

Preface

Nullum esse librum tam malum ut non aliqua parte prodesset.

—PLINY

From the First Edition

THIS BOOK emerged from a series of course notes I used to teach advanced undergraduates and graduate students in the Neuroscience Program at UCLA. In both classes I describe what I believe to be a synthesis of neurophysiology at the level of the molecules and cells of the nervous system. The basic premise of these courses and of this book is that molecules and cells matter. That is not to say that the nervous system can be completely understood merely by studying events at the cellular level, but that it *cannot* be understood unless we know how single molecules and cells function. I make no effort in my courses or in this book to cover topics in higher-level integration, such as sensory or motor function, neural networks, or whole-brain imaging. These topics are an essential part of any neuroscientist's formation, but they are covered in other courses taught at UCLA.

The level of this book reflects the needs of our students, who have had calculus and college physics, as well as introductory biology including molecular biology. But because a few of our students are weak in these areas, I have included a review of resistance and capacitance in Chapter 2, and brief explanations of techniques in gene cloning and expression in Chapters 1, 6, and 9. Our students have not in general had physical chemistry, matrix algebra, or differential equations. I have therefore postponed topics such as current

flow in finite cables, rate theory, and single-channel kinetics to later study.

My aim has been to provide as much cellular physiology as I believe to be necessary to any serious student of the nervous system, regardless of his or her particular orientation. In addition, I have provided up-to-date reviews of many of the subjects currently of interest to neuroscientists, including channel activation and diversity, mechanisms of transmitter release, neuromodulation (including long-term potentiation), and sensory transduction. I hope this book will be useful not only to advanced undergraduates and beginning graduate students but to anyone interested in the role of molecules and cells in the CNS.

Preface to Second Edition

In the fifteen years since the first edition was written, our understanding of the molecular and cellular physiology of the nervous system has undergone considerable transformation. From the complete sequencing of the human genome, we now have a nearly comprehensive inventory of many of the protein families essential for nerve cell function. Remarkable progress in our ability to crystallize membrane proteins has given us structures for ion channels and transmitter receptors, and from this work we have gained new insight into mechanisms of permeation and gating. Optical methods for stimulating and recording single cells even in the intact nervous system have made possible experimental approaches that would have been unthinkable only a few years ago.

Because of these important advances, our understanding of the nervous system has been greatly transformed. In consequence, I have had to undertake a nearly complete rewriting of all but a few of the chapters, and many of the figures of the earlier edition had to be replaced. I was fortunate to be able to convince my colleague Tom O'Dell to do revisions of three of the chapters, in spite of his heavy administrative responsibilities. Tom also read the rest of the book in earlier drafts and made many useful suggestions. I am exceedingly grateful to him for his assistance. In addition, I wish to thank the many scientists around the world who have written reviews of work in their specialized fields, even though this labor is seldom appreciated by universities or funding

bodies. No book of this nature could ever be attempted without these many contributions.

I am thankful for the hospitality of the Whiteley Center at the Friday Harbor Laboratories, of the Department of Physiology, Development and Neuroscience of the University of Cambridge, and of Churchill College, Cambridge, where parts of the book were written and corrected. I am particularly grateful to Michael Fisher of Harvard University Press for his faith in this project, and to the reviewer of the Press who read the entire book and made many useful recommendations. I deeply appreciate the support of many friends who provided valuable counsel and guided me to important papers I might otherwise not have noticed, and in particular to the following colleagues who read one or more chapters in an earlier draft: Jonathan Ashmore, Peter Barr-Gillespie, Dean Buonomano, Jeffrey Diamond, Henricus von Gersdorff, Cameron Gundersen, Heidi Hamm, Criss Hartzell, Carolyn Houser, Stephen B. Long, Jonathan Lytton, Peter Nguyen, Elena Oancea, Riccardo Olcese, Richard Olsen, Thomas Otis, Diane Papazian, Johannes Reiser, William Ross, Kathleen Sweadner, and Jerrel Yakel. Finally, I want to express my deepest gratitude to my wife Margery, who did all the illustrations and helped with the many administrative tasks necessary to get the text into print. This book would not have been possible without her.