PREFACE

This book is targeted for students of bioengineering, biomedical engineering, applied physiology, biological cybernetics and related fields, and for engineers and scientists who have an interest in neuroprosthetics. The text will also be useful for physicians and surgeons who are involved in the management of patients fitted with neuroprosthetic devices. In order to provide a comprehensive and up to date coverage of issues and topics relating to neuroprosthetics, a diverse group of scientists and workers in the field have provided a general overview of their chosen fields of interest with, in some cases, particular emphasis on their own areas of research. As such, the book can also be used for courses in applied neurophysiology or neuroprosthetics.

Since it is aimed at a diverse audience with different backgrounds and training, the attempt has been to present a coherent overview of the field with detailed emphasis in selected areas of neural interfaces and neuroprosthetics. The covered topics will provide readers with sufficient background to understand the theory, rationale, design, and functioning of neuroprosthetic devices currently in clinical use and under development.

Neuroprosthetics is maturing from a laboratory based science to providing engineered applications in clinical fields such as cardiac pacing, phrenic nerve stimulation, control of micturition, cochlear implants, deep brain stimulation, and control of limb function in paralyzed individuals. Increasingly, clinicians are playing an important role in the advancement of this field. However, neural engineering is rarely (if ever) taught to prospective physicians during their medical school and postgraduate education. This volume should help remedy this deficit.

The practice of neuroprosthetics requires a fundamental understanding of the anatomy and physiology of the nervous system, mathematical neurobiology, material science, electrochemistry, and electrophysiology. These areas are reviewed in this text, with the aim of consolidating principles fundamental to understanding the field. The text assumes some familiarity with basic anatomy, physiology, calculus, electrophysiology, and bioinstrumentation, which typically are covered in undergraduate and first year graduate bioengineering curricula. Some degree of repetition has been included to emphasize certain aspects of the field, and to present them from somewhat different viewpoints to help the reader appreciate the range of their importance. Because modeling is an integral part of solving and defining critical engineering problems, the book addresses theory, modeling, and quantitative physiology as relevant to the understanding and design of neural interfaces.

The book is divided into eight sections:

Section I introduces and develops basic concepts and principles in neurophysiology, neuroanatomy and neuroplasticity;

Section II provides a guide to theories and models related to neural stimulation and recording;

Section III covers materials used in neuroprosthetic devices and the effects of electrical stimulation on neural tissue;

Section IV discusses techniques and design considerations for peripheral nerve and neuromuscular stimulation and recording;

Section V discusses techniques and geometric factors related to brain and spinal cord stimulation;

Section VI reviews several existing functional electrical stimulation systems in clinical use, including cortical recording with closely spaced electrode arrays;

Section VII previews current work in the field and introduces visions about future neuroprosthetic devices and systems;

Section VIII deals with regulatory and biocompatibility testing issues that must be dealt with to bring a neuroprosthetic device to the clinical market.

The aim is to provide a realistic overview of the capabilities of neuroprosthetic devices and technologies presently in use, and to present a realistic view of future developments in the field. The potential of neuroprosthetics is enormous and exciting, but one's enthusiasm needs be moderated by an appreciation for the complexity and delicacy of the nervous system, and the limits to which neural plasticity can compensate for injury or loss of function.

This is not a textbook in the traditional vein, so there are no study questions. However, there is plenty of work left for students. While the attempt has been to provide the necessary background to understand the material presented here, no single book can present "everything", at all levels of detail needed by every reader. This leaves room for students to pursue and discuss in further detail many of the topics presented here.

We hope that this book will serve to encourage and attract an ever widening cadre of highly motivated and well trained individuals from the basic sciences, engineering, and clinical practice to the challenging yet rewarding field of neuroprosthetics.

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