

Preface

Thomas Kuhn wrote that a textbook is principally a means of communicating to students the paradigms of their time. We have had three principal goals in preparing the content of this book. One, in accord with Kuhn's dictum, has been to articulate the central paradigms of contemporary animal physiology. A second content goal has been to provide our readers with a source of both lucid explanations of physiological concepts and accurate information about physiological systems. Our third content goal has been to draw attention to the cutting edges of physiological science, the places where the onward progress of research is challenging old paradigms and potentially creating footholds for new ones.

We have also had goals for presentation. Most visibly, we have combined our words with an ambitious, informative art program. More fundamentally, we have strived to take advantage of all the assets of traditional bookmaking to achieve a book that—through constant integration of the full suite of pedagogically relevant elements—is a first-rate learning tool. Many sorts of professionals have important contributions to make for a book to be excellent. Thus many sorts of professionals have traditionally found personal fulfillment by engaging in the cooperative, synergistic production of books. The authors listed on the cover are just the tip of the iceberg. A book's art program depends on scientific illustrators. Coordination between the art and the text—a key to the success of any textbook—depends on the editorial expertise of the book's editor. An attractive science text needs to be designed and physically executed by talented people who combine scientific acumen with artistic sensibility. To the degree that the presentation of the material in this book achieves success, the reason is that it is the creative product of a team of at least a dozen people playing diverse, mutually reinforcing roles. One of our goals has been to take advantage of this time-proven model to provide students with a superior text.

In these pages, we consistently and deliberately address animal physiology as a discipline integrated with other disciplines in biology—especially genetics, molecular biology, evolutionary biology, and ecology. We also consistently emphasize the roles of physiology throughout the life cycle of an animal by discussing physiological development and by examining animal function during such important life-cycle processes as exercise, long-distance migration, seasonal rhythms, and accommodation to severe conditions (we generally omit pathology and parasitism, however). Although we give particular attention to mammals, we make a point of recognizing the other vertebrate groups and at least the arthropods and molluscs among invertebrates. We address all levels of organization that are germane, from the genome to the ecological context.

We want to mention four specific strategies we have adopted to add interest and breadth to the book. First, we start every chapter with a vivid example of the application of the chapter's material to

the lives of animals in their natural habitats. Second, we devote five entire chapters (our "At Work" chapters) to in-depth explorations of how physiologists do their work; in these chapters we break out of the usual textbook mold to discuss exciting topics—such as the diving physiology of marine mammals—with emphasis on experiments, theory maturation, integration of physiological systems, and prospects for future research. Third, we include many photographs and drawings of animals throughout the book to remind readers of the animals we discuss. Fourth, entirely new to this edition, we have started a program of inviting specialists to contribute expert Guest Boxes on emerging topics that expand the book's subject content.

With our aspirations being as numerous as we have described, we have put a great deal of effort into balancing competing demands for space. The product is a complete physiology textbook that in one volume will meet the requirements of a diversity of one- or two-semester courses in animal function. Our intended audience is sophomores through beginning graduate students. To make the book accessible to as wide an audience as possible, we have included both a glossary of nearly 1200 terms and 11 appendices on important background concepts.

Our approach to the writing has been to work from the original scientific literature and obtain extensive peer review. Another aspect of our approach is that we have opted for the pedagogical consistency of a book written by just three principal authors. Margaret Anderson wrote Chapters 16, 20, and 21, and Gordon Wyse wrote Chapters 12–15, 18, and 19. Richard Hill wrote Chapters 1–11, 17, and 22–30. David S. Garbe, Scott A. Huettel, Matthew S. Kayser, Kenneth J. Lohmann, and Margaret McFall-Ngai wrote Guest Boxes. Matthew S. Kayser and Gordon Fain assisted with topic development in certain parts of the principal text.

NEW TO THIS EDITION: As in other editions, our two central goals for this edition were to update content and enhance pedagogical effectiveness. To these ends, we have reconsidered every sentence and every element of the art program. Of the 690 figures and tables in this edition, over 60 are either new or greatly enhanced. Chapter 14, on sensory processes, has been entirely rewritten. We have also added a new chapter (Chapter 4) on physiological development and epigenetics. Other chapters that have received exceptional attention are: Chapter 5 (transport of solutes and water), Chapter 8 (aerobic and anaerobic metabolism), Chapter 9 (activity energetics), and Chapter 29 (kidney physiology, edited throughout to emphasize plasma regulation). The book now includes Guest Boxes on functional magnetic resonance imaging, magnetoreception, optogenetics, sleep, symbiosis in the bobtail squid-*Vibrio* system, and synaptic development. Treatment of topics in global warming has been tripled. Treatment of altitude physiology in Chapters 23 and 24 is entirely revised. The index is new and upgraded. A limited list of

To Our Readers

the many topics that have been added or substantially upgraded includes: aquaporins, basal ganglia function, bioluminescence, breathing in crocodilians, chemiosmosis, calcium metabolism, color change, daily rhythms in transcription, efficiency of ATP synthesis in oxidative phosphorylation, endothermy in plants, evolution of nervous systems, function of P-type ATPases, the gut microbiome, hibernation, hippocampal specialization in place learning, ion-transport proteins in fish, kisspeptin neurons, metabolic scaling, neurotransmitter release mechanisms, photoperiodic control, reactive oxygen species, smooth muscle, thermal performance curves, and voltage-gated channels.

The book is organized in modular fashion with the express purpose of providing instructors and students with flexibility in choosing the order in which they move through the book. The first of the six parts (modules) consists of Chapters 1 to 5, which are background chapters for the book as a whole. Most instructors will want to assign those chapters at the beginning of the course of study (or, when students have exceptional preparation, skip the chapters in part or in whole). Each of the subsequent five parts of the book is written to be free-standing and self-contained, so that students who have mastered the material in Part I will be well prepared to work through any of the other five parts. Two of the final five parts begin with explicitly introductory chapters that present fundamentals. All five of these parts end with "At Work" chapters. Within a part, although chapters will probably be best read in order, most chapters are themselves written to be relatively self-contained, meaning that the order of reading chapters within a part is flexible. Three additional features promote flexibility in the order of reading: the glossary, the new index, and page cross-references. Text is cross-referenced both forward and backward, so that instructors and students can link material across chapters.

We have tried to keep animals front and center. At the end of our production, as the orchestra goes silent and the klieg lights dim, we hope that animals leading their lives in their natural habitats will be the enduring image and memory left by this work—animals now better understood, but still with much to attract the curiosity of upcoming generations of biologists.

Our peer reviewers are particularly important to the quality of the book, even though at times—accepting full responsibility for the product—we have followed our own inclinations rather than theirs. We are thus happy to acknowledge our current peer reviewers as well as individuals who acted as reviewers for earlier editions and whose influence remains clearly evident: Doris Audet, Brian Bagatto, Jason Blank, Charles E. Booth, Eldon Braun, Warren Burggren, Heather Caldwell, Jeffrey C. Carrier, Sheldon Cooper, Daniel Costa, Emma Creaser, David Crews, Stephanie Gardner, Stephen Gehnrich, Joseph Goy, Bernd Heinrich, Raymond Henry, James Hicks, Carl S. Hoegler, Richard Hoffman, Mark A. Holbrook, Jason

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While acknowledging the many ways others have helped, we of course accept full responsibility for the finished product and invite readers' opinions on how we could do better. Please contact us with your observations.

One of the gratifications of writing a book like this is the opportunity to participate in the raw enthusiasm of scientists for science. On countless occasions, many colleagues have performed great favors on short notice without the slightest hint of wanting pay for their professional expertise. Pure science must be one of the last redoubts of this ethic in today's professional world. We are honored to play the role of synthesizing and communicating the insights and questions that arise from the exciting search for knowledge.

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