodium salicylate and IL-1 did not alter the activity of all the 4 warm-units and 2 cold-units tested. Continuous application of mepacrine blocked the response to IL-1 in 5 of 7 warm-units and one cold-unit. The activity of the remaining 2 warm-units were slightly inhibited by IL-1 under mepacrine. The results suggest 1) that IL-1 and salicylate act in the PO/AH to produce fever and antipyresis, respectively, by appropriately offsetting the activity of thermosensitive neurons, and 2) that the release of arachidonic acid at the PO/AH is essential for the development of IL-1-induced fever.

744, II F 1400

ACTIVITY OF PREOPTIC THERMOSENSITIVE NEURONS DURING THERMOREGULATORY AND FEEDING BEHAVIORS IN THE MONKEY.

HORI, T., KIYOHARA, T., OOMURA, Y.*, NISHINO, H.*, AOU, S.* AND FUJITA, I.* Dept. Physiol., Saga Medical College, Saga 840-01 and *Dept. Higher Humoral Control, National Institute of Physiol. Sci., Okazaki 444

Unit activities of thermosensitive (TS) and non-TS neurons in the preoptic area (PO) of the monkey were investigated during high FR bar press (BP) tasks for seeking coor air (CT) or food (FT). The monkey pressed a bar when ambient temperature (Ta) was raised (35-42°C) and the animal was rewarded with a fall in Ta (23-25°C). The FT was guided by presentation of cue light or food and the animal was rewarded with food. Thirty-eight percent of the neurons responded to changes in PO temperature. The population of neurons which changed in firing rate during CT was higher among TS neurons than among non-TS neurons. The most frequently observed response was a sustained decrease in activity during the bar pressing and reward periods. The magnitude and duration of activity changes at the reward stage were affected by the animal's core and skin temperatures and appeared to be associated with the rewarding value of thermal stimuli. More than half of TS neurons which changed the activity during CT also showed the same type of response during FT. The results suggest that PO TS neurons are involved in the drive and/or reward mechanism of thermoregulatory behavior, and that they are also somehow related to the neural processes of non-thermal emotional behaviors, such as feeding.

745, II F 1415

EFFECT OF CHANGES IN MIDBRAIN TEMPERATURE ON FUSIMOTOR ACTIVITY IN RATS.

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The midbrain contains many locally temperature sensitive neurons, most of which have negative temperature coefficients(Nakayama & Hardy, 1969; Hori & Harada, 1976). Cooling of the midbrain produces a slight increase in heat production(Cabanac, 1970). The effect of midbrain cooling on fusimotor activity, as an index for the initiation of shivering, was investigated in urethan anaesthetized rats. The preoptic/anterior hypothalamus were electrically destroyed, to eliminate the influences from those areas on fusimotor neurons(Sato, 1984). The local temperature of the midbrain was controlled by implanting water perfused thermodes. During cooling or warming of the midbrain, a standard ramp and hold stretch was repeatedly applied to the left sural muscle, and the response of muscle spindle primary and secondary afferents to stretch of the muscle was analyzed for dynamic or static fusimotor activation, by measuring the dynamic index in each response. In most of the afferents studied, midbrain cooling produced a mixed activation of dynamic and static fusimotor neurons, but with a predominant activation of the former. Whereas by warming of the midbrain a consistent inactivation of both fusimotor neurons was observed.

746, II F 1430

NEUROTENSIN MODULATION OF METABOLIC THERMOREGULATION. TSUZUKI, S., KUBO, K. AND SASAKI T. Dept. of Bioregulation, Inst. for Med. Gen., Kumamoto Univ. Med. Sch., Kumamoto 862.

The effects of intra-third ventricular injection of neurotensin (NT, 1-10 g) on rectal and tail-skin temperatures (*Tre* and *Ttail*), and oxygen consumption ($\dot{V}O_2$) measured with an open-circuit method were studied in the warm-acclimated rats (22°C) under exposure to various ambient temperatures (*Ta*, 32.5°, 22°, 12.5° and 5°C). *Tre* was maintained at the normal level for warm environment after the exposures, for $\dot{V}O_2$ altered in each *Ta* having a negative correlation with the given *Ta* and *Ttail* changed dependent on each *Ta*. NT at *Ta* 22°-5°C induced a fall in *Tre* with a rise in *Ttail* (excepted at *Ta* 5°C) and a decrease in $\dot{V}O_2$ from each post-exposure level with a short latency. NT at Ta 32.5°C induced a gradual rise in *Tre*, though it failed to change a lowered post-exposure level of $\dot{V}O_2$ at this *Ta*. Mean $\dot{V}O_2$ during maximum response to NT at *Ta* 22°-5°C falled near to the lowered post-exposure level at *Ta* 32.5°C, and yet it at *Ta* 5°C was significantly higher than it at *Ta* 12.5°C. The data suggest that NT may act to inhibit an increase in autonomic thermogenesis from basal metabolism by suppressing responsiveness of the brain to thermal stimuli.

747, II F 1445

INTERRELATION AMONG TEMPERATURES OF THE BRAIN, ABDOMINAL CAVITY AND SKIN IN RABBITS. FUJITANI,Y. HOSOGAI,M. AND OIKAWA,T. Dept. Physiol., Tottori Univ. Sch. Med., Yonago 683

Diurnal rhythms of the temperatures in the pretectal region, abdominal cavity and ear lobe and their interrelation were studied under conscious and unrestrained state of 4 non-pregnant rabbits. Each temperature was measured using chronically implanted thermister and their values of every minute were printed out with a personal computer during several days up to 9 days in the longest. Those temperatures showed the changes independent of the room temperature which was maintained at 25 ± 0.5°C. Though, usually, a light(L) and dark(D) cycle of each 12 hrs was used, the findings were independent also of LD cycle. The diurnal process of the abdominal temperatures was such that it falls from about 6 o'clock in the morning, is at lower level and rises from evening to night. A similar trend was seen in the brain, but was not clear in the skin. Cross-correlation analyses revealed that the changes of the brain temperature precedes by about 1 min those of the skin temperature which were followed by those of the abdominal temperature with several min delay.

748, II F 1500

STUDIES OF THERMOREGULATION AND THERMAL ACCLIMATIZATION ON PIKA (AN OLD-FASHIONED RABBIT). KOSAKA, M., OHWATARI, N., IWAMOTO, J., TSUCHIYA, K., FUJIWARA, M. AND FAN, YU-JEN. Dept. of Environment. Physiol., Inst. for Trop. Med., Nagasaki Univ., Nagasaki 852

Pika (family Ochotonidae, not Lepordae) provided from Central Institute for Experimental Animals, in Kawasaki city, has been reared individually at 22-23°C in P2-facilities, in Animal Research Center in Institute for Tropical Medicine, Nagasaki University. Pika, the so-called a living fossil seems to preserve its morphological characteristics of those days of Eocene epoch in the Tertiary period. Namely, their lacking of ear-radiator and strong long hind legs are thought to be evolutionally undeveloped. Therefore, the objective of the present report is to estimate the capability of pika, in heat loss and heat gain mechanisms in hot and cold environment. Mean rectal temperature was 39.6°C and mean respiratory rate was 131c/min, with no statistical significant in sexual difference. At 25°C of ambient temperature, O_2-consumption (VO_2) was 19.8ml/min·kg and respiratory rate was 120-130c/min. At 15°C, VO_2 was 32.0ml/min·kg and respiratory rate was decreased to 86-92c/min. A 29°C of high ambient temperature, VO2 showed increased value of 27.9ml/min·kg, with 200-230c/min of respiratory rate. From these results, physiological evidences of thermal adaptation relation to evolutional changes of thermoregulatory mechanism of pika were discussed in this report.

749, II F 1515

HUMAN ORAL AND TYMPANIC MEMBRANE TEMPERATURE. UCHINO, K., *MASUDA, M. and **HATTORI, M. Dep. Student Health Center, Yokohama Nat. Univ. Yokohama 240, *Jikei Univ. Sch. Med., Tokyo 105. **Dep. Physical Education, Tokai Univ., Hiratsuka 254.

Rectal(Tre), oral(Tor), tympanic membrane(Tty), frontal skin(Tsf) and thigh skin(Tst) temperatures were measured in five healthy subjects to three conditions; (1) ambient temperature(Ta) variation between 28 °C and 18 °C; relative humidity(rh) ranged from 40%-45%, (2) for 10 min immersion in hot water(40 °C); Ta were 20-25 °C and rh 80%. (3) work load variation on a bicycle ergometer at a constant Ta(24 °C); order of test were respectively for 10 min 25W, 50W, 75W, 50W, 25W.
1. Subjects were rested 30 min in 28 °C Ta and rapid exposed to cooling air(18 °C). If a subject at cooling had shivered, Tre and Tor usually raised, but no shivered usually both temperature decreased. 2. At 3-8 min after first load(25W) exercise Tor and Tty decreased greater than Tre. Thereafter Tor, Tty and Tre increased during maximal intensity exercise. In spite of load decline (from 75W to 50W) Tre decreased more than 10 min.

750, II F 1530

HEAT EXCHANGE DURING EXERCISE IN WATER OF DIFFERENT TEMPERATURES. KONDA, N., SAGAWA, S., YOUSEF, M.K., YOSHINO, H. AND SHIRAKI, K. Dept. Physiol., Sch. Med., Univ. Occup. Environ. Hlth., Kitakyushu 807; Des. Biol. Res. Cent., Univ. Nevada, Las Vegas, U.S.A.

Thermal balance was studied in six men during rest and exercise while immersed up to the neck for 1 h in water maintained at 29, 31, 34 and 36°C. Subjects performed leg exercise at three intensities; 2, 3 and 4 mets for 30 min at each water temperature (Tw). Metabolic heat production ($\dot{M}$) did not change over time during rest or exercise except at 29°C where $\dot{M}$ was increased both during rest and exercise at 2 mets partly due to shivering. During rest, esophageal temperature (Tes) continued to decline at 29, 31 and 34°C, but it was maintained relatively constant at 36°C. At all Tw, heat flow ($\dot{H}$) reached a steady state after 30 to 40 min. Exercise at 2 mets caused a slight increase in $\dot{H}$ at 29 and 31°C for the first 10 to 15 min and then it remained relatively steady thereafter. The decline in Tes at 29°C was prevented by a work load of 2 mets. As intensity of exercise increased, $\dot{H}$ increased at a greater rate at 31°C than at other Tw. The rate of rise in Tes was related to work intensity. These results indicate that thermal balance remains possible at 29°C with an exercise of 2 mets, and that Tw has to be lowered when intensity of exercise increases.

751, II F 1545

EFFECTS OF LOCAL COOLING ON ELECTRICAL ACTIVITY OF SUPRAOPTIC CELLS IN VIVO AND IN VITRO. MATSUMURA, K. AND NAKAYAMA, T., Dept. Physiol., Osaka Univ. Med. Sch., Kita-ku, Osaka 530

Effects of local cooling on firing rates of the supraoptic (SO) cells were examined both in vivo and in vitro. In vivo study, the SO cells were antidromically identified following electrical stimulation of the posterior pituitary. Twenty out of 31 SO cells recorded in vivo showed lower mean firing rates at low temperatures (33-36°C) than at normal temperatures (36-38°C). The remaining 11 cells did not fire spontaneously between 33-38°C of the hypothalamic temperature. In vitro study, 24 SO cells were recorded in hypothalamic slice preparations. Twelve out of 24 SO cells decreased mean firing rates at lower temperatures. Seven cells showed higher mean firing rate at lower temperatures and 5 cells did not fire spontaneously between 33-38°C. The slopes of temperature-firing rate curves were steeper in vivo than in vitro. It was concluded that hypothalamic cooling mainly suppresses SO cells either directly or indirectly and that extra- and intra-hypothalamic inputs may increase the thermosensitivity of SO cells.

752, II F 1600

EFFECTS OF THERMAL STIMULATION ON SALIVARY SECRETION IN ANESTHETIZED RATS. TANAKA, H., KANOSUE, K., MATSUO, R.* AND NAKAYAMA, T. Dept. of Physiol., Osaka Univ. Med. Sch., Kita-ku, Osaka 530 and *Dept. of Oral Physiol., Osaka Univ. Faculty of Dentistry, Suita, Osaka 565

Rats do not sweat or pant in a hot environment. However, they spread saliva onto their body surface (grooming) for evaporative heat loss. To make this heat loss behavior effective, an autonomic process of secreting copious saliva is indispensable. Present study examined effects of thermal stimulation of various parts of the body on salivary secretion in urethanized rats (1.0 g/kg). When rectal temperature was over a certain value, skin warming of the face, scrotum and abdomen elicited salivary secretion. Local brain warming of the preoptic area and anterior hypothalamic regions elicited salivary secretion. This is in contrast with the finding that grooming in unanesthetized animal is evoked by the posterior hypothalamic warming. Thermally induced salivary secretion was affected complementarily by temperature of various parts of the body. Temperature signals from both core and periphery thus appear to be integrated together in bringing about salivary secretion.

753, II F 1615

FACIAL FANNING AND EXERCISE PERFORMANCE DURING HYPERTHERMIA IN A HOT AND HUMID ENVIRONMENT. HIRATA, K., NAGASAKA, T. AND NUNOMURA, T. Dept. Physiol., Kanazawa Univ. Sch. Med., Kanazawa 920

To investigate the effects of facial fanning on local exercise performance during hyperthermia, we studied five men, aged 25 - 52 years. Subjects performed hand-grip exercise on a hand-ergometer by the weight of 20% of individual maximal hand-grip strength at the rate of 30 cpm until volitional exhaution. Tests were performed in the following three conditions at random; normothermia (N) and hyperthermia either with (H-f) or without facial fanning (H-nf) at wind speed of 5.5 $m \cdot sec^{-1}$ by electric fan. Hyperthermia (>0.5°C in T_{es}) was induced by immersion of both lower legs into 42°C warm water bath in an environment of 35°C T_a and 75% rh. N tests were performed in the environment of 25°C T_a and 40% rh. Exercise performance time (EPT) was 28.0 ± 4.1 min, 10.7 ± 3.0 min and 15.3 ± 2.1 min in N, H-nf and H-f, respectively. EPT decrements due to hyperthermia ($P<0.005$) were accompanied by greater increases in heart rate (HR), skin blood flow, rating of perceived exertion (RPE) and skin temperatures (T_{sk}) of mean, legs and foot. Facial fanning induced significant improvement on EPT ($P<0.02$) and decreases in T_{ty}, HR, RPE and T_{sk} of forehead. These results showed that facial fanning during hyperthermia improved local exerciseperformance through a decrease in cardiovascular and thermal loads.

754, II F 1630

VASOCONSTRICTION IN THE SKIN HEATED LOCALLY TO ABOVE CORE TEMPERATURE. NAGASAKA, T., CABANAC, M*., HIRATA, K. AND NUNOMURA, T. Dept. Physiol., Kanazawa Univ. Sch. Med., Kanazawa 920 and *Dept. Physiol., Claude Bernard Univ. Sch. Med. Lyon-Sud, Oullins, France

This study examined the effect of local heating on the blood flow of the finger or forearm in male subjects in an environment of 35°C 40% rh. The subjects wore only shorts, and rested on a reclining seat 30 min before and during measurements. One hand or forearm was immersed in a water bath the temperature of which (T_w) was raised 1°C every 10 min from 35°C to 43°C, while the other hand or forearm was kept immersed in a bath of T_w 35°C. Blood flow was measured by venous occlusion plethysmography, using mercury-in-Silastic strain gauges. Local heating caused a significant fall in finger blood flow (FBF) at T_w of 39 - 41°C, but not in forearm blood flow. This fall in FBF was, however, limited in the first few min of the respective heating periods, which seemed to be in parallel with an increase in local thermal sensation. At T_w of 42 - 43°C, however, FBF increased beyond the previous values and masked the early transient vasoconstriction. This vasoconstriction in the skin elicited by local heating seems to be paradoxical in so far as it is contrary to the generally accepted theory. However, we assume that this may be a defence mechanism to suppress excess heat gain from the skin areas subjected to pressure against hot foreign materials.

755, II F 1645

THE MECHANISM OF HEAT-INDUCED VASOCONSTRICTION IN THE FINGER. NUNOMURA, T., NAGASAKA, T. AND HIRATA, K. Dept. Physiol., Kanazawa Univ. Sch. Med., Kanazawa 920

This study examined how whole body thermal state affects the heat-induced vasoconstriction in the finger. The subjects, dressed in shorts, rested on a reclining chair for 1.5 hr in either 25°C 40% rh, 35°C 40% rh or 35°C 80% rh condition. In the 35°C 80% rh condition only, the lower legs were kept immersed in a foot-bath (41°C). One hand was immersed in a water bath the temperature of which (T_w) was raised by 2°C every 10 min from 35°C to 43°C. The finger blood flow (FBF) was measured by venous occlusion plethysmography, using mercury-in-Silastic strain gauges. Esophageal (T_{es}) and mean skin temperature ($\bar{T}_s$) were continuously recorded. There were significant differences in $\bar{T}_s$ and T_{es} between the 3 conditions; lowest at 25°C 40% rh and highest at 35°C 80% rh. FBF at T_w 35°C were 29, 89 and 108 ml·100 ml^{-1}·min^{-1} at 25°C 40% rh, 35°C 40% rh and 35°C 80% rh respectively. The heat-induced vasoconstriction was observed at T_w 39 and 41°C significantly at 35°C 40% rh and significantly but less at 35°C 80% rh. No such vasoconstriction was observed in 25°C 40% rh condition. From these results, we conclude that FBF is reduced to inhibit excess heat gain through the locally heated skin only at moderately higher levels of thermal state in humans. At extremely higher levels of thermal state, such vasoconstriction may be masked by stronger vasodilator drives from the cardiovascular centers.

756, III F 0915

EFFECTS OF REPETITIVE IMMOBILIZATION STRESS(RIS) AND COLD ACCLIMATION(CA) ON THE ADRENOCORTICAL HORMONE SECRETION. YAHATA,T., MURAZUMI, K. AND KUROSHIMA, A. Dept. of Physiol., Asahikawa Medical College, Asahikawa 078-11

Repetitive stress imposed as immobilization causes cross adaptive effect to cold through an enhanced nonshivering thermogenic capacity (Kuroshima et al., 1984). Many humoral factors such as catecholamines, glucagon and adrenocortical hormones being common to responses to both cold and stress seem to be involved in this phenomenon. The present study was undertaken to evaluate role of adrenocortical hormones in the stress- or cold-induced nonshivering thermogenesis(NST) by measuring plasma corticosterone(CS) and deoxycorticosterone(DOCS) with the aid of HPLC (Shimazu LC-5A). RIS (3 hr/day, 4 weeks) elevated the resting (24 hr after the last immobilization) level of CS, but not DOCS. Acute stress (immobilization for 30 min) or cold exposure (-5 ℃ for 15 min) caused marked increases of CS and DOCS in both naive controls and repetitively stressed rats. RIS potentiated the responsiveness of CS to both acute stress and cold, and that of DOCS to acute stress, but not that of DOCS to cold. Cold acclimation (5 ℃, 4 weeks) did not affect the resting level of CS and decreased that of DOCS. Moreover, it did not affect the responsiveness of both CS and DOCS to either acute stress or cold. These results suggest that RIS, but not CA, could enhance NST, at least in part, through an improvement of responsiveness of adrenocortical hormone secretion to acute stress or cold.

757, III F 0930

EFFECTS OF NORADRENALINE ON DYNAMIC PROPERTY OF THE THERMOREGULATORY SYSTEM IN SPINAL RATS. ASAKI, Y. and IRIKI, M.[1] Dept. Physiol., Tokyo Metropol. Inst. Gerontol., Tokyo 173, [1]Dept. Physiol., Med. Univ. Yamanashi, Yamanashi 409-38

Effects of noradrenaline(NA) (ip.: dose 50-100 μg/hr) in spinal rats were examined by the dynamic property of thermoregulatory system. The result was compared with the dynamic property of spinal rats administered placebo, that of spinal intact rats, and that of dead bodies. The dynamic property was measured by rectal(Tr) and tail skin(Ts) temperatures changing ambient temperature(Ta) in a sine wave of which interval was one hour. The mean levels and the fluctuations during a 2-hour experiment in Tr, Ts and Ta were calculated by means of Fast Fourier Transform(FFT).

1. The fluctuation of Tr in spinal rats injected NA was significantly smaller than that in spinal rats injected placebo, and larger than that in intact rats.
2. Due to administration of NA, mean Ts decreased and mean Tr increased.
3. The fluctuation of Tr in dead bodies indicated a constant value regardless different mean Ta of 10, 20 and 30 ℃.
4. At mean Ta of 30 ℃, the fluctuation of Tr in dead bodies indicated intermediate values between that in spinal rats and that in intact rats.

It can be concluded that the affection of disturbance to rectal temperature depended on the efficiency of thermoregulation and thermal transmission in a body.

758, III F 0945

CHARACTERISTICS OF CARDIOVASCULAR RESPONSES OF THE BULLFROG (RANA CATESBEIANA) TO THERMAL STIMULATION OF THE SPINAL CORD. NAGAI, M. AND IRIKI, M. Dept. Physiol., Medical Univ. Yamanashi, Tamaho, Nakakoma, 409-38 Yamanashi

Correlation between spinal cord temperature and cardiovascular functions was investigated in urethane-anesthetized bullfrogs (Rana catesbeiana). Warming the spinal cord significantly increased ventricular pressure (VP) and pulmocutaneous blood flow (PCBF), and cooling decreased VP and PCBF. Since heart rate did not change during thermal stimulation, spinal cord thermal stimulation changed cardiac output through concordant changes in stroke volume. Changes in VP was antagonized with propranolol, but not influenced by transection of the sympathetic twigs innervating the chromaffin tissue. This shows that inotropic effect of spinal cord temperature is mediated by β-adrenergic mechanism of cardiac sympathetic origin. Changes in PCBF were not antagonized with atropine, although pulmonary vessels of the frog receive cholinergic control. Therefore, changes in PCBF are not mediated by active vasomotor mechanism.

759, III F 1000

EFFECTS OF SPORTS WEAR ON THERMOREGULATORY RESPONSE DURING EXERCISE. OHNUKI, Y. AND NIWA K., Dept. Health and Phys. Ed., Yamagata Univ. Fac. Ed., Yamagata 990

The aim of this study is to investigate the thermoregulatory responses when the five male students exercised wearing the three different types of clothes, the shorts (N), the training wear (W) and the Gore-tex ski wear (G). We let the subjects one hour exercise in three work intensities of 49.0, 73.5 and 98.0 W under the ambient temperature of 21.4°C, relative humidity of 58.8 % and wind velocity of 0.1 m/sec. At the work intensity of 98.0 W, metabolic heat production was not significantly different among the three clothing conditions. Body weight loss of N was significantly less than those of W and G. However, no significant difference was made between W and G. Mean skin temperature wearing G was higher than those of W and N, but the rectal temperature rose similarly. Clothes wearing resulted in an upwaed shift of the regression line of body weight loss with rectal temperature level. But by paying special regard to the fact that an additional amount of the loss was retained by the clothing, the overall regression coefficient turned out to be doubled.

760, III F 1015

EFFECTS OF QI-GONG PRACTICE ON SWEATING. OGAWA, T., SHEN, Z., YAMASHITA, Y., OHNISHI, N., ASAYAMA, M. AND SUGENOYA, J. Dept. Physiol., Aichi Med. Univ., Nagakute 480-11

Qi-gong is a traditional psychosomatic practice in China for health conservation, used also for prevention and therapy of various chronic diseases. It consists in principal of straightening of the posture, conscious regulation of breathing pattern and mental concentration of consciousness of energy, "Qi". Previously we demonstrated marked changes in skin temperature of extremities during Qi-gong practice, indicating cutaneous vasoconstriction during Shou-gong (afferent transmission and suspension of Qi) and vasodilation during Fa-gong (efferent transmission of Qi). Presently, the effects of Shou-gong and Fa-gong on sweating were investigated in 5 subjects: 3 well-trained, 1 moderately trained, and 1 untrained to Qi-gong. In response to periodical practice of Shou-gong, the forearm sweat rate increased periodically in the well-trained subjects, while periodical Fa-gong practice caused more obscure response of periodical sweat depression. Such changes were hardly reproducible by self-suggestion of heat and cold or by biofeedback. Palmar sweating also responded similarly. Progressive decrease in such responses of sweating due to habituation was rather gradual, compared with sweat response to other sensory or emotional stimuli. The results suggest strong intervention of the higher central controlling system in autonomic functions.

761, III F 1030

INCREASE OF SWEATING CAPACITY BY VARIOUS TYPES OF HEAT ACCLIMATION. OHNISHI, N., SUGENOYA, J., OGAWA, T., ASAYAMA, M. AND YAMASHITA, Y. Dept. Physiol., Aichi Med. Univ., Nagakute 480-11

Characteristics of the frequency of sweat expulsions (Fsw) were analyzed before and after heat acclimation by the following methods; 1) controlled hyperthermia (CH) by dry (Sauna box) and wet (Blanketrol) heating with Tre clamped at 38 ± 0.1°C, 2) CH by exercise in cool environment with Tre clamped at 38.0 ± 0.2°C, and 3) controlled "peripheral hyperthermia" by Sauna box with $\bar{T}s$ clamped at 38.5 ± 1.0°C and Tty at 37.1 ± 0.1°C by face fanning. Each exposure continued for 90min. per day for nine consequtive days. The regression line relating Fsw to body temperature shifted to the left after the acclimation course of 1) and 2). The regression line relating total sweat rate to Fsw frequently shifted to the left after the acclimation course of 1), while it hardly changed in the others. The results revealed that CH by 1) induced an increment in sweating capacity, due mainly to enhancement of central sudomotor activity and partly but inconsistently to increase in sweat gland activity, while the increment in sweating capacity caused by CH by 2) was attributed almost exclusively to adaptive changes in the central mechanism. On the other hand, in case where the brain temperature assumably remained at a low level such as 3), it appeared to be difficult to cause an increment of sweating capacity.

762, III F 1045

EFFECTS OF LOCAL Ca^{++} ON THE EXCITABILITY OF ECCRINE SWEAT GLANDS IN MAN. OHARA, K, HASHITANI, T, KUMAZAKI, M,* 2nd Dept. Physiol., Nagoya City Univ. Med. Sch., Nagoya 467

Studies upon the activities of human eccrine sweat glands were carried out in vivo experiments using field electrical stimulation of local sudomotor nerve fibers. The following results were obtained for the effects of Ca^{++} from experiments where intradermally administered calcium antagonists such as nifedipin, L-verapamil and diltiazem were used.
(1) With nifedipin (10^{-8} and 10^{-7}gr/ml) and/or L-verapamil (10^{-8}, 10^{-7} gr/ml) threshold current strength was not changed, while the maximal sweat production rate was reduced.
(2) With diltiazem (10^{-8}, 10^{-7}gr/ml) threshold current strength was not changed, however, both of the maximal secretion rate as well as the current strength with which the maximal secretory activities was produced were lowered.
These results seem to indicate that local Ca^{++} play any roles in the secretory activities of sweat glands, presumably mainly through metabolic process in the gland cells.

763, I P (20) 0900

EFFECT OF LESIONS IN RAPHE DORSALIS OR LOCUS COERULEUS ON RESPONSE OF THALAMIC NEURONS IN RATS TO SKIN WARMING AND COOLING. SAKATA, Y. AND MURAKAMI, N. Dept. Physiol., Yamaguchi Univ. Sch. Med., Ube, Yamaguchi 755

It was electrophysiologically examined if the activity of neurons in ventro-basal (VB) complex in thalamus responding to the skin warming (from 30 to 42°C) or cooling (from 30 to 17°C) was influenced by lesions of the raphe dorsalis or the locus coeruleus. The lesion of selected brain regions was performed by the D.C. current of 50 to 200 μA through bipolar electrode. 1) The activity of VB neurons increased steeply (switch-like response) or gradually (graded response) with a rise in the skin temperature. 2) Both types of VB neurons did not respond to skin warming after the lesion of the raphe dorsalis. 3) The response of VB neurons to the skin cooling which had a peak at the skin temperature between 20 and 28°C, was also disappeared after lesions in the limitted area including the locus coeruleus or the sub-coeruleus.

764, I P (21) 0900

EFFECTS OF ENDOGENOUS PYROGEN AND PROSTAGLANDIN E_2 ON HYPOTHALAMIC NEURONS OF GUINEA PIG BRAIN SLICE.

ONO, T., WATANABE, T. AND MURAKAMI, N. Dept. Physiol., Yamaguchi Univ. Sch. Med., Ube, Yamaguchi 755

We investigated the effects of endogenous pyrogen (EP) and prostaglandin E_2 (PGE_2) on the preoptic and anterior hypothalamic (PO/AH) neurons using brain slice preparations of guinea pig. EP or PGE_2, applied into the bathing medium via a side route, changed the activity in about 42 % of the PO/AH region neurons although the facilitated and inhibited neuron shows different proportion in each administration of pyrogens. In the case which EP and PGE_2 were applied on the same neuron, respectively, 23 % of the neurons changed the activity with the same direction, 31 % of the neurons different direction and 46 % of the neurons did not respond at all. These results may explain a part of the cellular mechanism at the PO/AH region in pathogenesis of EP- and PGE_1-fever.

765, I P (22) 0900

EFFECT OF THYROTROPIN RELEASING HORMONE (TRH) AND CYCLO-(His-Pro) ON PREOPTIC THERMOSENSITIVE NEURONS IN THE RAT.

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A total of 209 single neurons were recorded with multibarrlled microelectrodes from the medial preoptic area (MPO) of urethane anaesthetized male rats. After studying the neuronal sensitivity to changes in hypothalamic temperature, TRH and its metabolite, Cyclo-(His-Pro), were applied electrophoretically to the recording cells.

An application of TRH inhibited 30 of 64 warm-units, excited 10 warm-units and had no effect on 24 warm-units. Of 23 cold-units, 11 units were excited and 4 were inhibited by TRH. Among 122 non-thermosensitive units, 35 were excited and 34 were inhibited by TRH. The decreased activity of MPO warm-units and the increased activity of MPO cold-units to TRH were appropriate in explaining the decreased vasodilatation and increased heat production induced by MPO microinjection of TRH.

On the other hand, the study on the responses of 93 units to Cyclo-(His-Pro) revealed that about one third of units were excited and one third were inhibited by Cyclo, regardless of the type of thermosensitivity of neurons.

766, I P (23) 0900

PREOPTIC AND ANTERIOR HYPOTHALAMIC NEURONS RESPONDING TO CHANGES IN LOCAL TEMPERATURE AND BLOOD PRESSURE.

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Preoptic and anterior hypothalamus (PO/AH) has been known to be involved in cardiovascular control as well as in thermoregulation. The present work concerns with the effect of changes in hypothalamic temperature and arterial blood pressure on the activity of single neuron in the PO/AH of urethane-anesthetized rat. Blood pressure was changed (10-30 mmHg) by reversible withdrawal of blood from jugular vein or by i.v. injection of nitroprussid (1-5 ug) and phenylephrine (5-15 ug). Of 24 warm-units, 18 units (75 %) and 4 units (17 %) increased and decreased the firing rate at the steady state to a fall in blood pressure respectively. By contrast, hypotensive stimuli decreased the activity of 5 (71 %) of 7 cold-units and increased only one cold-unit. A majority of non-TS neurons (56/96) were not affected by blood pressure change, 25 and 15 of 96 non-TS units increased and decreased the activity respectively during hypotension. The threshold of PO/AH neurons to blood pressure changes was estimated as low as 10 mmHg. Increased and decreased activity of warm-units and cold-units during hypotension suggests that at least a part of hypothermia observed during acute hemorrhage might be mediated centrally. The result also suggests involvement of PO/AH TS neurons in blood pressure control besides their postulated thermoregulatory function.

767, I P (24) 0900

RESPONSES OF THERMORESPONSIVE NEURONS IN GUINEA-PIG PREOPTIC-HYPOTHALAMIC AREA AND THALAMUS TO SEROTONIN AND NORADRENALINE. ISHIKAWA, Y. AND HINCKEL, P.* Dept.of Physiol., Osaka Univ. Med. Sch., Kita-ku Osaka, 530. Physiol. Institut, Univ. Giessen, F.R.G.

In 36 urethane anaesthetized guinea-pigs 60 neurons were tested for their responses to thermal skin stimulation, microiontophoretic application of serotonin(5-HT) and noradrenaline(NA) and electrical stimulation of nucleus raphe magnus(NRM) and subcoeruleus area(SC). Twenty one units were warm-responsive to the abdominal and thoratic cutaneous warming. Nineteen out of 21 warm units responded to 5-HT with excitation(E:68.4%) and inhibition(I:31.6%) and 16 warm units to NA(E:6.2%, I:93.8%). Ten units were cold responsive. Eight out of 10 cold units responded to 5-HT(E:25%, I:75%) and 9 cold units to NA(E:66.7%, I:33.3%). Twenty nine units were non-thermoresponsive. Fourteen out of 29 units responded to 5-HT(E:14.3%, I:85.7%) and 21 units to NA(E:33.3%, I:66.7%).Thus 5-HT and NA produced opposite effects in regard to the directions of responses on a majority of warm responsive and cold responsive neurons studied. In contrast to thermoresponsive neurons, both 5-HT and NA produced inhibitory effects on a majority of non-thermoresponsive neurons studied.

There were 2 warm responsive units excited by NRM stimulation and 5-HT. In addition, 3 cold responsive units excited by SC stimulation and NA were found. The tips of stimlation electrode were located within the aimed areas.

768, I P (25) 0900

EFFECTS OF HYPERCAPNIA AND HYPOXIA ON THE THERMOSENSITIVITIES OF PREOPTIC NEURONS TO PREOPTIC TEMPERATURE.

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In urethanized rats, the effects of hypercapnia and hypoxia on preoptic (PO) thermosensitive neurons were examined by regression of neuronal activity on PO temperature. During hypercapnia, 14 of 24 warm-sensitive neurons (W-neuron) were examined at 4 and 7% CO_2, and 13 neurons at 10% CO_2. Two of 3 cold-sensitive neurons (C-neuron) were examined at all CO_2 concentrations. In 44 of the 46 pairs, the slope of the regression line for hypercapnia did not differ significantly from that for air inhalation in either W-neurons or C-neurons ($P<0.01$). Twenty-nine of these pairs, however, showed significant parallel shifts in firing rate. Of the pairs with parallel shifts 76% showed upward shifts and 24% downward shifts. During hypoxia (10% O_2), 19 W-neurons and 2 C-neurons were recorded. In 8 of the 22 pairs, the slope of the regression line for hypoxia differed significantly from that for air inhalation. During hypoxia, the slope of the regression line decreased in 4 W-neurons and 1 C-neurons, and increased in 3 W-neurons.

769, I P (26) 0900

THERMOSENSITIVITY OF PREOPTIC NEURONS IN PIGEON HYPOTHALAMIC TISSUE SLICES.

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In mammals local warming and cooling of the preoptic-anterior hypothalamus (PO/AH) is capable of evoking both autonomic and behavioral thermoregulatory mechanisms, suggesting that there is a neuronal mechanism within this region responsible for sensing temperature. But in birds cooling of the PO/AH produces either no effect or inappropriate effects on both kinds of thermoregulatory mechanisms, whereas warming of this region produces similar effects as in mammals. In this experiment, thermosensitivity of preoptic neurons was tested in pigeon hypothalamic tissue slices.

Neurons were classified as warm-sensitive units if their $Q_{10}>2$ and thermal coefficient $(m)>0.6$ impulses/s/℃ and cold-sensitive units if their $Q_{10}<0.1$ and $m<-0.6$ impulses/s/℃. All other neurons were considered thermally insensitive units. Forty-three single-units were recorded from the PO/AH. Of these units, 14 (33%) units were warm-sensitive, 3 (7%) units were cold-sensitive and 26 (60%) units were thermally insensitive units. Effect of synaptic blockade was also examined in 6 thermosensitive units. Three units (50%) retained their thermosensitivity during synaptic blockade perfusion. The results suggest that some thermosensitive neurons in the PO/AH possess an inherent thermosensitivity in the pigeon.

770, I P (27) 0900

INVOLVEMENT OF VENTROMEDIAL AND ANTERIOR HYPOTHALAMUS IN THE CONTROL OF BROWN ADIPOSE TISSUE THERMOGENESIS INDUCED BY PREOPTIC COOLING.
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The effects of local anesthesia of the ventromedial hypothalamus (VMH), anterior hypothalamus (AH) or lateral hypothalamus (LH) were observed on the brown adipose tissue (BAT) thermogenesis indused by preoptic (PO) cooling. Rats were chronically implanted with thermode, guide cannulae in the brain and polyethylene tubes beneath the interscapular BAT. BAT temperature (T_{bat}) decreased when lidocaine was injected bilaterally into VMH during PO cooling. The mean maximum decrease of T_{bat} (n=7) was 0.5°C which occurred 7 minutes after lidocaine injection. T_{bat} increased when lidocaine was injected into AH. The mean maximum increase of T_{bat} (n=4) was 0.8°C which occurred 7 minutes after lidocaine injection. Lidocaine into LH had no effect on T_{bat}. T_{bat} was not influenced by similar injection of saline into VMH, AH or LH. These results suggest that efferent pathway from PO to BAT runs through VMH but not LH and that VMH facilitates and AH inhibits BATthermogenesis induced by PO cooling.

771, I P (28) 0900

EFFECT OF COLD ACCLIMATION AND REPETITIVE STRESS ON PLASMA AND TISSUE cAMP LEVELS.
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Noradrenaline(NA) and glucagon(G) are considered to be responsible for cold-enhanced nonshivering thermogenesis(NST). Effects of these factors are developed via cAMP. In order to assess a role of cAMP, the effects of NA (2 μg/min) and G(4 μg/min) infusion for 5 min were studied in cold-acclimated (5 ℃, 4 wk) (CA) and repetitively stressed (3 hr immobilization, 4 wk)(ST) rats. The latter group has been evidenced to be cross-adapted to cold with enhanced NST (Pflüg. Arch. 402:402, 1984).

The basal cAMP level was significantly elevated in brown and white adipose tissues of CA and ST. However, NA or G did not further increase these elevated levels. G elevated cAMP level of liver, and the response was potentiated in CA, but not in ST. NA also elevated cAMP level of liver, but there were no differences in the response between controls and CA or ST. G caused greater increases in plasma cAMP of CA and ST than those of controls. NA also induced increases in plasma cAMP, but the extent of response was smaller than that of G and the responses in CA and ST were not different from those in controls.

These results suggest that cAMP is involved in the enhanced NST in CA and ST, possibly being formed by NA and G in a regulatory way.

772, I P (29) 0900

STRAIN DIFFERENCE IN THERMAL SALIVATION AND BODY WATER ECONOMICS AMONG 10 WISTAR RAT STRAINS EXPOSED TO HEAT.
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Large strain difference in thermoregulation was observed among 10 strains of 13-weeks male Wistar exposed to 42.5°C. Five strains survived heat significantly longer than the other five strains. Wistar King A and so-called Japanese Wistars except a couple of sister strain, Wistar kyoto and Wistar/Ms, belonged to the latter group. CRJ: Wistar and Lewis survived heat longer than the other Wistars and as long as SD rats (Furuyama, 1982). The wider rats spread saliva on, the longer they survived heat during 100 min from the begining of heat exposure. Saliva spread area did not extend since. Body water loss (BWL) increased according to survival time (ST). ST/BWL ratio also increased according to ST, showing highly efficient body water economics during evaporative heat loss in more heat tolerant strains.

773, I P (30) 0900

CHANGES IN HEART RATE DURING THERMAL STIMULATION OF THE THORACIC CORD OF CHRONIC SPINAL RATS WITH AND WITHOUT ANESTHESIA. TSUCHIYA, K. Dept. of Environment. Physiol., Inst. for Trop. Med., Nagasaki Univ., Nagasaki 852

Male adult rats of Wistar strain were used. Spinal cord was transected at the level of C7/Th1, and a U-shaped polyethylene tube was implanted into the thoracic peridural space as the thermode under anesthesia. After the operation, rats were reared in the warm room (30°C). The thoracic cord was stimulated thermally by perfusing hot or cold water through the thermode for 5 min. Heart rate (HR) was evaluated by measuring the intervals of R waves of ECG. In chronic spinal rats that were anesthetized with urethane, mean HR was 308 ± 11 beats/min (M ± SE, N=12) before the stimulation, and both in cooling and in heating the thoracic cord an increase of HR was induced. For the experiment in the conscious condition, spinal rats were housed individually into a wire mesh cage (5cm X 6cm X 15cm). Mean HR of spinal rats in conscious condition was 366 ± 18 beats/min (N=6) before the stimulation, and a decrease followed by an increase of HR was observed during the thoraic cooling, while during the thoracic heating a decrease of HR was observed. In these spinal rats, noxious stimulation by pinching the tail skin induced only a slight change in HR. From these facts, it is suggested that the response to the spinal thermal stimulation changed according to the physiological conditions in these experiments.

774, I P (31) 0900

SUPPRESSION OF NONSHIVERING THERMOGENESIS BY DEVELOPMENT OF HEAT-SEEKING BEHAVIOR. NAKAMORI, T.*, MORIMOTO, A. AND MURAKAMI, N. Dept. Physiol., Yamaguchi Univ. Sch. Med., Ube, Yamaguchi 755

Changes in rectal temperature (Tre) during cold exposure (0 ± 1°C) were observed in three groups of rats: heat-seeking, no-behavior and semi-restrained groups. Significant increases in the Tre were observed in the no-behavior and the semi-restrained groups during cold exposure. In the heat-seeking behavior group the Tre remained constant during cold exposure. The increased Tre in the semi-restrained group during cold exposure was markedly attenuated by the systemic injection of β-blocker, indicating that this increase of the Tre was caused by activation of nonshivering thermogenesis (NST). The enhanced NST in the no-behavior and the semi-restrained groups was simultaneously accompanied by a significant increase of metabolic activity in the anterior part of ventromedial hypothalamus. We concluded that the motionlessness during cold exposure is profitable for animals to increase NST when thermoregulatory behavior is not effective enough to gain heat. This increased NST by motionlessness is mediated via activation of hypothalamic function under cold environment.

775, I P (32) 0900

CHANGES IN METABOLIC ACTIVITY OF RAT BRAIN REGIONS DURING HEAT-SEEKING BEHAVIOR IN THE COLD ENVIRONMENT. MURAKAMI, N., MORIMOTO, A. AND ONO, T. Dept. Physiol., Yamaguchi Univ. Sch. Med., Ube, Yamaguchi 755

The central nervous structures involved in behavioral thermoregulatory responses during cold exposure were investigated in conscious rats by means of the 2-deoxy-D-[^{14}C]glucose ([^{14}C]-DG) autoradiographic technique. When animals were only exposed to cold, significant increases in [^{14}C]-DG incorporation were observed in the caudate putamen, lateral preoptic area, medial forebrain bundle, ventromedial hypothalamus (VMH), posterior hypothalamus, ventroposteromedial thalamus (VPM), dorsomedial thalamus (MD), substantia nigra (SN) and the red nucleus (RN). Lower activities were observed in the hippocampus and the medial habenula. However, when animals performed the behavioral thermoregulation (heat seeking behavior), significant increases were noted in the sulcal prefrontal cortex, sensory-motor cortex, and MD, while decreases were also noted in the piriform cortex, VMH, VPM, medial habenula, SN and the RN, compared with those in the group without the thermoregulatory behavior.

776, I P (33) 0900

CHANGE IN SALT INTAKE DURING THE RECOVERY FROM THERMAL DEHYDRATION IN RATS.
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For the full restitution from thermal dehydration in rats, it was shown by us that replacement of NaCl is required (Amer. J. Physiol. 249:R166, 1985).
In this experiment, thermally dehydrated rats were given a choice of tap water and saline, and the salinity of their choice during rehydration was measured for 16 h. Rats were dehydrated by about 8% of their body wt under heat (DBT:36°, RH:20%) for 6 h and then they were provided with tap water and NaCl solution (either 0.9% or 1.8%) simultaneously. The rats consumed more water than saline for about 2 h after the start of fluid replacement while they consumed more saline than tap water thereafter.
The concentration of their choice was about 50 meq/l for the initial 2 h and about 100 meq/l thereafter. Urine output and urinary Na output were only about 20% of their intake during initial 3 h of rehydration, while they became almost equal with the intake in both 0.9% and 1.8% groups thereafter. The change in salt intake was found at about 80% of the final rehydration level. These results indicate that the rats choose dilute salt solution during the initial stage of the rehydration and then regain body fluid isotonically. Studies on the change in blood volume and plasma sodium concentration during the dehydration process is under way.

777, I P (34) 0900

THE ROLE OF PROSTAGLANDINS IN THE DISSOCIATION OF THERMOREGULATORY RESPONSES DURING LPS FEVER.
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When body temperature stabilized at a new elevated level 90 min after LPS i.v. injection, the threshold core temperature for ear cutaneous vasoconstriction (Th v) rose, while the threshold value for shivering (Th sh) fell in neutral environmental temperature; this phenomenon was designated the dissociation of thermoregulatory responses during fever. On the other hand, after PGE_2 injection both Th v and Th sh were increased, compared with the control levels, in parallel with the elevation of core temperature. The present experiments were conducted to ascertain the role of PGE_2 on the mechanisms of the dissociation of thermoregulatory responses during LPS fever.
Experiments were performed on conscious rabbits in a chamber at 25°C. The results obtained were: 1) After inhibition of PGE synthesis by acetylsalicylte (500mg/kg perOs), core temperature, Th v and Th sh did not change significantly. 2) 90 min after i.v. injection of LPS lug/kg in rabbits pretreated with acetylsalicylate, core temperature and Th v rose significantly, while Th sh did not change significantly.
The results support the previous view that there are additional mechanisms, which can not be accounted for prostaglandins, that play an important role in the dissociation of thermoregulatory responses during LPS fever.

778, I P (35) 0900

ENDORPHIN EFFECTS ON THERMAL ADAPTATION TO EMOTIONAL STRESS.
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The effects of intraventricular injection of β-endorphin (ED) on core temperature (T_c) and oxygen consumption ($\dot{V}O_2$) were studied in rats under immobilization stress with wire mesh for 3 hours once a day for 10 days. The stress induced a rapid fall in T_c and $\dot{V}O_2$ during initial 1 h followed by further progress of hypothermia. Repeating the stresses, the hypothermic responses were diminished day by day, and the levels of T_c and $\dot{V}O_2$ at 1 h of stress were significantly less after day 7 of stresses than those on day 1. ED, which induced hyperthermic responses in non-stress state, acted to enhance the stress-induced hypothermic responses if injected at 1 h of stress on day 1, but it on day 10 increased $\dot{V}O_2$, so that accelerated recovery from the hypothermia. Thus ED effects on T_c and $\dot{V}O_2$ were different with the stress states. However, if ED was given at 1 h of the stress every day, diminishment of the hypothermic responses during repeated stresses and hyperthermic responses to ED normally occured by day 10 were not observed. Therefore, ED appeared to inhibit development of adaptational changes in energy metabolism and thermoregulation during stress.

779, I P (36) 0900

SEASONAL VARIATIONS IN LOCAL SWEAT RATE OF MEN. TSUJITA,J., HORI,S., MAYUZUMI,M., AND MEREN,J* Dept. of Physiology., Hyogo Coll. of Med., Nishinomiya 663, *Dept. of Physical Education, Mukogawa Women's Univ., Nishinomiya 663

Observation of sweat rate on different parts of the body surface was made on six young men in summer and winter. Each subject, dressed in shorts only, sat in a chair in the room of 20-22 °C with 70% relative humidity for 30 min. Then each subject in the sitting-resting position was exposed to a hot environment for 2 hrs. Physiological responses to heat were measured under four different environmental conditions, 35 °C and 50% R.H., 35 °C and 70% R.H., 40 °C and 50% R.H., and 40 °C and 70% R.H. Samples of local sweat from the forehead, forearm, chest, abdomen and thigh were collected for a 5 min. period using the filter paper method.

Sweat volume was greater in summer than in winter and onset of sweating was earlier in summer than in winter. There were considerably individual differences and seasonal variations in sweating patterns. Heidromeiosis occured later and rate of decrease in sweat rate during heidromeiosis was smaller in summer than in winter.

780, I P (37) 0900

THERMAL INSULATION IN MAN AT A SIMULATED DEPTH OF 10 M. SAGAWA, S., YOSHINO, H., KONDA, N., SHIRAKI, K., AND YOUSEF, M. K. Dept. of Physiol., Sch. Med., Univ. Occup. Environ. Hlth., Kitakyushu 807; Des. Biol. Res. Cent., Univ. Nevada, Lasvegas, U. S. A.

Thermal insulation during rest and exercise was evaluated in 5 men wearing wet suits during water immersion (water temperature: 25°C) to the neck at 1 ATA and 2 ATA (10 m water depth). Each subject performed leg exercise for 20 min at a work intensity of 2.5 mets following a 40 min-rest. Heat flux from the surface of the skin and the wet suits, esophageal (Tes) and skin (Tsk) temperatures, and metabolic heat production were measured to estimate thermal insulation of the tissue (Itis) and wet suits (Isuit). A significant reduction ($p<0.05$) in Isuit and a concomitant increase in Itis were observed during resting at 2 ATA. The decreased Isuit was attributed to a reduction of bubble layer in the suit, and increased Itis was a vivid sign of vasoconstriction at the hyperbaric environment. Exercise reduced Itis and increased $\bar{T}sk$ and Tes at both 1 and 2 ATA, however, the increase in Tes and $\bar{T}sk$ was less at 2 ATA. Consequently, an attenuated heat storage during exercise at 2 ATA was attributed to an increased heat loss from the skin, i.e. a reduced Isuit.

781, I P (38) 0900

COLD INDUCED VASODILATATION IN THE RATS. AZUMA, T. Dept. Physiol., Mie Univ. Sch. Med., Tsu 514

The cold induced vasodilatation response (CIVD) in rats anesthetized with sodium pentobarbital was produced by immersing the tail, front paw pad or back paw pad in cold water for 15 to 30 minutes. An increase or decrease of CIVD was dependent upon the ambient temperature, water temperature of the bath, and age. CIVD was most pronounced under the conditions where the ambient temperature was 33°C, or water temperature was around 0°C. CIVD was observed in the rat over three week old. The number of rats showing CIVD decreased with ambient temperature below 27°C. Injection of 2% lidocaine (0.2 ml) produced a marked decrease of CIVD in the tail or back paw pad. After the nerves supplying the paw pad were severed in 8 rats, CIVD temporarily increased and disappeared completely in 2 weeks; this phenomenon might be due to degeneration of the nerves. Administration of tolazoline gave rise to a significant increase of CIVD in the back paw pads of 5 rats. In contrast, administration of norepinephrine disappeared the CIVD in 5 rats. These results strongly suggest the appearance of CIVD in the rats requires an involvement of the nervous system.

782, II F 1015

RETARDED GROWTH OF THE SUPRACHIASMATIC NUCLEUS AND PINEAL BODY IN dw AND lit DWARF MICE. Noguchi, T., Sugisaki, T., Kudo, M. and Satoh, I. Depts. of Physiol. and Path. and R.I. Res. Unit, Gen. Res. Center, Toho Univ. Sch. Med. Tokyo-143.

The suprachiasmatic nucleus (SCN) and the pineal body in 3 types of inherited hormone-deficient mice, the dw, lit and hyt mice were examined morphological, morphometric and biochemical techniques. In the dw and lit mice the SCN was underdeveloped. In the ventral part of the SCN, where most of the retinal fibers appeared to terminate, both cell number and cell size were decreased, although the size of the SCN was unaltered. In addition, the pineal bodies of both mice were morphologically underdeveloped and showed low levels of N-acetyltransferase activity. In contrast, the hyt SCN was comparable to the normal controls in every respect. The hyt pineal was well developed and showed levels of enzyme activity comparable to the controls. However, in all the deficient mice, the optic nerve appeared to be normal in morphological and biochemical studies. These results suggest that the underdevelopment of the pineal body, the reduced levels of spontaneous locomotion and the indistinct diurnal periodicity of the dw and lit mice might be related to the retarded neuronal growth of the SCN, and that growth hormone likely is indispensable for the development of the SCN.

783, II F 1030

CIRCADIAN LOCOMOTOR RHYTHM IN SCN LESIONED RATS; EFFECTS OF METHAMPHETAMINE. HONMA, S. HONMA, K. AND HIROSHIGE, T. Dept.Physiol., Hokkaido Univ.Sch.Med., Sapporo 060

We reported a marked change in rats' circadian locomotor rhythm by chronic treatment of methamphetamine, which can be explained by its effects on the circadian system. In this experiment, rats were lesioned in the suprachiasmatic nucleus (SCN), the putative site of the circadian oscillator, and treated with methamphetamine to further clarify the mechanism of the change in locomotor rhythm. Materials and Methods Wistar female rats were lesioned in the SCN electrolytically and loss of the circadian rhythm was comfirmed by a chi-square spectrum method. Spontaneous locomotor activity was measured continuously by an ANIMEX under light-dark cycle (LD 12:12). Rats were administered methamphetamine either dissolved in drinking water (0.0025 or 0.005%) or filled in a mini-osmotic pump (Alzet model 2002) which was implanted subcutaneously. Results By methamphetamine treatment, robust locomotor rhythms (period around 26 h) appeared in the SCN lesioned rats. The period was longer under the treatment with 0.005% than with 0.0025%. After the withdrawal of methamphetamine, SCN lesioned rats became arrhythmic again with a traisient period of several days in most cases. These results indicate that the changes in locomotor rhythm by methamphetamine is induced not by changes in the circadian system but by the manifestation of another oscillation which interacted with the circadian oscillation.

784, II F 1045

Ontogenesis of PHI-containing neurons in the rat SCN. ISHIKAWA K. and L.A. FROHMAN (Div. Endo. & Meta., Univ. Cincinnati, Cincinnati Ohio USA).

The ontogenesis of PHI-containing neurons in the rat SCN has been studied by immunohistochemistry, using a specific anti-serum. Both immunoreactive neural perikarya and processes were first detected in the SCN on day 18 of gestation, long before they became evident in other brain structures (such as the cortex, amygdala, hippocampus, paraventricular nucleus, bed nucleus of stria terminalis, lateral geniculate nucleus). These PHI neurons in the SCN showed an immature aspect being faint and small. During the subsequent three days of fetal life, they rapidly increased in number and scattered over the SCN by day 21. After birth, they rapidly increased in intensity of the staining and in number. By day 10 postnatally, they distributed throughout the entire extent of the SCN, although the population of PHI neurons was still small as compared with that in the adult rat. Between the day 10 and 20, PHI neurons within this structure showed a dramatic increase in intensity of the staining. The neurons in the 20-day-old rat SCN were mature, well developed and intensely immunoreactive, as in the adult.

785, II F 1100

PHASE-DEPENDENT RESPONSES OF HUMAN CIRCADIAN RHYTHMS TO A BRIGHT LIGHT PULSE : EXPERIMENTS IN A TEMPORAL ISOLATION UNIT.
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Human sleep-wakefulness and body temperature rhythms have been demonstrated to entrain to an artificial bright light cycle in a temporal isolation unit (J. Physiol. Soc. Japan 47:496, 1985). In order to understand the mechanism of light entrainment, the response of human circadian rhythms to a bright light pulse was examined under free-run conditions in a temporal isolation unit.
Materials and Methods Four healthy male students (20 to 27 years old) lived alone in an temporal isolation unit for 3 weeks without knowledge of the time of day. Rectal temperature and sleep time were measured continuously. Subjects were allowed to turn-on and -off the lights of low intensity (about 500 lx). On the 7th and 14th days, the unit was illuminated with the lights of 5,000 lx for a period of 3 or 6 hours.
Results Circadian rhythms of sleep-wakefulness and rectal temperature in all subjects free-ran with a period longer than 24 h. A bright light pulse turned-on at the early subjective day produced an advance phase-shift of the circadian rhythms, while that placed at the late subjective day had no effect on the phase of the circadian rhythms. This phase-dependent responses of the circadian rhythms to the light pulse provide evidence for a non-parametric entrainment to the light cycle in human circadian system.

786, II F 1115

PHASE RESPONSE CURVE, FREE-RUNNING PERIOD, AND ACTIVITY TIME IN CIRCADAIN LOCOMOTOR RHYTHMS OF RATS.
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Phase-response-curves(PRCs) for running wheel activity rhythms were studied in rats by applying short light pulses(200 lx) under constant illumination(DD) for every two weeks Phase shifts of rhythms were yielded by three different light pulses of 0.5hr, 2hr, and two pulses (separated for 1.5hr) of 0.5hr. A "Standard shapes" of PRCs of nocternal rodents was obtained by 0.5hr pulses. While, PRCs by 2hr and two pulses of 0.5hr, phase advance section of the late subjective night was absent. Histograms of both circadian period(τ) and activity time(α) analysed in total number of 119 observations by 0.2-hourly bin did not show a Gaussian distribution. A correlation coefficients between T and A caluculated in 119 estimation was not significant. Correlation between inter individual means of τ and α was negative, significantly. In half of the animals tested, intra individual correlation of τ and α was significantly positive. These results may indicate that τ or α length does not always relate to the shape of PRC.

787, II F 1130

EFFECTS OF PEPTIDE HORMONES ON CIRCADIAN SLEEP RHYTHM IN BRATTLEBORO RATS.
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Circadian rhythm in sleep-wakefulness and locomotor activity were examined in female Brattleboro rats (homozygous for diabetes insipidus, DI) genetically deficient for vasopressin. Their rhythms were compared with those of young cycling Sprague-Dawley(SD) and Brattleboro rats (heterozygous for DI, non-DI). The suprachiasmatic nucleus(SCN), which has been known to be an important area for central circadian oscillating systems and to have vasopressin(VP), somatostatin(SRIH) or vasoactive intestinal peptide(VIP) containing neurons. DI rats showed the circadian slow wave sleep(SWS), paradoxical sleep(PS) and locomotor activity under light-dark(L:D=14:10) schedule. The constant dark(DD) exposure of DI rats reduced the circadian cyclicity of SWS and PS, but did not alter the circadian locomotor activity. While the DD exposure of SD rats enhanced the circadian PS rhythm. The intraventricular administration of monoclonal antibody for VIP and anti-rabbit serum to SRIH(anti-SRIH) in DI rats disrupted the circadian SWS rhythm for 1 or 2 days. While in SD and non-DI rats, anti-VIP and 2-O(Met)TyrAVP (an antagonist of VP) did not alter the circadian SWS and PS rhythm. Therefore, VIP and SRIH neurons, correlating with VP neurons, may play the important role for central regulation of circadian rhythm and the SCN may have multiple oscillating mechanism.

788, II F 1145

ENTRAINMENT OF CIRCADIAN BEHAVIORAL RHYTHMS OF RATS TO THE PERIODIC AVOIDANCE-TASK. ABE, H., KIDA, M. AND MANO, T. Dept. VI, Res. Inst. Environ. Med., Nagoya Univ., Nagoya 464.

In order to search for the possibility of entrainment of circadian rhythms to a periodic event of environment except for the lighting and feeding, Sidman avoidance task was assigned to rats only for one hour at a fixed time in a day (periodic task) in the constant darkness (DD) for about 40 days. Sidman avoidance task was performed with the procedure that a footshock presented for 0.3 sec. every 10 sec. could be postponed for 25 sec. by pulling the lever. Circadian locomotor and feeding rhythms free-ran under DD condition without the periodic task. However, these free-running rhythms were stopped by the periodic task. A stable phase relationship between the rhythms and the periodic task was formed, so that the offset of active phase coincided with the task time. After elimination of the periodic task, the rhythms free-ran again, but the initial phases of these rhythms did not correspond to the phases obtained by extrapolation from the rhythms observed before the periodic task. These results might suggest that the periodic task could entrain the circadian behavioral rhythms in rats.

789, I P (17) 0900

COMPLEX PHASE-LOCKED RESPONSES OF MOLLUSCAN NEURON. ISHIZUKA, S. AND *HAYASHI, H. Dept. Physiol., Fac. Dent., Kyushu Univ., Fukuoka 812 *Dept. Electronics, Fac. Engineering, Kyushu Univ., Fukuoka 812.

Self-sustained oscillation of excitable membranes synchronizes to a periodic stimulation because of its nonlinear characteristics: threshold and refractory period. m/n-harmonic responses (m and n are integers, $m < n$) are also observed under proper stimulus parameters. The m/n-harmonic responses (periodic sequences) mean the membrane fires m times every n periods of the stimulation.

Poincaré return map is useful to investigate periodic or aperiodic oscillations; the return maps are obtained from intersections between trajectories in a three-dimensional phase space, $(I, V, \dot{V})$ and a plane, $\dot{V} = \text{constant}$. In the present report, complex phase-locked responses of a pacemaker neuron of Onchidium to a sinusoidal current stimulation were analysed by means of the return maps.

Periodic sequences, {1/1-, 4/5-, 3/4-, 2/3-, 3/5- and 1/2-harmonics}, were observed between the regions of 1/1- and 1/2-harmonic responses when the frequency of the stimulation was slowly sweeped. One-dimensional return maps of $\{I_n\}$ indicate that the m/n-harmonic responses are caused by a periodic switching of the orbit between the branches of 1/n- and 1/(n+1)-harmonic oscillations.

790, I P (18) 0900

EFFECTS OF PHOTOPERIOD AND AMBIENT TEMPERATURE ON CIRCADIAN RHYTHMS OF PREFERRED AMBIENT TEMPERATURE SELF-CONTROLLED BY THE DJUNGARIAN HAMSTER, PHODOPUS SUNGORUS. TOKURA, H. Lab. Physiol., Dept. Clothing Sci., and Div. Human Life and Environ. Sci., Graduate Div. Human Culture, Nara Women's Univ., Nara 630

I attempted to make clear the significance of photoperiod and ambient temperature for the circadian rhythms of preferred ambient temperature self-controlled by the animal itself. When the animal pressed the small lever located at the corner side of animal cage, cool air of 10°C poured into the animal room for 10 min, resulting in lowering an ambient temperature of either 30°C or 20°C several degrees. The hamster pressed the lever more frequently under short photoperiod of 8 hr light-16 hr dark than under long photoperiod of 16 hr light-8 hr dark, i.e., the animal preferred cooler ambient temperature under short photoperiod. Furthermore, the animal pressed the lever often at definite times of day, indicating that there exists circadian rhythms of preferred ambient temperature.

791, I P (19) 0900

CIRCADIAN CELLULAR MECHANISM OF NON-PARAMETRIC AND PARAMETRIC ENTRAINMENTS. HASEGAWA, K. AND TANAKADATE, A. Dept. Physiol., Kitasato Univ. Sch. Med., 1-15-1 Kitasato, Sagamihara 228

Non-parametric and parametric entrainments of circadian cellular pacemaker are examined with a phase plane technique, which is based on a mathematical simulation of limit cycles of the circadian behavioral rhythm in a population of a single-celled animal, Paramecium. In the simulation, two processes are assumed: 1) a process directly coupled to a photoreceptor, which quickly causes passive outward flow of intracellular ions (mainly K^+) on the onset of light and keeps the flow during the photoperiod; and 2) a process involving an active transport of extracellular ions (mainly K^+) into the cell, which is gradually encouraged after the onset of light and slowly discouraged after the offset of light. The simulation well matching with experimental limit cycles predicts that: 1) difference in time constants of emergeces of the two processes causes transient decrease of the intracellular ions, which may cause to reset the phase of the pacemaker (the non-parametric entrainment); and 2) keeping the active transport against the passive outward flow during the photoperiod, acts to slow down the pacemaker oscillatcn (parametric entrainment).

792, ⅢH1115

RELATIONSHIP BETWEEN VENTILATORY RESPONSES AND TETANIC STIMULATION DURING VOLUNTARY CONTRACTIONS OF THE TRICEPS SURAE.

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Dept. Bio-Dynamics, Toho Univ. Sch. Med., Tokyo 143

The ventilatory responses were studied about five healthy men, whose intermittent tetanic contractions were evoked with the electric stimulus on the triceps surae of the right leg, while rhythmic voluntary contractions were generated on the other left leg. The purpose of this study were to exermine comparative changes in pattern of breathing at the tetanic contractions and the circulatory occlusion added externally. Circulation were occluded by thigh cuff (280 Torr) for 2 min during 4 min on voluntary contractions. During these experimental conditions, $\dot{V}E$, $\dot{V}O2$ and $\dot{V}CO2$ were measured by the method of breath by breath. Also, ECG and EMG of the left vastus lateralis were recorded every 15 sec during these contractions.

At the initial period of cuffing, marked hyperpnea was associated with the elapsed time of muscular contractions. Circulatory occlusion resulted in a remarked increase of $\dot{V}E$ despite with little change of ventilatory responses on $\dot{V}O2$ and $\dot{V}CO2$. These results suggest that neural pathways might play a fundamental role on the ventilatory responses to tetanic contractions, and then humoral pathways would perform a little role on these conditions.

793, ⅢH1130

EFFECTS OF LATERALITY AND IMMOBILIZATION OF ARM ON WALKING PATTERN.

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To clarify the effects of functional laterality in the upper limb and restricting motion at a shoulder on walking pattern, five right-handed and six left-handed subjects performed treadmill walking at speeds ranging from 50 to 130m/min, with an increment of 10m/min. At each speed, mean step length, step duration and shoulder rotation of 200 steps were determined by means of a computerized system. In the upper limb, both left-handed and right-handed subjects showed great shoulder rotation of the same side of the handedness. When an arm was tied to the trunk, the rotation of untied shoulder increased in comparison with normal gait. On the other hand, in the lower limb, right step length was generally longer than left step length in both groups. In addition, the difference between right and left step length was larger in right-handed subjects. During walking with an arm tied to the trunk, there was hardly any change in the pattern of lower limb movement. It was confirmed that the movement patterns of the upper and lower limbs during walking showed a right-left asymmetry which was closely related to the handedness.

794, ⅢH1145

THE EFFECTS OF VIBRATORY STIMULATION AND WEIGHT LOADING ON THE ERROR MAGNITUDE IN FOREARM POSITION SENSE.

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To elucidate the mechanism of the error induced by finger pointing task, further experiments were performed in healthy adults with a specially devised protractor previously used. Either a vibrator with 1 mm in amplitude or 1 kg weight belt was used for stimulation. Two types of vibratory stimuli of relatively low frequency (30 Hz) and the optimal frequency for TVR (100 Hz) were applied to the most effective portion (the spine of scapula close to the acromion) and the effects on the cutaneous receptors and proprioceptors of the shoulder were examined. By 100 Hz stimulus the error magnitude was significantly increased in either hand and the errors shifted downward in the dominant hand, while either direction in the nondominant hand as compared with control (without vibration). In addition, the error magnitude was increased more in 100 Hz stimulus than 30 Hz stimulus. These results suggest that the rapidly and slowly adapting receptors exert influences on accuracy of the position sense. Although weight loading slightly increased the error magnitude, the direction of the errors was opposite to that in vibratory stimulation in the dominant hand and upward or downward in the nondominant hand.

795, ⅢH1300

ELECTROMYOGRAPHIC ANALYSIS OF DELAYED MUSCLE SORENESS AFTER MUSCLE FATIGUE.
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Five male subjects volunteered for this study in order to elucidate the changes in the myoelectric signal characteristics at delayed muscle soreness after plantar flexion test which had contracted concetrically and eccentrically. Myoelectric signals were picked up by one electrode attached over the belly of the triceps surae muscles. The muscle soreness were determined using pressure transdusor. The subject was asked to indicate verbally when the sensation of pressure changed to one of discomfort.

Maximal voluntary force was reduced in both muscles after exercise, the reduction being significant only in the muscle which had contracted eccentrically when pre-exercise values were compared with those at 5 and 60 min after exercise(fatigue). The force did not recover to pre-exercise values until 24h after exercise. The changes in electrical activation(IEMG) were seem during the exercise test. The only muscle which had contracted eccentrically showed increase electrical activation for the generation of a given muscle tension. Subjective soreness was reported by all subjects in the triceps surae muscle which had contracted only eccentricallyin the exercise test. The soreness was fist apparent approximatly 12h after exercise and reached maximal intensity between 24 and 48h after exercise in different subjects.

796, ⅢH1315

EFFECT OF EXERCISE TRAINING ON ZINC METABOLISM IN HUMAN BLOOD. OHNO,H. AND YAHATA,T. Dept. Physiol., Asahikawa Medical College, Asahikawa 078-11.

It has been demonstrated that runners are disposed to marginal zinc deficiency in addition to sports anemia. The present study examined fasting erythrocyte and plasma zinc concentrations during 10-week physical training in 7 previously sedentary male students. The training consisted of running over 5 km six times per week. Maximum aerobic capacity and 12-min walk-run performance increased significantly after 10 weeks training. Although there were no definite changes in hematocrit and hemoglobin levels after training, plasma iron concentration decreased significantly. The erythrocyte concentrations of total zinc and of zinc derived from carbonic anhydrase isoenzyme I (CA-I) increased significantly after training, from 40.0 and 31.3 to 44.4 and 34.4 $\mu g \cdot gHb^{-1}$, respectively, whereas no such effects were noted in CA-II-derived zinc, CuZn superoxide dismutase-derived zinc and other zinc. On the other hand, plasma total zinc concentration did not vary substantially after training although albumin-bound zinc concentration declined significantly. After training plasma α_2-macroglobulin concentration showed a significant elevation and alkaline phosphatase activity appeared to rise. Exercise training may stimulate production of zinc-dependent enzymes in erythrocytes or other tissues.

797, ⅢH1330

Investigation of optimum amount of exercise from view point of mobilization characteristics of serum free fatty acids. Iwagaki,S. and Kazami, M. Dept. physiol. Tokai Univ. Sch. physical education. Hiratsuka-city, 259-12

Repetitious swimmings of rats caused qualitative and quantitative changes in lipid metabolism and the changes were different with number of the swimmings. Especially mobilization of serum free fatty acids(FFA) was biphasic and significantly influenced on stored triglyceride(TG) and cellular component lipids. In the initial swimmings, imbalance between the mobilization of serum FFA and lipolysis of the TG was brought about instant decrease of the TG. In the mobilized phase the TG recovered and showed steady state during the swimmings. At the peak, decrease of phospholipids(PLs) and changes in the fatty acid composition were appeared and amount of the repetitious swimmings influenced on cellular component lipids. But in the following mobilization of serum FFA, the TG and PLs decreased again. Cardiolipin(CL) increased during the swimmings, but at the later mobilization of serum FFA skeletal muscle CL especially decreased at below the normal level. From these results, significance of the optimum amount of exercise was observed in the time when serum FFA maximally was mobilized; appearance of influences on cellular component lipids. But at the amount of swimmings over the optimum number of swimmings biochemical disruption in mitochondria(CL) occured. Then, under these biochemical changes different significance of exercise would be existed.

798, ⅢH1345

PERSONAL SPACE PERCEPTION IN HUMAN EXTREMITIES.

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In order to examine the personal space perception, the bisection method was devised. The test was conducted on both arms and legs in 315 healthy adults. Each subject, with his (her) eyes closed, was instructed to stop the swing motion of his (her) certain joint at the point he (she) considered to be the middle of the range of possible motion. Joints tested were shoulder, elbow, metacarpophalangeal and knee joints. Mean values of bisected angles (MBA) in the shoulder joints were deviated from the middle points in the direction of horizontal adduction, and the deviation was larger in the right arms. MBA in the elbow joints were deviated in the direction of extension, and the deviation was larger in the horizontal plane than in the vertical plane. The deviation from the mid-bisection point in the index finger and the standard deviation, and also the two point threshold on the thumb side of the palm in the proximo-distal direction, were less when the hand was positioned most comfortably and near the face than when the hand was positioned in the more uncomfortable position and further from the face. MBA in the knee joints were deviated in the direction of extension, and the deviation was smaller at the extended position of the hip joint. It is suggested that the personal space perception is warped in the range of motion at each joint.

799, ⅢH1400

IS EMG ACTIVITY CONSTANT DURING AT VARIOUS KINDS OF CONSTANT SPEED?

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In order to study the correlation between EMG activity, respiratory and circulatory responses, the surface EMG of limb muscles(tibialis anterior, medial and lateral sides of gastrocnemius, vastus lateraris, biceps femoris), heart rate,respiratory rate, ventilation and oxygen-intake were measured during treadmill walking at various kinds of constant speeds. An apparatus of automated metabolic analyzer, a cassette data recorder and telemeter were used for the determination of these items. In general, it is said that EMG activity is constant during exercise. However, the decline of surface EMG activity at a few minutes after start of treadmill-running, ground-running and one leg cycling of bicycle ergometer recognized significantly without the decrease of oxygen-intake, which had already been reported. On the contrary, these phenomena did not occured during one hand ergometric motion and hand walking. On the occasion of walking, the declines of surface EMG activities of both sides of gastrocnemius and biceps femoris at a few minutes after start of exercise were recognized significantly without the decrease of oxygen-intake. These phenomena were observed during high speed walking easily.

800, ⅢH1415

EFFECT OF TRAINING ON CREATINE KINASE ISOENZYMES OF HEART AND SKELETAL MUSCLE.

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The purpose of this study is to clarify whether training induces the changes of creatine kinase (CK) isoenzymes composition of muscle. Male Wistar strain rats were used in this study and divided into 3 groups, sprint, endurance training, and control groups. The soleus (Sol), the extensor digitolum longus (EDL), and heart were excised, homogenized. After centrifugation, the supernate were used in the assay of CK isoenzymes composition (CK-MM, -MB, and -BB). After sprint training CK activity in heart was higher than endurance and control groups, while in Sol and EDL there were no differences between training and control. In Sol, sprint or endurance training increased CK-MB% compared with control, on the other hand in heart and EDL no differences were observed in CK isoenzyme composition. In conclusion, the possibility that the origin of serum CK-MB elevation after exercise or training is muscle tended to increase.

801, ⅢH1430

URIC ACID METABOLISM AT EXERCISE (5TH REPORT)— EFFECT OF EXERCISE ON PRESECRETORY RE-ABSORPTION, SECRETION AND POSTSECRETORY REABSORPTION OF URATE IN RENAL TUBULE. MIKAMI, T., MURAKAMI, H., SAITO, A., HADANO, S., KANAI, C., GOTO, K., ONO, T. AND ITO, A. Institute of Health and Sports Science, Tsukuba Univ., Sakuramura, Niiharigun, Ibaragi 305

The purpose of this study was to investigate the effect of exercise on presecretory reabsorption, secretion and postsecretory reabsorption of urate in renal tubule. Five healthy male subjects performed exhaustive running on a treadmill three times. Prior to exercise they were given drugs which changed the handling of urate in renal tubule. The administration of durgs was as follows: 100 mg of benzbromarone in experiment 1, 4 g of pyrazinamide and 100 mg of benzbromarone in experiment 2, 4g of pyrazinamide and 1000 mg of probenecid in experiment 3. On basis of the data of these experiments, the rates of glomerular filtration, presecretory reabsorption, secretion and postsecretory reabsorption of urate were calculated. The results were as follows. 1) The rate of presecretory reabsorption was 99.2±0.6% before exercise and didn't significantly change after exercise. 2) The rate of secretion was 40.7±14.3% before exercise and significantly decreased to 9.6±2.3% and 23.1±13.2% 3 min and 1 hour after exercise respectively($p < 0.05$). 3) The rate of postsecretory reabsorption was 82.2±8.9% before exercise and had no significant change after exercise. These results suggest that exercise-induced decrease of renal urate excretion is caused by decreased urate secretion and the decreased urine pH is concerned.

802, ⅢH1445

EFFECT OF EXERCISE TRAINING ON THE COUPLING CONDITIONS BETWEEN β-RECEPTORS AND GUANINE NUCLEOTIDE REGULATORY PROTEINS. IZAWA, T., KOMABAYASHI, T., TSUBOI, M. AND KOSHIMIZU, E. Lab. Exercise Physiol., and Dep. Pharmacol., Tokyo Coll. Pharma., Tokyo 192-03

Recently, it has been suggested that the receptor-cyclase coupling is enhanced in adipocytes from exercise trained rats. The present study was designed to clarify the effect of exercise training on the coupling conditions between the β-adrenergic receptors and guanine nucleotide regulatory proteins (N_S) in rat adipocyte membranes by means of an assay of the agonist-induced [^{3}H]GDP release.

Exercise training significantly increased the release of [^{3}H]GDP in response to isoproterenol and adenylate cyclase activity induced by Gpp(NH)p in rat adipocyte membranes. These results suggest that the enhanced adenylate cyclase activity induced by exercise training may be responsible for, at least in part, the potentiated "turn-on" reaction, although the [^{3}H]GDP-release based on the actual amount of N_S-protein present in the membrane could not be defined.

803, IP⑩0900

VISUAL STABILIZATION OF POSTURE - REFERENCE TO SIZE OF VISUAL FIELDS. WATANABE, S., TAKAGI, S., TAKABAYASHI, A., HASHIBA, M., MORI, S. and SAKAKIBARA, M. Dept. Aerospace Physiol., Res. Inst. Environ. Med. Nagoya Univ. Nagoya 464 and Dept. Otorhinolaryngol. Nagoya City Univ. Sch. of Med. Nagoya 467.

During stance the body sways incessantly and irregularly though small. This sway is stabilized by vision as well as proprioceptive inputs from somatsensory and vestibular organs. Also a clinically applied visual test is well known as the Romberg test in patients suffering from either proprioceptive sensory dysfunction of cerebellar ataxia. Visual stabilization of the posture is practiced to feedback a movement of visual scene. According to this point of view, we examined effects of visual field by changing the size. Subjects were placed on a force-plate and were tested for sway with free stance of Romberg position under different visual conditions such as; 1)gazing a fixiation point in the light, or 2)in the dark, 3)eyes opened but covered by black spectacles in the dark, 4)gazing a fixiation point with one eye through each centrally holed spectacle from 20° to 50°. As results, in the dark whether gazing a fixiation point is placed or not, the body sway was characterized by the frequency spectrum, in which the amplitude increased in 0.2 - 0.5 Hz. By limitation of visual field the body sway increased in the same frequency ranges as in the dark, and the smaller the size the greater the sway. The visual stabilization of posture have greater relation to visual field.

804, I P (11) 0900

SWIMMING EXERCISE-INDUCED CHANGES OF THE ETHANOL METABOLISM AND ADMINISTERED ETHANOL LEVELS IN RATS. TACHIYASHIKI, K., IMAIZUMI, K., TAKAMATA, A., TODA*, N. AND OGITA*#, Z-I. Dept. Living & Health Sci., Joetsu Univ. of Educ., Joetsu, Niigata 943 and #Dept. Pathol. Biochem., Res. Inst. for Oriental Med., Toyama Med. & Phrmaceu. Univ., Toyama 930-01.

The effects of swimming(1hr., 25°C) on the ethanol(EtOH) metabolism and time courses of EtOH concentration levels were studied by successively measuring concentrations of EtOH in the stomach, liver and plasma of male SD rats(275 ± 21g, n=80) to which EtOH(1g/Kg B.W.) was orally administered. The specific activity of alcohol dehydrogenase(ADH) in the liver homogenate was also determined. The inner temperatures in the liver and rectum during and after swimming were quickly measured after decapitation, at about 30 minute intervals. The survival percentage of total EtOH in the stomach decreased according to the apparent first order kinetics. The apparent rate constants(k_d) for swimming group and the control were $0.087min^{-1}$ and $0.037min^{-1}$, respectively. The k_d value for swimming group is 2.4 times higher than that for the control. The disappeared times of EtOH in the plasma and liver of swimming group elongated significantly 1.40 to 1.48 times than those in the control. The maximum concentrations of EtOH in the liver and plasma did not affect appreciably by swimming. No liver ADH activity was varied with swimming. The inner temperature of liver was essentially similar to that of rectum. The rectal and liver temperatures after swimming became from ~38°C to ca. 27°C.

805, I P (12) 0900

A TRIAL FOR MEASURING OXYGEN UPTAKE USING WIRELESS TELEMETER. IKEGAMI,Y. AND MIYAMURA,M. Research Center of Health, Physical Fitness and Sports, Nagoya University. Chikusa-ku, Nagoya 464

A new system for wireless telemetry of oxygen uptake was developed. Oxylog type-S (P.K. Morgan, England) which is a portable type for measuring oxygen uptake was used to obtain pulmonary ventilation and oxygen uptake ; ventilation and oxygen uptake for one minute can obtain as 8 and 10 bits parallel digital electric pulses, respectively. These two signals were transformed to serial signals and modulated by FM method (low level : 239Hz, high level : 326Hz). In addition, the modulated signals were transferred to a transmitter of a telemeter system (model 271, Sanei Instrument,Japan) and transmitted with 76.47MHz carrier wave. The signal from the transmitter was received and demodulated to the serial pulses. The serial pulses were again transformed to 8 and 10 bits parallel digital pulses corresponding to the measured values both of ventilation and oxygen uptake. These data were transferred to a personal computer to calculate related values such as oxygen uptake per body weight etc. and to display and print out the results of measurements. Ventilation and oxygen uptake measured by the new system were compared to those obtained by Douglas bag method to examine the accuracy of the new system.

806, I P (13) 0900

VENTILATORY AND HEART RATE RESPONSES TO HYPOXIA IN TRACK AND FIELD ATHLETES. OHYABU, Y.,USAMI, A.*,ISHIDA, Y.*,MIYAGAWA, C.*,ARAI, T.*,OHYABU, I.*,SATO, M. AND HONDA, Y. Dept. Physiol., Chiba Univ. Sch. Med.,Chiba 280
Dept. Physical Education, Tokai Univ.,Kanagawa 259-12 *

Sixty-six track and field athletes(27 long distance runners, 25 sprinters and 14 throwers) and 18 non-athletes were examined by an isocapnic progressive hypoxia test.

The results of ventilatory and heart rate responses to hypoxia were analyzed by the hyperbola equation.

1) Sprinters exhibited a significantly less ventilatory response ($\Delta\dot{V}_{E40}$) than the non-athletes. 2) Long distance runners, sprinters and throwers exhibited a significantly higher hypoxic ventilatory sensitivity, A_{VEN}, than the non-athletes. 3) The vertical asymptote in P_{ETO2} for infinite ventilation, C_{VE}, in all athletes groups was smaller than that of non-athletes. 4) Heart rate sensitivity to hypoxia, A_{HR}, in long distance runners and throwers was significantly higher than that of non-athletes. 5) The vertical asymptote in P_{ETO2} for infinite heart rate, C_{HR}, in all athletes groups was also smaller than that of non-athletes.

These results suggested that characteristic features of hypoxic ventilatory response are similar with those of hypoxic heart rate response in different athletes groups.

807, ⅢF1100

TEMPERATURE ACCLIMATION AND FATTY ACID(FA) COMPOSITION OF SKELETAL MUSCLES. OGAWA,K., OHNO,T., AND KUROSHIMA,A. Lab. of Physical Educat., Hokkaido Tokai Univ., Lab. of Nutrition Physiol., Hokkaido Univ. of Educat. and Dept. of Physiol., Asahikawa Medical Coll., Asahikawa.

Enhanced nonshivering thermogenesis(NST) is a well-known phenomenon in the cold-acclimated organism. Brown adipose tissue is shown to be a major site for NST. However, skeletal muscle is also claimed to be involved in an enhanced NST.

The present study examined the effect of thermal acclimation on FA composition of triglyceride(TG) and phospholipid(PL) in the skeletal muscles of rats, since lipids are important constituents for cell function as fuel reserve(TG) as well as membrane component(PL). Cold acclimation caused no significant changes in TG-FA in the muscles, while it increased polyunsaturated(PU) and decreased saturated and monounsaturated(MU) PL-FA of white quadriceps(Q), resulting in increased unsaturation index and C20-4/C18-2(AI) and bringing these values close to those of red Q. Similar changes were also observed in the soleus PL-FA. On the other hand, heat acclimation increased MU and PU of PL-FA in red Q, but it decreased AI. No significant changes were observed in white Q and soleus. These findings suggest some functional changes in the muscle membrane contributing to modified metabolism induced by thermal acclimation.

808, ⅢF1115

MYOGLOBIN(MB) DETERMINATION BY POLYACRYLAMIDE GEL ELECTROPHORESIS AND EFFECT OF THERMAL ACCLIMATION ON SKELETAL MUSCLE MB. OHNO,T. and KUROSHIMA,A. Lab. of Nutrition Physiol., Hokkaido Univ. of Education and Dept. of Physiol., Asahikawa Med. Coll., Asahikawa.

Modified capacity of nonshivering thermogenesis(NST) is characteristic of metabolic acclimation to cold and heat. Although major site of NST is evidenced to be brown adipose tissue, skeletal muscle has been claimed to be also responsible for NST from histological, histochemical and biochemical viewpoints. The present study was made to evaluate a role of skeletal muscle in NST by observing the changes of Mb. At first we established the method of Mb determination by the use of gel electrophoresis. Mb level was higher in red quadriceps(Q) and soleus than in white Q. Heart showed the highest value among the tissues examined. Diaphragma showed the intermediate level between red and white Q in 11 wk old rats. These values, except heart, were higer in the older rats(28 wk old) than in the younger ones. Cold acclimation for 4 wk at 5 ℃(11 wk old) elevated Mb level in white Q, heart and diaphragma, but not in red Q and soleus. Longer cold acclimation(5 ℃, 21 wk, 28 wk old) effected higher Mb level in white Q. Cold-acclimated rats reard in cold for 20 generations(11 wk old) showed higher Mb levels in all tissues than the age-matched warm controls. Heat acclimation(33 ℃, 4wk) caused no significant changes in Mb levels. These results suggest that Mb may be involved in cold-induced enhancement of muscle thermogenesis.

809, ⅢF1130

SEASONAL CHANGES IN PLASMA AND AORTIC LIPIDS IN DOMESTIC RATS. HASHIMOTO, H., FURUI, H., HARA, T. AND MASUMURA, S. Dept. Physiol., Shimane Medical Univ., Izumo, Shimane 693

Young, female Wistar rats were housed at a constant temperature (19 ± 1°C) and plasma and aortic lipids were examined. Plasma lipids in winter and spring significantly decreased as compared with those determined during the summer months. Here, decreasing percentages were 28.4 % for total cholesterol, 36.1 % for (HDL + LDL)-cholesterol, 46.0 % for triglyceride and 8.9 % for phospholipid ($p<0.05$). Aortic triglycerides increased 2.5 times in winter and spring in comparison with the values in summer, whereas aortic total cholesterol and phospholipid levels remained unchanged. The seasonal variations in plasma and aortic lipids in these domestic rats were observed under conditions of the constant temperature.

810, ⅢF1145

SEX DIFFERENCES IN THE EFFECT OF URIC ACID ADMINISTRATION TO FASTING ANIMALS

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Analbuminemic rat (NAR) died within 18 hrs whereas other rats, Wister, Charles River, Sprague Dawley, survived over 40 hrs, when the animals were kept without food at 5°C. Administration of uric acid extended survival of female NAR in that condition and incresed body temperature of female NAR and SD rat. Furthermore uric acid administered C57BL/6J-ob/ob mouse survived 4 weeks whereas no injected mouse survived only 1 week. The effect of uric acid on survival of male rat was negative. Those effect on female rat abolished by ovariectomy. When C57BL/KsJ-db/db mouse was administered the mixture of uric acid and estradiol, it did not get obesity whereas uric acid alone had no effect on that mouse. When radiolabelled uric acid was administered to control lean mouse, appreciable amount of radioactivity was found in its ovary.

811, ⅢF1300

ENHANCEMENT OF METABOLIC AND CARDIOVASCULAR RESPONSES TO FEEDING ACTIVITY IN FREELY MOVING SPONTANEOUSLY HYPERTENSIVE RATS.

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Atrial temperature (T_{at}), heat production ($\underline{M}$) and mean arterial blood pressure (BP), and feeding (FA) and locomotor (LA) activities were measured every min over a 24-hr period in 10 spontaneously hypertensive rats (SHR) and 10 their normotensive controls (Wistar Kyoto rats; WKY) at an ambient temperature of 24 ± 0.2°C. Clear circadian changes in all variables were observed in both groups except for BP and LA in SHR. In the light phase (0600 - 1800 hr), SHR moved more frequently and seemed to eat more food than WKY. However, the total amount of food consumed for the 2 consecutive days was the same in both SHR and WKY. Compared with WKY, average $\underline{M}$ and BP in the light and dark phases and FA and LA in the light phase only were significantly higher in SHR. The responses of T_{at} in a day, $\underline{M}$ in the light phase and during the whole day, and BP in the light phase to FA were significantly enhanced in SHR. There were no such significant differences of responses in T_{at}, $\underline{M}$ and BP to LA between SHR and WKY. The results suggest that SHR is hyper-responsive in metabolism and cardiovascular system particularly in the light phase of a day, and SHR may expend more energy in response to the same amount of energy intake during the day.

812, ⅢF1315

BROWN ADIPOSE TISSUE CHARACTERISTICS IN WILD RODENTS.

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Four species of wild rodents were captured with live traps and snap traps in Mt. Yatsugatake and Tobira pass over several years throughout four seasons. The weight of the brown adipose tissue (BAT) was measured in the field mice (Apodemus speciosus), wood mice (Apodemus argenteus) and red-backed vole (Eothenomys smithi, Clethrionomys andersoni). The relative weight of the BAT was greatest in the animals raised for two weeks at captured sites after trapping. The seasonal changes of the BAT were also marked in all species, especially in winter. On the other hand, the BAT value in animals died of cold in the live traps was lowest. In the animals, there was neither seasonal change nor difference of interspecies. The BAT values in animals killed on the spot by snap traps were greater in mice than in voles. As for the BAT composition in wood mice, the lipid component weight in animals died of cold was remarkably lower than those in snap-trapped and raised groups.

813, ⅢF1330

ROLE OF THE HIPPOCAMPUS ON THESTRESSFUL HORMONES SECRETION AND THERMO-REGULATION UNDER THE IMMOBILIZATION STRESS. MOHRI,M.,NEGORO,H.AND HIGUCHI,T. Japan Marine Science and Technology Center Yokosuka 237, Dept. of Physiol., Fukui Med. Sch., Matsuoka 910-11

Effects of immobilization stress on stressful hormone secretion and colonic temperature(T_{col}) were studied in intact and stereotaxic fornical sectioned male rats. Both rats were forced to immobilize 7 days each day for 6 h. 1st stress remarkably decreased Tcol, however, 7th stress did not change Tcol in intact rats. In other rats, 1st and 7th stress markedly decreased Tcol. The rats whose fornix was severed less the secretion of oxytocine, prolactin and corticosterone than the intact rats.The secretion of stressful hormones in both rats were remarkably increased by 1st stress, however, these hormones were not changed by 4th and 7th stress.

The relation between the control mechanism of stressful hormone secretion by the hippocampus-fornix-hypothalamus system and body temperature regulation was discussed.

814, ⅢF1345

COUNTER-CURRENT RESPONSE OF EAR VESSELS TO COLD. UEDA,G., YANAGIDAIRA,Y., TAKEOKA.M., AND KASHIMURA,O. Dept. Environmental Physiol. Shinshu Univ. Sch. of Medicine, Matsumoto, 390

Approximately the peripheral one-third of rabbit's earlobe was immersed (n=16) into liquids of 6 ℃ to -6℃. At the central artery, the temperatures, proximal (T_1) and distal (T_2) sites outside the liquid, were measured continuously. Simultaneously the proximal (T_4) and distal (T_3) temperatures were measured at the posterior marginal veins. Besides, the tip area of the artery inside the liquid was measured. Both analog and digital recordings were attempted. The steady levels for one hour immersion were compared. The differences for $T_1 - T_2$ and for $T_4 - T_3$ were denoted as ΔA and ΔV. The values ΔV were greater than those of ΔA for example in three among four cases of 6 ℃ cold at 5～20 min. The similar tendency appeared also for -6 ℃ stimulus. In both cases, the incidence of " $\Delta V > \Delta A$ " was greater at the initial phase than at the later. This is considered to be due to warming effect from artery to venous side. The incidence of $\Delta V > \Delta A$ was 5/8 for analog data and 5/8 also for digital data. Thus the counter current response was assumed in ear vessels. The calculation was programmed in basic words.

815, ⅢF1400

EFFECTS OF CENTRIFUGAL ACCELERATION EXPOSING TO Z AXIS OF THE HAMSTERS' BODY UPON CARDIOPULMONARY FUNCTIONS. SATAKE,H., MIZUNO,Y.[1], MATSUNAMI,K. and WATANABE,S.[2] Inst. Equilibrium Res., Gifu Univ. Sch. Med., Gifu 500, [1]Daido Inst. Tech., Nagoya 457, [2]Res. Inst. Environ. Med., Nagoya Univ., Nagoya 464

Previously we examined the cardiopulmonary reactions of hamsters by exposing to -Gz centrifugal acceleration (from foot to head), which showed the remarkable decreases in stroke volume (SV), cardiac output (CO), tidal volume (TV) and minute volume (MV). Even when exposed to -10Gz animals recovered fully to the control condition after the cessation of an exposure. In this study we aimed to investigate the directional difference of Z axis in cardiopulmonary responses. All hamsters were anaesthetized with Nembutal during exposure of +2Gz and +4Gz (head to foot). Heart rate decreased slightly during +Gz exposure. SV and CO showed a transient decrease in early stage followed by a respondent increase and held a certain decreased level. Respiratory rate was decreasing slowly during 4G exposure. MV also decreased remarkably. These results suggest that ischemia of the brain occurs because +Gz cause a pooling of blood in the lower parts of the body, resulting in a decrease of venous return from the peripheral vesseles. It is supposed that the reductions of TV and MV are caused by the immobility of the thorax and shoulder girdle which limits thorax expansion. It is considered that +Gz exposure affects cardiopulmonary system more severly than -Gz exposure.

816, ⅢF1415

EFFECT OF ACUTE EXPOSURE TO SIMULATED HIGH ALTITUDE ON WATER AND ELECTROLYTE METABOLISM IN MAN---INFLUENCE OF SPIRONOLACTONE---. MIYAMOTO, N., TAMURA, Y., SEO, H., MURATA, Y., KANDA, K. AND MATSUI, N. 2nd Dep. Res. Inst. Environ. Med., Nagoya Univ., Chikusa-ku, Nagoya 464

Acute exposure to simulated high altitude causes a decrease in serum K due to hyperventilation and an increase in aldosterone concentration. The latter increase may exaggerate the disturbance of electrolyte metabolism. Present investigation was carried out to clarify the effect of increased secretion of aldosterone on hypoxia-induced electrolyte disturbances by inhibiting peripheral action of aldosterone. Twenty male subjects, of which 10 were administered 100 mg of spironolactone (SP) and the other 10 placebo, were exposed to simulated 6,000 m altitude (2-hr ascent, 2-hr sojourn and 2-hr decent). In SP group, an initial rise of serum Na observed in control was abolished. The decreases by altitude exposure in urine volume, urinary Na excretion and urinary Na/K were less than control. The rises of plasma renin activity, noradrenaline, serum cortisol, aldosterone and the increase in urinary adrenaline were all larger in SP group. Plasma atrial natriuretic polypeptide slightly rose by the exposure in both groups but the difference was not significant.

From the results it is concluded that the increase in aldosterone secretion by acute altitude exposure contributes to exaggerate disturbances in electrolyte metabolism.

817, ⅢF1430

EFFECTS ON RED CELL DEFORMABILITY OF EXERCISE UNDER ACUTE AND CHRONIC EXPOSURE TO A LOW ATMOSPHERIC PRESSURE. KIKUCHI, Y., ASANO, K.*, AND OHSHIMA, N. Dept. Bioeng., Inst. Basic Med. Sci., and *Dept. Work Physiol., Inst. Health and Sport Sci., University of Tsukuba, Ibaraki 305

Studies were made on red cell deformability and other hematological properties in humans (members of a party for Himalaya expedition) before and after exposure to atmospheric pressure of 354 Torr (corresponding to altitude of 6,000 m; chamber was decompressed in 30 minutes) and also after cycling exercise (50 W, 30 minutes) at that pressure. Marked increases in hematocrit and plasma protein concentration, which suggest a considerable water shift from blood plasma to interstitial spaces, were observed immediately after attaining the decompression. Deformability of red cells, which was evaluated by their mean passage time through 5 μm diameter pores, was also found to be considerably impaired. Whereas, changes observed after exercise were relatively small in comparison with those marked effects of hypoxia only. These results suggest that the oxygen transport to tissues at high altitudes is impeded not only by environmental hypoxia but also by a reduced blood volume and impaired blood flow properties. Measurements made after the party returned home suggested that some adaptative processes appeared to have operated; even a decrease in plasma protein concentration after the exposure to hypoxia and an increase in red cell deformability after the exercise were observed in some cases.

818, ⅢF1445

CARDIAC FUNCTION AT SUPINE REST AND DURING SUBMAXIMAL EXERCISE IN ACUTE SEVERE HYPOXIA. Kikuchi k., and Asano k. Lab. for Work Physiol. Inst. of Health & Sports Sciences, Univ. of Tsukuba. Sakura, Niihari, Ibaraki 305

The purpose of this study is to clarify the effects of acute severe hypoxia on the cardiac function at supine rest and during submaximal exercise by using the methods of M-mode echocardiography, systolic time intervals(STIs), and impedance cardiography. The physiological measurements were performed at sea level(SL), 4000 m(462 Torr), 5000 m (405 Torr) and 6000 m(354 Torr) simulated altitudes. The results were as follows: <REST> 1) The mean HR and Q were increased in the altitudes significantly compared to SL, but mean SV showed a tendency to decrease. 2) In STIs, all the parameters were decreased in the altitudes and suggested an enhancement of cardiac function. 3) The echocardiographic results also indicated an improvement of LV function, although LVESV was decreased significantly in 5000 and 6000 m altiutdes. <EXERCISE> 1) The SVs under hypoxic conditions were smaller than those at SL. 2) The PEP/LVET ratio reduced from rest to Ex. 1, then increased. From these results, it is suggested that no cardiac dysfunction occurs at rest, but the function tends to be deteriorated by the increase of the work load.

819, ⅢF1500

MODIFICATION OF RHYSUS MONKEY UNDER HIGH GAS DENSITY HYPERBARIC ENVIONMENT (51 bar, ρ=27g/l BTPS, He-N_2-O_2, 4 days).

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A series of simulation dives was carried out to depth of 500m&1200m seawater using Cat and Monkey until 1981 (SEKI et al. 1981, 1982, 1983 1984 and 1985). Experiments was designed to study the effect of High Gas Density Hyperbaric Environment and the use of He-N_2-O_2 gas mixture on polysomnography. Tow adalt Monkeys (male) had been operated on chronically implanted electrodes (EEG, EOG, EMG, EKG and brain Temperature). The experimental schedule was as follows: Predive (1 bar, Air, 2 days) 51 bar (PO_2=0.2 bar, PHe=30.8 bar, pN_2=20 bar Ta=34°C, 4 days), decompression (2.8 days), Postdive (1 bar, Air, 1 day). The results shows: Two monkey stayed at 51 bar for 96 hours. fH and fR increased during sleep and awake time at 51 bar. Body weight of one monkey decreased in -10% and the other increased +6% after decompression. These results show that the action N_2narcotic is antagonism and PHe *per se*.

820, ⅢF1515

Hormone changes in renin-angiotensin system under hyperbaric heliox environment.

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Under hyperbaric helium-oxygen environment, increased nocturnal urine flow has been shown, associated with decreased plasma volume in the early morning. To investigate whether this fluid depleted state persists throughout daytime, hormone levels in renin-angiotensin system and hematocrit(Ht) as well as their responses to tilting(supine to standing position) were examined in 3 men and compared before, during and after 7-day exposure to 31 atmospheres absolute(ATA). Blood samples were obtained at awakening(7:00) and at the time of tilting(8:00-10:00 and 20:00-22:00) in different pressure stages. At awakening, plasma renin activity(PRA), angiotensin I(A-I), aldosterone, cortisol and Ht were higher at 31 ATA than pre- and post-dive period(pre-, post-D). Morning pre-tilt levels of PRA and Ht were lower than their levels at awakening, suggesting certain degree of recovery from dehydrated state in the morning. Evening pre-tilt Ht, however, showed higher level than that in the morning. By tilting, PRA and Ht rose at every pressure stage, and increment from pre-tilt value was larger at 31 ATA than pre-D, and in the morning than in the evening. A-I increased at 31 ATA and post-D morning.

These results suggest that plasma volume is depleted at high pressure, and the fluid depletion is marked in the early morning and a depleted state persists till evening.

821, IP(14)0900

Changes of cardiopulmonary response during centrifugal acceleration.

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Cardiopulumonary investigation was conducted in female rats exposed to -Gx (back to abdomen), +Gz (head to tail) and -Gz (tail to head) accelerations, and the intensities of centrifugal acceration were 3,4,5 and 6G. They were anesthetized with pentobarbital sodium at 3mg/100g body weight. Physiological parameters were recorded during the last 5 minutes before start, during the entire 30 minutes acceleration period and for 10 minutes after the centrifuge stopped. The recorded parameters were heart rate (HR), blood pressure (BP), respiratory frequency (RF), tidal volume (TV) and respiratory minute volume (MV). Results: 1) While HR did not change during -Gx exposure, it decreased during +Gz and -Gz exposures. The rate of the decrease was greater in -Gz exposure than in +Gz exposure. 2) BP decreased during every exposure, in order of +Gz, -Gz and -Gx. 3) Although transthoracic impedence Zo decreased during -Gx and -Gz exposure, it increased during +Gz exposure. This suggests that interthoracic blood volume is increased by -Gx and -Gz accelerations and that blood volume in the lower body is increased by +Gz acceleration. 4) RF increased during -Gx exposure, and it showed a decreasing tendency corresponging to the intensity to the exposed +Gz and -Gz accelerations.

822, I P (15) 0900

SINGLE UNIT ACTIVITY OF THE HYPOTHALAMUS UNDER HYPERBARIC ENVIRONMENTS IN RATS.
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Single unit activity of hypothalamic neurons in the lateral hypothalamic area and paraventricular nucleus was recorded with chronically implanted electrodes in rats. Neurons in the prefrontal cortex and central medial thalamus were also recorded for comparison. Out of 38 hypothalamic neurons, 19 reversibly decreased their firing rate to 67%, on an average, under high pressure (7 atmospheres absolute) of air compared with precompression control. On the other hand, the remaining 19 neurons and all prefrontal and thalamic neurons tested were unaffected. Decreased hypothalamic unit activity was also found under normobaric hyperoxic environment and normoxic hyperbaric environment. In separate acute experiments, activities of hypothalamic neurons were recorded in the isolated forebrain preparation: the brain was cut transversly between the hypotalamus and midbrain with a knife. Out of 5 neurons, 3 were depressed and 2 were unaffected at 7 atmospheres absolute. The results suggest that hyperbaric air directly acts on the forebrain and specifically depresses the hypothalamic neurons by means of increased partial pressure of both oxygen and nitrogen.

823, I P (16) 0900

IN VIVO KINETICS OF ETHANOL ADMINISTERED ORALLY TO RAT.
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The in vivo kinetics of ethanol (Et-OH: dose = 100mg/100g B.W. as 30%) administered orally to male Sprague-Dawley rat (322 ± 14g, n=47) was studied by measuring the concentrations of Et-OH in the stomach, liver and plasma. At 30 minute intervals, Et-OH concentrations were determined with gas-chromatograph. The specific activity of alcohol dehydrogenase (ADH) in the soluble fraction of liver was also determined by measuring the formation rate of NADH at 340 nm. No liver ADH activity was induced by Et-OH administration. After administration, Et-OH level in the liver reached to maximum at 20 to 30 min. and maintained its maximum concentration up to ca. 100 min.. The plasma Et-OH level became to maximum at 80 to 90 min.. The decay processes of Et-OH in three compartments obeyed to apparent first order kinetics. The apparent decay rate constants of Et-OH in the stomach, liver and plasma were 0.026 min^{-1}, 0.025 min^{-1} and 0.011 min^{-1}, respectively. The order of the decay rate constant of Et-OH was stomach ≈ liver > plasma. The decay rate constant for liver was 2.3 times larger than that for plasma, reflecting that Et-OH degradating enzymes are contained only in liver. In conclusion, Et-OH level in each compartment depends upon the time after administration of Et-OH and the functional characteristics and size of the compartment.

AUTHOR'S INDEX

A

演題番号

ABE, H. 79, 717, 788
ABE, K. 369, 381
ABE, T. 62
ABURADA, M. 105, 106, 148
ADACHI, A. 228
AEBA, A. 483
AIKAWA, S. 314
AIKAWA, T. 719, 721
AIZAWA, K. 6, 23, 127
AKAIKE, N. 191, 204, 205 206, 315
AKAISHI, T. 737
AKASU, T. 184, 189
AKAYAMA, M. 83, 84, 85
AKEMA, T. 736
AKITA, H. 314
AKITSU, H. 611
ALKON, D. L. 124
AMAKAWA, Y. 515
AMANO, T. 171
ANDO, M. 72, 178, 255
ANRAKU, M. 197
AOKI, K. 389
AOKI, M. 281, 300, 554 690, 691, 694, 794
AOU, S. 744
AOYAGI, K. 328
ARAI, O. 467
ARAI, T. 643, 806
ARAISO, T. 8, 678
ARAKI, T. 347
ARATA, A. 688
ARIGA, T. 662
ARIMA, T. 530, 531
ARITA, A. 618
ARITA, H. 684, 692
ARITA, J. 731, 735
ARITA, M. 500, 575
ASADA, H. 266, 291, 372
ASADA, N. 519
ASAHARA, T. 292, 556
ASAHI, R. 644
ASAKI, Y. 757
ASAMI, A. 743
ASAMI, K. 54, 70
ASAMI, T. 62, 743, 765
ASANO, K. 668, 817, 818
ASANO, M. 656
ASANO, S. 77
ASANUMA, A. 173
ASAYAMA, M. 760, 761
ASHIDA, H. 366
ASOU, H. 105, 106, 107 150, 151, 157, 158
ATOMI, Y. 62, 545, 546
ATSUMI, T. 87
AYA, K. 395, 488
AYER, Jr. R. K. 563
AZUMA, M. 354
AZUMA, T. 617, 781
AZUMI, T. 633

B

BABA, K. 496, 497
BAKER, J. F. 290
BAN, T. 271
BANDO, H. 48, 49
BANDO, T. 352
BECKER, W. J. 549
BISHOP, P. O. 360

C

CABANAC, M. 754
CAPRIO, J. 475
CHAEN, S. 543
CHANG, H. 42
CHIBA, A. 193, 376
CHICHIBU, S. 193, 376

D

DE GROAT, W. C. 185
DE HAAN, R. L. 563
DEIE, M. 176
DEJOURS, P. 696
DE LONG, M. R. 339
DOBASHI, K. 645
DOI, A. 56, 57
DOI, K. 706
DOI, Y. 536
DOIDA, Y. 38

E

EBISU, H. 596
EDAKI, A. 153
EDAMURA, M. 300
EDASHIGE, N. 326
EDGERTON, V. R. 285
EGASHIRA, K. 369
EGUCHI, K. 685, 693
EHARA, T. 579, 593, 594
EMURA, A. 510
ENAMI, J. 50
ENDO, K. 347
ENDO, M. 525
ENDOH, E. 661
ENOKI, Y. 650, 676
ENOMOTO, K. 213
ENOMOTO, T. 45
ERA, S. 12, 13, 17 18, 19, 21
EZURE, K. 695

F

FAN, YU-JEN 748
FETZ, E. 435
FROHMAN, L. A. 784
FUJII, H. 17
FUJII, K. 223
FUJII, S. 217, 563

FUJII, T. 53
FUJIMOTO, M. 78, 79, 102 103, 429
FUJINO, M. 233, 530, 531
FUJISAKI, Y. 687
FUJISAWA, S. 365
FUJISHIRO, M. 151, 158
FUJISHIRO, N. 528
FUJISHITA, S. 403
FUJITA, I. 317, 318, 384 386, 744
FUJITA, K. 280
FUJITA, M. 697
FUJITA, Y. 229, 269, 276
FUJITANI, Y. 747
FUJITO, Y. 690, 691, 694
FUJITSUKA, N. 485, 487
FUJIWARA, M. 741, 748
FUJIWARA, N. 145
FUKADA, Y. 438, 441
FUKAI, K. 253, 698
FUKAO, H. 48, 49
FUKUDA, A. 244, 254 258, 382
FUKUDA, H. 29, 253, 698
FUKUDA, M. 319, 324
FUKUDA, Y. 23, 455 673, 682
FUKUSHI, Y. 249, 250
FUKUSHIMA, J. 283
FUKUSHIMA, K. 283
FUKUSHIMA, Y. 100
FUNAHASHI, A. 484
FUNAKOSHI, M. 125, 474 728
FUNASE, K. 199
FURUI, H. 809
FURUICHI, H. 144, 211
FURUKAWA, N. 712
FURUKAWA, T. 461
FURUKAWA, Y. 600
FURUKAWARA, M. 465, 466
FURUYA, K. 132
FURUYAMA, F. 772
FUSE, M. 821
FUWA, T. 285

G

GEMBA, H. 357
GERSHON, M. D. 220
GOMI, S. 518
GONDO, H. 593
GOTO, K. 565, 572, 801
GOTO, Y. 583, 588
GOTOH, H. 165
GOTOW, T. 409
GRADY, M. K. 669
GREMMELT, A. 273

H

HABARA, Y. 771
HADA, J. 433
HADA, R. 483
HADANO, S. 801
HAGIHARA, K. 436
HAGIWARA, N. 79, 103
HAMADA, I. 339
HAMAGUCHI, K. 326
HAMAI, Y. 651
HAMAMURA, M. 726, 739
HAMANAKA, S. 314
HAMASAKI, T. 435
HAMASUNA, S. 655, 667
HANADA, Y. 383
HANAI, S. 613, 637
HANAWA, I. 430
HARA, T. 703, 809
HARADA, A. 406
HARADA, E. 32
HARADA, H. 269, 276
HARADA, K. 799
HARADA, Y. 157, 158, 187
HARIYAMA, T. 406
HARRISON, R. E. W. 290
HARUTA, R. 433
HASEGAWA, H. 20, 154, 666
HASEGAWA, K. 47, 59, 61 791
HASEGAWA, M. 645
HASEGAWA, S. 664
HASHIBA, M. 803
HASHIGUCHI, M. 71
HASHIGUCHI, T. 174, 175
HASHIMOTO, H. 809
HASHIMOTO, M. 25
HASHIMOTO, N. 36
HASHIMOTO, R. 732
HASHIMOTO, T. 459
HASHIMOTO, Y. 163, 412
HASHIMURA, S. 197, 409
HASHITANI, T. 762
HASHIZUME, K. 555
HASUO, H. 189
HATA, Y. 436
HATAE, J. 528
HATAKEYAMA, I. 75, 610
HATAMOTO, H. 639
HATANAKA, H. 112
HATASE, O. 56, 57
HATO, F. 51, 52
HATTORI, M. 749
HATTORI, Y. 349
HAYAMA, T. 478
HAYASHI, H. 65, 261, 618 789
HAYASHI, I. 616
HAYASHI, R. 549
HAYASHI, Y. 349, 433, 434
HAYASHIDA, Y. 369
HAZAMA, A. 135
HE, B. 375
HIDA, E. 452
HIGASHI, H. 134, 145 202, 203
HIGASHI, T. 62, 654
HIGASHITANI, Y. 218
HIGUCHI, H. 521
HIGUCHI, K. 556
HIGUCHI, T. 724, 727 734, 813
HIGUCHI, Y. 615
HIJI, Y. 126, 708

HIJIKAWA, H. 76
HIJIRIKAWA, K. 203
HIKOSAKA, O. 288, 344
HIKOSAKA, K. 377
HIMUKAI, M. 716
HINCKEL, P. 767
HIRAKAWA, S. 561, 668
HIRAKAWA, T. 192
HIRAMATSU, Y. 29
HIRAMOTO, Y. 36
HIRANO, K. 167
HIRANO, S. 105, 106, 107
150, 151, 157, 158, 167
HIRANO, T. 169, 254
HIRANO, Y. 573, 585
HIRAOKA, M. 564, 585
HIRATA, K. 753, 754, 755
HIRATA, Y. 152
HIRONO, C. 119, 120, 132, 147
HIROSE, T. 719
HIROSE, Y. 293
HIROSHIGE, T. 733, 783
HIROTA, A. 577, 578, 590
HIROTA, K. 62
HIRUTA, S. 681
HISADA, M. 275
HISHIDA, F. 279
HISAMITSU, T. 252, 287
HONDA, K. 391, 496, 497
724, 727, 734
HONDA, T. 623, 624
HONDA, Y. 674, 683
700, 806
HOMMA, I. 688, 689, 703
HOMMA, S. 267, 278, 375
553, 713
HONGO, T. 270
HONMA, K. 733, 783, 785
HONMA, S. 783, 785
HORI, A. 364
HORI, H. 108
HORI, S. 162, 255, 714, 779
HORI, T. 743, 744, 765, 766
HORI, Y. 278, 349
HORIE, H. 108, 149
HORIE, M. 569
HORIE, N. 649
HORIGUCHI, K. 4
HORIKAWA, J. 471
HORIKOSHI, T. 173
HORIUCHI, J. 602, 627
HORIUTI, K. 525
HORIO, T. 385
HOSHI, T. 34, 66, 81, 133
HOSHI, M. 241
HOSHINA, Y. 363
HOSHINO, M. 164
HOSHINO, T. 238, 242, 256
HOSOGAI, M. 747
HOSOI, K. 87
HOSOI, S. 63
HOSOKAWA, K. 90
HOSOKAWA, Y. 462, 471
HOSOMI, H. 603, 619, 620
621, 626
HOSOYA, E. 105, 106, 148
HOTTA, H. 234
HOTTA, K. 526, 538
HOTTA, M. 561
HOTTA, Y. 408
HOTUMI, K. 314
HUKUHARA, T. Jr. 686, 687
HURUKAWA, C. 303
HYONO, A. 39

I

ICHIKAWA, O. 126
ICHIKAWA, S. 502, 688, 689
ICHIKAWA, T. 298, 405, 599
ICHIKI, M. 493
IDE, Ch. 229
IFUKU, H. 616
IGARASHI, K. 611, 612
IGARASHI, Y. 583, 588
IGARI, T. 428
IGUSA, Y. 36
IGUSA, Y. 117
IIO, M. 390
IIZUKA, S. 105, 106, 148
IKAWA, S. 821
IKAWA, Y. 271
IKEDA, H. 320
IKEDA, K. 201, 458
IKEDA, R. 655, 667
IKEGAMI, S. 383
IKEGAMI, Y. 805
IKEHARA, T. 90
IKEMOTO, Y. 115, 592
IKESHIMA, K. 60
IMAGAWA, M. 6
IMAI, H. 653, 661
IMAI, K. 14
IMAI, S. 144, 211
IMAI, Y. 31, 68, 74, 80, 96
IMAI-MATSUMURA, K. 770
IMAIZUMI, K. 14, 804, 823
IMAIZUMI, M. 541
IMANAGA, I. 582, 718
IMANISHI, T. 161
IMAZATO, C. 179
IMOTO, T. 708
IMOTO, Y. 593
INAGAKI, Y. 599, 600
INAMURA, K. 245, 260
INASE, M. 395
INATOMI, K. 582
INOKUCHI, H. 146
INOMATA, H. 499
INOMATA, K. 241
INOUE, A. 79
INOUE, H. 151, 166, 316, 408
INOUE, I. 136
INOUE, M. 191, 205
INOUE, S. 391
INOUE, T. 296
INOUE, Y. 166
INOUYE, Y. 638, 704
IRIKI, A. 294, 295
IRIKI, M. 757, 758, 777
IRIMAJIRI, A. 54, 70, 97
IRISAWA, H. 566, 567, 568
569, 589

IRIUCHIJIMA, J. 631, 636
ISA, T. 297
ISHIDA, A. 558, 559
ISHIDA, Y. 806
ISHIGE, A. 105, 106, 148
ISHII, K. 696
ISHIKAWA, K. 784
ISHIKAWA, T. 67, 235, 384
ISHIKAWA, Y. 767
ISHIKO, N. 236
ISHIZAWA, M. 503
ISHIZUKA, I. 301
ISHIZUKA, S. 115, 789
ISOBE, A. 502, 689
ISOBE, Y. 786
ISOGAI, Y. 262
ISOJIMA, C. 532
ISOMOTO, A. 25, 654
ISONO, K. 407
ISU, N. 290, 298
ITANO, T. 56, 57
ITO, A. 665, 801
ITO, F. 113, 484, 485
486, 487
ITO, H. 614, 628
ITO, I. 119, 120, 147
ITO, K. 216, 547, 738
ITO, S. 437, 471, 479, 713
ITO, T. 579, 594
ITO, Y. 2, 439, 512, 729
ITOGA, H. 343
ITOH, K. 105, 106, 107
148, 150
ITOH, M. 513
ITOH, S. 632
ITOH, T. 608
ITOW, H. 393
IWAGAKI, S. 797
IWAI, E. 377
IWAI, T. 22, 704
IWAMOTO, H. 514, 544
IWAMOTO, J. 741, 748
IWAMURA, Y. 344
IWANO, T. 84
IWASE, K. 241
IWASE, S. 245, 246, 260
IWATA, J. 600
IWATA, K. 343
IWATA, M. 178, 255
IWATSUKI, N. 65
IZAWA, T. 28, 802

J

JIJIWA, H. 470

K

KABA, H. 329, 330
KAGAWA, T. 706
KAGAMIHARA, Y. 272
KAI, Y. 259, 382
KAJI, S. 361
KAJIWARA, K. 107, 150, 257
KAJIYA, H. 476
KAKIUCHI, Y. 643
KAKU, S. 4
KAKUDO, Y. 710
KAMEDA, K. 29, 381
KAMEI, K. 112
KAMEYAMA, M. 570
KAMINO, K. 577, 578, 590
KANAI, C. 801
KANAI, K. 640
KANAI, S. 35
KANAMATSU, K. 167
KANAZAWA, M. 71
KANBE, M. 88, 101
KANDA, K. 179, 555
816, 820
KANEKO, A. 411, 414, 415
416, 449
KANEKO, K. 99
KANEKO, M. 607
KANG, Y. 347
KANEMOTO, H. 390
KANNAN, H. 722, 723, 822
KANNO, T. 33, 55, 67, 91
KANNO, Y. 45, 46
KANO, M. 143
KANOSUE, K. 752
KARADI, Z. 382
KARAKIDA, T. 713
KASAGI, T. 708
KASAHARA, Y. 475
KASAI, M. 723
KASAI, S. 60
KASHIHARA, Y. 264
KASHIMURA, O. 814
KATADA, A. 365, 367
KATAFUCHI, T. 315
KATAGIRI, Y. 717
KATAKURA, T. 75, 610
KATAYAMA, Y. 153, 221
222
KATO, C. 580
KATO, F. 686, 687
KATO, H. 215, 216, 217, 218
KATO, K. 19, 255
KATO, M. 283, 333, 725, 730
KATO, N. 351
KATO, R. 109
KATO, S. 427
KATO, T. 113
KATOH, K. 65
KATOH, S. 303
KATSUDA, S. 430
KATSUKAWA, H. 728
KATSUNO, Y. 733
KATSUTA, Y. 437
KAWABATA, M. 323
KAWABATA, M. 327
KAWABATA, N. 361
KAWADA, M. 603
KAWAKAMI, K. 821
KAWAKAMI, T. 108
KAWAGUCHI, S. 351
KAWAGUCHI, T. 810
KAWAGUCHI, Y. 322
KAWA, K. 123
KAWAHARA, K. 679
KAWAI, N. 196
KAWAI, Y. 597
KAWAMURA, H. 383

KAWAMURA, S. 410
KAWAMURA, T. 440, 539
KAWANO, K. 15, 302
KAWANO, S. 564
KAWANO, Y. 523
KAWASAKI, F. 214
KAWASAKI, H. 690, 691, 694
KAWASAKI, I. 714
KAWASAKI, T. 299
KAWASAKI, Y. 149
KAWASE, M. 650
KAWASHIMA, T. 1
KAWATA, H. 528
KAWATA, M. 619, 620, 626
KAWATANI, M. 185
KAWAWAKI, H. 370, 371
KAYANO, F. 347
KAZAMI, M. 797
KIDA, M. 788
KIDA, K. 18
KIDOKORO, Y. 117
KIHARA, H. 197
KIHIRA, M. 507, 508
KIKKAWA, S. 613
KIKUCHI, H. 48, 49, 644
646, 664
KIKUCHI, K. 818
KIKUCHI, M. 378
KIKUCHI, Y. 817
KIM, H. K. 431
KIMURA, F. 284, 457, 731
732, 735, 736
KIMURA, H. 682
KIMURA, J. 566
KIMURA, M. 391, 558, 559
KIMURA, N. 686, 687
KIMURA, S. 51, 52
KINJO, K. 651
KINOSHITA, C. 326
KINOSHITA, M. 136, 190
750
KINOSHITA, Y. 39, 51, 52
54, 97, 663
KIRCHNER, F. 273
KIRIYAMA, H. 32
KISHII, K. 144, 211
KISHIMOTO, T. 36
KISHIMOTO, Y. 159
KITA, H. 214
KITADA, Y. 494
KITAGAWA, K. 453
KITAHARA, M. 6, 660
KITAMURA, R. 495
KITAMURA, T. 269, 276
KITANI, K. 35, 711
KITANO, S. 697
KITANO, T. 540
KITAOJI, H. 442, 455
KITASATO, H. 38, 88
KITAOKA, K. 326
KITASATO, H. 89, 101, 140
KIYOHARA, S. 475
KIYOHARA, T. 743, 744
765, 766
KIYOSUE, T. 500, 575
KOBASHI, M. 228
KOBAYASHI, H. 176, 209
614
KOBAYASHI, K. 168
KOBAYASHI, S. 314
KOBAYASHI, T. 544, 682
KODAMA, T. 396, 397
KOGA, H. 766
KOGA, M. 47, 50, 59, 61
KOGA, N. 684, 692
KOGURE, I. 285
KOGURE, S. 331
KOHNO, T. 4
KOHSAKA, S. 151, 161
166, 316
KOHZUKI, H. 650, 676
KOIBUCHI, N. 725
KOIDE, T. 596
KOIKE, H. 274
KOIKE, T. 365, 367
KOISHI, H. 715
KOJIMA, S. 561
KOKUBUN, S. 586
KOMABAYASHI, T. 28, 802
KOMATSU, A. 697
KOMATSU, Y. 435
KOMATSUBARA, J. 107
150, 257
KOMETANI, K. 540
KOMIYA, H. 616
KOMODA, Y. 391
KOMURO, H. 577, 578, 590
KON, K. 657
KONDA, N. 750, 780
KONISHI, M. 539, 587
KOSAKA, M. 741, 748
KOSHIMIZU, E. 28, 802
KOSHITA, M. 526
KOSHIYA, N. 684, 692
KOSUGI, T. 651
KOTERA, K. 78, 102, 103
KOUYAMA, N. 448
KOYAMA, N. 311, 312
KOYAMA, S. 603, 619, 620
621, 626
KOYAMA, T. 8, 678
KOYAMA, Y. 317, 318
KOYANO, H. 238, 242, 256
KOZEKI, K. 393
KRASNEY, J. A. 670
KUBA, K. 177, 183
KUBO, K. 746, 778
KUBO, M. 369
KUBO, Y. 169
KUBOTA, K. 355, 356
KUDO, M. 782
KUDO, N. 270, 277
KUDO, Y. 171
KUDOH, M. 465, 466
KUJIRAOKA, T. 423, 450
KUKITA, F. 131, 139
KUKITA, K. 132
KUMADA, M. 598, 684, 692
KUMAMOTO, E. 183
KUMAZAKI, M. 762
KUMAZAWA, N. 100

KUMAZAWA, T. 84, 472 685, 693
KUMODE, O. 102
KUNO, M. 187, 192, 264, 629
KURAHASHI, M. 241
KURASAWA, I. 293
KURATA, H. 552, 798, 799
KURIHARA, K. 87
KURIHARA, S. 539, 587
KURIYAMA, H. 33
KURODA, H. 37
KURODA, Y. 168
KUROKAWA, K. 42, 671
KUROSAWA, E. 229
KUROSAWA, M. 233
KUROSAWA, N. 20, 154 666
KUROSAWA, Y. 281, 691
KUROSHIMA, A. 756, 771 807, 808
KUSAKA, Y. 10
KUSAKARI, J. 458
KUSUMOTO, S. 536
KUWABARA, N. 389
KUWAHARA, H. 374
KUWANA, S. 675, 702
KUWATA, K. 12, 13, 17 18, 19
KWAN, C. Y. 9

L

LEE, S. 370, 371
LEE, R. G.* 549
LUO, C. P. 287

M

MAEDA, M. 629
MAEDA, N. 16, 642, 657
MAEKAWA, M. 359
MAENO, T. 195
MAKINO, K. 615
MAKINO, Y. 647, 648
MANABE, M. 695
MANO, N. 339
MANO, T. 245, 246, 260, 788
MARU, E. 366
MARUHASHI, J. 191
MARUI, T. 475
MARUMO, F. 73
MARUNAKA, Y. 38, 88 89, 140
MARUTA, K. 505
MARUYAMA, E. 229
MARUYAMA, M. 655, 667
MARUYAMA, N. 465, 466
MARUYAMA, R. 673, 674 683, 700
MARUYAMA, T. 41, 206
MARUYAMA, Y. 66, 133
MASAKI, H. 78
MASAKI, R. 83
MASKE, R. 360
MASUDA, M. 749
MASUDA, T. 311, 312
MASUDA, Y. 599
MASUI, H. 436
MASUMURA, M. 809
MASUYAMA, H. 674
MATSUBARA, I. 522, 576
MATSUDA, H. 7, 567
MATSUDA, K. 628
MATSUDA, M. 273, 652
MATSUDA, T. 565, 572
MATSUI, A. 263, 265
MATSUI, H. 56, 57, 720
MATSUI, N. 816, 820
MATSUI, Y. 263, 265
MATSUKAWA, K. 237, 624
MATSUI, Y. 524
MATSUMOTO, A. 236
MATSUMOTO, H. 274, 388
MATSUMOTO, I. 719, 721
MATSUMOTO, J. 388, 394
MATSUMOTO, M. 182
MATSUMOTO, N. 431, 473
MATSUMOTO, T. 91, 93, 94
MATSUMURA, K. 751, 768
MATSUMURA, M. 355, 524
MATSUMURA, Y. 79, 102 103
MATSUNAGA, H. 66, 133
MATSUNAMI, K. 1, 815
MATSUNARI, S. 374
MATSUO, H. 620, 621
MATSUO, O. 48, 49
MATSUO, R. 306, 752
MATSUOKA, T. 200
MATSUSHITA, H. 536, 810
MATSUTANI, T. 152
MATSUYAMA, K. 308, 309 310
MATSUURA, H. 593
MATSUURA, N. 345
MATSUURA, S. 192, 370 371, 629
MATSUURA, T. 454
MATSUZAWA, K. 507
MATTHEWS, E. K. 718
MAYUZUMI, M. 779
McDONALD, T. F. 562
MEREN, J. 779
MIFUNE, T. 10
MIHARA, H. 655, 667
MIHARA, S. 225
MIKAMI, T. 801
MIKI, K. 670
MIKOSHIBA, K. 158, 161 166
MILES, F. A. 302
MINAGAWA, T. 668
MINAMI, T. 258
MINAMI, S. 462, 471
MINAMIYAMA, M. 637
MINE, S. 439
MINOKOSHI, Y. 231, 243
MISATO, E. 558
MISHIMA, K. 24
MITARAI, G. 421
MITSUGI, N. 731
MITSUIYE, T. 115, 592
MIYAGAWA, C. 806
MIYAGAWA, H. 266

MIYAKAWA, H. 215
MIYAKAWA, K. 607, 640
MIYAKE, M. 112, 138
MIYAMAE, S. 565, 572
MIYAMOTO, H. 90
MIYAMOTO, J. K. 229
MIYAMOTO, M. 80, 96
MIYAMOTO, N. 816
MIYAMOTO, S. 554, 794
MIYAMOTO, T. 477
MIYAMOTO, Y. 679
MIYAMURA, M. 681, 805
MIYANO, Y. 339
MIYAOKA, Y. 699
MIYASAKA, K. 711
MIYASHITA, E. 353
MIYASHITA, Y. 332
MIYATA, A. 620, 621
MIYATA, Y. 264
MIYAZAKI, H. 303
MIYAZAKI, M. 608
MIYAZAKI, S. 36
MIYAZAKI, T. 209
MIYAZAWA, T. 384, 591
MIYOSHI, H. 715
MIYOSHI, M. 126, 709
MIURA, K. 18
MIURA, M. 226, 227
MIWA, A. 196
MIZOBE, H. 516
MIZUMURA, K. 472
MIZUNAMI, M. 404
MIZUNO, Y. 815
MIZUSHIMA, Y. 819
MIZUTANI, M. 224, 372
MOCHIDA, S. 176
MOCHIZUKI, M. 707
MOCHIZUKI, T. 163
MOCZYDLOWSKI, E. 137
MOHRI, M. 813
MORI, A. 345
MORI, K. 332, 481
MORI, S. 308, 309, 310, 803
MORIKAWA, T. 683, 700
MORIMOTO, A. 740, 742 774, 775
MORIMOTO, K. 131
MORIMOTO, N. 655, 667
MORIMOTO, T. 296, 608 635, 672, 776
MORIMOTO, Y. 78, 102
MORITA, F. 434
MORITA, H. 603, 619, 620 621, 626
MORITA, K. 221, 222
MORITA, M. 240, 517, 672
MORITA, Y. 362, 388 444, 445
MORIYAMA, T. 261, 462
MORIWAKI, A. 349
MOROOKA, N. 599
MOTOKIZAWA, F. 482
MOTOOKA, T. 470
MURAKAMI, H. 161, 801
MURAKAMI, M. 9, 91, 93 94, 410, 417
MURAKAMI, N. 740, 742 763, 764, 774, 775
MURAKAMI, T. 301
MURAKAMI, T. H. 380
MURAMOTO, K. 327
MURASE, K. 188
MURATA, K. 462, 471, 625
MURATA, Y. 816, 820
MURAYAMA, K. 38, 89, 140
MURAZUMI, K. 756
MURO, M. 550, 792, 795
MUSHA, T. 375
MUSHIAKE, H. 396, 397

N

NABEKURA, J. 258
NAGAI, K. 44
NAGAI, M. 758
NAGAI, T. 208
NAGAMI, K. 534
NAGANO, M. 128, 129
NAGASAKA, T. 733, 753 754, 755, 811
NAGASAKI, H. 392
NAGASAWA, T. 39, 663
NAGASE, S. 810
NAGASE, Y. 367
NAGASHIMA, T. 296
NAGATA, A. 550, 792, 795
NAGATA, T. 434
NAGATA, Y. 178, 255 280, 596
NAGAYAMA, T. 275
NAGAYOSHI, M. 152
NAITO, H. 304, 320, 364
NAITO, K. 345
NAKA, K-I. 420, 452
NAKADA, H. 83
NAKAGAKI, I. 68, 69
NAKAHAMA, H. 387, 395 396, 397, 488
NAKAHARA, Y. 534
NAKAHARI, T. 31, 74
NAKAI, K. 167
NAKAI, M. 353, 622
NAKAJIMA, H. 298
NAKAJIMA, S. 122, 435
NAKAJIMA, Y. 122, 278 375, 553
NAKAMORI, T. 740, 742 774
NAKAMURA, J. 603, 619 620, 621, 626
NAKAMURA, K. 323, 327
NAKAMURA, M. 651
NAKAMURA, T. 296, 362
NAKAMURA, S. 284, 575
NAKAMURA, Y. 293, 294 295, 436
NAKANISHI, S. 4, 187
NAKANISHI, Y. 1
NAKANO, M. 565, 572, 819
NAKANO, S. 534, 565 572, 709
NAKASHITA, A. 665

NAKASHITA, T. 743, 765, 766
NAKAYA, S. 20, 154, 666
NAKAYAMA, H. 354, 819
NAKAYAMA, K. 187, 301
NAKAYAMA, S. 224, 248, 506
NAKAYAMA, T. 751, 752, 768, 770
NAKAYAMA, Y. 527
NAKAYE, T. 424, 446
NAKAZONO, Y. 679
NARA, Y. 73, 606
NARUSE, K. 113
NARUSE, S. 230
NARITA, K. 214
NATSUI, T. 675, 702
NATSUYAMA, T. 608
NEGORO, H. 724, 727, 734, 813
NEGISHI, K. 425, 426
NEMOTO, A. 86, 87
NEMOTO, H. 186, 190, 705
NEMOTO, S. 386
NEYA, T. 224
NEZU, E. 30
NIIJIMA, A. 244, 254
NIIMI, H. 609
NIKARA, T. 363, 547
NIIZEKI, K. 706, 707
NINOMIYA, I. 5, 237
NINOMIYA, Y. 474
NINOMIYA, I. 604, 623, 624, 633, 634
NISHI, S. 118, 134, 146, 201, 202, 203, 374
NISHIBAYASHI, Y. 674, 683, 700
NISHIDA, I. 603
NISHIDA, S. 610
NISHIDA, Y. 619, 620, 621, 626
NISHIGORI, A. 266, 291
NISHIJIMA, H. 537
NISHIJIMA, T. 160
NISHIJO, H. 323
NISHIKAWA, H. 3, 10, 94
NISHIMOTO, Y. 599
NISHIMURA, H. 259, 630
NISHIMURA, M. 4
NISHIMURA, S. 40
NISHIMURA, Y. 292, 556
NISHINA, Y. 11
NISHINO, H. 289, 317, 318, 319, 324, 382, 384, 386, 744
NISHIURA, N. 5, 624
NISHIYAMA, A. 26, 27, 65, 458
NISHIYE, S. 127
NISHIYE, H. 584
NIWA, K. 759
NODA, K. 314, 476
NODA, M. 547
NOGUCHI, T. 156, 782
NOJIMA, K. 641
NOMA, A. 566, 568, 569, 589
NOMOTO, S. 179, 769
NOMURA, H. 551
NOMURA, M. 307, 398, 596
NOMURA, Y. 535
NUNOMURA, T. 753, 754, 755
NORTH, R. A. 225
NOSAKA, S. 155, 625
NOSE, H. 635, 672, 776
NOZAKI, S. 294, 295

O

OBA, T. 538
OBANA, E. 381
OBARA, K. 512
OBARA, S. 180, 208
OBATA, S. 37
OCHI, K. 524
OCHI, R. 571
OGASAWARA, T. 505
OGASAWARA, Y. 661
OGATA, E. 121
OGATA, M. 314
OGAWA, A. 668
OGAWA, H. 478, 479, 491, 492
OGAWA, K. 807
OGAWA, M. 54, 235
OGAWA, T. 437, 760, 761
OGAWA, Y. 161, 552, 798, 799
OGIHARA, T. 24
OGINO, K. 164
OGITA, Z. 804
OGUNI, E. 270
OGURA, A. 171
OGURA, T. 111, 212
OHARA, A. 38, 140
OHARA, K. 762, 772, 786
O'HATA, S. 6, 23, 71, 127, 660
OHBA, M. 595
OHGA, Y. 650, 676
OHGUCHI, Y. 168
OHHASHI, T. 333, 597, 601, 617, 632
OHHIRA, A. 601
OHIRA, T. 668
OHKAWA, H. 247
OHKUBO, C. 656
OHMORI, H. 2, 460
OHNISHI, N. 760, 761
OHNO, H. 796
OHNO, M. 333
OHNO, T. 346, 807, 808
OHNUKI, Y. 759
OHRI, A. 326
OHSAWA, K. 92
OHSHIMA, N. 817
OHTA, A. 313
OHTA, H. 235
OHTA, Y. 308, 309, 310
OHTANI, S. 162
OHTANI, T. 23, 127
OHTSUKA, K. 300

OHTSUKA, T. 448
OHWATARI, N. 741, 748
OHYABU, I. 806
OHYABU, Y. 674, 806
OI, Y. 715
OIKAWA, T. 747
OIKI, S. 43, 135
OKA, H. 321, 350
OKADA, H. 253, 712
OKADA, J. 227
OKADA, K. 48, 49
OKADA, M. 252
OKADA, S. 644
OKADA, T. 39, 581, 663
OKADA, Y. 43, 95, 135
207, 219, 477
OKADA, H. 110
OKAI, O. 615
OKAJIMA, M. 223
OKAMOTO, J. 366
OKAMOTO, J. M. 170
OKAMOTO, M. 320
OKAMOTO, T. 287
OKAMOTO, U. 649
OKAMOTO, Y. 375
OKAMURA, K. 307, 398
OKAMURA, Y. 110
OKANO, H. 158
OKANO, K. 180, 348
OKANO, Y. 391
OKAZAKI, M. 16
OKIMOTO, T. 51, 52
OKUBO, T. 229
OKUDA, K. 489
OKUDA, T. 671, 715
OKUDAIRA, N. 390
OKUHATA, S. 358
OKUNO, T. 776
OKUYA, S. 722
OMORI, K. 83, 84, 85
ONAKA, T. 726, 739
ONIMARU, H. 688, 689
ONO, T. 289, 319, 323, 324
327, 764, 775, 801
ONOZUKA, M. 144, 211
OOE, M. 473
OOHASHI, K. 379
OOMURA, Y. 191, 204, 205
206, 258, 259, 315
317, 318, 328, 382
384, 386, 744
OONISHI, T. 659
OONUKI, M. 141
OOTA, I. 517
OOUCHI, M. 689
OOYAMA, H. 325, 463, 464
OSA, T. 505
OSADA, H. 591
OSAKA, T. 822
OSHIBA, S. 653, 661, 662
OSHIMI, Y. 560
OSHITANI, N. 52
OTANI, M. 151, 161
166, 316
OTSUKA, K. 641
OTSUKA, M. 103
OZAKI, H. 365, 367
OZAKI, T. 363, 611, 612
OZAWA, T. 26, 27
OZUTSUMI, N. 273

P

PETERSON, B. W. 290
PRAPUTPITTAYA, C. 731

R

RANDIC, M. 188
ROBBINS, A. 234
RUTIGLIANO, M. 185

S

SADA, K. 604, 633, 634
SAEKI, Y. 580, 598
SAGAWA, S. 654, 750, 780
SAIGUSA, A. 567
SAIKI, H. 821
SAITO, A. 801
SAITO, H. 6, 71, 233, 329
330, 438, 453, 641, 660
SAITO, M. 196, 231, 243
245, 246, 260
SAITO, N. 181, 358, 359, 467
SAITO, T. 55, 104, 240
423, 450, 600
SAITO, Y. 26, 27, 458
SAKADA, S. 239, 240, 483
SAKAGUCHI, H. 181
SAKAGUCHI, M. 617
SAKAGUCHI, T. 284
SAKAI, H. 23, 413
SAKAI, J. 665
SAKAI, S. 6, 71, 174, 175
SAKAI, T. 48, 49, 537, 539
577, 578, 587, 590
SAKAI, Y. 502
SAKAKIBARA, M. 124, 803
SAKAKIBARA, Y. 701
SAKAKIDA, K. 10
SAKAMOTO, M. 288, 393
SAKAMOTO, T. 62
SAKAMOTO, Y. 160, 718
SAKANISHI, A. 645
SAKASHITA, K. 659
SAKATA, H. 439
SAKATA, S. 636, 650, 676
SAKATA, Y. 763
SAKUDO, F. 476
SAKUMA, Y. 737
SAKURAI, H. 304
SAMEJIMA, A. 350
SAMEJIMA, M. 445
SANADA, S. 665
SASAKI, H. 433, 434
SASAKI, K. 182, 186, 190
357, 705
SASAKI, M. 268
SASAKI, S. 68, 69, 297
SASAKI, T. 746, 778, 793
SASAKI, Y. 46, 557
SASTRODIHARDJO, S. 46
SATAKE, H. 1, 815

SATAKE, N. 78
SATO, A. 233, 628, 738
SATO, H. 208, 436, 745
SATO, J. 472
SATO, K. 388
SATO, M. 182, 238, 242
256, 674, 806
SATO, S. 591
SATO, T. 269, 276, 279
377, 431, 440, 473
477, 489, 606
SATO, Y. 234, 299, 524
530, 531, 738
SATOH, I. 156, 782
SATOH, K. 24
SATOH, R. 143
SATOH, T. 616
SATOW, Y. 468
SAWADA, H. 23, 536
SAWADA, K. 585
SAWADA, S. 18
SAWADA, Y. 554, 794
SAWAGUCHI, T. 355
SAWAGUCHI, H. 613
SAWAI, H. 455, 661
SAWANOBORI, T. 573
SCHWARTZ, J. H. 165
SHEN, Z. 760
SHIBA, Y. 45
SHIBASAKI, T. 568
SHIBATA, M. 743, 765, 766
SHIBATA, R. 289
SHIBATA, T. 39
SHIBUTANI, H. 439
SHIBUYA, I. 707
SHIBUYA, M. 703
SHIBUYA, Y. 195
SHIDARA, F. 819
SHIDO, O. 811
SHIGA, K. 11
SHIGA, T. 16, 642, 657, 823
SHIGEMATSU, Y. 419
SHIGEMI, J. 18
SHIGEMI, K. 608
SHIMA, K. 387, 395, 396
397, 488
SHIMABUKURO, S. 668
SHIMADA, K. 699
SHIMADA, M. 543
SHIMADA, T. 34, 286, 719
SHIMAMURA, M. 285
SHIMOMURA, F. 482
SHIMATANI, Y. 717
SHIMAZU, H. 614
SHIMAZU, T. 155
SHIMIZU, M. 600
SHIMIZU, N. 259, 328, 386
SHIMIZU, S. 373, 650, 676
SHIMIZU, T. 605
SHIMODA, Y. 432
SHIMODE, M. 810
SHIMOJI, K. 145
SHIMOKOCHI, M. 385
SHIMOSHIKIRYO, K. 792
795
SHIMURA, T. 385
SHINAGAWA, Y. 7, 15, 378
644, 646, 659, 664
SHINNICK-
GALLAGHER, P. 184
SHINOZAKI, T. 166, 316
SHINZAWA, H. 465, 466
SHIOSAKA, S. 289
SHIOZAKI, K. 239
SHIRAI, M. 604, 633, 634
SHIRAISHI, T. 313
SHIRAKI, M. 628
SHIRAKI, K. 750, 780
SHIRATAKA, M. 606
SHOSAKU, T. 43
SHOZUSHIMA, M. 182
SIMBULAN, D. 685, 693
SEKI, K. 389, 614, 819
SEINO, K. 232, 379
SEKIGUCHI, K. 105, 106
148, 150
SEKIYA, S. 591
SEKIYA, T. 303, 600
SENO, H. 388, 816, 820
SEO, Y. 9, 10, 91, 93, 94
506
SERIZAWA, K. 261
SETO, K. 326, 329, 330, 641
SEYAMA, I. 109, 574
SLAYMAN, C. L. 63
SOEDA, H. 476
SOGAMI, M. 12, 13, 17
18, 19, 21
SOHMA, Y. 80
SOHMA, A. 608
SOBUE, K. 457
SOKABE, M. 113, 484, 486
SORIMACHI, M. 40
STANFIELD, P. R. 122
STAUB, N. C. 669
SUDO, S. 565, 572
SUDOH, M. 821
SUGA, H. 583, 588
SUGA, S. 611, 612
SUGAI, T. 325, 463, 464
SUGAWARA, K. 427
SUGAWARA, Y. 469, 647
648
SUGAYA, A. 106, 107
SUGAYA, E. 105, 106, 107
144, 148, 150, 211, 257
SUGAYA, K. 308, 309, 310
SUGENOYA, J. 760, 761
SUGI, H. 510, 511, 514
515, 516, 518, 520
542, 543, 544, 560
SUGIE, I. 665
SUGIHARA, I. 461
SUGIMOTO, A. 105, 106
148
SUGIMOTO, E. 635
SUGIMOTO, N. 273
SUGISAKI, T. 156, 782
SUGISHITA, E. 665
SUGITA, K. 86
SUGITA, Y. 441, 447
SUGITANI, M. 325, 463, 464

SUGIYAMA, H. 119, 120, 147
SUGIYAMA, M. 39
SUMI, H. 655, 667
SUMINO, R. 343, 345
SUN, X. P. 199
SUNADA, T. 293
SUYAMA, H. 377
SUNAMI, T. 349
SUZUKI, E. 12, 17, 18, 19
SUZUKI, H. 354, 365, 367
424, 441, 551
557, 697, 738
SUZUKI, M. 725, 730
SUZUKI, N. 116, 142
SUZUKI, S. 560
SUZUKI, T. 98, 164, 239, 240
SUZUKI, T. A. 431, 473, 489
SUZUKI, Y. 68, 98, 99
SWENSON, R. S. 233

T

TABATA, T. 51
TACHIBANA, M. 411, 449
TACHIYASHIKI, K. 804, 823
TADAKI, E. 685, 693
TADOKORO, Y. 724, 727, 734
TAGUCHI, H. 311
TAGUCHI, K. 599
TAIRA, M. 439
TAIRA, K. 489
TAJIMA, A. 81
TAJIMA, N. 644
TAKABAYASHI, A. 421
468, 803
TAKADA, A. 647, 648
TAKADA, Y. 647, 648
TAKAGI, S. 468, 803
TAKAGI, T. 106, 107
150, 257
TAKAHAMA, K. 178, 255
TAKAHASHI, A. 537
TAKAHASHI, H. 65
TAKAHASHI, I. 515
TAKAHASHI, K. 110, 390
417, 706
TAKAHASHI, M. 19
TAKAHASHI, T. 187, 282
572
TAKAI, A. 501, 506, 509
513
TAKAI, N. 710
TAKAI, M. 220
TAKAKUSAKI, K. 309, 310
TAKAKUWA, M. 241
TAKAMA, M. 515
TAKAMATA, A. 804
TAKAMATSU, K. 151
TAKAMIYA, Y. 161
TAKANASHI, Y. 262
TAKANO, K. 273, 686, 687
TAKANO, N. 680
TAKAO, K. 653
TAKAORI, M. 653
TAKASAKA, T. 458
TAKASHIMA, K. 182
TAKASHIMA, N. 654
TAKAYAMA, H. 166, 316
TAKAYAMA, K. 226, 618
TAKAUJI, M. 529
TAKEGUCHI, N. 77
TAKEI, Y. 630
TAKEMIYA, T. 616
TAKEMORI, S. 521
TAKEMURA, K. 364
TAKENAKA, T. 108, 149
TAKEO, T. 611
TAKEOKA, M. 814
TAKESHIGE, C. 279, 287
TAKEUCHI, A. 606
TAKEUCHI, H. 172, 198
199, 200, 820
TAKEUCHI, N. 194
TAKEUCHI, T. 80, 602
627, 708
TAKIKAWA, Y. 194
TAKUWA, N. 81
TAMAI, A. 453
TAMAI, M. 441
TAMAI, Y. 353
TAMAKI, T. 534
TAMAKI, Y. 768
TAMEYASU, T. 533
TAMOTSU, S. 444
TAMURA, K. 343
TAMURA, Y. 816, 820
TANAKA, E. 134, 203
TANAKA, H. 68, 74, 96
518, 544, 752
TANAKA, J. 329, 330
TANAKA, K. 85, 438
TANAKA, M. 344, 533
TANAKA, N. 714
TANAKA, R. 272
TANAKA, S. 49, 584
TANAKA, T. 292, 556
TANAKA, Y. 20, 154, 210
384, 608, 666, 674
683, 700, 719
TANAKADATE, A. 791
TANIFUJI, S. 22, 638
677, 704
TANIGUCHI, I. 459, 467
TANIGUCHI, K. 492
TANIMOTO, M. 207, 219
TANJI, J. 348
TANNO, T. 363
TANOKURA, M. 523, 540
541
TASAKA, J. 174, 175
TASAKI, I. 446
TASAKI, K. 424, 441, 446
447
TASHIRO, Y. 83, 84, 85
TATEDA, H. 404
TATSUMI, H. 221, 222
TATSUNO, J. 170, 366
TAUCHI, M. 451
TAYA, Y. 819
TERADA, N. 602, 627, 645
TERAKAWA, S. 128, 129
TERANISHI, T. 425, 426

TERANISHI, Y. 631
TERAO, T. 709
TERASAWA, T. 60, 652
TERASAWA, S. 401
TERUI, N. 598
TOCHINAI, A. 431
TODA, K. 343, 490
TODA, N. 804
TOHGI, H. 628
TOHYAMA, M. 289
TOKUNO, H. 507, 508, 509
TOKURA, H. 790
TOKUTOMI, N. 206
TOMA, S. 553
TOMITA, S. 369
TOMINO, S. 546
TOMITA, T. 429, 496, 497 501, 506, 507 508, 509, 513
TOMIYA, H. 600
TONOSAKI, K. 125
TONOUE, T. 232, 379
TORIDE, M. 511
TORII, S. 390
TOSAKA, T. 71, 174, 175
TOSHINO, S. 559
TOTSUKA, T. 548
TOYA, S. 151, 161, 166, 316
TOYAMA, J. 562
TOYAMA, K. 435, 442, 455
TOYODA, J. 450
TOYOKAWA, T. 51, 52
TOYOTA, H. 524
TSUBOI, M. 28, 802
TSUBOI, N. 589
TSUBOKAWA, H. 346
TSUCHIHASI, K. 613
TSUCHIYA, K. 603, 619 620, 621, 626, 748, 773
TSUCHIYA, T. 516, 520
TSUDA, T. 106, 107
TSUJI, K. 654
TSUJI, S. 177, 536
TSUJIMOTO, T. 100, 353 535
TSUJITA, J. 779
TSUKADA, Y. 151, 158 161, 166, 316
TSUKAHARA, R. 260
TSUKAHARA, S. 443
TSUKAHARA, Y. 406, 407 441
TSUKAMOTO, Y. 82, 414
TSUKADA, K. 402
TSUMOTO, T. 436, 457
TSURUGI, K. 439
TSURUHARA, H. 282
TSURUOKA, M. 263, 265
TSUSHIMA, H. 655, 667
TSUTSUMI, T. 591
TSUTSUURA, M. 529
TSUYAMA, N. 703
TSUZUKI, S. 746, 778, 793
TYUMA, I. 14, 25, 654, 658

U

UCHIDA, H. 186, 190, 705 798
UCHIDA, K. 390, 707
UCHIHASHI, K. 710
UCHIMOTO, M. 23
UCHIMURA, N. 202
UCHINO, K. 749
UCHINO, Y. 298
UDO, M. 286
UEDA, G. 812, 814
UEDA, S. 95
UEDA, Y. 658
UEHA, T. 86, 87
UEHARA, A. 137
UEKI, K. 412
UEKI, S. 1
UESHIMA, S. 48, 49
UEZU, E. 401
UMAZUME, Y. 521
UMEKITA, S. 180
UMETANI, K. 442, 455
UMINO, O. 418
UMITSU, Y. 274
UNO, Y. 501
URAMOTO, I. 548
USAMI, A. 806
USUI, S. 422
UYAMA, J. 433
UYEDA, M. 22, 638, 677, 704
UYESAKA, N. 644, 646, 659 664

W

WADA, N. 267
WADA, T. 785
WAKO, H. 194
WAKUI, M. 249, 250
WARASHINA, A. 111, 212
WASHIO, H. 179, 210
WATANABE, A. 130
WATANABE, J. 377
WATANABE, K. 47, 59, 61 172, 418, 527 548, 662, 697
WATANABE, M. 654, 800
WATANABE, S. 278, 298 421, 468, 470, 803, 815
WATANABE, T. 562, 740 764
WATANABE, Y. 153, 527
WATARI, H. 9, 12, 13, 17 19, 91, 93, 94, 506
WICKLAND, C. R. 290
WU, M. M. 169

Y

YABU, H. 498, 512, 517
YAGI, K. 726, 739
YAGI, N. 522, 576
YAGI, S. 20, 154, 666
YAGI, T. 415
YAGINUMA, S. 193, 376
YAHATA, T. 756, 796
YAJIMA, T. 76
YAKEHIRO, M. 109

YAKUSHIJI, T. 204, 205
YAMADA, J. 686
YAMADA, K. 523, 540, 541
YAMADA, M. 23, 414, 419
YAMADA, O. 588
YAMADA, S. 545, 546, 669
YAMADA, T. 277, 542
YAMAGAMI, K. 40
YAMAGISHI, S. 127, 131
132
YAMAGUCHI, H. 90, 159
YAMAGUCHI, K. 122
YAMAGUCHI, M. 527
YAMAGUCHI, T. 613
YAMAGUCHI, Y. 266, 291
372
YAMAKAWA, T. 609
YAMAKOSHI, K. 614
YAMAMOTO, A. 83
YAMOTO, A. 84, 85
YAMOTO, D. 116
YAMOTO, J. 649
YAMAMOTO, M. 387, 395
396, 397, 488
YAMAMOTO, N. 729
YAMAMOTO, T. 350, 364
495, 655, 667, 824
YAMAMOTO, Y. 715
YAMANE, M. 251
YAMANE, S. 360
YAMAO, M. 6, 127
YAMAOKA, K. 574
YAMAOKA, S. 787
YAMASAKI, M. 765, 793
YAMASATO, T. 248
YAMASHITA, E. 428
YAMASHITA, F. 10
YAMASHITA, H. 722, 723
822
YAMASHITA, N. 42, 121
671
YAMASHITA, Y. 478, 491
760, 761
YAMATANI, K. 324
YAMAZAKI, Y. 245, 600
YANA, K. 194
YANAGIDAIRA, Y. 812, 814
YANAGISAWA, K. 173, 580
YANAIHARA, C. 163, 164
230
YANAIHARA, N. 163, 164
230
YANO, J. 325, 463, 464
YANO, T. 613
YASUDA, K. 107
YASUHARA, M. 304, 320
364
YASUI, A. 230
YASUI, H. 685
YASUI, S. 416
YASUMO, W. 266, 291, 372
YASUNAMI, T. 629
YAWATA, T. 776
YAZAWA, Y. 519
YOKOI, I. 153
YOKOTA, T. 311, 312
YOKOYAMA, S. 504
YONA, M. 792, 795
YONEDA, K. 207, 219
YONEDA, T. 558, 559
YONEMOTO, K. 552, 798
799
YONEMURA, K. 236
YONEYAMA, T. 30, 431
YONEZAWA, Y. 5
YONGSIRI, A. 198
YOSHIDA, A. 21, 673
YOSHIDA, E. 655, 667
YOSHIDA, H. 31, 74, 603
619, 620, 626
YOSHIDA, K. 151, 166, 270
316, 321
YOSHIDA, M. 241, 661
YOSHIDA, S. 114
YOSHIDA, T. 155, 772
YOSHIDA, Y. 710
YOSHIMATSU, H. 315
YOSHIMOTO, Y. 36
YOSHIMURA, A. 485
YOSHIMURA, H. 714
YOSHIMURA, K. 29, 30, 160
YOSHIMURA, M. 118, 145
YOSHIMURA, T. 500
YOSHINO, H. 373, 750, 780
YOSHINO, M. 498
YOSHIOKA, S. 708
UASHIOKA, T. 408, 534, 709
YOSHIOKA, Y. 20, 154, 666
YOSHIZAKI, K. 58, 238
242, 256
YOUSEF, M. K. 750, 780
YOZA, H. 611
YUNOKI, T. 381

〔会　報〕

続日本生理学教室史(仮称)の編纂事業

酒井敏夫

日本生理学教室史　上巻　が出版されてから早や足かけ4年にもなります．この時の編集後記に，いずれ本史の続編として戦後創設された生理学教室並びに生理学関係研究所の歴史編纂の時期が到来するであろうから，その為の措置が必要であろうと述べました．この措置として次期編集委員長に率先どなたかが手を挙げて下さることを望みました．上巻の刊行をお伝えした私は，以上の事で何か心残りを感じながら時の経過を待ちました．

昨年の夏，ハンガリー生理学会50周年記念大会に出席された伊藤正男庶務幹事は，生理学の歴史のシンポジウムの中で，各国ともが生理学の進路のために生理学の歴史に意を用いていると日生誌　47巻　10号に報告されました．

私は，かねがね**続日本生理学教室史**（仮称）の件では，戦後創設校の先達の中からリーダー・シップを取られる事が良いかなと思っておりました．あんずるより産むが易しとか，山形大学の望月政司教授が第63回日本生理学会大会の当番幹事とならられました．当番幹事としての新しい計画の御発表は正に当を得たものといえます．**続日本生理学教室史**（仮称）の音頭取りの労をお願いしたところ，多くの支持者があればとの快諾を得ましたので，早速全国の医学部，歯学部の関係各位にその計画を開陳し発起人としての賛成方をお願いしました．御賛同の声の大きさは，正に驚異的なものがありました．

そこで，去る昭和60年12月23日の日本生理学会常任幹事会の席上，望月政司教授を委員長とする**続日本生理学教室史**（仮称）の編集委員会設置の承認方の発言を行い，日本生理学会の事業として取上げられることになりました．

来る昭和61年4月の山形大会の評議員会，総会で望月政司教授からの御挨拶があろうかとも期待しております．すでに，われわれは日本生理学教室史　上巻で刊行のための困難さを克服してきました．願わくは，望月政司教授山形大学御在任中に本史が完成されるよう祈って止みません．

〔お知らせ〕

1986年 国際宇宙生物科学シンポジウムの御案内

上記 1986 INTERNATIONAL SYMPOSIUM ON BIOLOGICAL SCIENCES IN SPACE を下記のように開催致します．

近年，スペースシャトル利用による本格的な実験が宇宙空間において行なうことができるようになり，我が国も1988年初頭には実行することになっております．さらに，1990年代には宇宙ステーション計画が進み，ここ10年以内には宇宙空間に長期滞在することにより各種の実験が行なわれようとしています．このような情勢に鑑み，現在行なわれている各国の宇宙生物科学の分野の研究成果を発表し，討論する機会を持つことになりました．本シンポジウムは 1) SPACE PHYSIOLOGY AND MEDICINE 2) SPACE BIOLOGY INCLUDING CELSS (CONTROLLED ECOLOGICAL LIFE SUPPORT SYSTEM) 3) SPACE RADIOLOGY 4) SPACE BIOTECHNOLOGY の四つのトピックスセッションからなっております．この新しい分野の発展を願いつつ，多数の方々の御参加御来聴を期待いたしております．

日　　時：昭和61年11月10日(月)～11月12日(水)
場　　所：名古屋市中小企業振興会館
〒464 名古屋市千種区吹上2丁目6-3
主　　催：名古屋大学環境医学研究所，日本マイクログラビティ応用学会，ヨーロッパ低重力研究協会(ELGRA)
共　　催：宇宙開発事業団

協　　賛：日本生理学会，日本宇宙航空環境医学会
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開催責任者：渡辺　悟（シンポジウム会長）

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故塚原仲晃教授のこと
——教官公募に寄せて——

酒井敏夫

昭和60年8月12日の夕刻におけるTVニュースは忘れることができない．まさかと思ったが，“世の中には同姓同名の人があるもんだ”と繰返し放映される画像に釘づけにされた事は後になって痛恨事になるとは誰が予想したであろうか．

日生誌編集幹事として，内薗耕二先生に故塚原教授追悼記をお願いしなければならなくなった時は，やる瀬ない気持ちであった．私は，塚原さんとは仕事が違うので深い親交はなかったが，岡崎の生理学研究所の運営協議委員会のメンバーとして落ちついた姿に接してきた．多弁ではないが，正しく物事を判断される態度には尊敬の念を禁じ得ないものがあった．

後任教授の公募が阪大基礎工学部生物工学教室の葛西道生教授より送られて来た時には，改めて故塚原仲晃さんの事を思い出し，早速筆をとる気持ちになった．勿論，後任教授も**神経科学・脳生理学**を専門分野とする方が望まれている．応募締め切りは**昭和61年5月31日**（土）．書類提出先は〒560 豊中市待兼山町1—1．大阪大学基礎工学部生物工学教室　葛西道生教授宛になっている．

私は，故塚原教授の残された業績に続いて，世界の先頭に立って脳生理学の開拓に活躍される方の誕生を心から期待し，筆を擱く次第．

〔報　告〕

昭和61年度生理学研究所　共同研究，研究会の採択課題について

生理学研究所共同研究委員会
委員長　金　子　章　道

かねて公募中でありました昭和61年度生理学研究所共同研究及び研究会については研究所運営協議委員会議によって審査が行なわれ別表のように共同研究63件，研究会11件が採択になりました．共同研究と研究会には予算の枠内で旅費が支給されます．なお，研究会は公開で行なわれますので，参加は自由ですが，開催時期の変更も予想されますので，予め代表者に照会されることをお勧めします．

昭和61年度共同研究一覧表

提案代表者	研究課題
筑波大学・基礎医学系 教授 真崎知生	筋細胞分化過程における蛋白分子種の変化
大分医科大学 教授 山田和廣	ミオシン活性部位の構造ならびにヌクレオチドとの相互作用
北海道大学・獣医学部 教授 菅野富夫	分泌・吸収機能と高エネルギーりん酸化合物動態の同時測定

北海道教育大学函館分校 助教授 下山雄平	生体膜の動的構造
山形大学・医学部 助教授 鈴木裕一	NMRを用いた大腸イオン能動輸送とエネルギー代謝の研究
岐阜大学 学長 早野三郎	^{1}H-NMRによる水晶体，角膜，硝子体などの水および蛋白質の研究
岐阜大学・医学部 教授 鶴見介登	急性および慢性炎症における水構造変化と抗炎症薬の影響
岐阜大学・医学部 教授 高橋正宜	核磁気共鳴による病変検出のための基礎的研究
岐阜大学・医学部 教授 曾我美勝	^{1}H-NMR測定による血漿アルブミン分子の構造転移とMOLECULAR AGINGおよび水構造の研究
名古屋大学医学部附属病院 講師 口脇博治	脳血管攣縮における鉄イオンの役割に関する検討
名古屋大学・医学部 教授 富田忠雄	平滑筋におけるエネルギー代謝分析への^{31}P核磁気共鳴の応用
名古屋市立大学・医学部 助手 古山富士弥	遺伝的高温適応と唾液腺機能
京都府立医科大学 助手 成瀬昭二	In vivo NMRによる実験的脳神経疾患の研究
京都大学・理学部 助教授 赤坂一之	ペプチド結合の特異的切断によるタンパク質構造の変化とその安全性
大阪医科大学 教授 今井雄介	NMRによる腺の水・イオン輸送等のエネルギー過程の研究
香川医科大学 教授 畠瀬修	NMRによるカルモデュリン分子の機能発現と超微構造解析
熊本大学・医学部 教授 志賀潔	生体内酸化還元酵素系の機能発現に関する分子生理学的研究
早稲田大学・教育学部 助手 石龍徳	カエル皮膚の神経ペプチド産生細胞の分化・発達
福井医科大学 助教授 村松郁延	生理活性ペプチドGalaninの自律神経および平滑筋に対する作用
群馬大学・医学部 教授 小幡邦彦	イカ巨大シナプスによる神経伝達物質放出の分子機構の研究
東京医科歯科大学 医用器材研究所 助教授 橋本享	聴覚受容器の変換機能の時間空間特性
杏林大学・医学部 教授 平野寛	多価性リガンドと結合した興奮性膜の形態と機能
富山医科薬科大学 和漢薬研究所 教授 野村靖幸	神経伝達物質レセプターの反応機序，生合成，細胞内動態に関する研究
藤田学園保健衛生大学医学部 教授 永田豊	神経成長因子による上頸部交感神経節へのアミノ酸取込みの促進作用
生理学研究所 助教授 杉山博之	Clチャネルの精製とタンパク化学的分析
広島大学・歯学部 教授 菅野義信	ギャップ結合機能を修飾するモノクローナル抗体の作製

熊本大学・医学部 助手 森元克士	単離平滑筋細胞膜のパッチクランプ法による研究
東京医科歯科大学 難治疾患研究所 教授 片山芳文	消化管壁内在神経系における神経活動の光学的方法による解析
独協医科大学 教授 田中康夫	誘発耳音響放射に関する研究
琉球大学・医学部 助教授 長野みさ子	甲殻類における神経分泌機構の研究
農林水産省 農業生物資源研究所 主任研究官 笠毛邦弘	植物原形質膜 H^+-輸送 ATPase の反応速度論的研究—Na^+-K^+-ATPase との比較—
名古屋大学環境医学研究所 助手 武居能樹	刷子縁膜 Na^+, カーグルコース共輸送系の Na^+ 勾配持続性リポゾーム再構成
和歌山県立医科大学 助手 熊沢紀之	(Na^+, K^+)-ATPase のリン脂質2分子層膜への再構成
徳島大学・薬学部 教授 寺田弘	膜酵素反応における高エネルギー状態について
帝京大学・医学部 教授 小原昭作	感覚内シナプスにおける求心神経伝達物質の同定
浜松医科大学 教授 森田之大	松果体光受容細胞イオン機構のパッチクランプ法による解析
生理学研究所 助教授 大塚輝弥	カメ網膜における色情報抽出の神経機構
生理学研究所 教授 金子章道	マウス網膜神経細胞におけるソマトスタチンの作用に関する研究
名古屋大学・医学部 教授 伊藤文雄	筋紡錘神経末端における機械受容チャネルの超微形態
大阪大学・基礎工学部 講師 村上富士夫	発生過程における脳障害からの機能回復の神経機構
神戸大学医学部付属病院 講師 垰本勝司	培養神経細胞及びグリア細胞の立体観察
北海道大学・歯学部 助手 鎌田勉	反響効果の異なる環境におけるコウモリのエコーロケーション行動の相違
生理学研究所 教授 久野宗	摘出脊髄標本におけるシナプスの可塑的変化の検討
山梨医科大学 助手 佐藤広康	単離洞房結節細胞の細胞内槽流法による電気生理学的解析
東京慈恵会医科大学 助手 国分真一朗	単一房室結節細胞の自動能発現のメカニズム
生理学研究所 教授 入澤宏	家兎心臓単一ペースメーカ細胞における遅延性K電流
生理学研究所 教授 入澤宏	単一心筋細胞研究のための方法考案
生理学研究所 助手 亀山正樹	神経細胞及び分泌細胞におけるイオンチャネルの活動の調節機構
九州大学・医学部 教授 野間昭典	心筋の Na-Ca 交換機転による膜電流の解析

大分医科大学 教授 有田 真	二連パッチクランプ電極による細胞内灌流法の開発
生理学研究所 教授 大森治紀	興奮性膜におけるイオンチャネル・ゲート機構の研究
長崎大学・医学部 講師 吉田 繁	哺乳動物細胞イオンチャネルに対するエタノール作用の解析
新潟大学・医学部 教授 新島 旭	食欲中枢による自律神経調節機構
新技術開発事業団早石生物情報伝達プロジェクト 総括責任者 早石 修	サルにおけるプロスタグランジンD2の睡眠誘発作用について
産業医科大学 教授 山下 博	視床下部室傍核の摂食行動に対する役割
生理学研究所 教授 大村 裕	慢性オペラント摂食条件づけサルにおける化学感受性ニューロンおよびNAカテコールアミン作動系の役割
佐賀医科大学 教授 堀 哲郎	サルのバー押し行動による環境温及び体温認知の脳内機構
長崎大学・医学部 助手 松本逸郎	副腎皮質ホルモン分泌に及ぼす食欲中枢の作用
名古屋大学 総合保健体育科学センター 助手 近藤孝晴	運動が消化管運動機能におよぼす影響
福島県立医科大学 名誉教授 横山正松	Meissner 神経叢の機能
帝京大学・医学部 教授 小原昭作	脳内活性物質とその生物検定法の検討
明治鍼灸大学 教授 森 和	脳内活性物質と針麻酔の関連性についての研究
島根医科大学 教授 沖 充	ラット先天性無神経節腸管の発生機序及び外来神経の解析

昭和61年度研究会一覧表

提案代表者	研究会名	開催予定期日
東京医科歯科大学 医用器材研究所 教授 井上昌次郎	睡眠促進物質研究会	61. 5. 7～61. 5. 8
日本医科大学 教授 早川弘一	心臓自動能に関する研究会	61. 7. 3～61. 7. 4
岐阜大学・医学部 教授 曾我美勝	生体内における水構造および水輸送の研究	61. 8.21～61. 8.22
東京女子医科大学 教授 橋本葉子	視覚情報の伝達・認識機構の研究	61. 9.22～61. 9.24
産業医科大学 教授 山下 博	水・電解質調節環境適応	61.10. 3～61.10. 4
愛媛大学・医学部 教授 志賀 健	蛋白質の物性から電気生理へ（Ⅲ）	61.10. 3～61.10. 4
東京医科歯科大学 難治疾患研究所 教授 村田計一	聴覚研究の新しいアプローチ	61.10.23～61.10.24

大分医科大学・医学部 教授 山田和廣	筋収縮におけるエネルギー転換の生理学的研究	61.11. 1～61.11. 2
横浜市立大学・医学部 教授 竹中敏文	軸索輸送の基礎と臨床	61.12. 2～61.12. 3
新潟大学・医学部 教授 新島旭	内・外受容器のブドウ糖分子受容識別機構の特性と役割	61.12. 4～61.12. 5
岡崎国立共同研究機構 生理学研究所 教授 亘弘	電子スピン共鳴画像の生理学への応用	61. 5.10～61. 5.11

〔編集後記〕

第63回日本生理学会大会号をお届けします．例年は，学会場で提出された抄録を載せた8・9合併号として大会号が発行されてきましたが，今年は予稿集を兼ねた大会号で，いつもとは異った形式です．

振り返ってみますと，1976年に東北大学で開かれた第53回大会の際にも，今回と同じく事前抄録集として大会号が発行され，和文あるいは英文の抄録465題が掲載されています．

当時編集委員の星猛教授は，編集後記の中で，この試みの利点として，予稿集発行のための労力が軽減され，大会経費が大幅に節約されることを挙げて居られます．その反面，難点として演題締切り期日が早まったため，結果の記載と検討が充分なされていない演題が往々見受けられたことを指摘されています．学会直前ぎりぎりまで実験して，そのデータを発表するのが常だった若い頃を思い出すと，このような予稿がなかった抄録があっても，けっして他人事とは思えません．

星教授はまた，事前抄録集発行に当たっての最大の問題は，大会に遅れてはならないことが至上命令であり，当番校も印刷所も最大の努力を傾けられたと述べて居られます．今回も，山形大学の当番幹事を始めとする大会事務局の方々と鶴岡印刷の皆様にとっては大変な御苦労であったことと思います．800題にも上る抄録集を，期日までに見事に完成されたことをお慶び申し上げるとともに，御努力に心から敬意を表します．

東北大学での大会の後を追ってみますと，翌年第54回の鹿児島大学，翌々年第55回の日本歯科大学新潟歯学部の大会号は，和文あるいは英文の事後抄録集として発行され，第52回以前の形式に戻っています．そして，1979年41巻の東京慈恵会医科大学の第56回大会号からは，全演題とも英文で書かれた事後抄録集を8・9合併号として発行する形式が続いて来ました．

事前抄録集を発行するに当たって，当番校は，できるだけホットな知見を盛り込んだ発表をしていただいて大会を成功させるために，抄録提出期限を最大限に遅く設定するでしょう．その結果，抄録集作成の時間は圧縮され，大会事務局と印刷所との間には，素早い連絡が頻繁になされることになります．東北大学と山形大学が事前抄録の発行を決意された理由として，印刷所との地理的近接性が大きな要因となったのではないでしょうか．

前回の東北大学での大会の場合のように，和文，英文ともに活字を拾って印刷していた時代に比べれば，現行の方式では英文抄録集作成の時間は大幅に短縮でき，当番校と印刷所とが地理的に離れていても，技術的には事前抄録集の発行にそれほど困難はないでしょう．しかし内容的には，事後抄録に比べれば事前抄録は3ヶ月ほど鮮度が落ちることは避けられません．

生理学会関係の学術集会には，毎年2回以上開催される地方会，毎年1回の大会，3年毎のIUPS総会があり，この順序に発表の内容はまとまったものになっては行きますが，鮮度は逆に落ちて行きます．抄録集を大会の前あるいは後のどちらにするかについての判断は，生理学会大会を各種の学術集会の中でどのように位置づけるかに大いに関係している問題です．

また，地方会の抄録は日本語で書いて，大会の抄録は英語で書くのですから，大会号は読者として明らかに外国の研究者をも想定しています．したがって，日本語で大会で発表して，抄録を日生誌に英文で発表するという現行の方式には見過せない利点があります．Journal of Physiology のように，日生誌に事後抄録を載せて行くのも一つの見識でしょう．

さらにまた，大会抄録を Japanese Journal of Physiology に載せるという可能性もあるわけですが，この場合でも大会の全演題の事前抄録集の発行は可能で

しょうか.

大会号を事前抄録集とするか事後抄録集とするかについては，さまざまの問題が関係しており，今後の検討を要する重要な課題でしょう.

ともあれ，この大会号を学会場に御持参になることをくれぐれもお忘れなく.

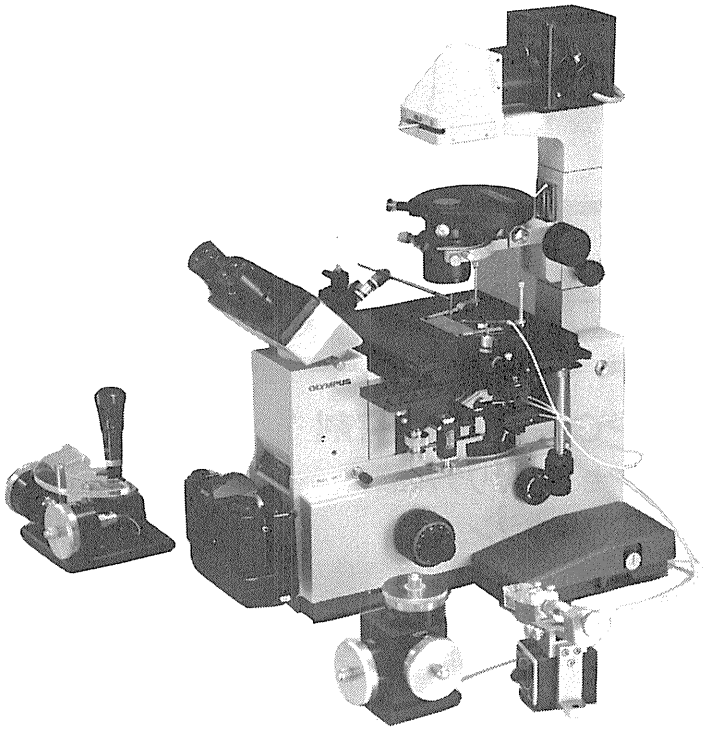
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もうミクロの世界は NEW 震えません

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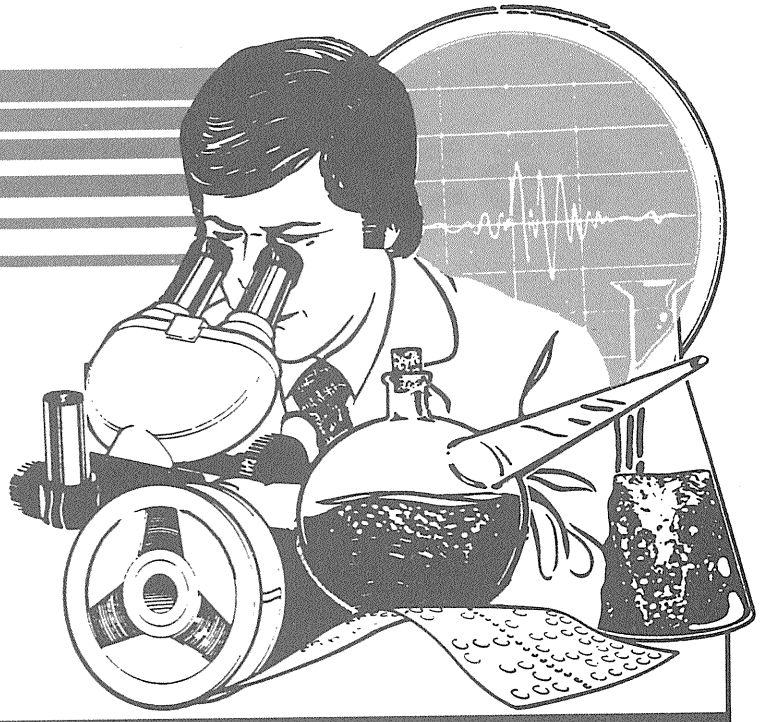
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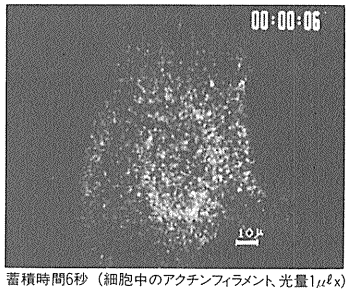
手にとるように見えてくる。

PHOTONIC MICROSCOPE SYSTEM
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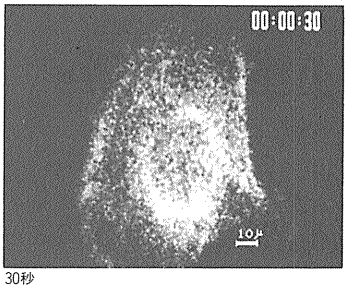
フォトンカウンティングによる極微弱光イメージング技術を応用した、超高感度の顕微鏡用画像処理装置

これまで可視化できなかった非常に弱い蛍光像や生体発光像の観察・記録が可能になりました。フォトンカウンティングによる極微弱光イメージング技術を応用した顕微鏡用画像処理装置・VIMシステムの活用によって、極微弱光下での観察が可能になったためです。照射光を抑えることにより、試料の損傷を防ぎ、生きたままの動態を追跡することができます。

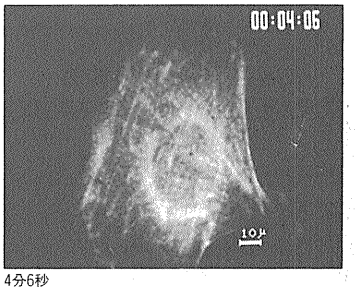
VIMシステムはカメラヘッドに2次元光子計数管と低残像ビジコンを組み込み、従来のSITカメラをはるかに超える検出能力を達成しました。光子ひとつひとつを計数、蓄積して画像化するフォトンカウンティング撮像を行い、さまざまな画像処理を実行することができます。また通常のアナログ撮像も可能ですから10^0～10^9フォトン/mm²・秒の広いダイナミックレンジとなります。また、カメラヘッドを交換することにより、紫外～近赤外の任意の波長域を選択することもできます。VIMシステムは、光学顕微鏡の観察領域を一段と拡大し、生物学や医学の研究分野に大きな成果を提供します。



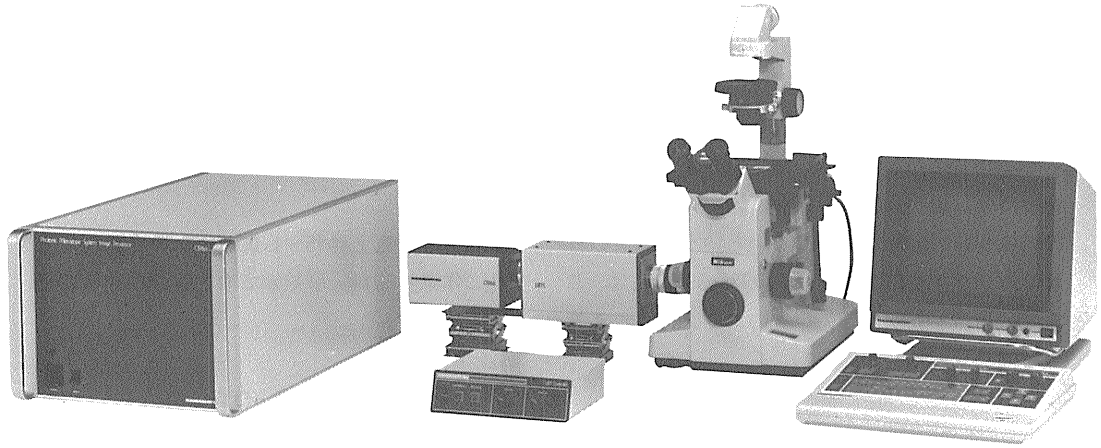
蓄積時間6秒（細胞中のアクチンフィラメント、光量1μℓx）



30秒



4分6秒

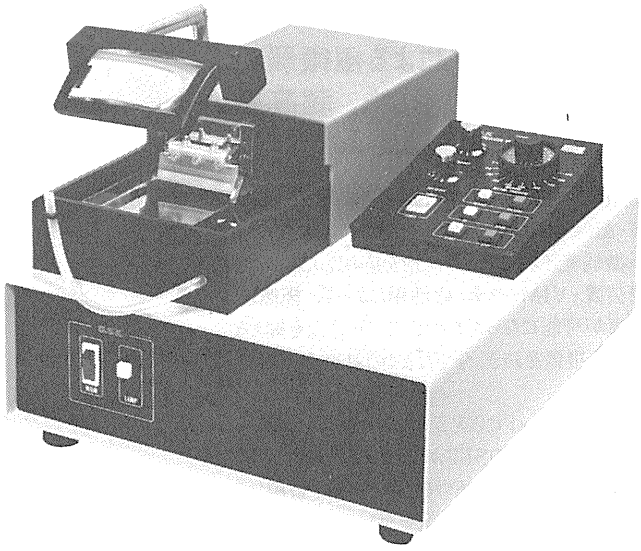


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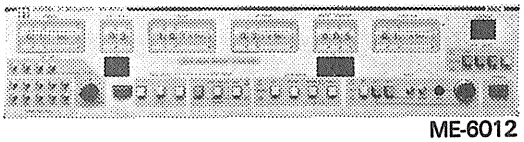


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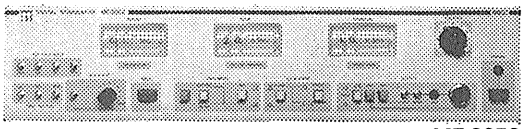
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Q1. 実地医家で慢性膵炎を診断するには?

生活歴(アルコール多飲、脂肪食)や病歴(胆石症)、以前に原因不明の腹痛を経験した人で、腹痛・背部痛・腹部膨満感・消化不良などの腹部不定愁訴をもつ人は、慢性膵炎を考え、腹部X線で膵石を発見したり、アミラーゼ(血清・尿中)を測ることによって慢性膵炎と診断できます

Q2. 慢性膵炎の治療法は?

禁酒、脂肪制限の生活管理とともに、膵炎の急性化を治療する経口抗トリプシン剤(フオイパン)や制酸剤などが有効で、実地医家でも慢性膵炎の治療ができるようになりました

Q3. 慢性膵炎はふえているといわれますが?

慢性膵炎と診断された症例は増加しており、実際、疑いをもつ症例はかなり多いといわれています とくに日常生活の欧米化、アルコール消費量の増加にともない、慢性膵炎が年々増加しております

順天堂災害医学研究所　副所長　内藤聖二(㈱)

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〔文献〕 1)山本祐夫, 他:和漢医薬学会誌, 1(1), 1984. 2)小川和朗, 他:第17回国際内科学会議, 1984. 3)亀田治男, 他:第17回国際内科学会議, 1984. 4)小田島肅夫, 他:診断と治療, 71(6), 1983.



＊胸脇苦満：心窩部より季肋部にかけて苦満感を訴え、抵抗・圧痛の認められる症状。
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8 ツムラ大柴胡湯（ダイサイコトウ）

エキス顆粒(調剤用)　健保適用

〔適応症〕
比較的体力のある人で、便秘がちで、上腹部が張って苦しく、耳鳴り、肩こりなどを伴うものの次の諸症：
胆石症、胆のう炎、黄疸、肝機能障害、高血圧症、脳溢血、じんましん、胃酸過多症、急性胃腸カタル、悪心、嘔吐、食欲不振、痔疾、糖尿病、ノイローゼ、不眠症

体力中等度の人で、胸脇苦満*のある場合
しばしば食欲不振、口中不快感、舌白苔などの症状を伴う

9 ツムラ小柴胡湯（ショウサイコトウ）

エキス顆粒(調剤用)　健保適用

〔適応症〕
体力中等度で上腹部がはって苦しく、舌苔を生じ、口中不快、食欲不振、時により微熱、悪心などのあるものの次の諸症：
諸種の急性熱性病、肺炎、気管支炎、感冒、胸膜炎・肺結核などの結核性諸疾患の補助療法、リンパ腺炎、慢性胃腸障害、肝機能障害、産後回復不全

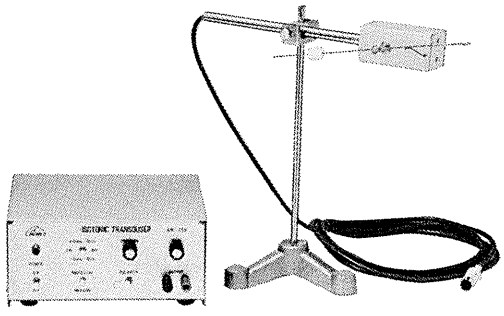
体力中等度以下の人で、胸脇苦満*、腹直筋の緊張があり、精神不安、不眠などの精神神経症状を伴う場合

10 ツムラ柴胡桂枝湯（サイコケイシトウ）

エキス顆粒(調剤用)　健保適用

〔適応症〕
発熱汗出て、悪寒し、身体痛み、頭痛、はきけのあるものの次の諸症：
感冒・流感・肺炎・肺結核などの熱性疾患、胃潰瘍・十二指腸潰瘍・胆のう炎・胆石・肝機能障害・膵臓炎などの心下部緊張疼痛

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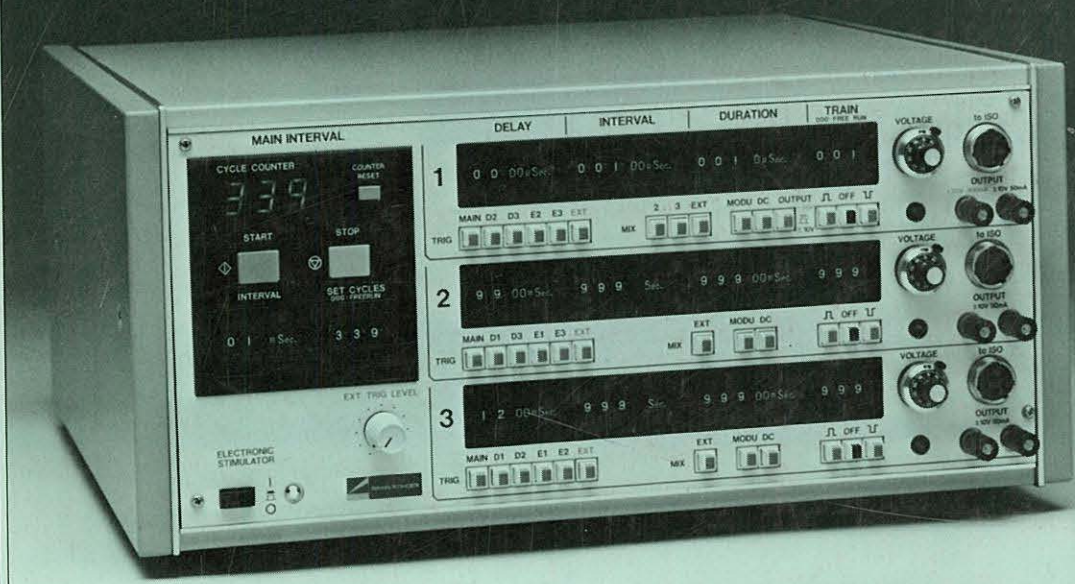
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