

T E N T H   E D I T I O N



# *Structure & Function*

*of the Body*

H I B O D E A U / P A T T O N

# *Structure & Function* O F T H E BODY

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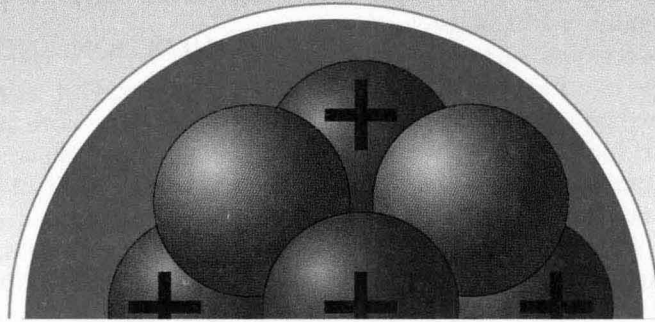
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# Preface



**W**e have been privileged to teach human anatomy and physiology for several decades. Each time we interact with students in the classroom or laboratory we become more aware of the challenges of teaching—and learning—about a body of knowledge that is not only fascinating and complex but ever-growing.

Advances in many areas of science have an impact on anatomy and physiology, perhaps more than other biological disciplines. Classroom instructors in the late 1990s are faced with the growing dilemma of selecting the most appropriate information for inclusion in introductory but nonetheless rigorous and demanding anatomy and physiology courses. New information is constantly being published describing advances in areas such as medicine, laboratory and clinical instrumentation, physiological chemistry, biotechnology, immunology, and molecular genetics. The result is an information explosion of incredible magnitude that makes it more and more difficult for teachers to select appropriate material and to give an up-to-date, contemporary presentation of anatomy and physiology that is accurate and user friendly for students. This edition of *Structure & Function of the Body* retains many features that have proved successful in over 35 years of classroom use; yet as a new text it presents a wealth of

carefully selected new content, as well as pedagogical enhancements that will better serve the needs of today's instructors and students. The writing style and depth of coverage are intended to challenge, reward, and reinforce introductory students as they grasp and assimilate important concepts.

During the revision of this text, each change in the selection, sequencing, or method of presentation of material was evaluated by anatomy and physiology teachers working in the field—teachers currently assisting students to learn about human structure and function for the first time. The result is a text that students will read—one designed to help the teacher teach and the student learn. It is particularly suited to introductory anatomy and physiology courses in nursing and allied health-related programs. Emphasis is on material required for entry into more advanced courses, completion of professional licensing examinations, and successful application of information in a practical work-related environment.

Dr. Kevin Patton, who contributed significantly to the previous edition of this book, joins now as a coauthor to form a dynamic new writing team. We are confident that you will agree that our teamwork has resulted in a synergistic blend of talents evident throughout the book.

## Special Features

### UNIFYING THEMES

Anatomy and physiology encompass a body of knowledge that, because of its sheer magnitude, can easily discourage and overwhelm the introductory student. There is no question, however, that competency in both anatomy and physiology is essential for student success in almost every clinical or advanced course in a health-related or science curriculum. If a textbook is to be successful as a teaching tool in such a complex and important learning environment, it must assist and complement the efforts of instructor and student. It must help unify information, stimulate critical thinking, and motivate students to master a new vocabulary as they learn about the beauty and connectedness of human structure and function.

*Structure & Function of the Body* is dominated by two major unifying themes: the *complementarity of normal structure and function* and *homeostasis*. In every chapter of the book the student is shown how organized anatomical structures of a particular size, shape, form, or placement serve unique and specialized functions. Repeated emphasis of this principle encourages students to integrate otherwise isolated factual information into a cohesive and understandable whole. As a result, anatomy and physiology emerge as living and dynamic topics of personal interest and importance to the student. The integrating principle of homeostasis is used to show how the “normal” interaction of structure and function is achieved and maintained by dynamic counterbalancing forces within the body.

### PRESENTATION OF CLINICAL AND PATHOLOGICAL INFORMATION

Highly selective clinical and pathological examples are included in each chapter of the book to help students understand that the disease process is a disruption in homeostasis and a breakdown of the normal integration of form and function. In the use of clinical examples the intent is to reinforce the normal mechanisms of body defense and adaptation and to stimulate student interest. The unifying themes are based on the need for introductory students in anatomy and physiology to

have a firm foundation in the normal state before primary learning emphasis is focused on the diseased state. This text deals primarily with normal anatomy and physiology. An alternate text, *The Human Body in Health & Disease*, emphasizes pathology in addition to normal structure and function and is intended as an introduction to structural anomaly and pathophysiology.

### ORGANIZATION AND CONTENT

The 20 chapters of *Structure & Function of the Body* present the core material of anatomy and physiology most *important* for introductory students. The selection of appropriate information in both disciplines was designed to eliminate the confusing mix of nonessential and overly specialized material that unfortunately accompanies basic information in many introductory textbooks. Information is presented so that students know and understand what is *important*. Further, pedagogical aids in each chapter identify learning objectives and then reinforce successful mastery of this clearly identified core material. As a result, students and instructors can interact more effectively as active participants in the learning experience. The sequencing of chapters in the book follows a course organization most commonly used in teaching at the undergraduate level. Because each chapter is self-contained, instructors have the flexibility to alter the sequence of material to fit personal teaching preferences or the special content or time constraints of their courses or students.

At every level of organization, both within and between chapters, care has been taken to couple structural information with important functional concepts. Students are presented with a conceptual framework and the necessary information on which to build. In each chapter of the text, appropriate physiological content balances the anatomical information that is presented. As a result, the student has a more integrated understanding of human structure and function. Throughout the text, examples that stress the complementarity of structure and function have been consciously selected to emphasize the importance of homeostasis as a unifying concept.

Acquiring and *using* the terms so necessary for any study of anatomy and physiology can be difficult for many students. To assist students in this



area, new terms are introduced, defined, and incorporated into a working vocabulary. In addition to vocabulary development, every chapter incorporates skillfully designed visuals to reinforce written information with sensory input. Information related to body structure and function is presented in ways designed to help students develop the ability to integrate conceptual material and reinforce the normal integration of form and function.

The style of presentation of material in this text and its readability, accuracy, and level of coverage have been carefully developed to meet the needs of undergraduate students taking an introductory course in anatomy and physiology. *Structure & Function of the Body* remains an introductory textbook—a teaching book and not a reference text. No textbook can replace the direction and stimulation provided by an enthusiastic teacher to a curious and involved student. A good textbook, however, can and should be enjoyable to read and helpful to both.

## PEDAGOGICAL FEATURES

*Structure & Function of the Body* is a student-oriented text. Written in a very readable style, it has numerous pedagogical aids that maintain interest and motivation. Every chapter contains the following elements that facilitate learning and the retention of information in the most effective manner.

**Chapter Outline:** An overview outline introduces each chapter and enables the student to preview the content and direction of the chapter at the major concept level before the detailed reading.

**Chapter Objectives:** Each chapter opening page contains approximately five measurable objectives for the student. Each objective clearly identifies for the student, before he or she reads the chapter, what the key goals should be and what information should be mastered.

**Key Terms and Pronunciation Guide:** Key terms, when introduced and defined in the text body, are identified in **boldface** to highlight their importance. A pronunciation guide follows each new term that students may find difficult to pronounce correctly.

**Boxed Inserts and Essays:** Brief boxed inserts or longer essays appear in every chapter. These

inserts include information ranging from clinical applications to sidelights on recent research or related topics to exercise and fitness. Pathological conditions are sometimes explained in essay format to help students better understand the relationship between normal structure and function. Examples include AIDS, ulcers, and shingles. New boxed essays on Home Health Care issues have been added to this edition and reflect the growing trend in home based health care. Due to this trend, many students using this text will at some point encounter some of the issues discussed in the boxes. Topics reflect the diversity and wide range of conditions and problems a home health care worker must be prepared to deal with, including procedures, assessments, and administration. All boxed material is highlighted with an easily recognized symbol so that students can see at a glance whether the box contains clinical, general, fitness, or home health care information.

**Outline Summaries:** Extensive and detailed end-of-chapter summaries in outline format provide excellent guides for students as they review the text materials when preparing for examinations. Many students also find these detailed guides useful as a chapter preview in conjunction with the chapter outline.

**Chapter Tests:** Objective-type Chapter Test questions are included at the end of each chapter. They serve as quick checks for the recall and mastery of important subject matter. They are also designed as aids to increase the retention of information. Answers to all Chapter Test questions are provided at the end of the text.

**Review Questions:** Subjective review questions at the end of each chapter allow students to use a narrative format to discuss concepts and synthesize important chapter information for review by the instructor. The answers to these review questions are available in the Instructor's Manual that accompanies the text.

**Critical Thinking Questions:** Review questions that encourage students to use critical thinking skills are highlighted at the end of the Review Questions section. Answers to these questions are found in the Instructor's Manual along with the answers to the other Review Questions.

**Chemistry Appendix:** Recognizing that some students may need to review basic chemistry, we

have added a new fully-illustrated Chemistry of Life appendix. This section discusses in simple, straightforward terms the concepts needed to understand basic anatomy and physiology with *concept summaries* to emphasize key points. As an appendix, this information will be readily available to students who need it, but it won't burden the text itself with unnecessary detail for those who do not. References within the chapters point students exactly to the appropriate coverage in the Appendix.

Additional learning and study aids at the end of the text include **Common Medical Abbreviations, Prefixes, and Suffixes**; an extensive **Glossary** of terms to assist students in mastering the vocabulary of anatomy and physiology; and a detailed **Index** that serves as a ready reference for locating information.

## ILLUSTRATIONS

A major strength of *Structure & Function of the Body* is the exceptional quality, accuracy, and beauty of the illustration program. The truest test of any illustration is how effectively it can complement and strengthen written information found in the text and how successfully it can be used by the student as a learning tool. Extensive use has been made of full-color illustrations, micrographs, and dissection photographs throughout the text. Illustrations proven pedagogically effective in previous editions of *Structure & Function of the Body* have been retained or updated in appearance to provide accurate information and visual appeal. Each illustration is carefully referred to in the text and is designed to support the text discussion. The illustrations are an integral part of the learning process and should be carefully studied by the student.

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## Supplements

The supplements package has been carefully planned and developed to assist instructors and to enhance their use of the text. Each supplement, including the test items and study guide, has been thoroughly reviewed by many of the same instructors who reviewed the text.

## INSTRUCTOR'S RESOURCE MANUAL AND TEST BANK

The Instructor's Resource Manual and Test Bank, prepared by Judith Diehl of Reid State Technical College, provides text adopters with substantial support in teaching from the text. The following features are included in every chapter:

- Sample lecture outlines** based on student objectives

- Transparency masters** for duplication or overhead projection

- Outlines and worksheets** for class demonstrations

- Suggestions** for student activities and assignments

- Sources** of audiovisual support

- Information** on current topics for distribution to students

- Answers** to the Chapter Test and Review Questions in the textbook

- Critical Thinking Exercises** for each chapter provide a step-by-step problem-solving opportunity for students

- A **computerized test bank** is also available for Windows and Macintosh users.

## TRANSPARENCY ACETATES

A set of full-color transparency acetates—all with large, easy-to-read labels—is available to adopters of the text for use as a teaching aid.

## STUDY GUIDE

The Study Guide, written by Linda Swisher of Sarasota County Vocational Technical Center, provides students with additional self-study aids, including chapter overviews, topic reviews, review questions keyed to specific pages in the text, and application and labeling exercises, as well as answers to the questions in the Study Guide.

## MULTIMEDIA

Exciting new software is now available to facilitate the learning of difficult concepts in anatomy and physiology using the power of interactive media. **The Dynamic Human CD-ROM** uses animations, interactive anatomy and histology images, clinical illustrations and movies, and

three-dimensional rotating viewers to bring the 10 major body systems to life for the student to explore and learn.

Mosby is pleased to bring to the scientific community a remarkable series of multimedia and print products made possible the National Library of Medicine's Visible Human Project (VHP) and innovative software technology developed by EAI. The first of these products is the **Dissectable Human CD-ROM**, which uses segmented, volume rendered VHP data to present systems-based human anatomy and digital dissection of major organs, both for the first time. Body systems can be studied in isolation or in context with other organs and tissues, with rotational viewing in three dimensions. Labeling can be toggled on or off, and authoring capability allows users to create customized presentations and study programs. This software will change the way anatomy is taught, and the way it is understood. Images from the Mosby-EAI image library are also available in a four color atlas, **Mosby's Systems Atlas of Anatomy**.

In addition to these exciting products, Mosby offers **Body Spectrum** software. The software provides reinforcement of anatomy with computerized coloring and labeling exercises.

## A WORD OF THANKS

Many people have contributed to the development and success of *Structure & Function of the Body*. We extend our thanks and deep appreciation to the various students and classroom instructors who have provided us with helpful suggestions following their use of earlier editions of this text.

A specific "thank you" goes to the following instructors who critiqued in detail the ninth and tenth editions of this text or various drafts of the revision. Their invaluable comments were instrumental in the development of this new edition.

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**GARY A. THIBODEAU**  
**KEVIN T. PATTON**

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# An Introduction to the Structure and Function of the Body

## 1

### OUTLINE

*Structural Levels of Organization*

*Anatomical Position*

*Anatomical Directions*

*Planes or Body Sections*

*Body Cavities*

*Body Regions*

*The Balance of Body Functions*

### OBJECTIVES

*After you have completed this chapter, you should be able to:*

1. Define the terms *anatomy* and *physiology*.
2. List and discuss in order of increasing complexity the levels of organization of the body.
3. Define the term *anatomical position*.
4. List and define the principal directional terms and sections (planes) used in describing the body and the relationship of body parts to one another.
5. List the nine abdominopelvic regions and the abdominopelvic quadrants.
6. List the major cavities of the body and the subdivisions of each.
7. Discuss and contrast the axial and the appendicular subdivisions of the body. Identify a number of specific anatomical regions in each area.
8. Explain the meaning of the term *homeostasis* and give an example of a typical homeostatic mechanism.

### BOXED ESSAY

Exercise Physiology

**T**here are many wonders in our world, but none is more wondrous than the human body. This is a textbook about that incomparable structure. It deals with two very distinct and yet interrelated sciences: **anatomy** and **physiology**. As a science, anatomy is often defined as the study of the structure of an organism and the relationships of its parts. The word *anatomy* is derived from two Greek words that mean "a cutting up." Anatomists learn about the structure of the human body by cutting it apart. This process, called **dissection**, is still the principal technique used to isolate and study the structural components or parts of the human body. Physiology is the study of the functions of living organisms and their parts. It is a dynamic science that requires active experimentation. In the chapters that follow, you will see again and again that anatomical structures seem designed to perform specific functions. Each has a particular size, shape, form, or position in the body related directly to its ability to perform a unique and specialized activity.

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## ● Structural Levels of Organization

Before you begin the study of the structure and function of the human body and its many parts, it is important to think about how those parts are organized and how they might logically fit together into a functioning whole. Examine Figure 1-1. It illustrates the differing levels of organization that influence body structure and function. Note that the levels of organization progress from the least complex (chemical level) to the most complex (body as a whole).

Organization is one of the most important characteristics of body structure. Even the word *organism*, used to denote a living thing, implies organization.

Although the body is a single structure, it is made up of trillions of smaller structures. Atoms and molecules are often referred to as the **chemical level** of organization (see Appendix A). The existence of life depends on the proper levels and proportions of many chemical substances in the cells of the body. Many of the physical and chemical phenomena that play important roles in the

life process will be reviewed in the next chapter. Such information provides an understanding of the physical basis for life and for the study of the next levels of organization so important in the study of anatomy and physiology—cells, tissues, organs, and systems.

1. **Cells** are considered to be the smallest "living" units of structure and function in our body. Although long recognized as the simplest units of living matter, cells are far from simple. They are extremely complex, a fact you will discover in Chapter 2.
2. **Tissues** are somewhat more complex than cells. By definition a tissue is an organization of many similar cells that act together to perform a common function. Cells are held together and surrounded by varying amounts and varieties of glue-like, nonliving intercellular substances.
3. **Organs** are more complex than tissues. An organ is a group of several different kinds of tissues arranged so that they can together (act as a unit) to perform a special function. For instance, the lungs shown in Figure 1-1 are an example of organization at the organ level.
4. **Systems** are the most complex units that make up the body. A system is an organization of varying numbers and kinds of organs arranged so that they can together perform complex functions for the body. The organs of the respiratory system shown in Figure 1-1 permit air to enter the body and travel to the lungs, where the eventual exchange of oxygen and carbon dioxide occurs. Organs of the respiratory system include the nose, the windpipe or trachea, and the complex series of bronchial tubes that permit passage of air into the lungs.
5. **The body as a whole** is all the atoms, molecules, cells, tissues, organs, and systems that you will study in subsequent chapters of this text. Although capable of being dissected or broken down into many parts, the body is a unified and complex assembly of structurally and functionally interactive components, each working together to ensure healthy survival.

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## ● Anatomical Position

Discussions about the body, the way it moves, its posture, or the relationship of one area to another