thrust faults somehow merge into the layered lower crust. This modern view contrasts with more traditional seismic interpretations that offer evidence for very substantial subvertical faults cutting across the lower crust.

The lower crust is also a region of low electrical resistivity, which is explained by the presence of increased amounts of water and perhaps also free carbon (graphite), or else by the presence of low-resistivity shear zones.

An important petrological assumption is that the lower crust is formed under metamorphic granulite facies conditions. Thus, petrographers visualize the lower crust as a combination of mafic rocks and quartzofeldspathic granulites that contain orthopyroxenes and garnets. Outcropping sections of tectonically uplifted lower crust are mafic in some regions and silicic in others. In all outcrop sections there is an upward change to amphibolite and then to greenschist facies. Thus, the common denominator of the lower crust is metamorphic grade rather than composition. Of course, lower crust outcrops may represent a special type of lower crust that can tectonically rise to the surface. Therefore, petrographers and geochemists also rely on xenoliths that are brought to the surface by igneous processes.

The primary formation of lower continental crust probably occurs in places of lithospheric convergence. In that situation lower crust would be formed by residual cumulates which would be geochemically complementary to the more silicic shallow intrusions.

Tectonic reworking of preexisting continental crust by either compressional or extensional processes is postulated by many workers in the area: hence the increased effort to better understand the nature and distribution of brittle and ductile layers within the lower continental crust. Ductility in the lower crust is greatly enhanced by the presence of volatiles such as water, carbon dioxide, and perhaps methane. Whether these volatiles are mantle-derived or got there by continental underthrusting associated with A-subduction, or else by the subduction of oceanic lithosphere (B-subduction), remains an open question. The presence of water in the lower crust leads some, including contributors to this book, to postulate high-pore pressure zones that would act as a guide for the soles of listric normal or listric thrust faults.

This book reviews much of what we know about the lower continental crust, but it does little to place the lower crust into a broad tectonic context. I would have liked to find specific discussions that related tectonics of the upper crust to the lower continental crust. Also, not much is said about the genesis of the Moho. Even though not as yet formally stated, it now appears that the Moho is formed and reset following thermal events that raise the lithosphere-asthenosphere boundary to the base of the crust. In extensional regimes the Moho is reset underneath a stretched crust, while in compressional settings a new Moho is formed after absorption of substantial lithospheric roots by a new asthenosphere. Thus, the evolution of the continental crust probably involves a resetting of the Moho following stretching or compression, and perhaps this subject ought to be addressed in future conferences on the lower continental crust.

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Fossil Synapsids

The Ecology and Biology of Mammal-like Reptiles. NICHOLAS HOTTON III, PAUL D. MACLEAN, JAN J. ROTH, and E. CAROL ROTH, Eds. Smithsonian Institution Press, Washington, DC, 1986. x, 326 pp., illus. $35; paper, $19.95. From a conference, Poolesville, MD, and Washington, DC, June 1981.

A conference held in 1981 has finally come to fruition with the publication of this exciting collection of 21 essays covering all manner of aspects of the fossil synapsid, or mammal-like, reptiles. Paleontologists and students of the physiology, ecology, and behavior of living vertebrates have combined to produce discussions of such topics as the phylogenetic relationships, paleoecology, biogeography, temperature physiology, and anatomy of these animals.

The mammal-like reptiles are a highly diverse and very long-lived group, appearing in the Pennsylvanian and surviving until around the end of the Triassic, a span of some 120 million years. They have never achieved the fame of the dinosaurs, being on the whole less bizarre, which is a pity because they have one supreme advantage over the dinosaurs for the evolutionary biologist. The earliest forms are about the most primitive reptiles known, whereas the latest members of the group are almost indistinguishable from mammals. And the group as a whole spans the enormous morphological, and presumably physiological, distance from stem reptile to mammal. If any fossil group is going to reveal the nature of the evolutionary transition from one great taxon to another, it is this one, a view that directly informs many of these essays. On the view that modern reptiles constitute vicariant ancestors of mammals, the mammals are assumed to have evolved features like endothermy from ectothermy, large, complex brain from small brain, and more sophisticated physiology and behavior of reproduction; therefore the mammal-like reptiles ought to illustrate intermediate stages in these transitions. How far this actually happens varies. For those functional systems which involve skeletal elements, much can be learned from the fossils. Crompton and Hylander on the acquisition of the mammalian jaw hinge and Allin updating his ingenious theory of the origin of the mammalian ear ossicles, for example, can propose functional hypotheses directly testable by reference to actual fossil morphology. At the other extreme, Duvall on the use of pheromones by mammal-like reptiles and Guillette and Hotton on the origin of mammalian reproductive characteristics search the fossils in vain for truly revealing comparative morphology and are reduced simply to speculating about what must have been so. Interesting and thought-provoking as such exercises are, their scientific value may be thought dubious in these days of hardened attitudes among paleontologists about what constitutes a proper, testable hypothesis.

Within the last few years paleontologists have also grown to appreciate that if the evolution of characters is to be explained in functional terms, then the first step must be the creation of a proper, testable hypothesis about just what the sequence of character states is that needs explaining. A cladistic analysis of relationships takes precedence over paleobiological theorizing. Thus the cladogram of the therapsids presented by Hopson and Barghusen is the most fundamental contribution to the volume. There will continue to be arguments about a number of their particular taxonomic conclusions, and it is noteworthy how few characters there are in support of several of the important groupings. But their study does give a solid baseline for future work.

As an overview of the nature of these particular fossils and of the ways in which such a fossil record can be made to generate questions of more general interest concerning evolutionary matters, this book is successful and deserves a much wider readership than synapsid specialists. There will be skepticism on the grounds that many of the conclusions reached by various authors exceed the evidence. But the mammal-like reptiles did exist, did live in particular habitats, and did evolve mammalian characters. Therefore it is perfectly rational to seek to understand them in terms of the functional and ecological meaning of the inferred changes they underwent. That the best answers currently available are rather poorly supported by the evidence of the morphology should not derogate from the attempt to seek them. One hopes this volume will stimulate a lot more work on such an interesting group of animals.

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Cellular Neurobiology

Neuromodulation. The Biochemical Control of Neuronal Excitability. LEONARD K. KACZMAREK and IRWIN B. LEVITAN, Eds. Oxford University Press, New York, 1987. xii, 286 pp., illus. $29.95.

In recent years it has become evident that neurons are subject to an extraordinary degree of modulation of diverse kinds. Neuronal properties can be modulated not only during long-term learning and development but also over a relatively short term as a function of motivational state and even during basic sensory and motor activities. This book attempts to explain some of the fundamentals of neuromodulation at the cellular level.

In the preface and chapter 1, the editors of this volume define neuromodulation as the capacity of neurons to change their electrical properties as a function of intracellular biochemical events that are evoked by synaptic or hormonal input. This simple and useful definition is broad enough to encompass most of the phenomena that researchers have called neuromodulatory, but narrow enough to avoid including so much that the concept becomes meaningless. The preface explains that the goal of the book is to introduce graduate students and researchers who do not directly work in the area to "the way one thinks about and studies neuromodulatory phenomena at the cellular and molecular level." In addition the book attempts to foster communication between biochemists and physiologists, the two main groups that study neuromodulation.

The first five chapters introduce general principles, with particular emphasis on ion channels and mechanisms of protein phosphorylation. The remaining eight chapters provide more detailed discussions of specific examples of neuromodulation. Benson and Adams discuss the control of rhythmic neuronal firing, with reference to studies of identified neuron R15 of *Aplysia*. Three chapters are devoted to the regulation of potassium currents, using as examples the firing of the bag cell neurons of *Aplysia* (Strong and Kaczmarek), the serotonin-regulated current of *Aplysia* (Siegelbaum), and the muscarine-regulated current of vertebrate neurons (Jones and Adams). Papers by Ewald and Levitan and by Tsien discuss modulation of calcium channels in vertebrate and invertebrate neurons and in vertebrate heart cells. Zucker provides a general discussion of synaptic plasticity, with emphasis on the role of calcium. Finally, Gribkoff and Dudek review examples of neuromodulation in the mammalian brain, with specific treatments of long-term potentiation and modulation of neuronal burst activity. The chapters are liberally illustrated with line drawings. Literature citations have been purposely kept to a minimum.

On the whole, the book achieves what it aims to accomplish, but it has a few weaknesses, most of which stem from the fact that it is multiauthored. This results in some unevenness in style and unneeded redundancy. For example, calcium-activated potassium channels are discussed in at least six different places, and the relationship of different nomenclatures is not always made explicit. However, this is not a collection of self-serving minireviews. The chapters have been written and edited to teach and explain, and as a focused textbook *Neuromodulation* is generally successful. With few exceptions, the topics are treated in a straightforward manner, with a minimum of jargon. Although both of the editors work with invertebrate preparations, the book does not lay undue emphasis on invertebrate work, considering that the editors wished to restrict the discussions primarily to analytic cellular studies.

This volume should prove useful not only to the novice but to virtually any investigator interested in cellular neurobiology. It certainly should be examined by individuals who teach neuroscience-related courses. The book is generally up to date, but because of the present ferment in the field I recommend that if you are going to read it, you do so quickly.

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Books Received

Clinical Pharmacology in Psychiatry. Selectivity in Psychotropic Drug Action—Promises or Problems? S. G. Dahl *et al.*, Eds. Springer-Verlag, New York, 1987. xii, 290 pp., illus. $53.90. Psychopharmacology Series, 3. Based on a meeting, Bethesda, MD, Sept. 1985.

Cloning Vectors. A Laboratory Manual Supplementary Update 1986. Elsevier, New York, 1986. Variously paged. In loose-leaf binder. $33.25.

Coding Microbiological Data for Computers. Morrison Rogosa, Micah I. Krichevsky, and Rita R. Colwell. Springer-Verlag, New York, 1986. xii, 299 pp., illus. $35. Springer Series in Microbiology. Sponsored by the Committee on Data for Science and Technology of the International Council of Scientific Unions.

Cognition and Instruction. Ronna F. Dillon and Robert J. Sternberg, Eds. Academic Press, Orlando, FL, 1986. x, 390 pp., illus. $29.95.

Coherence, Cooperation and Fluctuations. Fritz Haake, Lorenzo M. Narducci, and Daniel Walls, Eds. Cambridge University Press, New York, 1986. x, 456 pp., illus. $54.50. Cambridge Studies in Modern Optics, 5. From a symposium, Cambridge, MA. Oct. 1985.

A Guide to Statistical Methods. And to the Pertinent Literature. Lothar Sachs. Springer-Verlag, New York, 1986. xii, 212 pp. Paper, $25. Text in English and German.

Handbook of Behavioral Teratology. Edward P. Riley and Charles V. Vorhees, Eds. Plenum, New York, 1986. xx, 522 pp., illus. $65.

High Resolution NMR Spectroscopy of Synthetic Polymers in Bulk. Richard A. Komoroski, Ed. VCH, New York, 1986. xii, 379 pp., illus. $75. Methods in Stereochemical Analysis, vol. 7.

A History of Mathematics. Florian Cajori. 4th ed. Chelsea, New York, 1985. viii, 524 pp., illus. $22.50.

Intelligence. The Eye, the Brain, and the Computer. Martin A. Fischler and Oscar Firschein. Addison-Wesley, Reading, MA, 1987. xiv, 331 pp., illus., + plates. $27.95.

International Workshop on Applied Differential Equations. (Beijing, June 1985.) Xiao Shutie and Pu Fuquan, Eds. World Scientific, Philadelphia, 1986. x, 446 pp., illus. $63.

Intractable Epilepsy. Experimental and Clinical Aspects. Dieter Schmidt and Paolo Lucio Morselli, Eds. Raven, New York, 1986. xvi, 269 pp., illus. $49.50. L.E.R.S. Monograph Series, vol. 5. Based on a workshop, Saint Germain-en-Laye, France, April 1985.

An Introduction to Fetal Physiology. Frederick C. Battaglia and Giacomo Meschia. Academic Press, Orlando, Fl, 1986. xii, 257 pp., illus. $45.

Introduction to Molecular Embryology. J. Brachet and H. Alexandre. 2nd ed. Springer-Verlag, New York, 1986. xiv, 229 pp., illus. Paper, $19. Heidelberg Science Library.

Mechanisms of Ionic Polymerization. Current Problems. B. L. Erusalimskii. Consultants Bureau (Plenum), New York, 1986. x, 306 pp., illus. $89.50. Macromolecular Compounds. Translated and edited from the Russian by Trans-Inter-Scientia.

Melancholia and Depression. From Hippocratic Times to Modern Times. Stanley W. Jackson. Yale University Press, New Haven, CT, 1986. x, 441 pp. $35.

Membrane Skeletons and Cytoskeletal-Membrane Associations. Vann Bennett *et al.*, Eds. Liss, New York, 1986. xviii, 384 pp., illus. $96. UCLA Symposia on Molecular and Cellular Biology, New Series, vol. 38. From a symposium, Park City, UT, March 1985.

Membranes, Metabolism, and Dry Organisms. A. Carl Leopold, Ed. Comstock (Cornell University Press), Ithaca, NY, 1986. 374 pp., illus. $45. Based on a conference, Bellagio, Italy, Oct. 1985.

Prostacyclin and Its Stable Analogue Iloprost. R. J. Gryglewski, and G. Stock, Eds. Springer-Verlag, New York, 1987. xvi, 314 pp., illus. $53.90. From a workshop, Bad Kissingen, Germany, Nov. 1985.

Protein Engineering. Applications in Science, Medicine, and Industry. Masayori Inouye and Raghupathy Sarma, Eds. Academic Press, Orlando, FL, 1986. xvi, 424 pp., illus. $49.95. Based on a symposium, Stony Brook, NY, May 1985.

Protein Structure, Folding, and Design. Dale L. Oxender, Ed. Liss, New York, 1986. xviii, 332 pp., illus. $80. UCLA Symposia on Molecular and Cellular Biology, New Series, vol. 39. From a symposium, Keystone, CO, March 1985.

Quantum Concepts in Space and Time. R. Penrose and C. J. Isham, Eds. Clarendon (Oxford University Press), New York, 1986. x, 358 pp., illus. $80. Oxford Science Publications. Based on a conference, Oxford, U.K., March 1984.

Vision and Information Processing for Automation. Arthur Browne and Leonard Norton-Wayne. Plenum, New York, 1986. xiv, 484 pp., illus. $59.50.

Why Nothing Works. The Anthropology of Daily Life. Marvin Harris. Touchstone (Simon and Schuster), New York, 1987. xxii, 208 pp. Paper, $7.95. Revised edition of *American Now*.

Wintergreen. Rambles in a Ravaged Land. Robert Michael Pyle. Scribner's, New York, 1987. xiv, 303 pp., illus. $19.95.