

THIS textbook was begun, as it seems many textbooks are, because of a felt need for a better source of material for the students taking a course. Although several excellent texts are available in the areas of cellular biology, general physiology, and biochemistry, it seemed to me that students at the introductory level needed a text combining discussion of the important aspects of these three areas with a consideration of higher levels of animal structure and function—plus some consideration of the comparative aspects of physiology. To meet this need, this book is entitled *Principles of Animal Physiology*—an indication that important ideas from all areas of physiology are presented and that the approach is a broader one than is usually found in textbooks. I tend to think of physiology as a unit, not as a series of discrete areas, and I have tried here to examine animal functioning at all levels from the molecular to the whole organism.

Any textbook requires a central theme, and in this book I have taken regulation as a major concept. In addition, I have felt it important to incorporate the similarities and differences of structure and function found in various animals—in one sense, an incorporation of data from comparative physiology.

I did not hesitate to think in terms of a lengthy book. Most available texts, in my opinion, suffer from the major defect of shortness. To present adequately the basic terms, definitions, and concepts of physiology is a lengthy undertaking. Writing a short book also necessitates a degree of selectivity that amounts to mind reading on the part of the author as to what is going to be taught in physiology courses in many colleges and universities. Such a treatment can only drastically reduce the usefulness of a text. Nevertheless I too have omitted some topics or given them only sketchy treatment. However, I have tried to include sufficient references to the literature so that the interested student can proceed on his own.

This book is written primarily for the interested student—not one who is necessarily majoring in physiology, but one who finds some fascination in the subject matter of physiology. My philosophy is that if a text is written in such a manner, it will also be good for any student taking a physiology course.

The main purpose of this book is to describe how physiological systems work, and such descriptions are presented primarily in physical-chemical terms. Since physiology is an experimental science, I have tried to include as much as possible on the instrumentation, methods, and approaches used in the study of different levels of animal functioning. As much data as possible are given so that the student

Preface

may have some opportunity to see the sources of physiological hypotheses and theories. Naturally, space places a limit on such material but, again, references are provided that discuss methods and data not completely covered in the text itself.

The book is divided into four parts, beginning with the most basic levels of structure or function in animals and progressing to the most complex. Part I is concerned with molecules and cell organization and with the chemical and physical principles upon which biochemical reactions and energy exchanges are based. The first chapter contains a brief consideration of systems analysis, feedback regulation, adaptation, and regulation. These are extremely useful concepts to the physiologist, and they are used in all later chapters of the book. I have outlined the nature of biochemical evolution in Chapter 5. Evolution at any level is one of the most important of biological theories and especially deserves recognition in a physiology book that includes elements of comparative physiology. In Chapter 5, I have also included a listing of the names, and a rough indication of the relationships, of living animals. I find that many students taking physiology courses have either forgotten or have never been acquainted with animal names and relations. It is hoped that this listing can be used by the student to identify and relate the organisms discussed in later chapters of the book.

Part II contains the basic cellular mechanisms upon which much regulatory ability, adaptation, and responsiveness to environment are based, including a discussion of specialized cells, especially nerve and muscle cells, which exhibit such mechanisms to a high degree.

Part III on homeostasis carries regulation one step further—to the level of organized systems. The many differences that may be found among animals in the structures and functional abilities used in homeostasis are emphasized, although, as stressed in the first two parts of the book, cellular organization and functioning have many similarities in all animals.

Part IV includes elements of sensory physiology and a brief discussion of animal behavior based on selected examples. It is hoped that these examples will give an indication of how the cellular and organismal activities of the whole

Preface

animal are coordinated and integrated to produce successful responses to the environment.

Each chapter has its own reference and reading list, usually a lengthy one. Although textbooks are not the place for presenting long lists of shorter research papers, monographs and reviews by workers in various specialized fields are an aid in a bibliography that includes discussions of the research and its results. Therefore, research papers of proven significance or with important methodological details are given in the reference lists. Citations are inserted in the text in a way that creates a minimum of disruption. The citations were chosen to provide both a chronological map of physiological discoveries and also a listing of researchers associated with particular fields of study. Recognizing that some readers will not have all important sources of physiological information available to them, I have tried to provide two or more references to a given subject when possible, hoping that at least one will be available to the interested reader.

The book certainly has shortcomings, but I hope it will be of value to students, the people for whom it is written. I have not designated it as suitable for any particular level of student. Anyone with a background containing some chemistry, a little physics and mathematics, and some biology can easily learn to appreciate the physiological data. Graduate students may find it useful both for the material covered and for the references to the literature; however, it is a textbook and not an advanced treatise.

No author could be an expert in all the areas covered by this book. I have tried to present those

ideas which appear most generally accepted by workers in a given area. At the same time, I have not hesitated to present less well-accepted hypotheses, to give my own opinions or interpretations where necessary, and to go out on a limb when extrapolating present knowledge (or lack of it) to future work in physiology. It is hoped that the reader of this book will arrive at the conclusion that comparatively little is settled in physiology and that much remains to be done.

I gratefully acknowledge the many people who have read and criticized all or part of the manuscript. These include Professors G. S. Araki, K. S. Guthe, W. N. Holmes, T. C. Jegla, L. E. Moore, L. M. Passano, and J. Thomas. Of course, all errors both of omission and commission are my responsibility.

I also wish to thank John and Mary Richardson for their invaluable help in the preparation of the illustrations and in the preparation of the manuscript. Nearly all of the illustrations are either new or completely redrawn and corrected. Originally I had planned to use many more electron micrographs, but it appeared that in too many cases such micrographs would be of value only to people expert in their interpretation. Therefore, many morphological details are illustrated by line drawings rather than original halftones.

Last, but certainly not least, I wish to express my sincere gratitude to Mr. William D. Eastman, Executive Editor at The Macmillan Company, for his enthusiasm, his help, and especially for his patience when deadlines arrived but manuscript did not.

J. A. W.