The Structure and Function of Nervous Tissue

Edited by
GEOFFREY H. BOURNE

V

STRUCTURE III
AND
PHYSIOLOGY III

THE STRUCTURE AND FUNCTION OF NERVOUS TISSUE

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THE STRUCTURE AND FUNCTION OF NERVOUS TISSUE

VOLUME V

STRUCTURE III AND PHYSIOLOGY III

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Preface

Slowly in the course of evolution the generalized irritability of ancient protoplasm became transformed into a nerve impulse. This became possible because of the differentiation of a cell capable of transferring its reaction to stimulation without decrement along extensions of itself to other cells situated a considerable distance away, and even to cells which can store the stimulation and then produce it at will—a process known as "memory." Such cells are known as neurons. These cells and their processes together with supporting cells (neuroglia), investing cells (Schwann cells), various connective tissue, and ectodermal elements form "nervous tissue."

This open-end treatise will deal with nervous tissue as seen through the eyes of anatomists, embryologists, biochemists, pathologists, clinicians, and molecular biologists. So complex is this nervous tissue that all these disciplines have something to contribute to the understanding of its structure and function. The three volumes already published do not of course cover all the aspects of this tissue; subsequent volumes will fill the gap. This synthesis of knowledge is intended as a reference work for graduate students in a variety of disciplines and for those specializing in particular aspects of nervous tissue study who must keep informed of developments in areas other than their own. It is also intended as a general reference work.

The first three volumes were published in rapid succession. Successive volumes will be added from time to time.

Geoffrey H. Bourne

Contents of Other Volumes

Volume I: Structure I

Volume II: Structure II and Physiology

Volume III: Biochemistry and Disease

Volume IV: Physiology II and Biochemistry II

Contents

7. Representation in the Cerebral Cortex and Its Areal Lamination Patterns

FRIEDRICH SANIDES

8. Split-Brain Studies. Functional Interaction between Bilateral Central Nervous Structures

MICHEL CUÉNOD

9. Electrophysiological Studies of Learning in Simplified Nervous System Preparations

C. GALEANO

I

The Nerve Growth Factor

Rita Levi-Montalcini, Ruth H. Angeletti,
and Pietro U. Angeletti

I. Introduction

The outstanding feature of the nervous system is the diversification of its billions of cells at the structural and functional levels. While the recognition of this fact has promoted intensive search, particularly at the morphological level, and directed to exploration of the characteristics of different nerve cell populations and the bearing of the shape, orientation, and location of neurons on their function, much less is known about the biochemical basis of nerve cell specification. This is due to the fact that the large majority of nerve cells are embedded in the dense matrix of the cerebrospinal axis and only a few neurons, such as the cerebellar Purkinje cells and a handful of other neurons, are accessible to dissection and isolation from surrounding cells and intercellular tissue, thanks to their large size and other identification marks.

A privileged situation is held, in this respect, by nerve cells which reside outside the nervous system, such as sensory, sympathetic, and parasympathetic nerve cells, lodged respectively in the ganglia which bear the same name. It was this peripheral location which made of the sympathetic and parasympathetic nerve cells a favorite object of analysis of physiologists and pharmacologists in the early 1930's. Everyone is familiar with the fundamental role played by both cell types in elucidating the chemical basis of transmission of the nerve impulse from the nerve endings to the effector organs (Dale, 1935; Cannon and Rosenblueth, 1937). Three decades later, and by chance rather than calculated search, these same cells came again to the attention of the neurobiologist because of their remarkable growth response to the administration of a protein factor manufactured in some glands and the dramatic cytotoxic effects evoked by an antiserum to this factor. The specificity of these two opposite effects is taken as indicative of the high degree of biochemical diversity of these nerve cells from that of other nerve cell populations.

Since in biology, perhaps more than in all other fields of human endeavor, it is legitimate to choose a given system as a model and seek whether what has been learned with it is of general validity, we are confident that the information gathered on sympathetic nerve cells may, in turn, reflect on our knowledge of the inner biochemical and functional organization of other nerve cells.

Of the extensive work performed to a large extent in our laboratory in these past two decades, ever since we reported on the discovery of this specific nerve growth factor (NGF), we will consider in this article only the essential features of the phenomenon and refer the reader to previous articles where the historical background and the step-by-step progress of this investigation have been reported in detail (Levi-Montalcini and Hamburger, 1951, 1953; Bueker, 1952; Levi-Montalcini, 1952, 1964; Cohen, 1960, 1962; Levi-Montalcini and Angeletti, 1961b, 1968b; P. U. Angeletti *et al.*, 1964a).