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.

From the welter of studies on sensory units Somjen has probably selected the most important. His choices are up to date. He describes currently unsolved problems and possible approaches to them. A fatal weakness in the book, however, involves the very concept of sensory coding. This concept may denote transformation of physically specified stimuli into neural activity, or it may denote the relationship of psychological events to such activity. Somjen first foreswears the latter interpretation of coding and thereafter continually violates his vows. The result is constant confusion about what belongs to physics and what belongs to psychology. For example, he labels visual neurons "red-green" or "yellow-blue" cells. Red, green, blue, and yellow are psychological experiences quite distinct from sets of physical stimuli on which they are contingent. Somjen's inability to distinguish the two concepts of coding culminates, among other things, in his suggested cure for the uncertainty of psychological measures of sensory magnitude. He proposes (p. 221) to identify "the physical mechanism of the brain corresponding to intensity of feeling and to measure that with physical instruments." Identifying "the mechanism," however, presupposes adequate measurement of psychological intensity. And so the circle closes.

All figures in the book are collected into a single middle section. Coping with numerous and often tangential textual references to the figures requires bimanual acrobatics.

Mature scientists will find some value in this book. Students will be led into bad habits of thought.

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Genetic Machinery

Developmental Studies on Giant Chromosomes. W. BEERMANN, Ed. Springer-Verlag, New York, 1972. xvi, 228 pp., illus. $18.80. Results and Problems in Cell Differentiation, vol. 4.

The title of this volume is somewhat misleading, in that, except for two brief mentions of ciliate Protozoa and a discussion of the amphibian lampbrush chromosome by one of the nine authors, the book deals exclusively with giant polytene chromosomes of flies. The reasons behind this heavy emphasis are to be found on the first page of Beermann's introductory article. He comments on past oversimplification of chromosome structure, and the error of explaining higher (eukaryotic) genetic machinery in terms of simple molecular models. Beermann believes that developmental events can be analyzed only after eukaryotic chromosome organization is understood in terms of structural, functional, and genetic units, and "the only material in which such a combined approach seems to be feasible is the giant polytene chromosome of the Diptera."

Beermann's chapter, entitled "Chromomeres and genes," makes excellent specialized reading, correlating the latest biochemical and genetical findings with electron microscope observations. Beermann introduces the reader to the two structural entities discussed at length in the succeeding chapters: chromomeric regions or "bands," and the genetically very active regions visible as "puffs." The next article, by Lezzi and Robert, takes the reader into the detailed effects of various agents, particularly ions and hormones, on chromosomes that have been isolated from salivary gland cells of midges of the genus *Chironomus*. The review of replication in polytene chromosomes by Rudkin is detailed, concise, and logically presented. Pelling's article on transcription in giant chromosome puffs includes detailed correlations with amphibian lampbrush chromosomes. Puffing patterns in *Drosophila melanogaster* and related species are discussed by Ashburner. He shows, in beautifully illustrated sequences, the value of studying chromosome puffing patterns in a genus in which so much is known of the genetics and in which "genetic engineering" is easily possible. Ribbert considers the available data on the relation between puffing and differentiation in trichogen and pulvillar epidermal cells in the blow fly, *Calliphora*, and the flesh fly, *Sarcophaga*. Here, the electron micrographs are not quite up to the generally high standard of the micrographs in the rest of the book. Berendes's article returns to the subject of salivary gland chromosomes with a discussion of the control of puffing in *Drosophila hydei*. It is well illustrated and reviews specific findings in the light of general problems of the control of chromosome activity. It would have made a good concluding chapter. It is unfortunate that Panitz's short article on Balbiani ring activities in the midge genus *Acricotopus*, because of its terminal position, tends to sound repetitious in places.

On the whole the book is a valuable addition to the series, and achieves the aim of the general editors: "to render a thorough and up-to-date picture of giant polytene chromosomes" and "to discuss all angles of general biological interest."

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General Relativity

Gravitation and Cosmology. Principles and Applications of the General Theory of Relativity. STEVEN WEINBERG. Wiley, New York, 1972. xxx, 658 pp., illus. $18.95.

The discovery in 1965 of the 3°K background blackbody radiation by Penzias and Wilson has provided a powerful stimulus for research in the field of cosmology. Likewise the discovery of quasi-stellar objects and pulsars in the 1960's supplied the impetus for a host of new investigations in the field of relativistic astrophysics. Unfortunately, the rapid growth of papers in these fields, with the sudden appearance (and equally sudden demise) of new theories, has made it extremely difficult for the beginner to find his way through the literature and judge the value of new works in these fields. If nothing more, Weinberg's book will serve as guide through this maze. The author seems to have read just about every paper in these fields that has been written in the past 15 years and has succeeded in presenting the material in an extremely clear manner. In many cases he has succeeded in making understandable what was far from understandable in the original works. In his discussions the author tries to start from the beginning, so that the reader has a clear understanding of the underlying physical principles involved and the assumptions being made. There are very few rabbits pulled from a hat in these discussions. Furthermore, most of the discussions are more or less self-contained, so that the reader who has some background in the subject can read about one or another topic without having to begin on page 1.

As the subtitle of the work announces, the book concerns itself with both the principles and the applications of general relativity. The applications