
Preface

This book is a collection of protocols for experimentation into how neurons connect to produce the extraordinary functionalities of the nervous system. The complexity underlying the development of synapses allows and warrants an assortment of approaches to probe the many layers of structure, mechanism, and emergent function. Appropriately, neuroscience is populated by researchers across disciplines, and with them comes a range of technologies and methodologies that make the neuroscience toolkit one of characteristic wealth.

The experimental diversity converging onto the synapse has made it one of the most intensely studied and intricately described biological systems. Observing in real-time how a single protein flips between conformational states to regulate ion flows, following how thin cellular protrusions traverse the body to form networks of the highest complexity seen in nature, measuring how circuits interact and morph throughout the span of life to document its story, our understanding of synapse development is arguably unparalleled in its pluralism of perspective. Yet it seems the more detailed our descriptions, the more expansive their heterogeneity and the less inclusive the models. Depending on the system in question, synaptogenic behaviors range anywhere from the preordained pairings of Sperrian chemoaffinity to the play-by-ear modes of promiscuous exuberance and subsequent refinement. Plasticity in turn occurs up or down, fleeting or perduring, and is stirred on by molecules, voltages, and timing. While thankfully all these serve to construct a system able to produce both hiccups and quantum theory, they also do away with comfy notions of a generalizable synapse awaiting full description. The challenge is on, and the design of clever new experimentation ever more opportune.

In putting together this volume, we've had the aim of compiling a laboratory guide that covers a broad spectrum of applicable methods (largely excluding electrophysiology, which has merited its own dedicated volumes in this series), with the benefit of a narrower focus of implementation to the study of synapse development. I've asked experts to present the current state of the art of classic protocols, giving their insider tweaks, tips, and tricks for optimal application to the synapse and its particularities. I've also asked pioneers of highly specialized approaches to contribute detailed guides to methods utilizing sophisticated instrumentation that is often institutionally available to labs but for which methodological expertise is difficult to come by. These 23 chapters by 63 investigators are presented in five parts that deal with synapses: (1) in culture, (2) their constituents, (3) their structures, (4) their dynamics, and (5) the assemblies they form. Our hope is that these guides will minimize the barrier to entry for the integration of new approaches with existing expertise, producing syntheses that will foster novel perspectives on the many ways in which synapses form, transform, and transmit.

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Synapse Development

Methods and Protocols

Poulopoulos, A. (Ed.)

2017, XI, 372 p. 79 illus., 67 illus. in color., Hardcover

ISBN: 978-1-4939-6686-8

A product of Humana Press