Book Reviews

Muscles and Movement

Muscles, Reflexes, and Locomotion. THOMAS A. MCMAHON. Princeton University Press, Princeton, N.J., 1984. xvi, 332 pp., illus. $50; paper, $15

This book is set to become a classic. In it McMahon uses relevant studies from anatomy, physiology, biophysics, biochemistry, bioengineering, and animal mechanics to construct a coherent conceptual scheme for understanding how animals and humans move. The coverage ranges from the kinetics of myosin cross bridges and force development to the production of coordinated walking movements and the development of "tuned" athletic tracks to reduce running injuries and improve race times.

The book is brilliantly successful. As might be expected of someone trained in mathematics and engineering, McMahon's conceptual scheme is, where possible, a mathematical model. This does not mean that students of biology or medicine will find it dry or hard going. On the contrary, the book is entertaining and lucidly written, with many fascinating asides and anecdotes.

The book is logically organized and has a strong historical perspective that gives the reader a feeling for the excitement and pace of development of new ideas. All the more mathematical sections, such as those on cross-bridge kinetics (chapters 4 and 5), are painstakingly worked through, giving all the intermediate steps in the argument.

An unusual feature in a book of this type is the inclusion of a series of worked examples and unsolved problems at the end of each chapter. The answers to the problems are given in a short section at the end of the book. McMahon carefully evaluates the usefulness of and explores the predictions inherent in the various theories and models he develops, and he gives a full account of the experiments that have been carried out to test them. In a few cases, some experiments and hypotheses are taken rather more to heart than they would be by those actively engaged in research on the subjects involved. For example, the idea (p. 79) that nonuniformity of sarcomere lengths "provides a unifying principle" for explaining both the extra tension following stretch of a muscle and tension "creep" in fixed-end tetani and other phenomena remains controversial.

The book starts with Hippocrates's early ideas about muscle contraction and proceeds rapidly to assess the experiments on isolated muscles carried out by A. V. Hill and his colleagues at University College London between 1910 and 1950, which laid the foundation for studies of muscle mechanics. There follows a concise and authoritative account of muscle energetics and heat measurement experiments. In a few cases, for example in the discussion of the hydraulic model of free energy flow in muscle involving floats, valves, and resistances, I found the analogies harder to follow than the facts.

Accounts are given of the organization of muscles, x-ray diffraction in active muscle, the sliding filament model of muscle contraction, and the biochemistry of the contractile proteins. The account of the contractile proteins is somewhat superficial and out of date. For example, it is now three or four years since alkali light chains were shown not to be essential, after all, for adenosine triphosphatase activity of myosin. However, it is unreasonable to expect the same depth of treatment as that in far longer and more specialized books. These accounts were worth including as background for the more "meaty" chapters that follow.

The second section of the book deals with more integrated studies on such subjects as the structure and physiology of proprioceptors, the operation of reflexes, the nervous control of coordinated locomotory movements, and the classifications of gaits. Lucid accounts are given of the various engineering principles involved. This section ends with an amusing account of attempts to build robots with legs.

Chapters on the mechanics of locomotion and the effects of scale are probably the best of all. Excellent accounts are given of the importance of elastic storage of energy and of positive and negative work done by muscles during running, walking, and hopping. Finally, the usefulness of dimensional analysis for studying the effects of scale is explored and models of geometric similarity, elastic similarity, and constant stress similarity are developed and evaluated for such diverse parameters as blood pressure and adenosine triphosphatase activity of myosin. As is the case throughout the book, these chapters are well illustrated and contain diagrams that are simple yet informative and often original.

In conclusion, the book is highly recommended to all those interested in muscle and animal movement. It is likely to be equally useful to students and to established research workers in biophysics, bioengineering, biology, and medicine.

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Comparative Neurobiology

Comparative Neurology of the Optic Tectum. HORACIO VANEGAS, Ed. Plenum, New York, 1984. xx, 850 pp., illus. $125.

The optic tectum evolved into more than just a part of the midbrain roof. It became a model. To developmental neurobiologists, who used the regenerative capacity of fish and frogs to mimic ontogeny, the visual map in the tectum provided an opportunity to investigate how neural systems achieve a precise wiring. Following seminal work by Lettvin and his colleagues on prey catching in frogs, that group of sensory physiologists who would later be called "neuroethologists" explored the tectum for the type of feature detectors suggested by ethological models of behavioral control. The tectum's layered sensory and motor maps seemed an ideal substrate for extracting principles of sensorimotor integration. When comparative neuroanatomy became reenergized by the development of modern experimental techniques, vision, and especially the retinotectal system, became the focus of attention. Indeed, ten or 15 years ago, one might have thought comparative neuroanatomy *was* the comparative neuroanatomy of the optic tectum.

As comparative neurobiology has expanded, audition and electroreception have become the glamour sensory systems of the field. The volume of studies of the retinotectal systems in different vertebrates has gradually tapered off,