

pattern of cardiac innervation from hagfish to primate as well as the differential distribution of the sympathetic and parasympathetic nerves, the former predominantly ventricular and the latter mainly atrial in termination. At a finer level, the extensiveness of the terminal varicosities is also described in the book, along with the fact that every muscle cell appears to receive a nerve terminal. This point can be verified in the micrographs in spite of the somewhat murky reproduction of many of the illustrations.

The broader objective of the work, however, is to provide the anatomic details which "are necessary for a re-evaluation of cardiac physiology in health and disease." It is in the attainment of this goal that the book has fallen short. The same decade which saw the light microscopic studies of Hirsch also saw the fluorescent histochemical amine studies of the Karolinska group and the more recent electron microscopic observations of Thaemert, Burnstock, and others. These works are quite pertinent to the monograph and would have made possible meaningful interpretation of the results. There was an opportunity in this monograph to demonstrate the continuity between classical and modern anatomical studies and the dependence of one upon the other. Because the opportunity was missed, because the bridge between the two morphologies was not built, the monograph fails to reveal the applicability of current anatomical knowledge to cardiac physiology and is, overall, a disappointment.

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Neuropharmacology

The Pharmacology of Synapses. J. W. PHILLIS. Pergamon, New York, 1970. xii, 360 pp. + plates. \$16. International Series of Monographs in Pure and Applied Biology: Zoology, vol. 43.

At a time when synaptic pharmacology has become highly fashionable, and correspondingly complex and controversial, Phillis has dared to write a monograph covering a large part of the total field. It is clear that he is a man of courage. Moreover, the result will be valuable to investigators as well as to students. However, it should be clear that the title is a misnomer. It used to

be said that a drug could be defined as a substance which, when injected into a dog, produced a paper. Now, apparently, the substances that qualify, with few exceptions, are those that can be injected microionophoretically. Thus this book will disappoint anyone hoping to be enlightened about the mode of action of anesthetics, sedatives, or psychoactive drugs, all of which presumably act on synapses. Only with the final conclusions does the author explicitly state that he was concerned primarily with studies related to compounds which are putative synaptic transmitters.

The book divides roughly into three portions. Nearly half is concerned with acetylcholine and monoamine metabolism and with peripheral cholinergic and adrenergic synapses. About the same proportion is devoted to pharmacological studies on neurons in the central nervous system. To this is added a rather straightforward account of studies of junctional pharmacology in invertebrates, and there is also some consideration of candidates for transmitter function such as serotonin, histamine, substance P, and prostaglandins.

The discussion of amine metabolism and peripheral cholinergic and adrenergic systems lies somewhere between that found in most current pharmacology textbooks and that in many recent reviews; more extensive and documented than the former, it lacks much of the detailed consideration of controversial subjects to be found in the latter. It is disappointing that the author has largely omitted calling attention to the many gaping holes that still exist in our present understanding of even the most studied systems. For example, it is only since this book was published that the ionic mechanism of the muscarinic excitatory postsynaptic potential in sympathetic ganglia has been clarified. The student reading this book would be unaware that the problem existed. Surely it is in a monograph such as this that an author has the opportunity to consider not only those questions that have been answered but also those that have not.

The pharmacology of neurons in the central nervous system is the author's own area of special interest, and he provides an extensive review of the actions on neurons of ionophoretically applied acetylcholine, catecholamines, amino acids, and other substances which can excite or depress action potential frequency. It cannot be held against the author that the main effect

on the reader is one of depression rather than excitation. After so much work, by so many investigators, one feels that by now there should be some unequivocal evidence as to the identity of transmitters at anatomically and physiologically defined central synapses. Even five years ago one could accept tentatively the simplifying assumption that when a substance inhibited or excited a neuron it did so by a direct action on that cell, and perhaps by interacting with receptors for an endogenous transmitter. At the time, everyone seemed aware that any action just might be indirect, secondary to an action on nerve terminals, glia, or even neighboring neurons. Today, however, one looks in vain for experimental evidence justifying that earlier assumption. Many investigators still seem to think that it is sufficient to accumulate counts of cells excited or inhibited by this or that agent, in this or that area of the brain. Is it possible they have become committed to techniques which are incapable of providing any real answers?

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Russian Survey

Molecules and Life. An Introduction to Molecular Biology. MIKHAIL V. VOL'KENSHTEIN. Translated from the Russian edition (Moscow, 1965) by Serge N. Timasheff. Plenum, New York, 1970. xiv, 514 pp., illus. \$15.

"The purpose of this book is to explain molecular biophysics to all who might wish to learn about it, to biologists, to physicists, to chemists." This is the author's preface, written in Leningrad in 1964. The author is a distinguished Russian scientist, who has himself made extensive contributions to the theory of chain macromolecules. One might expect from this that the book would penetrate to the frontiers of our present understanding of the physics of the molecules of life, but it is apparent that Vol'kenshtein had a different aim in mind. This book is a survey of the whole field of molecular biology, starting with an elementary description of "cells, viruses, and heredity," amino acids and proteins, and the code. Biophysics is represented by chapters on the physics of macromolecules, of proteins, and of nucleic acids. Even the chapters that have "physics" in their