Nerve Cells

The Molecular Properties and Evolution of Excitable Cells. C. J. DUNCAN. Pergamon, New York, 1967. 265 pp., illus. $11. International Series of Monographs in Pure and Applied Biology, Zoology Division, vol. 35.

A by-product of the success of molecular biology in the field of genetics is the urge to fit other varieties of data into the same bed by Procrustean analogy. The author of this book seeks a unified "explanation" of the processes that result in the phenomenology of excitable membranes and particularly of those that develop bioelectric responses. One of the few aspects of his approach that I consider to be valid is the adoption of my classification of excitable membranes into three varieties of functionally differentiated components: an electrically inexcitable input component (receptive or postsynaptic), an electrically excitable, conductile, middle component, and a secretory output element.

The author's thesis is that all these different membrane components operate through a common, "molecular biological" mechanism. The permeability of the input membrane "is governed by . . . a mechanoenzyme ATPase system . . ." (p. 134), in which "the energy of the stimulus is used to produce a modification in the dynamic interaction between ATP and the ATPase enzyme system of the excitable membrane" (p. 101). Furthermore, "basically the same system operates in both [input and conductile components] for the control of cation-permeability, namely a mechanoenzyme system with ATPase and nonspecific cholinesterase properties" (p. 138). However, "It is proposed that the permeability system of the axon is not modified by an enzymic mechanism, but that the flow of current displaces inhibitory calcium ions from binding sites on the ATPase at the membrane pores . . ." (pp. 153–54). "The same ATPase-ChE enzyme complex is responsible for the control of release of transmitters at the output component" (p. 189). It is also suggested that RNA-controlled turnover of adenosine triphosphatase may be the basis of learning and memory.

As to the evolutionary aspects, the author concludes that "the ATPases of the nerve membrane, of the mitochondrial membrane, of myosin, of the erythrocyte membrane, of *Amoeba* and possibly of the spinach chloroplast, all have very similar properties. . . . Although these ATPases at first sight seem to be engaged in very different tasks, we can see that all probably depend on their ability to change their molecular configuration (to be 'contractile') as a function of the supply of energy-rich phosphate. . . . The number of molecular possibilities for producing movement was limited, but, by a number of subtle modifications and specializations of the mechanoenzyme system probably present in the simplest animals, it has evolved to serve a variety of functions" (pp. 193–94).

As a consequence of ever-widening comparative studies, most electrophysiologists are developing considerable respect for the reactive possibilities of living cells and are beginning to deal with the fact that the cell and its membrane systems form a complex of structures with complex functions. The simplistic, generalized approach of this book indicates that the author has not grasped these complexities. For example, he adopts a commonly held view regarding the "inhibitory" role of calcium in spike electrogenesis (adding a "molecular-biological" twist by endowing calcium with a role in interactions between adenosine triphosphate and adenosine triphosphatase; see p. 154). However, in the spike electrogenesis of some neurons and muscle fibers calcium plays the same role as does sodium in other cells. Under some conditions, in the squid axon, this "inhibitory" cation can even generate spikes. It seems pointless to provide a more detailed critique of the text and the thesis.

Electrophysiological and pharmacological methods make it possible to discern and to describe fairly precisely many differences in membrane properties of different cells and even in different components of the same cell. However, neither electron microscopy nor neurochemistry is at present capable of detecting, let alone of specifying, the different molecular structures that must underlie differences in membrane properties. In point of fact, therefore, we have no specific information about the molecular structure of the cell membrane, nor about molecular details as to its reactive components. Speculations that may lead to experiments are of course valuable, but a vague faith in adenosine triphosphate–adenosine triphosphatase interactions, with or without the benefit of cholinesterase, is neither helpful nor imaginative.

Despite the deficiency of its intellectual approach the book nevertheless describes and discusses many varieties of data that would be of interest and some profit to most readers. The scope of data cited is indicated by the fact that a text of only 205 pages is documented with 33 pages of references.

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Studies in Tectonics

Gravity, Deformation and the Earth's Crust, as Studied by Centrifuged Models. HANS RAMBERG. Academic Press, New York, 1967. 224 pp., illus. $11.

This is a delightful and timely little book that cannot help stimulating a wide range of earth scientists. The author, who is a leader in the field of model simulation of tectonic phenomena, uses a large-capacity centrifuge to duplicate in a scale model the effects of gravity in the earth. By "spinning up" appropriately scaled models which consist initially of flat-lying but unstably stratified layers, he is able to study the evolution of salt domes, batholiths, the rise of magma, and the sinking of heavy masses. In the process, he generates many secondary effects such as buckling, rifting, overthrusting, rim synclines, doming, transform faulting, and many more that are remarkably similar to geologic phenomena. The blow recently dealt to vertical tectonics by ocean floor spreading could tend to make one forget the important role of gravity and buoyancy in worldwide tectonics. Ramberg stresses the importance of *heterogeneous convection*, where melting or other phase changes, rather than thermal expansion, provide the buoyancy necessary to initiate the motion. The reviewer agrees with Ramberg that the density reduction caused by partial melting in the low-velocity zone of the upper mantle has profound tectonic implications.

The photographs of the scale-model results are the heart of the book, but the simple mathematical treatments of the dynamics of layered viscous solids in the appendix are also extremely useful. It is hard to see how a modern course in tectonics can be taught without the use of this book as a complementary text.

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