美国著名医学院校教材系列

HUMAN PHYSIOLOGY

From Cells to Systems

FOURTH EDITION

人体生理学

从细胞到系统

（英文影印版）

Lauralee Sherwood

中国协和医科大学出版社
科文（香港）出版有限公司
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作　　者：Lauralee Sherwood

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To my family,
with love and appreciation for
memories of the past,
pleasures of the present,
and
promises of the future,

my grandparents (in memoriam),
George and Lottie Wonch
Clarence and Amy Sherwood

my parents,
Larry (in memoriam) and Lee Sherwood

my husband,
Peter Marshall

my daughters and sons-in-law,
Melinda and Mark Marple
Allison and Christopher Hansen

my granddaughters,
Lindsay and Emily Marple

PREFACE FOR STUDENTS

GOALS, PHILOSOPHY, AND THEME

My goal is to help students not only learn about how the body works but hopefully also to share my enthusiasm for the subject matter. I have been teaching physiology since the mid-1960s and remain struck with awe at the intricacies and efficiency of body function. When a baby first discovers that it can control its own hands, it will be fascinated and spend many hours manipulating them in front of its face. Most of us, even infants, have a natural curiosity about how our bodies work. Our bodies are quite miraculous. No machine has been constructed that can take over even a portion of a natural body function as effectively. By capitalizing on students' natural curiosity about themselves, I have strived to make physiology a subject that they can enjoy learning.

Even the most tantalizing subject matter, however, can be drudgery to study and difficult to comprehend if not effectively presented. Therefore, this book has a logical, understandable format that is unencumbered by unnecessary details and emphasizes how each concept is an integral part of the whole subject matter. Too often, students view isolated sections of a physiology course as separate entities; by understanding how each component of the body depends on other components, a student can appreciate the integrated functioning of the human body. The text focuses on the mechanisms of body function from cells to systems and is organized around the central theme of homeostasis—how the body meets changing demands while maintaining the internal constancy necessary for all cells and organs to function.

The text is written with undergraduate students preparing for health-related careers in mind. Its approach and depth are appropriate, however, for other undergraduate student populations. Because it is intended to serve as an introductory text and, for most students, may be their only exposure to a formal physiology text, all aspects of physiology receive broad coverage, yet depth, where needed, is not sacrificed. The scope of this text has been limited by judicious selection of pertinent content that a student can reasonably be expected to assimilate in a one-semester physiology course. Materials were selected for inclusion on a "need to know" basis, not just because a given fact happens to be known. In other words, content is restricted to relevant information needed to understand basic physiological concepts and to serve as a foundation for future careers in the health professions. "Encyclopedic" peripheral facts have been excluded.

To keep pace with today's rapid advances in the health sciences, students in the health professions must be able to draw on their conceptual understanding of physiology instead of merely recalling isolated facts that soon may be outdated. Therefore, this text is designed to promote understanding of the basic principles and concepts of physiology rather than memorization of details. The text is written in simple, straightforward language, and every effort has been made to assure smooth reading through good transitions, logical reasoning, and integration of ideas throughout the text.

In consideration of the clinical orientation of most students, research methodologies and data are not emphasized, although the material is based on up-to-date evidence. New information based on recent discoveries has been included in all chapters. Some controversial ideas and hypotheses are presented to illustrate that physiology is a dynamic, changing discipline.

Because anatomy is not a prerequisite course, enough relevant anatomy is integrated within the text to make the inseparable relation between structure and function meaningful.

FEATURES AND LEARNING AIDS

Homeostatic model and chapter opening

A unique, easy-to-follow, pictorial homeostatic model depicting the relationship among cells, systems, and homeostasis is developed in the introductory chapter and presented on the inside

front cover as a quick reference. Each chapter begins with a specialized, tailor-made version of this model, accompanied by a brief written introduction, emphasizing how the body system to be discussed in the chapter functionally fits in with the body as a whole. This opening feature is designed to orient the student and help put the material that follows in perspective.

Chapter closing focusing on homeostasis

Each chapter concludes with a narrative, **Chapter in Perspective: Focus on Homeostasis,** which helps the students put into perspective how the part of the body just discussed contributes to homeostasis. This capstone feature, the opening homeostatic model, and the introductory comments are designed to work together to facilitate the students' comprehension of the interactions and interdependency of body systems, even though each system is discussed separately.

Narrative chapter summaries

A concise, section-by-section, narrative **Chapter Summary** at each chapter's end enables students to focus on the main concepts before moving on.

End-of-chapter learning activities

The **Review Exercises** at the end of each chapter include a variety of question formats for students to self-test their knowledge and application of the facts and concepts presented in the chapter. Traditional **Objective Questions** using true/false, multiple choice, matching, and fill-in-the blank formats are included, as are **Essay Questions.** Also available are **Quantitative Exercises** that provide the students with an opportunity to practice calculations that will enhance their understanding of complex relationships. A **Points to Ponder** section features thought-provoking problems that encourage students to analyze and apply what they have learned. The Points to Ponder section is capped off with a **Clinical Consideration,** a mini case study that challenges students to apply their knowledge to a patient's specific symptoms.

Boxed features

Each chapter has two boxed features, one entitled **Concepts, Challenges, and Controversies** and the other **A Closer Look at Exercise Physiology.** The Concepts, Challenges, and Controversies boxes expose students to high-interest, tangentially relevant information on such diverse topics as environmental impact on the body, aging, ethical issues, new discoveries regarding common diseases, historical perspectives, and body responses to new environments such as those encountered in space flight and deep-sea diving.

Current concepts related to exercise physiology are included in the other boxed feature for three reasons: increasing national awareness of the importance of physical fitness; increasing recognition of the value of prescribed therapeutic exercise programs for a variety of conditions; and growing career opportunities related to fitness and exercise.

Analogies

Many analogies and frequent references to everyday experiences are included to help students relate to the physiology concepts presented. These useful tools have been drawn in large part from my over three decades of teaching experience. Knowing what areas are likely to give students the most difficulty, I have tried to develop links that help these learners relate the new material to something with which they are already familiar.

Pathophysiology

Another effective way to keep students' interest is to help them realize that they are learning worthwhile and applicable material. Because most students using this text will have health-related careers, frequent references to pathophysiology and clinical physiology demonstrate the contents' relevance to their professional goals.

Full-color illustrations

Anatomical illustrations, schematic representations, photographs, tables, and graphs are designed to complement and reinforce the written material. A full-color art program is used as a functional tool to learning. Flow diagrams are used extensively to help students integrate the written information presented. In flow diagrams, lighter and darker shades of the same color are used to denote a decrease or an increase in a controlled variable, such as blood pressure or the concentration of blood glucose. Also in the flow diagrams, the corners of all physical entities, such as body structures or chemicals, have been rounded to distinguish them from the square corners of all actions. Thorough figure captions are provided to improve understanding of the figures.

A colored symbol precedes each figure ■ and table number and title ▲ and also precedes the first reference to the figure or table in the text. This feature enables students to easily find the text description of a figure or table and enables them to return quickly to the text they were reading before they referred to the learning aid.

Integrated color-coded figure/table combinations

Figure/table combinations enable students to better visualize what part of the body is responsible for what activities. For example, an anatomical depiction of the brain is integrated with a table of the functions of the major brain components, with each component shown in the same color in the figure and the table.

Diversity of human models

A unique feature of this book is that the people depicted in the various illustrations are realistic representatives of a cross section of humanity (they were drawn from photographs of real people). Sensitivity to the various races, sexes, and ages of undergraduate students should enable all students to identify with the material being presented.

Feedforward statements as subsection titles

Instead of traditional topic titles for each subsection (for example, **Heart valves**), feedforward statements alert the student to the main point of the subsection to come (for example, **Heart valves ensure the proper direction of blood flow through the heart.**).

Cross-references

Cross-references to related material in other chapters enable students to quickly refresh their memories of material already learned in earlier chapters or to proceed if desired to a more in-depth coverage of a particular topic in a later chapter.

Key terms

Key terms are defined as they appear in the text. Because physiology is laden with myriad new vocabulary words, many of which are rather intimidating at first glance, word derivations are provided as necessary to enhance understanding of new words.

Glossary with phonetic pronunciations

The glossary, which enables students to quickly review key terms when they occur later in the book, includes phonetic pronunciations of the entries.

Appendices

The appendices are designed for the most part to help students who need to brush up on some foundation materials that they are assumed to already have had in prerequisite courses.

- *Appendix A*, **The Metric System,** is a conversion table between metric measures and their English equivalents.
- Most undergraduate physiology texts have a chapter on chemistry, yet physiology instructors rarely teach basic chemistry concepts. The decision was made, therefore, to reserve valuable text space for physiological concepts and to provide instead *Appendix B*, entitled **A Review of Chemical Principles,** as a handy reference for students who need a review of basic chemistry concepts that are essential to understanding physiology.
- Likewise, *Appendix C*, entitled **Storage, Replication, and Expression of Genetic Information,** serves as a reference for students or as assigned material if the instructor deems appropriate. It includes a discussion of DNA and chromosomes, protein synthesis, cell division, and mutations.
- *Appendix D*, **Principles of Quantitative Reasoning,** is designed to help students become more comfortable working with equations and translating back and forth between words, concepts, and equations. This appendix is in support of the Quantitative Exercises at each chapter's end.
- *Appendix E*, **Answers to End-of-Chapter Objective Questions, Quantitative Exercises, and Points to Ponder** provides answers to all objective learning activities, solutions to the Quantitative Exercises, and explanations for the Points to Ponder and Clinical Consideration.

ORGANIZATION

There is no ideal organization of physiological processes into a logical sequence. With the sequence chosen, most chapters build on material presented in immediately preceding chapters, yet each chapter is designed to stand on its own to allow the instructor flexibility in curriculum design. The general flow is from introductory background information to cells to excitable tissue to organ systems. Every attempt has been made to provide logical transitions from one chapter to the next. For example, Chapter 8, *Muscle Physiology*, ends with a discussion of cardiac muscle, which is carried forward into Chapter 9, *Cardiac Physiology*. Even topics that seem unrelated in sequence, such as Chapter 12, *Defense Mechanisms of the Body*, and Chapter 13, *The Respiratory System*, are linked together, in this case by ending Chapter 12 with a discussion of respiratory defense mechanisms.

Several organizational features warrant specific mention. The most difficult decision in organizing this text was the placement of the chapters on the endocrine system. Intermediary metabolism of absorbed nutrient molecules is largely under endocrine control, providing a link from digestion (Chapter 16) and energy balance (Chapter 17) to the endocrine system (Chapters 18 and 19). There is merit in placing the chapters on the nervous and endocrine systems in close proximity because of these systems' roles as the body's major control systems. Placing the endocrine system chapters earlier, immediately after the discussion of the nervous system (Chapters 4 through 7), however, would have created two problems. First, it would have disrupted the logical flow of material related to excitable tissue. Second, the endocrine system could not have been covered at the level of depth its importance warrants if it had been discussed before the students were provided the background essential to understanding this system's roles in maintaining homeostasis. Placing the endocrine system chapters late in the book does not mean, however, that students are not exposed to endocrine function or hormones until near the book's completion. Endocrine control and hormones are defined in Chapter 1, are revisited again in Chapter 3 in the discussion of intercellular communication, and are compared with nervous control in Chapter 5. Specific hormones are introduced in appropriate chapters, such as vasopressin and aldosterone in the chapters on kidney and fluid balance. Chapters 18 and 19 explore the basic characteristics of endocrine glands and hormones as well as the control and functions of specific endocrine secretions.

Unique to this book, the skin is covered in the chapter on defense mechanisms of the body in consideration of the skin's newly recognized immune functions. Bone is also covered more extensively in the endocrine chapters than in most undergraduate physiology texts, especially with regard to hormonal control of bone growth and bone's dynamic role in calcium metabolism.

Departure from traditional groupings of material in several important instances has permitted more independent and more extensive coverage of topics that are frequently omitted or buried within chapters concerned with other subject matter. For example, a separate chapter is devoted to fluid balance and acid–base regulation, topics often tucked within the kidney chapter. The grouping of the autonomic nervous system, motor neurons, and the neuromuscular junction in an independent chapter on the efferent division of the peripheral nervous system, which serves as a link between the nervous system chapters and the muscle chapter, is another example.

Although there is a rationale for covering the various aspects of physiology in the order given here, it is by no means the only logical way of presenting the topics. Each chapter is able to stand on its own, especially with the cross-references

provided, so that the sequence of presentation can be varied at the instructor's discretion. Some chapters may even be omitted, depending on the students' needs and interests and the time constraints of the course. For example, a cursory explanation of the defense role of the leukocytes is covered in the chapter on blood, so an instructor could choose to omit the more detailed explanations of immune defense in Chapter 12. Similarly, the in-depth coverage of topics in Chapters 2, 6, 15, 17, and 19 could selectively be omitted without sacrificing a student's general appreciation of systems-approach physiology.

ANCILLARIES FOR STUDENTS

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Available exclusively from Brooks/Cole, this online library offers students unlimited access to more than 700 publications—over 700,000 articles—at any time of the day. With *InfoTrac*, students can search for complete articles from scholarly and popular periodicals, such as *Physiological Reviews, American Journal of Sports Medicine, Science News,* and *Discover,* dating as far back as four years. This password-protected site is updated daily, and a four-month subscription is offered free to students with each new text purchase. An online student guide correlates each chapter in this text to InfoTrac articles. This student guide can be accessed free at the following Web site: **http://infotrac.thomsonlearning.com/**

Physioconcepts.com

Interactive Concepts in Physiology is an online site dedicated to helping students study physiology interactively. Among the topics covered are: Graded Potentials and Action Potentials, Molecular Basis of Muscle Contraction, The Cardiac Cycle, Gas Exchange and Transport, and Urine Formation and Excretion. In addition to the interactive content, Physioconcepts.com will feature quick-study flashcards with audio, tutorial quizzing, testing, a complete communications suite (e-mail to class, threaded discussion, chat), and course management—gradebook, assignments, syllabus, testing, tutorial, communication, and reporting—all in one unified environment. This makes it convenient for students to access current grades, communicate with the instructor, and retrieve assigned course information. To access this helpful study tool, point your Web browser to **http://www.physioconcepts.com.** Follow the instructions to create your own user name and password. You will be asked to supply the text ISBN at the initial registration page. Your text ISBN number is 0-534-56826-2.

Web tutor on WebCT

This online tool offers students additional learning aids to reinforce and clarify complex concepts. Some features include Internet activities, quiz questions with feedback, flashcards, links, and much more. Instructors may request that this option be included in the textbook package at an additional cost. In this case, information regarding access to this Web site is bundled with the text. If an instructor does not request this option, a student may purchase this tool independently by ordering via the toll-free number or Web site below:

(800) 964-5815 (in the United States); (813) 282-8807 (outside the United States)

http://www.thomsonlearning.com
ISBN: 0-534-38156-1

Study guide

Each chapter of this student-oriented supplementary manual, which is correlated with the corresponding chapter in *Human Physiology: From Cells to Systems,* Fourth Edition, contains a chapter overview, detailed chapter outlines, list of key terms, review exercises (multiple choice, true/false, fill-in-the-blank, and matching), and "Points to Ponder" questions. Some chapters also include clinical perspective questions and an experiment of the day. Answers to the review questions are provided at the back of the Study Guide.

ISBN: 0-534-37261-9

Lab manual

This manual, which may be required by the instructor in courses that have a laboratory component, contains a variety of laboratory exercises that relate to topics covered in *Human Physiology: From Cells to Systems,* Fourth edition. Each lab exercise includes a student worksheet.

ISBN 0-534-38111-1

Case histories

This booklet presents a variety of case histories relevant to human physiology. Questions for students to answer are included after each case history, with the answers being provided at the back of the booklet.

ISBN 0-534-38110-3

Photo atlas for anatomy and physiology

This full-color atlas (with more than 600 photographs) depicts structures in the same colors as they would appear in real life or in a slide. Labels as well as color differentiations within each structure are employed to facilitate identification of the structure's various components. The atlas includes photographs of tissue and organ slides, the human skeleton, commonly used models, cat dissections, cadavers, some fetal pig dissections, and some physiology materials.

ISBN: 0-534-51716-1

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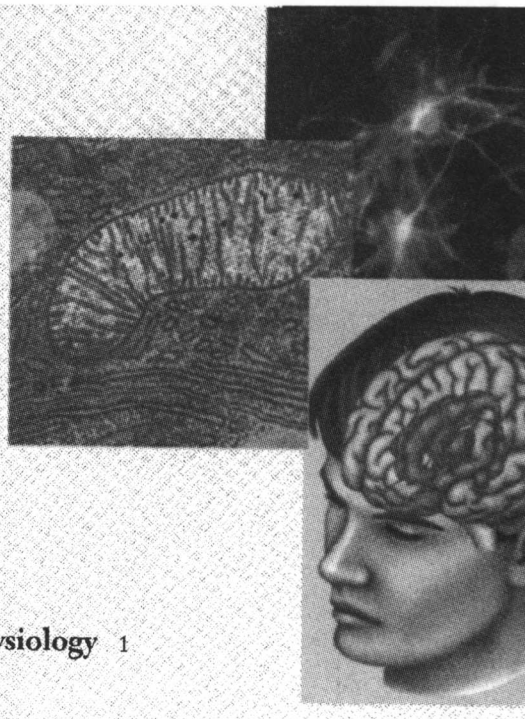

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