

## RECEPTORS AND SENSORY PERCEPTION

A discussion of aims, means, and results of electrophysiological research  
into the process of reception

RAGNAR GRANIT. Yale University Press, 1955, 369 pp., \$5.00

A number of the classics in the literature of physiology of this century owe their genesis to the stimulus of the Silliman Memorial Lectureship at Yale University — among them the *Integrative Action of the Nervous System* (Sherrington), *Respiration* (Haldane), *Blood* (L. J. Henderson), and *The Anatomy and Physiology of the Capillaries* (Krøgh). Sherrington's lectures that formed the basis for the text of *The Integrative Action of the Nervous System* were delivered in 1904 though the book itself did not appear until two years later. Acclaimed at once as a work of outstanding importance the book served to refashion thinking in neurophysiology for it gave those interested in the field a foundation of experimental observation upon which were erected broad generalizations fashioned with rare philosophic insight into meanings biological. The book provided an immense stimulus to research and largely determined the direction in which the subject was to develop for the three decades that followed its appearance.

The Silliman Committee in their selection of the lecturer for the year 1954 may well have been guided by a desire to recognize in a fitting fashion the golden anniversary of Sherrington's lectureship and its importance for the subsequent development of research and teaching on the physiology of the nervous system. In any event the choice of the lecturer for that year was a happy one and admirably served that worthy purpose for Professor Ragnar Granit, Director of the Nobel Institute for Neurophysiology in Stockholm and an outstanding contributor to the advancement of our understanding of sensory mechanisms was one of Sherrington's pupils. Granit's interests have been centered primarily in two areas of investigation — the electrophysiology of the retina and the role of the sensory system in the regulation of muscular tone; the latter area represents an extension of the fundamental researches of Sherrington on decerebrate rigidity and the function of the intrinsic afferents of skeletal muscle.

These interests form the central themes of the chapters of this monograph — the lectures of 1954 — and their great value stems from the fact that — like Sherrington's lectures fifty years earlier — they are a well documented record of first hand experience in the laboratory. Certainly no one could write with such authority about the physiology of muscle receptors, the reflexes they evoked and their

interplay with spinal and supraspinal systems in the regulation of muscle tone, for Granit and his co-workers are in large measure responsible for the elevation of our understanding of "spasticity" and "rigidity" from what might be designation an "anatomical" to a "physiological" level. Their disclosure of the role of the motor control to the intrafusal fibers in regulating the firing frequency of the spindle has clarified a host of phenomena among them — the lengthening and shortening reactions and the "claspknife" reflex — that were previously without mechanistic explanation. Their demonstration that the "sensitivity" of a receptor or group of receptors can be set and rest at a particular level by another group of neurons has not only broadened our concept of the function of sensory endings as physiological meters, it has reawakened interest in the functions of the efferent fibers to the cochlea and retina and given wider significance to the phenomena of "circus excitation" first emphasized by Hinsey and Rauson.

How far attention has shifted from the properties of the axon — and the form of the impulse — to those of the terminals of the neurons in the search for the unifying principles of neural activity and interaction is especially evident in Granit's excellent treatment of the primary processes of the sensory receptors. Recognition of the "slow potential" as the generator and antecedent of the rhythmic response to the steady state serves not only to bridge the gap between sensation — as quantitated by the Weber-Fechner law — and the stimulus intensity but to point up the fundamental similarity between the properties of sensory and motor neurons — a similarity early emphasized by Adrian and his pupils. The role of the neuron as a conductor and transmitter emerges as secondary to its capacity as a generator and integrator. Even the low safety factor at the site of the expansion of a sensory fiber at the junction of its smaller branches is clothed with an integrative function.

Similarly Granit has given new meaning and importance to the spontaneous activity of sensory endings and centrally placed neurons i.e., retinal elements. The burden of proof is at last placed upon those who would deny the existence of true spontaneous impulse generation. Where it occurs the suggested role of the spontaneous activity of sensory

endings is to energize central systems — to provide a central drive or level of excitation; from this concept, and the evidence in support of it, extend new and fruitful avenues of thought that — tested by experiment — may offer firm bridges to aspects of neurology now the domain of the psychologist. Granit makes especially clear the importance of spontaneous activity in those cases in which the

mechanism for excitation is subject to peripheral inhibition i.e., the labyrinth and muscle spindle, against a background of central activity a decrease in the peripheral signal is seen to have meaning as capable of interpretation as a rise.

This is a book that takes its proper place along with the other physiological classics born of the Silliman lectureship.

DONALD H. BARRON

### MEDICAL RESEARCH : A MIDCENTURY SURVEY

Vol. I American Medical Research: in Principle and Practice, 765 pages.

Vol. II Unsolved Clinical Problems: in Biological Perspective, 740 pages.

THE AMERICAN FOUNDATION, NEW YORK.

Little, Brown & Company, Boston. \$15.00.

A comprehensive intelligible survey of the entire field of medical research in biological perspective would seem an impossible task to anyone actively engaged in any special branch of research or medical practice. After reading these two volumes with growing enthusiasm and sustained interest one must admit that such an impossible task has been achieved with remarkable success, not by a specialist in medical or biological research, but by a non-medical woman, Esther Everett Lape, in charge of a non-medical Foundation whose purpose is "through fundamental and objective studies to clarify public thinking on subjects on which public thinking was notably non-existent or confused". The "public" should include, in this case, medical research workers as well as workers in the physical and biological sciences.

Each of the special fields is treated with equal critical competence, and with a sustained theme of the dependence of all medical research upon basic biological research. This extends from our understanding of virus infections or the principles of growth in normal and cancerous cells to our understanding of mental disorder such as schizophrenia.

This work is the culmination of 15 years of study with the aid of a distinguished list of consultants including George Bishop, Ralph Gerard, William Lennox, Francis O. Schmitt and Paul Weiss, familiar names to readers of this Journal.

The first volume deals largely with administrative aspects, organizations and financial support together with basic philosophy underlying the rapid expansion and direction of medical research in the United States. Some idea of the scope of this work is given by the chapter headings:

1. Medical Research in the Perspective of Biological, Chemical, Physical, Mathematical Science, 2. Current Trends and Current Problems in Medical and Biological Research in the United States, 3. Re-

search Agencies, 4. Clearing Results and Controlling Products of Medical Research. This is not a dry account of budgets and institutional organization. It is a searching authoritative analysis of basic principles underlying the most productive organization of medical and biological research and the training of research workers. Emphasis is upon the importance of the basic sciences, physical and chemical, as well as biological, and upon the development of research in University settings rather than in specialized Institutes.

In the second volume will be found more of special interest to readers of this Journal. It begins with a lucid review of "Current Metabolic Concepts Orienting Research in Biology and Medicine" including molecular mechanisms, cellular metabolism, correlation of chemical and electrical phenomena of nerve function, and neurohormonal mechanisms of metabolic equilibrium and adaptation. Specific examples are then taken for detailed treatment: *cancer*, *infertility*, *arteriosclerosis*, *hypertension*, the *rheumatic syndromes*, *tuberculosis*, the *nature of viruses and of virus diseases*, *alcoholism* (stressing metabolic approaches to an outstanding psychological and social problem) and *biology of schizophrenia* (illustrating interactions of physiological, psychological and social factors).

In summarizing current views regarding chemical and electrical events in nerve tissue the sodium-potassium theory of Hodgkin and Huxley, and Eccles, is compared with the metabolic theory of Lorente de N6 as supported by the work of Bronk and associates. "Energy rich phosphate is generated in neural tissue by the same mechanisms as in other tissues. This leaves to be answered the question as to the source or trigger mechanism of the specific change in permeability which generates the bioelectric potential for transmission of the nerve impulse along the