Book Reviews

Great Decades in Neurophysiology

Charles Scott Sherrington. An Appraisal. RAGNAR GRANIT. Doubleday, Garden City, N.Y., 1967. 210 pp., illus. $6.

Now, some 15 years after the flood of biographical writing that followed upon the death of Sir Charles Scott Sherrington, it is good to have this full-length account of his life and work. Ragnar Granit, until recently director of the Nobel Institute for Neurophysiology in Stockholm (and a 1967 Nobel laureate in medicine), is one of the few men fresh from the laboratory who can write of Sherrington from personal experience. Granit asks, What made Sherrington great? Why is he important to succeeding generations? How did he find neurophysiology and how did he leave it? What of his has survived the cruel test of time? What did he anticipate? What more has been learned?

In his attempt to answer these questions Granit offers not only a fine portrait of a man but also a good and remarkably compact introduction to modern neurophysiology through a succinct review of its recent history.

Charles Sherrington's scientific thinking was shaped during the great flowering of British and German physiology toward the end of the 19th century (around 1880). Between the time he declared for physiology and 1900 his main discoveries and generalizations were made or prefigured. They were brought together in his *The Integrative Action of the Nervous System*, first published in 1906 and still a powerful book.

Granit identifies as Sherrington's greatest contribution the proof that inhibition is central and that neurons to antagonistic muscles are reciprocally excited or inhibited so that a limb always does one thing at a time, never two opposite things. In short, the action of the limb is always integrated.

Basic to all Sherrington's work was the translation of the neuron theory into physiological thinking which, many years later, was to win him the Nobel prize (shared with Adrian). The familiarity with the cell and the microscope that Sherrington had gained as a pathologist and his acquaintance with Ramón y Cajal's work enabled him to develop the concept of neurons joined end to end synaptically (clasped) but separated by their two cell membranes—"contiguity without protoplasmic continuity." Thus the synapse became an arena where excitation and inhibition, each drawn from many sources, including the brain, battled for possession or interdiction of the spinal neuron passing to the skeletal muscles.

Another contender for primacy among Sherrington's contributions to physiology was the discovery of decerebrate rigidity and its analysis in terms of a reflex originating in sense receptors in the muscle, with impulses reflected back to the particular muscle. He stressed the adaptive significance of the stretch reflex—the maintenance of erect posture. Muscle tone, long a mystical concept, and the knee jerk, long considered a muscle phenomenon, were proved to be reflexes.

The way a scientist thinks is difficult to capture. Granit hints at an important aspect of Sherrington's mind when he quotes von Brücke (the elder): "Teleology is like the kind of woman people do not want to be seen with in the street, yet are prepared to tender their love to in secret." I have always believed that Sherrington was a teleologist, though a secret one. He held public opinions based on evidence and opinions expressed privately based on whether or not a finding made good sense biologically. Although he never used purpose as proof, I believe he used it as a guidepost. Sherrington was much concerned with purpose (adaptation), as is evidenced by the asking of such down-to-earth questions as, How does a dog scratch a flea? How does an animal stand? Or walk?

Granit describes the period of Sherrington's professional life from the end of World War I to about 1925 as one of quantitation. The concepts developed in the earlier period were tested and refined by an inertia-free system which recorded photographically the *forces* of rapid muscle contractions. Quantitative electrical and mechanical methods for eliciting reflexes were developed, and the string galvanometer recorded muscle action currents. From muscle contraction Sherrington could reason back to the events at the synapse. By 1925 he could formulate clearly the occurrence of two distinct events at the synapse, which, though opposite, were almost identical in their properties.

In a classic paper in 1925 Sherrington marshalled detailed evidence to prove that inhibition was a distinct entity obeying all the laws he had set down for central excitation. He conceived of excitation and inhibition interacting algebraically at the synapse—he used the chemical analogy of a base neutralizing an acid. Sensitive on the one hand to the discoveries of chemical transmission in the visceral nervous system and on the other to the concepts of prolonged nerve cell membrane changes, with characteristic caution he left room for both as the basis for excitation and inhibition. Had he done otherwise, his work might have been the focus of polemics and might not have stood as the framework in which modern neurophysiology still operates.

In the late 1920's Sherrington had learned virtually all that was to be learned about reflexes with the use of the isometric myograph. Had he, like Adrian at Cambridge and Gasser and Erlanger at Washington University, exploited the rapidly growing field of electronics, what an Indian summer there could have been in his scientific career. Though he developed the "single unit" concept, he never recorded from one electrically. However, since many scientific lives end at 40 or on assumption of a chairmanship, we should not regret what might have been in Sherrington's after age 70! Many of the first generation of his students, such as David Lloyd, John Fulton, Sir John Eccles, and Granit himself, and many of the second generation as well, blended the heritage of Sherrington with the electrophysiological heritage of Adrian, Gasser, Erlanger, Hodgkin, and Huxley so that now even the cerebral cortex is not safe from the probing of electrodes to record single neuron activity (Amassian, Jung, Jasper).

Neurophysiology is difficult to understand, but Granit's latter chapters, with the subject set in sharp relief but treated in enough detail, easily permit the reader to grasp the significant discoveries in the field. The reviewer will resist the temptation to catalog the triumphs of neurophysiology since Sherrington and instead will leave it to the interested reader to explore them from this biography.

What makes genius will continue to haunt us. Sherrington's accomplishments were evident early in life and were sustained throughout decades of scientific achievement. Philosophical and historical writings occupied much of his later—but not declining—years in matters of mind. Granit's warm and sensitive biography of a great scientist and great man should prove rewarding to anyone fascinated by the history and progress of neurophysiology.

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Hydrozoans

The Cell Biology of Hydra. THOMAS L. LENTZ. North-Holland, Amsterdam; Interscience (Wiley), New York, 1967. 211 pp., illus. $12.95.

This book will be welcomed by readers looking for a thoughtful and stimulating discussion of hydra. There is sufficient coverage of the general biology of hydra (including notes on its discovery and subsequent cultivation) to ease even the nonspecialist into the quite detailed presentation. About half the book deals with the structure, ultrastructure, and histochemical composition of hydra. This anatomical picture is then correlated with their physiology and development, particularly as related to cell permeability, the control of nematocyst discharge, and the influence of the nervous system on regeneration. Lentz's theme is that we must narrow the gap between form and function at the cellular and subcellular level.

Hydra specialists will be most grateful for the chapters on the nervous system, which provide the most comprehensive available discussion of this lively subject. Three types of nerve cells (ganglion, sensory, and neurosecretory) are catalogued, although there is an unfortunate lack of light-microscopic characterization. Also discussed are many biochemical and physiological characteristics attributed to the nervous system.

The Cell Biology of Hydra is not a critical review of any general or particular aspect of hydra, and it goes well beyond the cell in scope. As a review it is rather saltatory in treatment and has undue emphasis on Lentz's own work (although good literature references are included at the beginning of each chapter). As a research monograph (as the author terms it) it lacks precision in statement, especially in the presentation of experimental data (one is not even told with which species [pl.?] the book deals, and many statements are not applicable to all hydras). Also, observations are treated in a very speculative fashion. This volume might be best described as a record of Lentz's experiments with, observations on, and thoughts about hydra. As such it imparts a sense of direction and excitement to current research on hydra and covers in depth a wide spectrum of topics.

This book is generally attractive, although I did find the abundant illustrations to be disappointingly poor and errors in the text annoying. Nevertheless, many diverse types of readers will find this a modern and informing discussion.

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Magnetic Processes

Hyperfine Interactions. ARTHUR J. FREEMAN and RICHARD R. FRANKEL, Eds. Academic Press, New York, 1967. 774 pp., illus. $16.

The hyperfine interaction, or magnetic interaction of the electrons in ions, atoms, and molecules with the magnetism of the internal or neighboring nuclei, is weak and plays no significant role in basic structural perturbation compared with the more important spin-orbit or exchange interactions. Nevertheless, and perhaps even because of this, the hyperfine interaction is an important indirect tool for the determination of structure and in influencing magnetic processes. It is probably only a slight exaggeration to say that there are more physicists and physical chemists whose research interests have some important specialized contact with the hyperfine interaction than with any other single interaction per se. Nuclear physicists and others concerned with nuclear magnetism, and most optical and radio-frequency spectroscopists, find many effects and complications arising from this interaction. Whether it is more effective to deal with the subject inclusively, as is done in this book, or to introduce it in review books devoted to particular fields of research in which it plays a role depends on the sophistication of the reader.

Starting with a general introduction, by B. Bleaney, to the hyperfine interaction and its role in paramagnetic resonance, this collection of papers continues with a discussion of the Hartree-Fock determination of electron density at the nucleus, methods of calculating the interaction, and general articles on the most important methods of studying the interaction—namely, atomic-beam resonance, high-resolution optical spectroscopy, and paramagnetic-resonance techniques. The remainder of the articles are rather unique discussions of special topics in which the hyperfine interaction plays a role. There are papers on nuclear and paramagnetic resonance in metals and magnetic solids, nuclear relaxation and polarization phenomenon, effects involving the conduction electrons in metals, nuclear specific heats, Mössbauer absorption, angular-correlation experiments, low-temperature orientation, rotational cooling, and additional topics in nuclear resonance. Of these special articles, several on perturbed angular correlation and Coulomb-excited Mössbauer effects seemed to this reviewer to be unique and difficult otherwise to find in the review literature.

With an often uneasy blend of textbook style and concise, review-article style, this is clearly a reference book for specialists and research students. It is probable that the most interested readers will appreciate the book for individual contributions, and in this respect the editors are to be thanked for selecting predominantly young and currently active contributors. If an attempt to find weak points were really to be called for, it could include the comments that some of the subjects have been more completely, informatively, and naturally covered in well-known textbooks concerned with atomic and molecular beams, nuclear magnetism, or paramagnetic-resonance spectroscopy, and that the bibliography in many articles is rather restricted. A collection with this title might well have included a discussion of the role the hyperfine interaction plays in experiments for the precision determination of physical constants such as the g factor of the electron, the Lambe shift, and the fine-structure constant, or the