Mechanisms of Movement

Contractility of Muscle Cells and Related Processes. A symposium, Woods Hole, Mass., Sept. 1970. R. J. PODOLSKY, Ed. Prentice-Hall, Englewood Cliffs, N.J., 1972. viii, 274 pp., illus. $11. Society of General Physiologists' Symposia.

From the delightful introduction by Albert Szent-Györgyi, in which he reviews his personal involvement in helping to establish the molecular basis of biological movement, through each of the four major divisions of the book, the reader is given a contemporary view of the structure and function of proteins involved in movement, the process of activation, the modulation of muscle properties by nerve and exercise, and the cross-bridge contraction mechanism. The consistency of the style and the timeliness of each of the contributions do credit to the authors and the editor.

The key questions for biochemists dealing with muscle concern the molecular events taking place in the space where actin and myosin interact. After a brief review of the well-known structural details of actin and myosin a critical evaluation is presented of work on myosin light chains. Strohman and Patterson then go on to discuss experiments designed to establish the geography of the adenosine triphosphate binding sites of myosin. The data suggest that the light chains as well as the heavy subunits are involved. Although myosin from different species aggregates in a similar manner in vitro, the organization in situ may produce vastly different functional results. That such is the case in the molluscan muscle is suggested by Cohen and Szent-Györgyi in their analysis of the role played by paramyosin in organizing the structure of the myosin filaments. Data and arguments are presented supporting the idea that the paramyosin core of the thick filaments in catch muscles provides the mechanism for inactivating the cross-bridge cycle and thus fixing the catch. Although the idea is intriguing, the conclusion depends on extensive extrapolation from remote model systems. A review of the molecular regulation of contraction and relaxation is presented by Weber and Bremel. In addition to evaluating the state of the troponin-tropomyosin system they discuss the effects of low adenosine triphosphate and of the sulfhydryl content of myosin on the calcium sensitivity of the "actin troponin-tropomyosin myosin" system. Finally, Stephens reviews the status of protein biochemistry with regard to cilia and flagella. The differences and similarities in protein chemistry and function between different species and systems provide an important approach to understanding the biochemical basis of movement.

In the section on activity cycles the first two papers (Eisenberg and Costantin) concern electrical evaluation of the membrane and T system. The analysis presented for a lumped versus a distributed system leaves some of the theoretical background unclear to the reader, whereas that for regenerative versus electrotonic excitation convinces the reader of the regenerative hypothesis. The kinetics of the calcium aequorin system (Hastings and Morin) developed from the use of a double stop-flow apparatus is presented. These data are useful in establishing the ground rules for the intracellular use of aequorin and indicate that aequorin can be used for the determination of intracellular calcium movements. Movements more rapid than 10 milliseconds cannot be tracked, however. A good discussion of the calcium changes (concentration and amounts) in muscle during activation, contraction, and relaxation (Caldwell) follows. Finally the effect of calcium and magnesium on ciliary activity is discussed (Eckert and Murakami).

The section dealing with the modulation of muscle properties by nerve and exercise is engrossing, although with respect to the mechanisms involved this is least well understood of all the phenomena dealt with. There is an excellent description of the muscle types (three generally found in mammalian skeletal muscle) along with their anatomical, histochemical, biochemical, and physiological characteristics (Gauthier and Peter). The intriguing idea is presented, but not adequately defended, that heterogeneity is directly related to flexibility of the muscle. In any event heterogeneity and the plasticity (change in fiber types, chemistry, and performance) of muscle fibers are well documented. This lability is substantiated by the results of exercise programs of long duration in which fast-twitch white fibers are apparently converted into fast-twitch red fibers (Peter). Enzymatic changes are associated with changes in endurance. More striking are the changes produced by the cross-innervation experiments, where fast and slow muscles can be switched (Close). Associated with these changes in the mechanical properties are alterations in myosin adenosine triphosphatase activity. The trophic effects of nerves suggest that gene expression is controlled by the innervating fibers (Guth). Although knowledge of the nature of the trophic control and the precise mechanism of its effect is not at hand, this important and provocative set of experiments is thoroughly discussed and evaluated.

The final section of the book deals with the architecture of the cross-bridge interaction with actin. Data obtained by x-ray diffraction, electron microscopy, and precise dynamic mechanical measurements are used to carefully describe the constraints within which the cross-bridge mechanism must operate (Miller and Tregear, Reedy, and Podolsky and Nolan). Once again in this section the reader is brought up to date in an area of muscle physiology in which many of the future advances will be made.

This book gives a good overview of the state of achievement and current investigation into the mechanism of motion, which remains one of the most "basic, ancient and mysterious signs of life."

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Cellular Neurophysiology

Sensory Coding in the Mammalian Nervous System. GEORGE SOMJEN. Appleton-Century-Crofts, New York, 1972. xx, 386 pp., illus. $18.95. Neuroscience Series.

During the last two decades neurophysiological studies of single neurons in mammalian sensory systems underwent a remarkable flowering. Biophysics, pharmacology, and ultrastructural investigations have enriched this development. Somjen attempts to organize modern biological knowledge about activity in single sensory units, first in the peripheral and then in the central mammalian nervous system. Within each of these two subdivisions he arranges his material by sensory modality: skin senses, kinesthesis, chemical senses, audition, and vision. At appropriate points separate chapters neatly summarize methods and principles of cellular neurophysiology, discuss general problems of "coding" in neurons, consider how various synaptic arrangements would process inputs, and present Somjen's general theoretical views. He tries systematically to relate observations on sensory neurons to this material.