

years ago, and speaks of a time when our present conceptual abilities and the power of the sixth sense were not present at all. The brain is definitely a product of biological evolution, and as it has developed so have its capacities. Connes is willing to admit some differences between physics and mathematics, since for the former Nature is the final arbiter. Yet if one clings too hard to his general viewpoint, one must ask: where were Newton's and Maxwell's equations before Newton and Maxwell? Here one is reminded of Heisenberg's dictum: 'nature is prior to man, but man is prior to natural science'.

Among many other insightful accounts, the description of Hadamard's analysis of the process of mathematical creation is enthralling: the four stages of conscious mental preparation, unconscious incubation, sudden illumination, and then the verification and polished presentation of results. To go through such experiences is truly moving. And there is a very real role here for emotion and fear too. Changeux describes the results of neurobiological research on the structure, organization and complexity of the brain, and successes in relating 'mental experiences' to localizable activity in the brain. He even suggests that Darwinian selection may operate in the realm of mathematical argument and debate. On the way the duo educate one another—and enchant the reader—on the latest lessons of neuroscience and the structures of mathematics and physical theories.

The book concludes with an essay by Changeux on the need for a new rational understanding of ethics, free from dogma and mythology. He pleads for an approach based on experience, both of the species and of the individual, leaving room for growth. His quoting Darwin to the effect that man is 'a moral being', and remarks on the predisposition towards sympathy and cooperation among individuals, are encouraging—almost too good to be true.

Would that such a universe of informed debate, reaching beyond grasp of technical details of science to broader and general perspectives, could one day be created in our own midst!

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Annual Review of Physiology 1995. Hoffman, J. F. and Weer, P. D. (eds). Annual Review Inc., 4139, El Camino Way, P.O. Box 10139, Palo Alto, California 94303-0139, USA. Volume 57. 905 pp. Price: USA \$49, elsewhere \$54.

The *Annual Review of Physiology* has a long sustained tradition of publishing good articles on selected topics and/or areas relating to different fields of physiology, thereby highlighting the important developments in a particular field. I was particularly delighted to accept the offer to review the 1995 volume, for the reason that it has review articles on membrane ionic channels and cellular and neurophysiology which are closer to my research interests.

The Review begins with an autobiographical sketch by Hans J. Schatzmann, where he has attempted to convey the excitement of his many years of research on the ion pump mechanisms in biological membranes.

The comparative physiology section has topics related to thermal adaptation in membranes (J. R. Hazel), temperature-protein interactions (G. N. Somero), where the recent discoveries of temperature effects on protein structure-function and gene regulation in the experimental contexts are reviewed and attempt made to relate them to concerns of comparative, evolutionary and environmental physiologists. There is additionally a review on the evolution of endothermy in mammals (J. Ruben).

Among the topics covered in the section on Respiratory Physiology, there is a review by N. J. Gross on a recently identified enzyme surfactant convertase, a serine protease which acts on lung surfactant, converting one of the subtypes, tubular myelin (TM) to the small vesicle (SV) subtype. Drazen, Gaston and Shore review three different chemical regulatory mechanisms of pulmonary tone, viz. cysteinyl leukotrienes (LTD₄ being most potent), neuropeptides and nitrogen oxides, and the physiological significance of these in regulating airway tone in human asthma. While the individual effector systems are known, it is not clear how the three different effector systems function in an integrated fashion, which is where future research would be directed.

In the Endocrine Physiology section, Inagami, Naruse and Hoover review the current status of research on the thin unicellular layer, endothelium which forms a permeable and physical barrier protecting vascular smooth muscle cells, as an endocrine organ with multiple functions.

There is also a review by Woodruff and Mather on the recently discovered modulators of follicle stimulating hormone release, viz. inhibin, activin and follistatin. There are recent references on relationship between aberrant production of inhibin and cancer.

The section on Renal and Electrolyte Physiology has articles dealing with the role of reactive oxygen metabolites (S. V. Shah), transforming growth factor-beta and Angiotensin II (Ketteler, Noble and Border), and platelet growth factor in the pathogenesis of renal disease (H. A. Abboud).

The Cell Physiology section has an interesting and up-to-date review on mechanosensitive or stretch-activated channels by Henry Sackin. A hypothetical scheme with different pathways for how stretch-activated cation channels and stretch-activated K channels might be involved in volume regulation of the cell and K homeostasis is presented. I found this scheme particularly interesting. The earlier debate on the mechanosensitivity being an artefact of the patch-clamp technique, has been recently put to rest by the work of Sukharev *et al.* (*Nature*, 1994, 368, 265–268), by demonstrating that mechanosensitivity is an intrinsic property of certain channels that can be reconstituted into different lipid environments. Mechanosensitive channels are attracting a lot of current interest amongst cellular physiologists, and considering their mechano-transducer property, are found in cell systems where mechanosensation is required, viz. muscle spindles, vascular endothelium and auditory cells. They are also found in plant and fungus cells. Stretch-activated plant channels are suggested to be important in mediating the geotropic response by transducing mechanical (i.e. gravitational) signals, an interesting biological feature.

Membrane ionic channel-linked diseases are beginning to be understood, and pathological situations arising from channel dysfunction are beginning to be classified under 'channelopathies'. Like the CFTR chloride channels, abnormalities

in the skeletal muscle membrane sodium channel can produce clinical disease. Sodium channels that are too easily activated can produce repetitive membrane electrical activity or myotonia; while channels that resist activation can result in periodic weakness or paralysis. The review by Barchi discusses the concepts of muscle sodium channel structure and function and the role of abnormal sodium channels in the pathogenesis of human skeletal muscle disease along with certain recent results on the mutations in the D4-S4 (helical segment 4, of the 4th domain) in paramyotonia congenita.

Gadsby, Nagel and Hwang review the biophysical and pharmacological characterization of the CFTR (cystic fibrosis transmembrane transporter) chloride channel, and they predict their functional role in the heart and thereby its pathology in hearts of patients with cystic fibrosis.

Braun and Schulman review the recent work on functional aspects of CaM kinase, an ubiquitous serine/threonine protein kinase implicated in regulation of diverse functions such as muscle contraction, secretion, synaptic transmission to gene expression. Intracellularly, CaM kinase functions as a type of frequency detector in response to calcium spikes or oscillations.

In the Neurophysiology section, Jackson and Yakel review the current status on the 5-HT₃ receptor channel, which like acetylcholine receptor involves direct coupling of the receptor to an ion channel, unlike the commonly known slow 5-HT receptors where the receptors operate through slow transduction pathways involving G-proteins, second messengers and protein kinases. The 5-HT₃ receptor gene belongs to the nicotinic/GABA receptor gene superfamily. The receptor is made up of 5 homologous subunits, each consisting of four membrane spanning segments. A long N-terminal domain contains a cystine bridge. The M2 region shows very high homology with the M2 segment of other ligand-gated channels. The desensitization kinetics of the 5-HT₃ receptor changes with time, indicative of modulation by cytoplasmic factors.

The review by Edmonds, Gibb and Colquhoun on the mechanism of activation of muscle nicotinic acetylcholine receptors and the time course of end plate currents, discusses the principles that underlie the time course of synaptic currents and the methods used to understand it.

The authors in their conclusion extend a pointer towards the lack of quantitative demonstration of the expected relationship between burst length and end plate current decay, and an understanding of the mechanism of desensitization.

Almost on similar lines is a succeeding review by Edmonds, Gibb and Colquhoun on the mechanisms of activation of the glutamate receptors which can be broadly classified into NMDA type owing to their sensitivity to the synthetic agonist, *N*-methyl-D-aspartate and the non-NMDA type.

The review by McGehee and Role focuses on the nAChR subtypes expressed by neurons from the physiological perspective. The subunits of nAChRs are classified into 2 subfamilies, alpha type subunits named on the basis of substantial homology with the alpha subunit of muscle nAChR, $\alpha 1$ is homologous with the muscle $\alpha 1$ subunit, while $\alpha 2$ – $\alpha 8$ are distinct neuronal α subunit encoding genes. The β subunit does not have homology with the muscle subunit and has 3 members— $\beta 2$, $\beta 3$, $\beta 4$. A combined heterologous expression of a neuronal α subunit and a neuronal β subunit is necessary to form an ACh-gated channel, with properties similar to native neuronal nAChR. Further, AChRs with divergent electrophysiological properties can be generated by expressing different combinations of the subunit types. The diversity in nAChRs is important in synaptic development and transmission; in targeting to different structural domains of the neuron, and short-term changes in modulatory alteration in nAChR function by intracellular modulators such as protein kinase A, which is activated by different peptide transmitters.

In the section on Gastrointestinal Physiology the four reviews are primarily devoted to mucus, the slimy viscous secretion that covers epithelial surfaces and has important protective and lubricative properties.

The review by Lichtenberger on the hydrophobicity of gastrointestinal mucus, gives an interesting account of surface wettability analysis used in physical sciences, to study the hydrophobic nature of mucins using contact angle analysis. It also includes a discussion on ulcerogenic agents, e.g. aspirin and infection with the bacteria *H. pylori* which causes ulcers by decreasing mucosal hydrophobicity. The surface hydrophobicity is region-specific

and reaches high value in the stomach and colon.

The review on mucin biophysics (Bansil, Stanley and LaMont) although appropriate in the context of the overall focus of the section, could have been placed in *Annual Review of Biophysics and Molecular Structure*.

One of the main attractions of this volume is the special topic section on nitric oxide, which has been attracting a lot of interest in recent years. Rand and Li review nitric oxide transmission (NO as a neurotransmitter) in peripheral nerves, its first demonstration, the pharmacological tools to study aspects of nitric oxide neuroeffector transmission and mechanisms of release. The review of Garthwaite and Boulton, however, focuses on nitric oxide as a signaling molecule in the central nervous system, regulation of formation, its spread by diffusion, NO signal transduction and acute regulation of neuronal and neuroendocrine function; its role in ion channel modulation and synaptic plasticity.

Griffith and Stuehr review the properties and action mechanisms of nitric oxide synthase (NOS) enzyme. The role of NO has recently been implicated in various pathophysiological conditions, viz. vascular, inflammatory and neurodegenerative disorders, and this has been reviewed by Gross and Wolin.

In the section on Cardiovascular Physiology, Russell Ross in reviewing the cell biology of atherosclerosis discusses the cells involved (the endothelium, the smooth muscle, monocyte-derived macrophage, T-lymphocyte and platelets), their complex interactions and the molecules they form. The current understanding of the response-to-injury hypothesis is reviewed.

The review by Pfeffer, Fisher and Pfeffer suggests that the angiotensin cardiac enzyme (ACE) inhibitors are proving to be beneficial in treating patients with myocardial infarctions. The white blood cells (lymphocytes, granulocytes, neutrophils and eosinophils) have to continuously circulate and migrate to identify infectious pathogens and accumulate at sights of infection. This involves signaling at the endothelial cell lining, and the complex signaling mechanisms to effect this, is reviewed with a set of interesting models by Springer.

In reviewing this volume, I have probably been biased towards topics that

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currently occupy my interest, but I have hopefully conveyed what to expect in the different sections of the volume. The *Annual Reviews* are highly informative, and the 1995 volume is no exception. Serious research workers in emerging fields of physiology which is increasingly becoming molecular, would find this volume particularly useful.

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India and Antarctica during the Precambrian. Yoshida, M. and Santosh, M. (eds). Memoir 34. Geological Society of India, P.B. No. 1922, Bangalore. 1995. Price: Rs 400; \$50.

Amalgamation and dispersal of supercontinents present a fascinating story of the Earth's evolution. Reconstruction of palaeogeographic disposition of continents is an absorbing game of the latter-day tectonics buffs. The aggregation and disassembly of the Gondwana supercontinent continue to tickle the imagination of several front-ranking geoscientists. The cratons and mobile belts which constitute the Gondwana ensemble are themselves products of rifting, subduction and colli-

sion of smaller masses in several orogenic cycles. Such facts and fantasy are being interwoven in the multi-author volume under review.

Raphael Unrug sets the tone by outlining the changes through time in the configuration of Rodinia and Gondwana. John Rogers and others describe the Pan African Zone linking the East and West Gondwana. The reassembly of the Eastern Gondwanaland is narrated by Masaru Yoshida. The fit of Australia and Antarctica is brought out in detail by Lyal Harris. The section on structure deals with amphibolite-granulite transition in south India as related to deep structures (Katz), terrains in parts of East Antarctica (Dirks), intercontinental shear zones (Chetty) and evolution of 'arenas' in Sri Lanka (Tani and Yoshida). The section on metamorphism has three papers on Eastern Ghat granulites (S. Dasgupta, Fonarev *et al.*, Sanyal and Fukuo) and one paper on the Prydz Bay in Antarctica (Harley and Fitzsimons). In the related theme on fluid processes in the lower continental crust, there are two papers by Touret, Wada and Santosh.

The section on geochemistry has three papers: Peterman Ranges charnockites (Joshi and Pant), high-grade metapelites of southern Karnataka (Mahabaleswar and others) and Eastern Ghats charnockites (A. T. Rao and others). There is a lone paper on geophysical studies by India in Antarctica (Gupta and Verma). In the section on magmatism there are three

papers: tabular granites of Antarctica (Grantham), acid magmatism in Rajasthan (Bhushan) and Pan-African gemstone provinces (Menon and Santosh). The book concludes with the section on geochronology, where three papers (Jayananda *et al.*, Bartlett *et al.*, and Unnikrishnan-Warrier *et al.*) provide new ages and insights into the chronological evolution of the granulite terrain of south India.

This edited volume will provide a new impetus to global cooperation in unravelling the past history of continents in the Precambrian which will have long-term implications for future mineral discoveries. This volume will also hopefully trigger greater enthusiasm in the Gondwanic neighbours to share their past geological heritage. The theme of the book forms a major IGCP Project supported by UNESCO and IUGS whose outcome will be watched eagerly by the Gondwana geologists the world over.

The volume is neatly edited and published to international standards by the reputed Geological Society of India. Apart from unevenness in quality and lack of cohesion inherent in any multi-author effort, this volume is flawless in presentation and is an asset to every earth science library.

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