NEUROPHYSIOLOGY AND THE INTRACELLULAR TECHNIQUE

The Physiology of Nerve Cells

By Prof. John Carew Eccles. Pp. xi+270. (Baltimore, Md.: The Johns Hopkins Press, 1957.) 5.75 dollars.

THIS book, based on the Herter Lectures delivered at the Johns Hopkins University, presents the latest development of the fundamental work by Prof. J. C. Eccles and his colleagues at Canberra on the properties of motoneurones as revealed by the intracellular technique of electrical recording. His earlier book, "The Neurophysiological Basis of Mind" (Oxford University Press, 1953), was written for a broad circle of readers. The new book is something of a supplement for neurophysiologists, a thorough exploration of the properties of the membrane of the motoneurone cell body in terms of 'inside' records. The four leading chapters are devoted to this task, the two remaining ones to a discussion of recent work and current ideas in neurophysiology.

The motoneurone cell body, some 70μ across, is penetrated by the tip of a glass capillary $0\cdot5\mu$ in diameter and filled with an electrolyte. In these large cells, situated in the ventral horn of the spinal cord, the wound is reasonably well sealed by the cell membrane, which closes up around the capillary so that reflex excitation and inhibition can be studied in terms of potential changes across the cell body. Some excitatory changes, especially long-lasting ones, are presynaptic and are thus not accessible to this technique, whereas others are determined by events in the cell processes or dendrites and only indirectly reflected in the cell body. Intracellular recording is therefore a technique for studying the 'effector' end in the chain of events, rather than all aspects of central nervous excitation. However, bearing this limitation in mind it has proved a fascinating tool. This approach originated with the Canberra group, and they have followed it up with outstanding skill.

Their most important generalization, since confirmed both for motoneurones and many other cells, still remains the discovery that monosynaptic reflex excitation depolarizes the cell along a characteristic curve, whereas inhibition drives the membrane back towards its equilibrium potential or even hyperpolarizes it. Theoretically, inhibition could also be obtained by excessive depolarization, and this case has been described elsewhere with cerebellar Purkinje cells, but apparently the characteristic responses found by Eccles and his colleagues are common for many types of nerve cells.

The book opens with a thorough account of the electrical properties of the cell membrane, as measured by themselves and others, and then proceeds to a presentation and discussion of the results obtained with double-barrelled microelectrodes. One barrel is used for changing the level of membrane potential by electrophoretic injection of anions or cations, while the other records the membrane potential and the effects of reflex excitation and inhibition. These difficult and skilfully conducted experiments are also hard to interpret in physicochemical terms, but nevertheless represent an approach to the problem that had to be carefully explored. They gave very valuable information on the generation of an impulse or spike in relation to level of membrane potential. Both excitation and inhibition will be found analysed in the book from these points of view. The fundamental line taken is that excitatory or inhibitory synaptic mediators or transmittor substances initiate the flow of ions, culminating in the excitatory or inhibitory changes of membrane potential studied. The rhythmic discharge of spikes is found to emanate from the region around the excitor axon hillock of the motoneurone, which seems to be specialized for the emission of signals down the axon.

The experimental work presented in this book has required not only skill but also patience and industry far beyond the ordinary. It is a pioneer effort rewarded by real insight into the electrical properties of nerve cell bodies and it has stimulated much research in many other centres throughout the world. Prof. Eccles does not shun discussion, so that the well-informed student of the central nervous system will find much more in the book than the presentation of a new line of approach to the physiology of nerve cells.

RAGNAR GRANIT

THERMODYNAMICS AND THE STRUCTURE OF MATTER

Thermodynamics and Statistical Mechanics

By A. H. Wilson. Pp. xv+495. (Cambridge: At the University Press, 1957.) 50*s*. net.

THERMODYNAMICS and statistical mechanics are commonly treated as separate subjects. They are, however, so closely connected that there is great advantage in treating them in a single book, as is done here. Six of the fourteen chapters are devoted to development of the fundamental theory, and the other eight to various applications.

In the first three chapters thermodynamics is developed in the classical manner. Now thermodynamics is a subject that is much easier to apply than to develop. Its historical development, which has happened in an illogical order, has added to the difficulties. Accounts of the first principles of thermodynamics are therefore often confused, and contain concealed assumptions or even circular arguments. Dr. A. H. Wilson has here given a clear account of the classical theory with all the assumptions precisely stated. But the classical development of thermodynamics, however well described, is not completely logically satisfying; in the fourth chapter, therefore, Dr. Wilson describes Carathéodory's axiomatic approach. Readers may choose, therefore, between the more logical approach of Carathéodory, and the less abstract one of the classical method; but there would be advantage in reading both accounts.

Chapter 5 discusses the foundations of statistical mechanics. As with thermodynamics, this is the most difficult part of the subject; application to a particular problem is simple by comparison. There are several possible methods of approach. Dr. Wilson starts by considering quantal systems; his fundamental assumption is that the value of any dynamical variable of a macroscopic system is obtained by taking the average of the variable over all the possible stationary states of the system. The relations of temperature, entropy, etc., to the energy-levels of the system are then developed. Use is made of Stirling's theorem, but Dr. Wilson is careful to point out the problems and difficulties involved in this.