# Handbook of Neurochemistry and Molecular Neurobiology

## Neural Signaling Mechanisms

Abel Lajtha (Ed.)

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## Neural Signaling Mechanisms

Volume Editor: Katsuhiko Mikoshiba

With 130 Figures and 14 Tables

Springer

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# Preface

The brain is an organ with a complex structure and is composed of various types of cells. It is mainly composed of neurons and glia cells, and a higher brain function results from the formation of complex neuronal networks. What is the best way to understand the brain? One way is by understanding how molecular and cellular mechanisms are formed. Among them, it is important to know the molecular mechanisms by which neuronal networks are developed, a process initiated during early cell-cell interactions. In addition, it is essential to understand the mechanism of signal transduction inside the cells during network formation at various developmental stages and also in the mature brain. The functions of the brain are multiple and complex – it is a centrally regulating organizing system of multiple simultaneous functions. As we begin to understand it, we recognize the specific functions and specific role individual cells have to perform, and the interactions of the cells that are needed for such functions. The understanding of these cell to cell interactions, which involve intracellular changes, is essential for understanding the multiple role of the brain, and also for understanding any change responsible for malfunction of this organ.

This volume of the Handbook of Neurochemistry and Molecular Neurobiology is a collection of chapters that describe the "Neural Signaling Mechanism" of the brain. The first chapters briefly cover the molecular mechanisms occurring during the development of the nervous system: genesis, migration and differentiation of neurons and neuronal positioning, cell fate determination involved in the regulation of axonal formation, and neural process formation. Subsequently, the signaling mechanism in synaptic transmission is described; a key process of neural function is the way neurons influence one another through synaptic contacts.

There are many regulatory and signaling mechanisms inside the cells. Phosphorylation is one important mechanism that has already been studied successfully for some time, but recently the importance of phospholipid signaling has also been noted. This volume includes discussions of recent studies in phospholipid signaling and its role in cell function: metabolism, function, and delivery of inositol polyphosphates, and their role as regulators of nuclear function.

Various receptors located on synaptic plasma membranes are important places to communicate information from outside the plasma membrane to the cells inside. Recently it was found that a receptor dynamically moves inside the cell and moves to the plasma membrane; the density of the receptor at synapses is closely modulated. How receptors are targeted, and how their structure and sorting, insertion, clustering, and internalization may be regulated, indicate important regulatory mechanisms involved in receptor signaling and function. These interactions are discussed in this volume.

The importance of $Ca^{2+}$ ions is established and it is widely known that $Ca^{2+}$ can act as a global messenger inside and outside cells, to alter a variety of intracellular functions. Many molecules involving receptors and channels are reported to be associated with $Ca^{2+}$ signaling. These molecular mechanisms are closely correlated with morphological changes and functions, and cell fate changes in the brain, which are also well described in this volume.

Life system studies have advanced in a rapidly expanding fashion, yielding exciting and important information and pointing out the need for further studies. We know that each cell in each organ has unique function(s), although their basic cellular mechanisms may be common. Therefore, it is important to know how unique the signaling mechanism in the brain is, in addition to the common basic mechanisms, compared with other organs. There exist multiple specific cerebral mechanisms. This volume covers relatively wide perspectives of these topics; therefore, it will help the readers to put together the descriptions it contains, and to integrate them as a means to understand the system(s) of the brain as a whole.

In this volume, one can successfully learn about important signaling mechanisms in the brain at various levels, although there are other important signaling areas that it was not possible to cover in the present volume.

I would like to express my appreciation to the authors for their outstanding contribution for this most important volume titled "Neural Signaling Mechanisms." Finally, I would like to express my appreciation for the series editor, Abel Lajtha, and the managing secretary, Kristine Immediato, and the publisher for their encouragement and patience in publishing this volume.

Katsuhiko Mikoshiba

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