

8th  
EDITION

# anatomy & physiology



PATTON  
THIBODEAU

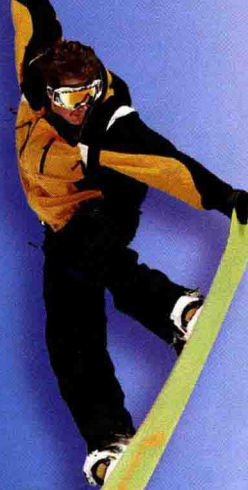
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# ANATOMY & PHYSIOLOGY

*8th Edition*

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# About the Authors



**Kevin Patton** has taught anatomy and physiology to high school, community college, and university students from various backgrounds for three decades. Kevin found that the work that led him to a PhD in vertebrate anatomy and physiology instilled in him an appreciation for the “Big Picture” of human structure and function. This experience has helped him produce a text that will be easier to understand for all students. He has earned several citations for teaching anatomy and physiology, including the Missouri Governor’s Award for Excellence in Teaching. “One thing I’ve learned,” says Kevin, “is that most of us learn scientific concepts more easily when we can see what’s going on.” His talent for using imagery to teach is evident throughout this edition with its extensive array of visual resources. Kevin’s interest in promoting excellence in teaching anatomy and physiology has led him to take an active role in the Human Anatomy and Physiology Society (HAPS), where he is a President Emeritus and was the founding director of the HAPS Institute. In 2008, he was awarded the HAPS President’s Medal for outstanding contributions in promoting the mission of excellence in A&P teaching and learning. Kevin also teaches graduate courses to prospective and current A&P professors and produces online resources for A&P students and teachers, including *theAPstudent.org* and *theAPprofessor.org*.

*To my family and friends, who never let me forget the joys of discovery, adventure, and good humor.*

*To the many teachers who taught me more by who they were than by what they said.*

*To my students who help me keep the thrill of learning fresh and exciting.*

Kevin T. Patton



**Gary Thibodeau** has been teaching anatomy and physiology for more than three decades. Since 1975, *Anatomy & Physiology* has been a logical extension of his interest and commitment to education. Gary’s teaching style encourages active interaction with students, and he uses a wide variety of teaching methodologies—a style that has been incorporated into every aspect of this edition. He is considered a pioneer in the introduction of collaborative learning strategies to the teaching of anatomy and physiology. Recent conferral of Emeritus status in the University of Wisconsin System has provided him with additional time to interact with students and teachers across the country and around the world. His focus continues to be successful student-centered learning—leveraged by text, Web-based, and ancillary teaching materials. Over the years, his success as a teacher has resulted in numerous awards from both students and professional colleagues. Gary is active in numerous professional organizations including the Human Anatomy and Physiology Society (HAPS), The American Association of Anatomists, and the American Association of Clinical Anatomists. His biography is included in numerous publications, including *Who’s Who in America*; *Who’s Who in American Education*; *Outstanding Educators in America*; *American Men and Women of Science*; and *Who’s Who in Medicine and Healthcare*. While earning master’s degrees in both zoology and pharmacology, as well as a PhD in physiology, Gary says that he became “fascinated by the connectedness of the life sciences.” That fascination has led to this edition’s unifying themes that focus on how each concept fits into the “Big Picture” of the human body.

*To my parents, M.A. Thibodeau and Florence Thibodeau, who had a deep respect for education at all levels and who truly believed that you never give up being a student.*

*To my wife, Emogene, an ever-generous and uncommonly discerning critic, for her love, support, and encouragement over the years.*

*To my children, Douglas and Beth, for making it all worthwhile.*

Gary A. Thibodeau

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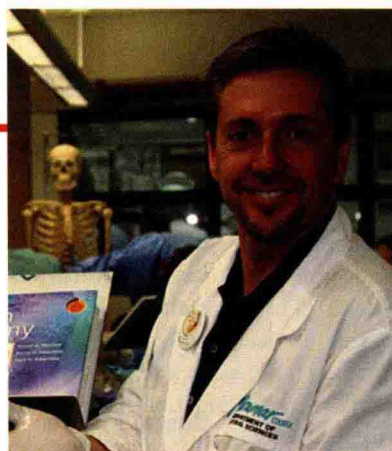
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# Preface

**S**uccess in both teaching and learning is, in many ways, determined by how effective we are in transforming information into knowledge. This is especially true in scientific disciplines, such as anatomy and physiology, where both student and teacher continue to be confronted with an enormous accumulation of factual information. *Anatomy & Physiology* is intended to help transform that information into a manageable knowledge base by effective use of unifying themes and by focusing on the significant and on what is truly relevant in both disciplines.

This textbook is intended for use as both a teaching tool and a learning tool. It was written to help students unify information, stimulate critical thinking, and acquire a taste for knowledge about the wonders of the human body. This textbook will help students avoid becoming lost in a maze of facts in a complex learning environment. It will encourage them to explore, to question, and to look for relationships, not only between related facts in a single discipline, but also between fields of academic inquiry and personal experience. It is our hope that *Anatomy & Physiology* will help both students and teachers transform information into knowledge.

This new edition of the text has been extensively revised. We built upon the successful art revision program begun in the previous edition by adding several new illustrations and photographs. Several of the longer chapters were split into smaller chapters to improve comprehension and better organize study. We also improved our execution of a page design and layout that maximizes learning effectiveness. As with each new edition, we added carefully selected new information on both anatomy and physiology to provide an accurate and up-to-date presentation. We have retained the basic philosophy of personal and interactive teaching that characterized previous editions. In addition, essential, accurate, and current information continues to be presented in a comfortable writing style. Emphasis is placed on concepts rather than descriptions, and the “connectedness” of human structure and function is repeatedly reinforced by unifying themes.

## UNIFYING THEMES

Anatomy and physiology encompasses a body of knowledge that is large and complex. Students are faced with the need to know and understand a multitude of individual structures and functions that constitute a bewildering array of seemingly disjointed information. Ultimately, the student of anatomy and physiology must be able to “pull together” this information to view the body as a whole—to see the “Big Picture.” If a textbook is to be successful as a teaching tool in such a complex learning environment, it must

help unify information, stimulate critical thinking, and motivate students to master a new vocabulary.

To accomplish this synthesis of information, unifying themes are required. In addition, a mechanism to position and implement these themes must be an integral part of each chapter. Unit One begins with “Seeing the Big Picture,” an overview that encourages students to place individual structures or functions into an integrated framework. Then, throughout the book, the specific information presented is highlighted in a special “The Big Picture” section so that it can be viewed as an integral component of a single multifaceted organism.

*Anatomy & Physiology* is dominated by two major unifying themes: (1) the complementarity of normal structure and function and (2) homeostasis. The student is shown, in every chapter of the book, how organized anatomical structures of a particular size, shape, form, or placement serve unique and specialized functions. The integrating principle of homeostasis is used to show how the “normal” interaction of structure and function is achieved and maintained by counterbalancing forces within the body. Repeated emphasis of these principles encourages students to integrate otherwise isolated factual information into a cohesive and understandable whole. “The Big Picture” summarizes the larger interaction between structures and functions of the different body systems. As a result, anatomy and physiology emerge as living and dynamic topics of personal interest and importance to students.

## AIMS OF THE REVISION

As in past editions, our revision efforts focused on identifying the need for new or revised information and for additional visual presentations that clarify important, yet sometimes difficult, content areas.

In this eighth edition, we have included information on new concepts in many areas of anatomy and physiology. For example, new data on the description of cranial nerves, protein structure, and updates in terminology have been included. Most of these changes are subtle adjustments to our current understanding of human science. However, the accumulation of all of these subtle changes makes this edition the most up-to-date textbook available.

One of the most apparent changes that you will notice in this new edition is a reorganization of chapters. Three of the longer chapters have been split into small chapters. In cell biology, we moved *cell growth and reproduction* to its own chapter (Chapter 5). In the nervous system, we moved the *autonomic nervous system* into its own chapter (Chapter 16). And the endocrine system was split into an introductory chapter on *endocrine regulation*



(Chapter 18) followed by a survey of major *endocrine glands* (Chapter 19). A hallmark of our textbook has been its effective “chunking” of material into manageable chapters and these changes reflect our continuing commitment to that approach.

The previous edition featured a complete redesign of the page layouts and the art program. This enabled us to make the textbook easier to use by putting the illustrations, graphs, and tables closer to the related text. In this edition, we have improved the creative layout even more. Additional tables help students visually organize important concepts and complement the improved design to provide a multisensory learning tool. We have expanded the art program, while preserving a style as consistent as possible throughout the book. In this edition, we have expanded and improved the use of a consistent Color Key (pp. xxiv-xxv) for certain cell parts, tissue types, and biomolecules to help make learning easier for beginning students.

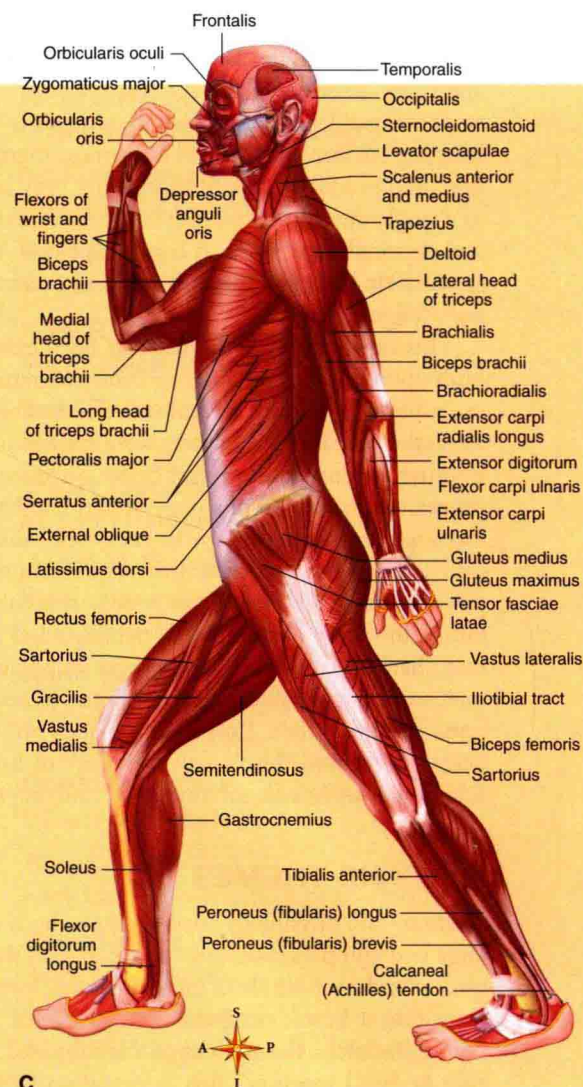
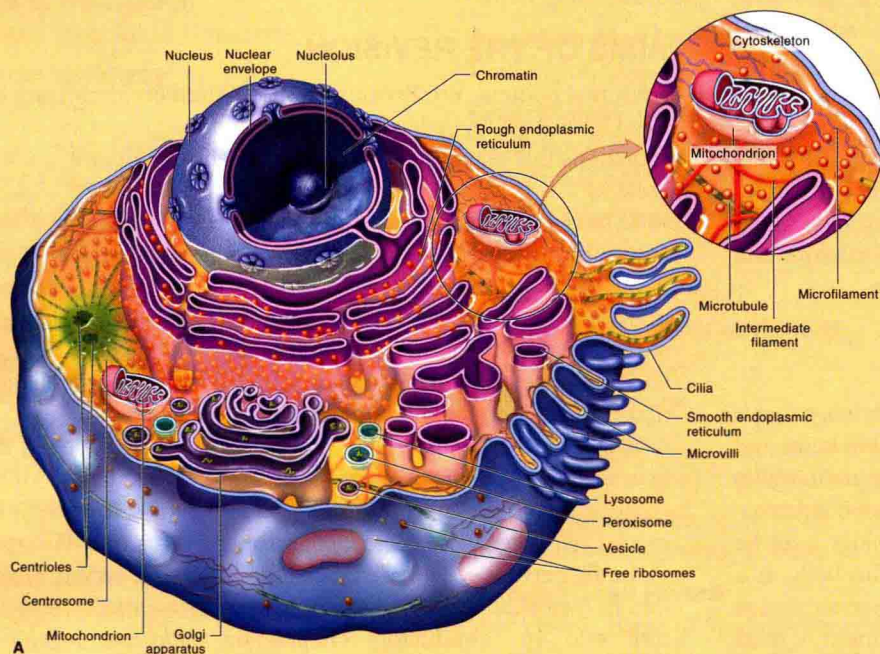
In this edition, great effort has been made to make this text accessible to students whose first language is not English. After consulting with ESL specialists and ESL learners, we have continued to enhance our word lists and improve our readability to make the concepts of human structure and function more understandable for all students.

As teachers of anatomy and physiology, we know that to be effective a text must be readable, and it must challenge and excite the student. This text remains one that students will read—one designed to help the teacher teach and the student learn. To accomplish this end, we facilitated the comprehension of difficult material for students with thorough, consistent, and nonintimidating explanations that are free of unnecessary terminology and extraneous information. This easy access to complex ideas remains the single most striking hallmark of our textbook.

## ILLUSTRATIONS AND DESIGN

A major strength of this text has always been the exceptional quality, accuracy, and beauty of the illustration program. It is the original “visual” anatomy and physiology textbook. We have worked very closely with scientific illustrators to provide attractive and colorful images that clearly and accurately portray the major concepts of anatomy and physiology.

The truest test of any illustration is how effectively it can complement and strengthen the written information in the text and how successfully it can be used by the student as a learning tool. Each illustration is explicitly referred to in the text and is designed to support the text discussion. Careful attention has been





## LEARNING AIDS

*Anatomy & Physiology* is a student-oriented text. Written in a readable style, the text is designed with many different pedagogical aids to motivate and maintain interest. The special features and learning aids listed below are intended to facilitate learning and retention of information in the most effective and efficient manner.

No textbook can replace the direction and stimulation provided by an enthusiastic teacher to a curious and involved student. However, a full complement of innovative pedagogical aids that are carefully planned and implemented can contribute a great deal to the success of a text as a learning tool. An excellent textbook can and should be enjoyable to read and should be helpful to both student and teacher. We hope you agree that the learning aids in *Anatomy & Physiology* meet the high expectations we have set.

## Unit Introductions

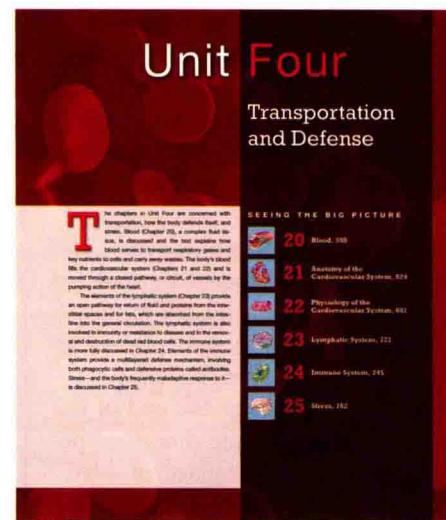
Each of the six major units of the text begins with a brief overview statement. The general content of the unit is discussed, and the

paid to placement and sizing of the illustrations to maximize usefulness and clarity. Each figure and all labels are relevant to—and consistent with—the text discussion. Each illustration has a bold-face title for easy identification. Most illustrations also include a concise explanation that guides the student through the image as a complement to the nearby text narrative.

The artistically drawn, full-color artwork is both aesthetically pleasing and functional. Color is used to highlight specific structures in drawings to help organize or highlight complex material in illustrated tables or conceptual flow charts. The text is also filled with dissection photographs, exceptional light micrographs, and scanning (SEM) and transmission (TEM) electron micrographs, some of which are new to this edition. In addition, examples of medical imagery, including CT scans, PET scans, MRIs, and x-ray photographs, are used throughout the text to show structural detail, explain medical procedures, and enhance the understanding of differences that distinguish pathological conditions from normal structure and function. All illustrations used in the text are an integral part of the learning process and should be carefully studied by the student.



chapters and their topics are listed. Before beginning the study of material in a new unit, students are encouraged to scan the introduction and each of the chapter outlines in the unit to understand the relationship and “connectedness” of the material to be studied. Each unit has a color-coded tab at the outside edge of every page to help you quickly find the information you need.



## Chapter Learning Aids

- **Study Hints**—give specific suggestions for using many of the learning aids found in each chapter. Because many readers have never learned the special skills needed to make effective use of pedagogical resources found in science textbooks, helpful tips are embedded within each Chapter Outline, Language of Science & Medicine list, Case Study, Chapter Summary, Review Question set, and Critical Thinking section. Answers for all of the case study questions and also the review and critical thinking questions are in the Instructor's Resource Manual, the Instructor's Electronic Resource DVD, and the instructor's EVOLVE site for *Anatomy & Physiology*. Teachers can then choose to use the questions as homework assignments or include them on tests.

- **Chapter Outline**—summarizes the contents of a chapter at a glance. 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 beginning a detailed reading. Page references enable students to quickly locate topics in the chapter.

CHAPTER OUTLINE	
Scan this outline before you begin to read the chapter, as	
Composition of Blood, 599	Blood
Blood Volume, 599	Blood
Formed Elements of Blood, 600	M
Red Blood Cells (Erythrocytes), 601	
Function of Red Blood Cells, 601	

- **Language of Science**—introduces you to new scientific terms in the chapter. A comprehensive list of new terms is presented at the beginning of the chapter. Each term in the list has an easy-to-use pronunciation guide to help the learner easily “own” the word by being able to say it. Literal translations of the term or its word parts are included to help students learn how to deduce the meaning of new terms themselves. The listed terms are defined in the text body, where they appear in boldface type, and may also be found in the glossary at

LANGUAGE OF SCIENCE	
embryonic stem cell (em-bree-ON-ik) [em-in, -bryo-fill to bursting, -ic relating to]	formed element globin (GLOB-in) [glob-bat]
eosinophil (ee-oh-SIN-oh-fil) [eosin-reddish color, -phil love]	granulocyte (GRAN-y) [gran-gra]
erythrocyte (eh-RITH-roh-syte) [erythro-red, -cyte cell]	hematopoietic (hee-mat) [hem-blo]
erythropoiesis	heme



the back of the book. The bold-face type feature enables students to scan the text for new words before beginning their first detailed reading of the material, so they may read without having to disrupt the flow to grapple with new words or phrases. The Language of Science word list includes terms related to the essential anatomy and physiology presented in the chapter. Another word list near the end of the chapter, a feature described below as the Language of Medicine, is an inventory of all the new clinical terms introduced in the chapter.

- **Color-Coded Illustrations**—help beginning students appreciate the “Big Picture” of human structure and function. A special feature of the illustrations in this text is the careful and consistent use of color to identify important structures and substances that recur throughout the book. Consistent use of a color key helps beginning students appreciate the “Big Picture” of human structure and function each time they see a familiar structure in a new illustration. For an explanation of the color scheme, see the Color Key on pp. xxiv-xxv.

- **Directional Rosettes**—help students learn the orientation of anatomical structures. Where appropriate, small orientation diagrams and directional rosettes are included as part of an illustration to help students locate a structure with reference to the body as a whole or orient a small structure in a larger view.



- **Quick Check questions**—test your knowledge of material just read. Short objective-type questions are located immediately following major topic discussions throughout the body of the text. These questions cover important information presented in the preceding section. Students unable to answer the questions should reread that section before proceeding. This feature therefore enhances reading comprehension. Quick Check items are numbered by chapter, and a numerical listing of their answers can be found on the EVOLVE site (<http://evolve.elsevier.com/Patton/AP/>).

#### QUICK CHECK

1. Name the fluid portion of whole blood.
2. What constitutes the formed elements of blood?
3. What factors influence blood volume?
4. Identify the component percentages of the normal hematocrit.

- **A&P Connect features**—call the reader's attention to online articles that illustrate, clarify, and apply concepts encountered in the text. Embedded within the text narrative, these boxes connect you with interesting, brief online articles that stimulate thinking, satisfy your curiosity, and help you apply important

#### Color Key

BIOCHEMISTRY			CELLULAR STRUCTURES		OTHER STRUCTURES
Carbon	Aspartic Acid	Tyrosine	Cytosol	Artery	
Chloride	Cysteine	Valine	Extracellular Fluid	Vein	
Energy	Glycine	Water	Plasma Membrane	Capillary	
ATP	Glutamic Acid	Hormone	Nucleus	Bone	
Hydrogen	Glutamine	Enzyme	Golgi Apparatus	Muscle	
Nitrogen	Histidine	Protein	Mitochondrion	Nerve	
Oxygen	Isoleucine	Carbohydrate	Endoplasmic Reticulum	Schwann Cell	
Potassium	Leucine	Fatty acid	Ribosome	Fat	
Sodium	Lysine	DNA, Nucleic Acid	Centrioles	Gland	
Sulfur	Methionine	RNA	Microtubule	Afferent (Sensory) Pathway	
Calcium	Phenylalanine	Cytosine	Intermediate Filament	Efferent (Motor) Pathway	
Organic Phosphate	Proline	Adenine	Microfilament	Sympathetic	
Inorganic Phosphate	Selenocysteine	Guanine	Actin / Thin Filament	Parasympathetic	
Alanine	Serine	Thymine / Uracil	Myosin / Thick Filament	Process Arrow	
Arginine	Threonine	Chromosome	Na <sup>+</sup> Channel		
Asparagine	Tryptophan				

concepts. They are often illustrated with micrographs, medical images, and medical illustrations.

#### A&P CONNECT

Blood transfusions are an important therapeutic tool. Learn more about blood transfusions, blood banking, and even artificial blood in **Blood Transfusions** online at **A&P Connect**.



- **Cycle of Life**—describes major changes that occur over a person's lifetime. In many body systems, changes in structure and function are frequently related to a person's age or state of development. In appropriate chapters of the text, these changes are highlighted in this special section.



- **The Big Picture**—explains the interactions of the system discussed in a particular chapter with the body as a whole. This helps students relate information about body structures or functions that are discussed in the chapter to the body as a whole. The Big Picture feature helps you improve critical thinking by focusing on how structures and functions relate to one another on a global basis.
- **Mechanisms of Disease**—helps you understand the basic principles of human structure and function by showing what happens when things go wrong. Examples of pathology, or disease, are included in many chapters of the book to stimulate student interest and to help students understand that the disease process is a disruption in homeostasis, a breakdown of normal integration of form and function. The intent of the **Mechanisms of Disease** section is to reinforce the normal structures and mechanisms of the body while highlighting the general causes of disorders for a particular body system.
- **Language of Medicine**—introduces you to new clinical terms in the chapter. A brief list of clinical terms is presented near the end of each chapter. As in the **Language of Science**





## LANGUAGE OF MEDICINE *(continued from p. 6)*

### acute anemia

(ah-KYOOT ah-NEE-mee-ah)

[acu-sharp, an-without, -emia  
blood condition]

### acute lymphocytic leukemia (ALL)

(ah-KYOOT LIM-foh-sit-ik loo-

### blood loss anemia

(ah-NEE-mee-ah)

[an-without, -emia blood condition]

### bone marrow transplant chronic lymphocytic leukemia (CLL)

list at the beginning of the chapter, each term has a phonetic pronunciation guide and

translations of word parts. The listed terms are defined in the text body, where they appear in boldface type.

- **Case Study**—challenges you with “real-life” clinical or other practical situations so you can creatively apply what you have learned. Every chapter has a case study preceding the chapter summary. The case study consists of a description of a real-life situation and a series of questions that require the student to use critical thinking skills to determine the answers.



- **Chapter Summary**—outlines essential information in a way that helps you organize your study. Detailed end-of-chapter summaries provide excellent guides for students as they review the text materials before examinations. Many students also find the summaries to be useful as a chapter preview in conjunction with the chapter outline.

- **Audio Chapter Summaries**—allow you to listen and learn wherever you may be. For the first time, the chapter summaries are now available in MP3 format for download at the EVOLVE site. You can play them on your computer, import them into your portable media device, or burn them onto a CD for playback in your stereo or car.



- **Review Questions**—help you determine whether you have mastered the important concepts of each chapter. Review questions at the end of each chapter give students practice in using a narrative format to discuss the concepts presented in the chapter.
- **Critical Thinking Questions**—actively engage and challenge you to evaluate and synthesize the chapter content. Critical thinking questions require students to use their higher level reasoning skills and demonstrate their understanding of, not just their repetition of, complex concepts.

## Boxed Information

As always, we made every effort to update factual information and incorporate the most current anatomy and physiology research findings in this edition. Although there continues to be an incredible explosion of knowledge in the life sciences, not all new information is appropriate for inclusion in a fundamental-level textbook. Therefore we were selective in choosing new clinical, pathological, or special-interest material to include in this edition. This text remains focused on normal anatomy and physiology. The addition of new boxed content is intended to stimulate student interest and provide examples that reinforce the immediate personal relevance of anatomy and physiology as important disciplines for study.

- **General Interest Boxes**—provide an expanded explanation of specific chapter content. Many chapters contain boxed essays, occasionally clinical in nature, that expand on or relate to

material covered in the text. Examples of subjects include the RNA revolution and the enteric nervous system.

- **Health Matters**—present current information on diseases, disorders, treatments, and other health issues related to normal structure and function. These boxes contain information related to health issues or clinical applications. In some instances, examples of structural anomalies or pathophysiology are presented. Information of this type is often useful in helping students understand the mechanisms involved in maintaining the “normal” interaction of structure and function.



- **Diagnostic Study**—keep you abreast of developments in diagnosing diseases and disorders. These boxes deal with specific diagnostic tests used in clinical medicine or research. Lumbar puncture, angiography, and antenatal diagnosis and treatment are examples.



- **FYI**—give you more in-depth information on interesting topics mentioned in the text. Topics of current interest, such as new advances in anatomy and physiology research, are covered in these “for your information” boxes.



- **Sports and Fitness**—highlight sports-related topics. Exercise physiology, sports injury, and physical education applications are highlighted in these boxes.



- **Career Choices**—highlight individuals in health-related careers.



A Career Choices box appears at the end of each unit. These boxes describe some of the diverse opportunities currently available in health-related occupations and also demonstrate the importance of how an understanding of anatomy and physiology will be useful to students in their futures.

## Glossary

A comprehensive glossary of terms is located at the end of the text. Accurate, concise definitions and phonetic pronunciation guides are provided. In this edition, word parts have also been added to each glossary entry. An audio glossary is also available on the expanded EVOLVE site (<http://evolve.elsevier.com/Patton/AP/>) with definitions and audio pronunciations for most of the key terms in the text.

## LEARNING SUPPLEMENTS FOR STUDENTS

### Brief Atlas of Human Anatomy

A full-color *Brief Atlas of Human Anatomy* containing cadaver dissections, osteology, organ casts, histology specimens, and surface anatomy photographs is packaged with every new copy of this edition of *Anatomy & Physiology*. This helpful supplement serves as a handy reference for students as they study the human body in class and in the laboratory—and even later on in clinical and career contexts.



## Clear View of the Human Body

This edition features a student favorite—a full-color, semitransparent model of the body called the *Clear View of the Human Body*. Found after the end of Chapter 12, this feature permits the virtual dissection of male and female human bodies along several different planes of the body. Developed by Kevin Patton and Paul Krieger, this tool helps learners assimilate their knowledge of the complex structure of the human body. It also provides a unique learning resource that helps students visualize human anatomy in the manner of today's clinical body imaging technology.

**EVOLVE**—<http://evolve.elsevier.com/Patton/AP/>



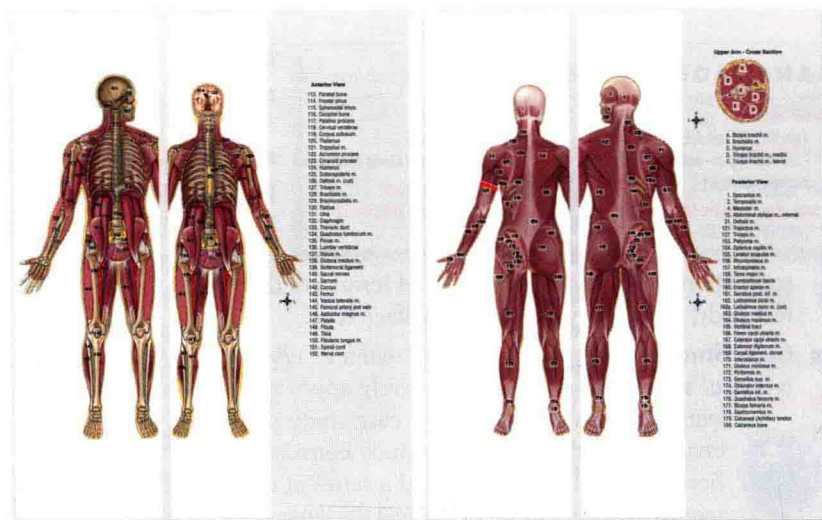
This new edition of *Anatomy & Physiology* is supported by an expanded multimedia EVOLVE website, featuring:

- **Audio Summaries** for each chapter available for download in convenient MP3 form
- **Anatomy and Physiology Online**, a 24-module online course that brings A&P to life and helps you understand the most important concepts presented in the book. Free to students who purchase a new textbook, this online course includes instructionally sound learning modules with more than 150 animations, 300 interactive exercises, and more than 100 assessments



- Answers to all of the **Quick Check** questions found in the textbook
- Quick access to all **A&P Connect** articles cited in the textbook
- **Online Tutoring** offering you one-on-one expert assistance from an experienced mentor
- An interactive **AudioGlossary** with definitions and pronunciations for more than 1000 key terms from the textbook
- The **Body Spectrum** electronic coloring book, which offers dozens of anatomy illustrations that can be colored online or printed out and colored by hand
- More than 500 **Student Post-Test** questions that allow you to get instant feedback on what you've learned in each chapter
- State-of-the-art **3-D animations**, which show and describe physiological processes by body system
- **WebLinks** to provide students with access to hundreds of important sites simply by clicking on a subject in the book's table of contents

You can visit the EVOLVE site by pointing your browser to <http://evolve.elsevier.com/Patton/AP/>.



## Survival Guide for Anatomy & Physiology

The *Survival Guide for Anatomy & Physiology*, written by Kevin Patton, is an easy-to-read and easy-to-understand brief handbook to help you achieve success in your anatomy and physiology course. Read with greater comprehension using the 10 survival skills, study more effectively, prepare for tests and quizzes, and tap into all of the information resources at your disposal. It also includes a **Quick Reference** filled with illustrations, tables, and diagrams that convey all of the important facts and concepts students need to know to succeed in an anatomy and physiology course.

## Study Guide

The *Study Guide*, written by Linda Swisher, is a valuable student workbook that provides the reinforcement and practice necessary for students to succeed in their study of anatomy and physiology. Important concepts from the text are reinforced through **Concept Reviews**, organized by objectives, and referenced to the text. *Clinical Challenges* apply the material to real-life situations. Matching, completion, and illustration labeling exercises are provided for every chapter.

## Anatomy & Physiology Laboratory Manual

The *A&P Laboratory Manual*, authored by Kevin Patton with new contributions from Daniel Matusiak, continues to be an invaluable resource for students. This extensively illustrated, full-color manual features an extensively revised illustration program. This popular lab manual contains more than 50 well-integrated exercises providing hands-on learning experience to help students acquire a thorough understanding of the human body.

Exercises in cat anatomy are included, along with cow and sheep organs, to allow the flexible use of dissection specimens. Other features are boxed hints on handling specimens and managing laboratory activities, safety tips, coloring exercises, and



summaries of landmark features used to distinguish microscopic specimens. Each exercise concludes with a lab report that may also serve as a homework assignment or self-test.

The new edition of the lab manual includes *eLabs for Anatomy & Physiology*, an online lab program designed to complement traditional lab exercises. The lab exercises, both anatomy and physiology based, are separated into modules. Each lab is composed of a variety of learning activities, animations, simulations, and quizzes. The labs are designed so that students can easily navigate between activities, allowing them the freedom to focus on the areas where they need the most help.

## TEACHING SUPPLEMENTS FOR INSTRUCTORS

### Instructor Resources on Evolve

The *Instructor's Resource* was written and developed specifically for this new edition of *Anatomy & Physiology*. Available on Evolve, it provides critical thinking questions, learning objectives and activities, teaching tips for the text, synopses of difficult concepts, and clinical applications exercises. To make lecture preparations a little easier, the Instructor's Resource also includes lesson plans

that allow you to hit the ground running. The Evolve website for instructors also includes a **Computerized Test Bank** with more than 7000 multiple choice, true/false, short answer, and challenge questions (which you can also import into your **Classroom Performance System** to quickly assess student comprehension and monitor your classroom's response), an **Electronic Image Collection** to accompany *Anatomy & Physiology*, featuring hundreds of full-color illustrations and photographs, with labels and lead lines that you can turn off and on, **Powerpoint Presentations**, and much more!

### Instructor's Guide for the Laboratory Manual

The Instructor's Guide for the *Laboratory Manual* on Evolve offers detailed information to help the instructor prepare for the laboratory exercises. Alternate activities, substitutions, student handouts, and other resources help instructors tailor the use of the *A&P Laboratory Manual* to their own course. Answers for all questions on the lab reports in the *A&P Laboratory Manual* are also provided either to check student work or to provide for students who use lab reports as self tests. Also included is a **cadaver dissection video**—shot in high definition— that you can use in lecture or lab.

# Acknowledgments

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Gary A. Thibodeau

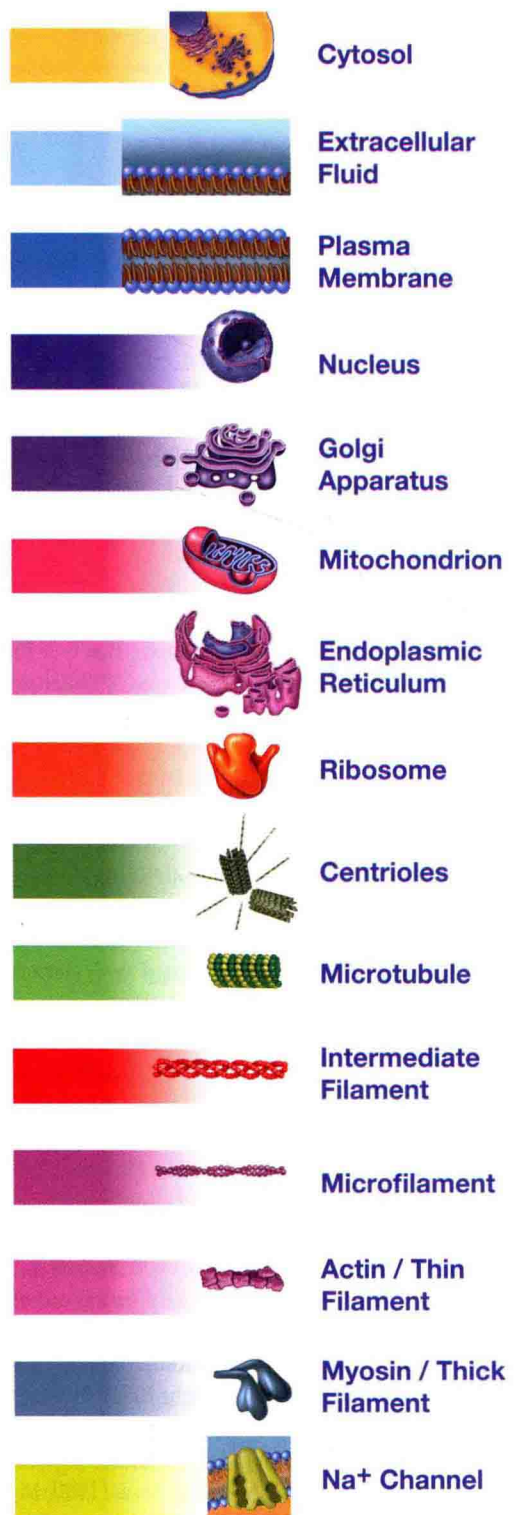


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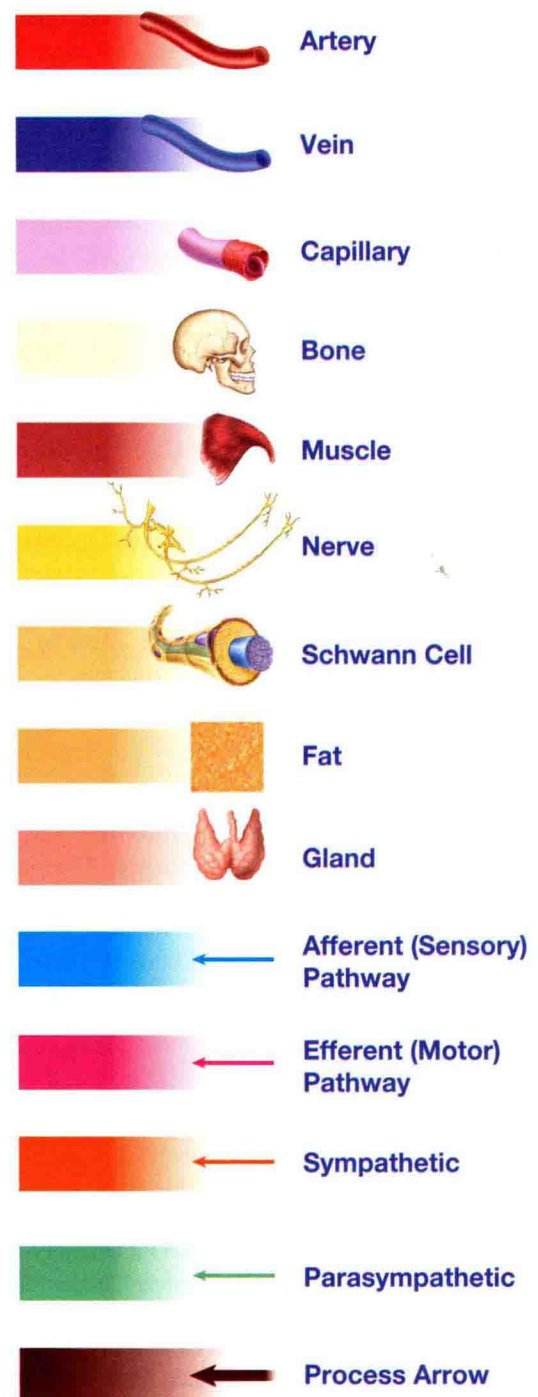
## BIOCHEMISTRY

 Carbon	 Aspartic Acid	 Tyrosine
 Chloride	 Cysteine	 Valine
 Energy	 Glycine	 Water
 ATP	 Glutamic Acid	 Hormone
 Hydrogen	 Glutamine	 Enzyme
 Nitrogen	 Histidine	 Protein
 Oxygen	 Isoleucine	 Carbohydrate
 Potassium	 Leucine	 Fatty acid
 Sodium	 Lysine	 DNA, Nucleic Acid
 Sulfur	 Methionine	 RNA
 Calcium	 Phenylalanine	 Cytosine
 Organic Phosphate	 Proline	 Adenine
 Inorganic Phosphate	 Selenocysteine	 Guanine
 Alanine	 Serine	 Thymine / Uracil
 Arginine	 Threonine	 Chromosome
 Asparagine	 Tryptophan	

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