

MARTINI / BARTHOLOMEW

FIFTH EDITION

ESSENTIALS OF
**anatomy &
physiology**

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FIFTH EDITION

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Text and Illustration Team



FREDERIC (RIC) MARTINI, PH.D. (author) received his Ph.D. from Cornell University in comparative and functional anatomy for work on the pathophysiology of stress. His publications include journal articles and contributed chapters, technical reports, and magazine articles. He is the lead author of six other undergraduate texts on anatomy and physiology or anatomy, and has a feature column, “Back to Basics,” in *Physician License and Practice Today*, a quarterly publication for medical students and residents. He is currently affiliated faculty of the University of Hawaii at Manoa and remains connected with the Shoals Marine Laboratory, a joint venture between Cornell University and the University of New Hampshire. Dr. Martini has been active in the Human Anatomy and Physiology Society (HAPS) for 18 years and was a member of the committee that established the course curriculum guidelines for A&P. He is now a President Emeritus of HAPS after serving as President-Elect, President, and Past-President during 2004–2007. He is also a member of the American Physiological Society, the American Association of Anatomists, the Society for Integrative and Comparative Biology, the Australia/New Zealand Association of Clinical Anatomists, the Hawaii Academy of Science, the American Association for the Advancement of Science, and the International Society of Vertebrate Morphologists.



EDWIN F. BARTHOLOMEW (author) received his undergraduate degree from Bowling Green State University in Ohio and his M.S. from the University of Hawaii. His interests range widely, from human anatomy and physiology to the marine environment and the “backyard” aquaculture of escargots and ornamental fish. During the last three decades, Mr. Bartholomew has taught human anatomy and physiology at both the secondary and undergraduate levels. In addition, he has taught a wide variety of other science courses (from botany to zoology) at Maui Community College. He is presently teaching at historic Lahainaluna High School, the oldest high school west of the Rockies, where he assisted in establishing a Health Occupations Students of America (HOSA) chapter. He has written journal articles, a weekly newspaper column, and many magazine articles. Working with Dr. Martini, he coauthored *Structure and Function of the Human Body* (Benjamin Cummings) and *The Human Body in Health and Disease* (Benjamin Cummings). Mr. Bartholomew is a member of the Human Anatomy and Physiology Society, the National Association of Biology Teachers, the National Science Teachers Association, and the American Association for the Advancement of Science.



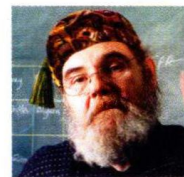
KATHLEEN WELCH, M.D. (clinical consultant) received her M.D. from the University of Washington in Seattle and did her residency at the University of North Carolina in Chapel Hill. For two years, she served as Director of Maternal and Child Health at the LBJ Tropical Medical Center in American Samoa and subsequently was a member of the Department of Family Practice at the Kaiser Permanente Clinic in Lahaina, Hawaii. She has been in private practice since 1987. Dr. Welch is a Fellow of the American Academy of Family Practice and a member of the Hawaii Medical Association, the American Medical Association, and the Human Anatomy and Physiology Society.



WILLIAM C. OBER, M.D. (art coordinator and illustrator) received his undergraduate degree from Washington and Lee University and his M.D. from the University of Virginia. While in medical school, he also studied in the Department of Art as Applied to Medicine at Johns Hopkins University. After graduation, Dr. Ober completed a residency in Family Practice and later was on the faculty at the University of Virginia in the Department of Family Medicine. He is currently an Instructor in the Division of Sports Medicine at UVA and is part of the Core Faculty at Shoals Marine Laboratory, where he teaches Biological Illustration every summer. The textbooks illustrated by his company Medical & Scientific Illustration have won numerous design and illustration awards.



CLAIRE W. GARRISON, R.N. (illustrator) practiced pediatric and obstetric nursing before turning to medical illustration as a full-time career. She returned to school at Mary Baldwin College, where she received her degree with distinction in studio art. Following a five-year apprenticeship, she has worked as Dr. Ober’s partner in Medical and Scientific Illustration since 1986. She is on the Core Faculty at Shoals Marine Laboratory and co-teaches the Biological Illustration course.



RALPH T. HUTCHINGS (biomedical photographer) was associated with the Royal College of Surgeons for 20 years. An engineer by training, he has focused for years on photographing the structure of the human body. The result has been a series of color atlases, including the *Color Atlas of Human Anatomy*, the *Color Atlas of Surface Anatomy*, and *The Human Skeleton* (all published by Mosby-Yearbook Publishing). For his anatomical portrayal of the human body, the International Photographers Association has chosen Mr. Hutchings as the best photographer of humans in the twentieth century. He lives in North London, where he tries to balance the demands of his photographic assignments with his hobbies of early motorcars and airplanes.

DEDICATION

To Kitty, P.K., Ivy, Kate, and Awley:

We couldn't have done this without you.

Thank you for your encouragement, patience, and understanding.

Preface

Welcome to the Fifth Edition of *Essentials of Anatomy & Physiology*! This textbook is designed to introduce the specialized terms, basic concepts, and principles important to an understanding of the human body. It has two primary goals:

1. **To build a foundation of essential knowledge in human anatomy and physiology.** Constructing this knowledge requires answers to questions such as: What structure is that? How does it work? What happens when it does not work normally?
2. **To provide a framework for interpreting and applying information for problem solving.** This framework is built around the themes and patterns that appear repeatedly in the study of anatomy and physiology. These themes and patterns provide the hooks on which to organize and hang the information in this text. Interpreting and applying information to problems involves asking questions such as: How does a change in one body system affect the others? How does aging affect various body systems?

Essentials of Anatomy & Physiology, Fifth Edition is designed to help students place information in a meaningful context and develop their problem-solving skills. Anyone embarking on a career in a medical or allied health field must master the same skills needed to succeed in this course. Developing an extensive technical vocabulary and retaining a large volume of detailed information is not enough. A person needs to know how to learn—how to organize new information, how to connect it to what is already known, and how then to apply it as needed.

This text uses a learning system that simplifies the processes involved in teaching and learning anatomy and physiology. The visual introduction (which begins on page x) outlines the pieces that make up our specific teaching framework and shows the many learning aids that are built into this textbook. These features were developed through feedback from students and instructors on a variety of campuses. Many students have told us—in person, by phone, or by email—that this system really works for them, whereas others have not.

What's Different About the Fifth Edition?

Each new edition provides an opportunity for revising and updating. Our first step in planning for the Fifth Edition was to integrate the feedback and queries from instructors and students with our own experiences in the classroom. We identified key areas in which students were having trouble following the text narrative or grasping important concepts and then revised the text accordingly. We targeted sections in which students struggled to match the text narra-

tive with the figures and worked with the illustration team to improve the art program. The Fifth Edition also provides students and instructors with updated media that will benefit their learning and teaching.

Improvements to the Text

New features, revised features, and other key revisions in this Fifth Edition include the following:

- **Learning Outcomes** are chapter-opening numbered lists that indicate what students should be able to do after studying the chapter. A&P educators have begun to shift from general “objectives” (which focus on what students “need to know”) to these more concrete “learning outcomes” (which focus on what students “need to be able to do”).
- **Full-sentence chapter headings** do more than introduce new topics; they state the core fact or concept that will be presented in the section. These numbered chapter headings are directly correlated with the numbered Learning Outcomes on the chapter-opening page. Together, the two elements help students readily grasp and learn the chapter’s core content.
- **Checkpoint** is the new name of what was called “Concept Check” in previous editions. Each Checkpoint checks not only students’ understanding of concepts but also of facts—according to what they most need at a precise point in a chapter. By appearing consistently throughout each chapter, the Checkpoints reinforce the Learning Outcomes so that they are systematically integrated over the course of the chapter. The Checkpoint questions are numbered sequentially throughout each chapter so that students can easily access the answers located in the blue Answers tab at the back of the book.
- **The Big Picture** was called “Key Note” in the Fourth Edition. Strategically placed throughout each chapter, The Big Picture presents the core facts and concepts necessary to an understanding of the basics of anatomy and physiology—the “nuggets” that students should remember five years after taking their A&P course, regardless of their chosen profession.
- **Clinical Notes**—a favorite feature among students—have been updated with the latest available clinical information and statistics. Definitions and descriptions of pathological processes have been revised as needed.
- **The Review Questions** at the end of the chapter include new questions based on modified chapter figures to ensure student understanding of key illustrations. Many other Review Questions are new or revised. A reference to the companion website is placed at the beginning of the Review Questions to

remind students of additional study and assessment materials that can be found there.

- **Eponymous terms** have, in most cases, been replaced with the preferred terms in *Terminologia Anatomica: International Anatomical Terminology (TA)*, the standard reference book of anatomical terminology created jointly by the Federative Committee on Anatomical Terminology (FCAT) and the International Federation of Associations of Anatomists (IFAA). Because terms other than those in the *TA* are still in common usage, we present those other terms parenthetically where appropriate. Furthermore, following the recommendations in the American Medical Association's *Manual of Style*, we use the non-possessive forms of eponyms in most instances; when the term appeared too foreign to us without the apostrophe "s," however, we let past convention rule.
- **Concept Links**, signaled by blue chain link icons, have been retained from previous editions and alert students to material that is related to, or builds upon, previous discussions. Each link contains a page number so that students can quickly review relevant material from an earlier chapter.

Chapter-by-Chapter Changes

Chapter 1 An Introduction to Anatomy and Physiology

1. Figure 1-4 was revised to clarify negative feedback regulation in thermoregulation.
2. A new **Clinical Note** entitled "Homeostasis and Disease" was added.
3. For clarification, an explanation of the conventional orientation of cross-sectional views was added to the text (p. 19) and to the caption for Figure 1-10. (By convention, transverse or cross-sectional views and radiological images are always presented as seen when standing at the feet looking toward the head.)

Chapter 2 The Chemical Level of Organization

1. Figure 2-6 was revised to clarify hydrogen bonding between water molecules.
2. Figure 2-7 was revised for clarity.
3. Figure 2-18 was revised to clarify an enzyme's active site.
4. Figure 2-19 was revised to show the proper helical orientation of DNA.

Chapter 3 Cell Structure and Function

1. Figure 3-2 was revised to illustrate that (1) cells may have microvilli or cilia, but not both structures, and (2) *plasma membrane* is the primary term for the membrane surrounding a cell, thus distinguishing it from other internal cell membranes.
2. Table 3-1 was reorganized for clarity.
3. Figure 3-14 was enhanced by illustrating the three dimensions of the ER and Golgi apparatus.

4. Figure 3-22 was revised to clarify the different stages of mitosis.

Chapter 4 The Tissue Level of Organization

1. Terminology related to intercellular connections in Figure 4-2 was revised.
2. The discussion of stratified epithelia was revised to include both stratified cuboidal and stratified columnar epithelia.
3. The text description of transitional epithelium, and the art depicting it (Figure 4-5), were revised to clearly indicate that it is a stratified epithelium.
4. The discussion of connective tissue proper cell types was revised to include fibrocytes and their functions.

Chapter 5 The Integumentary System

1. The **System in Perspective** was revised to more clearly delineate the functional relationships between different body systems.

Chapter 6 The Skeletal System

1. Terminology related to some cranial bones was revised (for example, "external acoustic canal" was changed to "external acoustic meatus").
2. The **System in Perspective** was revised to more clearly delineate the functional relationships between different body systems.

Chapter 7 The Muscular System

1. Terminology related to some sarcomere features was revised (for example, "H zone" was changed to "H band").
2. Figure 7-4 was revised to include a Step 5 (return to initial state).
3. The **System in Perspective** was revised to more clearly delineate the functional relationships between different body systems.

Chapter 8 The Nervous System

1. Figure 8-1 was revised to clarify the effectors receiving inputs from both divisions of the autonomic nervous systems.
2. Figure 8-4 features updated art of the axons in white matter and astrocyte connections.
3. Figure 8-8 was revised to correct the x-axis time scale.
4. Figure 8-14 contains updated art.
5. Terminology related to the ventricles of the brain was revised (for example, "mesencephalic aqueduct" was changed to "aqueduct of midbrain").
6. Labeling of cranial nerves VII and VIII was corrected in Figure 8-24.
7. The **System in Perspective** was revised to more clearly delineate the functional relationships between different body systems.

Chapter 9 The General and Special Senses

1. Figure 9-28 was revised to illustrate that axons of the cochlear branch of N VIII enter both the left and right cochlear nuclei of the medulla oblongata.

Chapter 10 The Endocrine System

1. The abbreviation for oxytocin, OXT, was introduced in the text discussion and also appears in Figure 10-8.
2. Figure 10-12 and related text were revised to reflect the designation of *suprarenal gland* as the primary term and *adrenal gland* as a secondary term.
3. The discussion of resistin in the adipose tissue section was deleted because it hasn't been scientifically substantiated for human physiology.
4. The **System in Perspective** was revised to more clearly delineate the functional relationships between different body systems.

Chapter 11 The Cardiovascular System: Blood

1. Figure 11-6 was enhanced for clarity with an updated design.
2. Figure 11-10 was enhanced for clarity.

Chapter 12 The Cardiovascular System: The Heart

1. Terminology was revised (from “voltage-regulated channels” to “voltage-gated channels”) in the text and Figure 12-8.

Chapter 13 The Cardiovascular System: Blood Vessels and Circulation

1. Terminology was revised (from “tunica interna” to “tunica intima”) in the text and Figure 13-2.
2. Figure 13-9 was enhanced for clarity.
3. Text within Figure 13-10 was changed from plural to singular (for example, “vasomotor centers” to “vasomotor center”).
4. The **System in Perspective** was revised to more clearly delineate the functional relationships between different body systems.

Chapter 14 The Lymphoid System and Immunity

1. This chapter has been retitled using “Lymphoid” instead of “Lymphatic” to reflect internationally accepted terminology for the system.
2. Figure 14-6 now includes labels indicating the distributions of B cells and T cells within a lymph node.
3. The **System in Perspective** was revised to more clearly delineate the functional relationships between different body systems.

Chapter 15 The Respiratory System

1. The **System in Perspective** was revised to delineate more clearly the functional relationships between different body systems.

Chapter 16 The Digestive System

1. The singular form for the term given to the transverse folds of the digestive tract lining was corrected to “plica circulares.”
2. The presence of microvilli on the intestinal epithelium of villi was clarified with a revised label in Figure 16-11.
3. The **System in Perspective** was revised to more clearly delineate the functional relationships between different body systems.

Chapter 17 Nutrition and Metabolism

1. Figures 17-1, 17-2, 17-3, 17-4, 17-5 (note that the label “Hydrogen ion channel” has been changed to “ATP synthase”), 17-6, 17-7, 17-8, and 17-9 were revised for clarity.
2. Figure 17-10 (The MyPyramid Plan) was replaced to reduce repetition of USDA Food Pyramid information given in Table 17-1.
3. Corrections were made to the “Recommended Daily Intake” values in Tables 17-2 and 17-3.

Chapter 18 The Urinary System

1. The text and art were revised to reflect the designation of *nephron loop* as the primary term and *loop of Henle* as a secondary term (see Figure 18-4).
2. Terminology for some of the arteries and veins within the kidneys has been updated (for example, “interlobular arteries” was changed to “cortical radiate arteries”; see Figure 18-4).
3. Missing description of Step 7 from Figure 18-8 was added to the text.
4. Corrections were made to the values in Table 18-2.
5. The **System in Perspective** was revised to more clearly delineate the functional relationships between different body systems.

Chapter 19 The Reproductive System

1. The text and art of the male reproductive system were revised to reflect the designations of *seminal gland(s)* as the primary term and *seminal vesicle(s)* as a secondary term, and *nurse cell* as the primary term and *sustentacular cell* as a secondary term.
2. Figure 19-13 was revised to indicate the distinction between the lobes of a mammary gland and the many lobules that make up each lobe.
3. Figure 19-14 (Hormonal Regulation of Ovarian Activity) now precedes Figure 19-15 (Hormonal Regulation of the Female Reproductive Cycle).
4. The **System in Perspective** was revised to more clearly delineate the functional relationships between different body systems.

Chapter 20 Development and Inheritance

1. Terminology was corrected in Table 20-1.
2. “The Human Genome Project and Beyond” section was revised with updated information.

Enhancements to the Art and Design

The art program builds on illustrations described as the most “teachable” and “learnable” of any illustrations in any anatomy and physiology textbook. We worked closely with our medical illustrators, William Ober, M.D. and Claire Garrison, R.N., to assess the illustrations and make improvements throughout the text. With their input, we revised, replaced, or added figures to enhance the visual presentation. The labels and leaders of virtually every anatomical figure in the book were reoriented and placed to make them visually cleaner and easier to follow. Increased color contrast and increased dimensionality help students see, understand, and appreciate the close relationship between structures and functions.

Features retained and revised from the previous edition include the following:

- Art-photo pairings that give students more than one way to see structures.
- Step-by-step diagrams with clearer headings and arrows to make sequences easier to follow.
- Illustrations combined with photographs to help students see the “real thing” in context.

For the Fifth Edition, we also worked with our editors and designers to create a fresh, contemporary, and welcoming look for the book. The new design highlights the pedagogical features more prominently and calls them out for easier navigation and use.

Media Ancillaries

Included with each new copy of the text is the Interactive Physiology® 10-System Suite (IP-10) CD-ROM, an award-winning student tutorial featuring animations and quizzes. Practice Anatomy Lab (PAL™) 2.0 is a virtual anatomy practice tool that gives students 24/7 access to the most widely used lab specimens, including human cadaver, anatomical models, histology, cat, and fetal pig. The PAL 2.0 CD-ROM can be added to the book package for no additional charge. See the inside front cover of the book for more about IP-10 and PAL 2.0.

The Anatomy & Physiology Place open-access companion website is available, complete with chapter-correlated vocabulary practice, quizzes, and animations. The **Instructor's Resource DVDs/CD-ROM** organizes all instructor media resources by chapter and includes all of the art and photos from the book, in multiple customizable formats, as well as PowerPoint® lecture outlines and the brand-new 3D movie-quality A&P Flix animations.

Acknowledgments

Every textbook represents a group effort. Foremost on the list are the faculty and reviewers whose advice, comments, and collective wisdom helped shape this edition. Their interest in the subject, their concern for the accuracy and method of presentation, and their experience with students of widely varying abilities and backgrounds made the re-

view process an educational experience. To these individuals, who carefully recorded their comments, opinions, and sources, we express our sincere thanks and best wishes.

We would also like to acknowledge the many users, survey respondents, and focus group members whose advice, comments, and collective wisdom helped shape this text into its final form. Their passion for the subject, their concern for accuracy and method of presentation, and their experience with students of widely varying abilities and backgrounds have made the review process much more fruitful.

The following individuals devoted large amounts of time reviewing drafts of *Essentials of Anatomy & Physiology*:

Reviewers for the Fifth Edition

Diane Berger, *Kankakee Community College*
Meg Flemming, *Austin Community College—Rio Grande*
Ann Geller, *San Diego Mesa College*
Michael Guthrie, *City College of San Francisco*
Georgia Householder, *Southwest Virginia Community College*
Sue Caley Opsal, *Illinois Valley Community College*
Diane Pelletier, *Green River Community College*
Penny Revelle, *City College Baltimore County—Essex*
Deborah Temperly, *Delta College*
Larry Walker, *Trident Tech College*
Bert Wartski, *Duke University*
Thomas White, *State University College at Buffalo*

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William Armstrong, *Eastern Michigan University*
Lynn Atkins, *University of Maine*
Sheri Boyce, *Messiah College*
Barbara Engebretsen, *Wayne State College*
Demetrio Fajardo, *Las Vegas College*
Joseph Gar, *Paducah Community College*
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Mary Hall, *Rhodes/Western Business College*
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Julie Huggins, *Arkansas State University*
Gary Hunt, *Tulsa Community College*
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Melissa Presch, *California State University, Fullerton*
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Christine Eckel, *Salt Lake Community College*
Lauren Gollahon, *Texas Technical University*
Cynthia Herbrandson, *Kellogg Community College*

Our gratitude is also extended to the many faculty and students at campuses across the United States (and out of the country) who made suggestions and comments that helped us improve this edition of *Essentials of Anatomy & Physiology*.

A textbook has two components: narrative and visual. In preparing the narrative, we were ably assisted yet again by our keen-eyed copyeditor Alan Titche, who played a vital role in shaping this text by helping us keep the text organization, general tone, and level of presentation consistent throughout.

Virtually without exception, reviewers stressed the importance of accurate, integrated, and visually attractive illustrations in helping students understand essential material. The creative talents brought to this project by our artist team, William Ober, M.D., and Claire Garrison, R.N., are inspiring and very much appreciated. Bill and Claire worked intimately and tirelessly with us, imparting a unity of vision to the book as a whole while making it both clear and beautiful. The superb art program is also greatly enhanced by the incomparable bone and cadaver photographs of Ralph T. Hutchings, formerly of The College of Surgeons in England.

We are deeply indebted to the Benjamin Cummings production staff and S4Carlisle, whose efforts were so vital to the creation of this edition. Special thanks are due to Caroline Ayres and Norine Strang for their skillful management of the project through the entire production process. We appreciate the excellent design contributions of

Mark Ong, Design Manager, and Marilyn Perry, interior text designer and cover designer. We must also express our appreciation to Kelly Reed, Assistant Editor, for her work on the numerous print supplements, and to Suzanne Rasmussen for her work on the media supplements that accompany this title.

Thanks also to Christy Lawrence, Director of Marketing, and the entire Pearson Science sales team for keeping their fingers on the pulse of the market and helping us meet the needs of our users.

Above all, thanks to our editor, Katy German, for her patience in nurturing this project and her efforts to coordinate the various components of the package, and to Leslie Berriman, Executive Editor, for her dedication to the success of this book.

Finally, we would like to thank our families for their love and support during the revision process.

No two people could expect to produce a flawless textbook of this scope and complexity. Any errors or oversights are strictly our own rather than those of the reviewers, artists, or editors. In an effort to improve future editions, we ask that readers with pertinent information, suggestions, or comments concerning the organization or content of this textbook send their remarks to us by email. Any and all comments and suggestions will be deeply appreciated and carefully considered in the preparation of the next edition.

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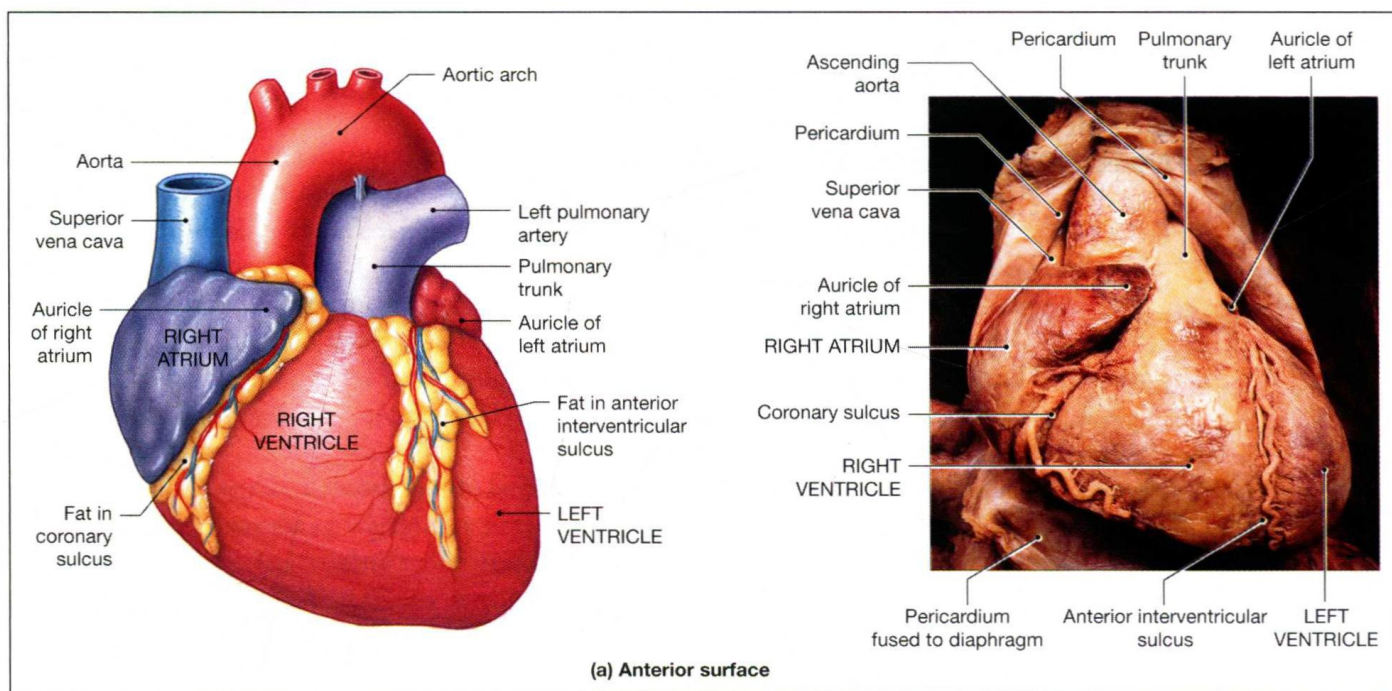
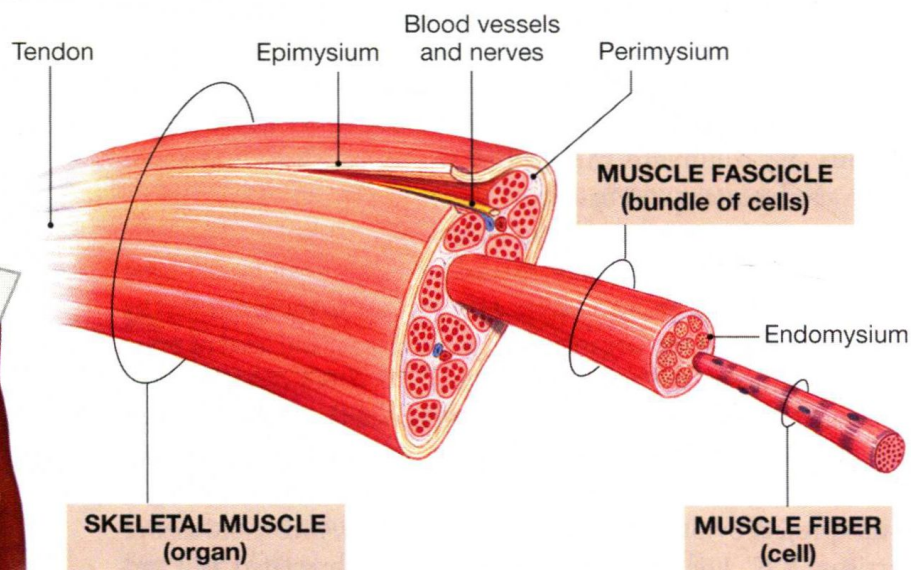
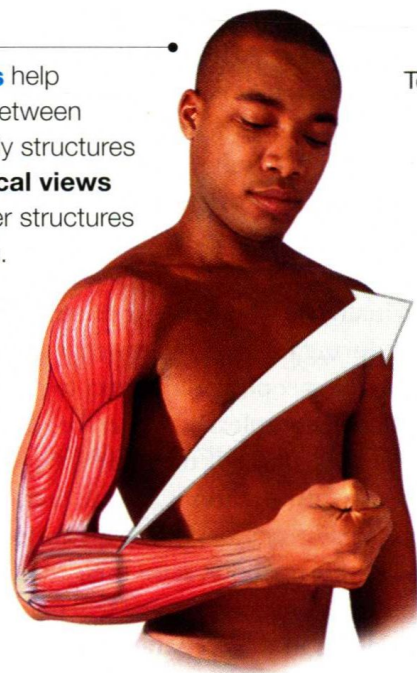
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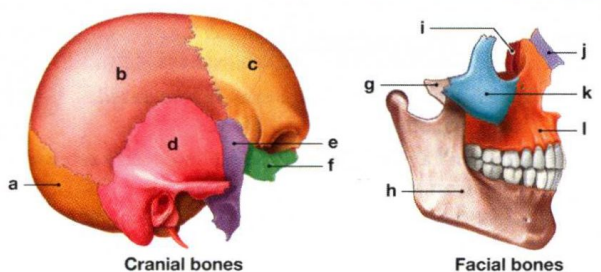
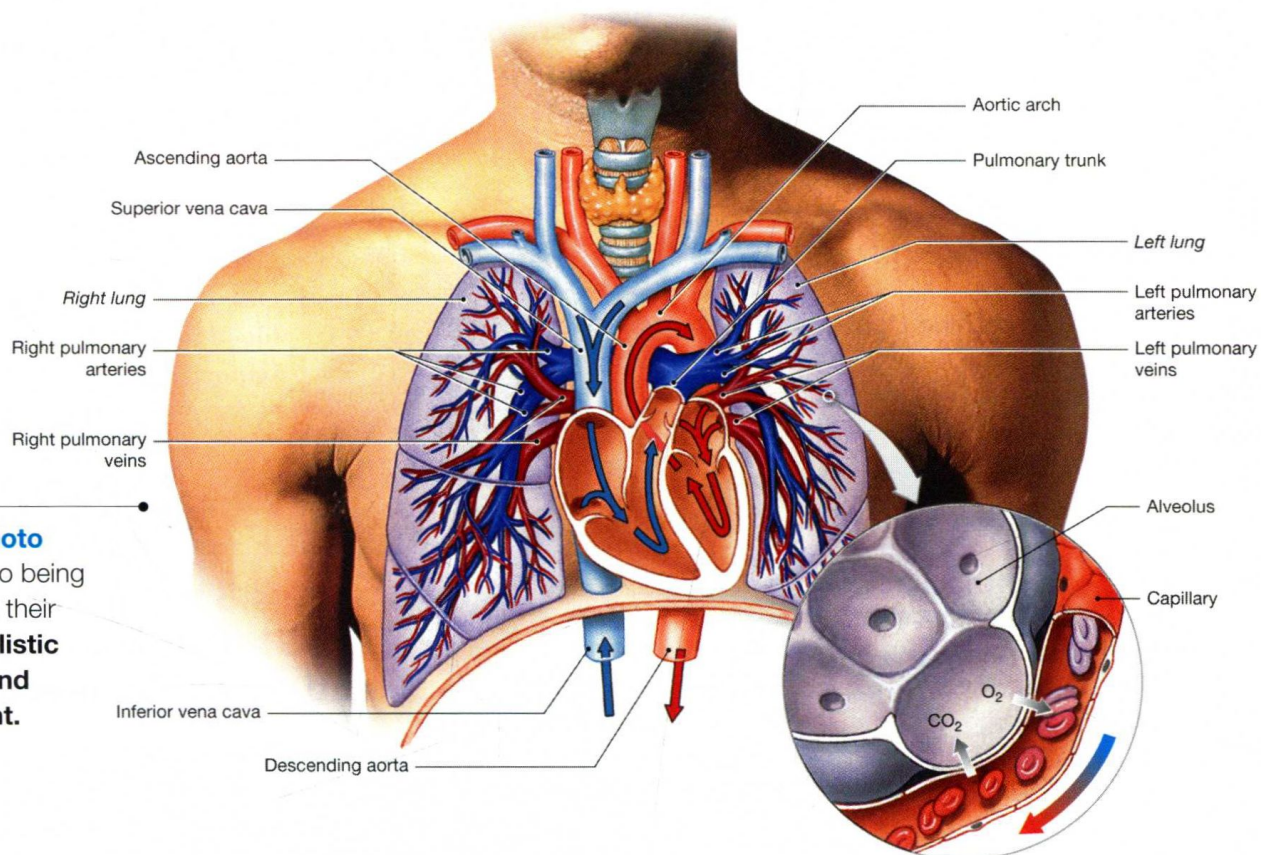
ART THAT TEACHES

Macro-to-Micro Figures help students bridge the gap between familiar and unfamiliar body structures by **sequencing anatomical views** from whole organs or other structures to their smaller body parts.



Side-by-Side Figures provide students with **multiple views** of the **same structure**, allowing them to compare an illustrator's rendering with a photo of the actual structure as it may be seen in a lab or clinical setting.

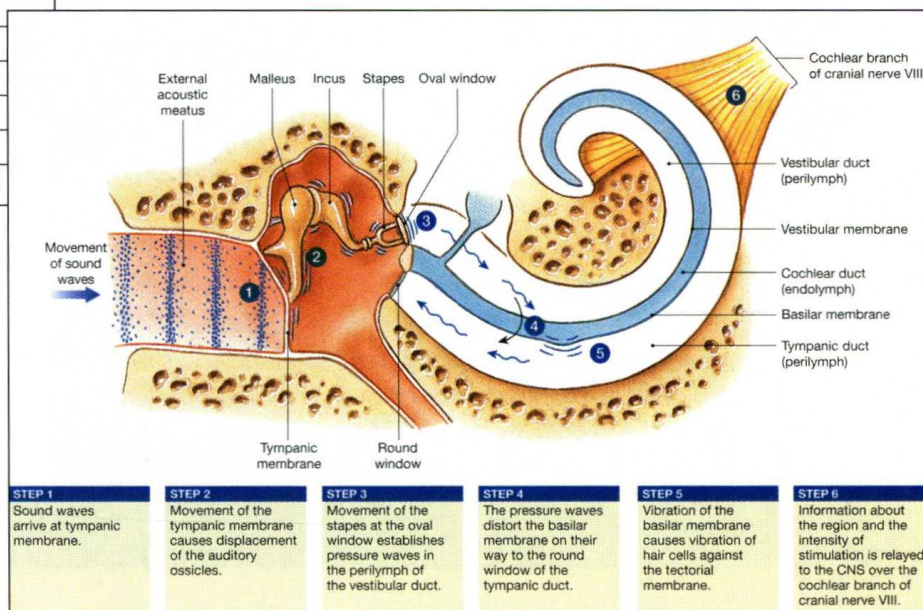
Illustration-over-Photo Figures, in addition to being visually dramatic with their 3D effects, teach **realistic body proportions and structure placement**.



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NEW! Visually-Based Questions have been added to the Review Questions at the end of each chapter to give students **visual practice** with what they are learning.

Step-by-Step Figures break down **multifaceted processes** into numbered step-by-step illustrations that coordinate with the authors' narrative descriptions.



AN ORGANIZATION THAT IS EASY TO USE AND TIED TO ASSESSMENT

*The **Fifth Edition** has been revised for ease of use and ease of assessment—starting with the new **Learning Outcomes**.*

NEW! Learning Outcomes, based on the Learning Outcomes developed and recommended by the Human Anatomy and Physiology Society (HAPS), are chapter-opening numbered lists that indicate what students should be able to do after studying the chapter.

NEW! Full-sentence numbered chapter headings are directly correlated to the numbered Learning Outcomes. The two elements, working together, help students “see,” navigate through, and learn the chapter content. Additionally, as full sentences, the chapter headings do more than introduce new topics—they state the core fact or concept presented in the chapter section.

Checkpoint questions map to the chapter's Learning Outcomes, further integrating the assessment-based Learning Outcomes into the chapter structure.

Assessment is easy!
Just like the text, the **Test Bank** and the **website tests and quizzes** are organized by the Learning Outcomes.

NEW! Repetition of **the full-sentence chapter headings in the Summary Outline** at the end of the chapter provides students with another opportunity to “see” the core information of the chapter.

11-4 Discuss the factors that determine a person's blood type, and explain why blood types are important.

11-4 The ABO blood types and Rh system are based on antigen-antibody responses

CHECKPOINT



- 10.** Which blood type(s) can be safely transfused into a person with Type AB blood?
- 11.** Why can't a person with Type A blood safely receive blood from a person with Type B blood?

See the blue Answers tab at the back of the book.

11-4 The ABO blood types and Rh system are based on antigen-antibody responses

- 12.** **Blood type** is determined by the presence or absence of three specific **surface antigens** (*agglutinogens*) in the cell membranes of RBCs: antigens A, B, and Rh. Antibodies (*agglutinins*) in the plasma of individuals of some blood types can react with surface antigens on the RBCs of different blood types. Anti-Rh antibodies are synthesized only after an Rh-negative individual becomes sensitized to the Rh surface antigen. (Figure 11-7; Table 11-2)

FEATURES THAT PREPARE STUDENTS FOR FUTURE CAREERS

SKELETAL

The Skeletal System in Perspective

Functional Relationships Between the Skeletal System and Other Systems

The Integumentary System

- The Integumentary System synthesizes vitamin D₃, essential for calcium and phosphorus absorption (bone maintenance and growth)
- The Skeletal System provides structural support

The Muscular System

- The Muscular System stabilizes bone positions; tension in tendons stimulates bone growth and maintenance
- The Skeletal System provides calcium needed for normal muscle contraction; bones act as levers to produce body movements

The Nervous System

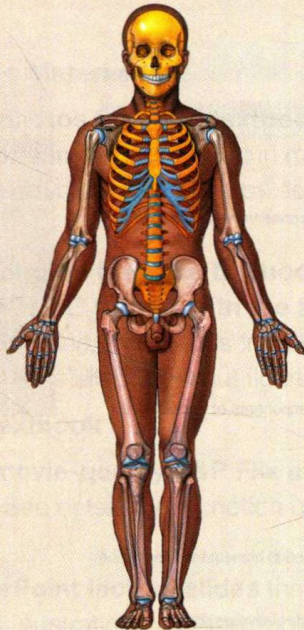
- The Nervous System regulates bone position by controlling muscle contractions
- The Skeletal System provides calcium for neural function; protects brain, spinal cord; receptors at joints provide information about body position

The Endocrine System

- The Endocrine System regulates skeletal growth with growth hormone, thyroid hormones, and sex hormones; calcium mobilization regulated by parathyroid hormone and calcitonin
- The Skeletal System protects endocrine organs, especially in brain, chest, and pelvic cavity

The Cardiovascular System

- The Cardiovascular System provides oxygen, nutrients, hormones, blood cells; removes waste products and carbon dioxide
- The Skeletal System provides calcium needed for cardiac muscle contraction, blood cells produced in bone marrow; axial skeleton protects heart and great vessels



For All Systems

The Skeletal System provides mechanical support; stores energy reserves; stores calcium and phosphate reserves

The Lymphoid System

- The Lymphoid System's lymphocytes assist in the defense and repair of bone following injuries
- The Skeletal System's bone marrow produces and stores lymphocytes and other cells of the immune response

The Respiratory System

- The Respiratory System provides oxygen and eliminates carbon dioxide
- The Skeletal System surrounds and protects lungs; movement of ribs important in breathing

The Digestive System

- The Digestive System provides nutrients, calcium, and phosphate
- The Skeletal System protects portions of liver, stomach, and intestines

The Urinary System

- The Urinary System conserves calcium and phosphate needed for skeletal system growth; disposal of waste products
- The Skeletal System provides protection for kidneys and ureters; pelvic girdle protects urinary bladder and proximal urethra

The Reproductive System

- The Reproductive System's hormones stimulate growth and maintenance of bones; sex hormones at puberty cause acceleration of growth and development of skeletal system (pelvis)
- The Skeletal System (pelvis) protects reproductive organs of females

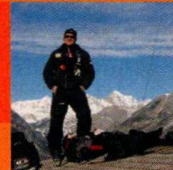
System in Perspective summaries appear at the end of each body system to help students quickly review that body system's structures, functions, and associated organs **in relationship to all other body systems.**

Chapter 6 The Skeletal System

Professional Profile

SPORTS TRAINER

Andy Walshe



“Anatomy and physiology is essential. It teaches you the parts of the engine you’re trying to improve, and it’s the foundation on which all sports disciplines are based.”

Andy Walshe is the high-performance

manager for the athletic program of the U.S. Ski and Snowboard Association. He works closely with over 150 athletes training to become Olympic champions. Andy supervises a staff of physiologists, nutritionists, dietitians, biomechanicists, and sports psychologists.

For trainers at this level, there is no such thing as a typical day. “This profession is full of variety. One day you may be running training camps, and the next you may be on the snow in South America shooting high-speed video for movement analysis.”

ELITE TRAINING

In addition to supervising the training team, Andy develops elite sports performance models—frameworks that allow a trainer to analyze athletes in relation to their sport to determine their strengths and weaknesses. His expertise is in biomechanical physiological analysis. This requires a strong background in anatomy and physiology. “You need to understand and analyze movement patterns, and you can’t do that without a good understanding of muscles and bones. And you need to understand energy systems as well, so the physiology element is very important.”

In fact, says Andy, for all of his staff, “Anatomy and physiology is essential. It teaches you the parts of the engine you’re trying to improve, and it’s the foundation on which all sports disciplines are based.”

Andy is one of a small group of elite-level trainers working with the best athletes in the world. Elite trainers bring to the job a combination of advanced academic work and practical experience. A master’s degree is required for this type of job.

Andy worked first as a volunteer assistant physiologist, traveling with teams in an unpaid position, and worked his

way up to his current job, which he’s had for seven years.

“I was always interested in sports and performance. I wanted to use my interests at the elite level. I actually started in summer sports—surfing—and then worked in snowboarding and then skiing.”

“To become a sports trainer, it’s a good idea to have as much practical training as possible in a variety of sports, working with athletes and coaches. Volunteer your time. Do what it takes to get your foot in the door.”

CAREER OPPORTUNITIES

Sports trainers can work at the junior level, college level, or elite level. There are jobs in the United States and chances to work in other countries. At the elite level, most entry-level jobs are unpaid internships, opportunities to learn while showing the trainers what you can do. Andy suggests, “Find out what organizations are associated with sports that interest you. The U.S. Olympic Committee has internship programs, and there are many organizations to investigate for each sport.”

Andy loves his job working in the world of elite sports, even though the pace is intense. “You live this job. You are on call all the time, doing anything and everything that involves preparing elite athletes. In a job like this, you’re a jack-of-all-trades. It’s important to be flexible and be willing to put parts of your life on hold. I travel over 200 days a year and I work 24/7.”

However, the rewards are great. “The athletes and the coaches are the best part of this job. It’s great being a part of the team that helps athletes chase their dreams. Along the way, you make great friends.”

And there’s a larger goal as well. “Our number one goal is to get more kids into the sport. Of course, we’re here to get our athletes medals, but the impact of those medals is that we get more kids involved in the sport.”

Professional Profiles give students insight into health-related careers that require an understanding of A&P. These enlightening interview-based vignettes appear at the end of each body system.

Clinical Note

Hip Fractures

Hip fractures most often occur in individuals over the age of 60, when osteoporosis has weakened the thighbones. These injuries may be accompanied by dislocation of the hip or by pelvic fractures. For individuals with osteoporosis, healing of such fractures proceeds very slowly. In addition, the powerful muscles that surround the joint can easily prevent proper alignment of the bone fragments. Trochanteric fractures usually heal well if the joint can be stabilized; steel frames, pins, screws, or some combination of these devices may be required to preserve alignment and permit normal healing.

Clinical Notes present engaging information on diseases and disorders to prepare students for future workplace situations.

The Big Picture

The autonomic nervous system operates largely outside of our conscious awareness. It has two divisions: a sympathetic division concerned with increasing alertness, metabolic rate, and muscular abilities, and a parasympathetic division concerned with reducing metabolic rate and promoting visceral activities such as digestion.

NEW! The Big Picture boxes succinctly organize core concepts at salient points in a chapter. They include the information all students should remember five years after their A&P course, regardless of their chosen career.

THE ANATOMY & PHYSIOLOGY PLACE WEBSITE



HOME FAQ TECH SUPPORT SYSTEM REQUIREMENTS AW-BC.COM CREDITS ACCOUNT SUMMARY

ESSENTIALS OF **anatomy & physiology** MARTINI / BARTHOLOMEW FIFTH EDITION

Chapter 1: GO Site Search: GO ?

[Home](#) > [Chapter Guide](#) > Etc.

Step 1 Take a Pre-Test

Step 2 Mini-Quizzes

- 1-1 Describe the basic functions of living organisms.
 - Mini-Quiz
- 1-2 Explain the relationship between anatomy and physiology, and describe various specialties of each discipline.
 - Activities
 - Mini-Quiz
- 1-3 Identify the major levels of organization in living organisms.
 - Activities
 - Mini-Quiz
- 1-4 Identify the 11 organ systems of the human body and the major components of each system.
 - Activities
 - Mini-Quiz
- 1-5 Explain the concept of homeostasis.
 - Mini-Quiz
- 1-6 Describe how negative feedback and positive feedback are involved in homeostatic regulation.
 - Mini-Quiz
- 1-7 Use anatomical terms to describe body sections, body regions, and relative positions.
 - Activities
 - Mini-Quiz
- 1-8 Identify the major body cavities and their subdivisions.

Step 3 Take the Post-Test

Welcome

- Learning Outcomes**
- Chapter Pre-Test**
- Chapter Mini-Quizzes**
- Chapter Post-Test**
- Animations & Tutorials**
- Study Tools**
- Professional Profiles**
- Instructor Resources**

The Anatomy & Physiology Place (www.anatomyandphysiology.com) is an open-access website with resources for both students and instructors. Chapter content is organized around each chapter's Learning Outcomes to keep students within an outcomes-based learning and assessment environment.

Learning Outcomes remind students of the chapter outcomes in their book and organize all chapter-specific assessments and media activities on one page.

Chapter Pre-Tests alert students to what they don't know and generate a Study Plan.

Chapter Mini-Quizzes allow students to check their understanding of each chapter section.

Chapter Post-Tests assess students' overall understanding of the chapter and include a timer feature.

Animations & Tutorials help students learn via labeling activities, visually-based tutorials, and simple animations.

Study Tools include Bone Review, Muscle Review, Histology Review, Case Studies, Flashcards, and a Glossary with Pronunciations.

Professional Profiles help students explore and visualize their future careers.

Instructor Resources include downloadable resources for instructors.

INSTRUCTOR'S RESOURCE DVDs/CD-ROM

The **Instructor's Resource DVDs/CD-ROM** organizes all instructor media resources by **chapter** into one convenient and easy-to-use package. **DVD 1** includes **chapter-specific material**. **DVD 2** includes **Additional Resources**. A **CD-ROM** includes the **Computerized Test Bank** (on the TestGen® platform) for all chapters. A **fold-out Quick Reference Guide** displays all media assets by chapter. Included on the disks:

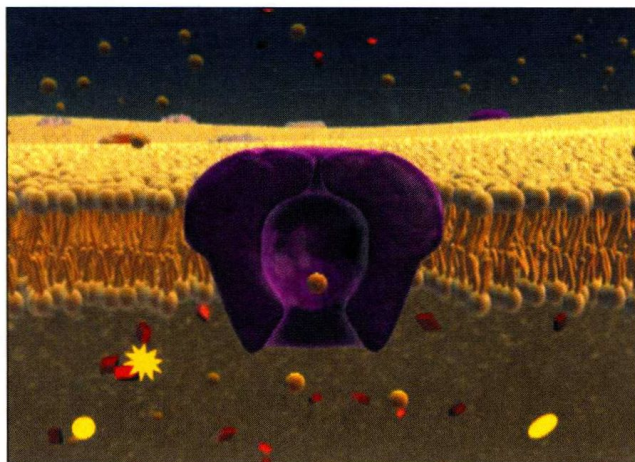
DVD 1: Chapter-Specific Material

- **All illustrations and photos from the textbook in labeled and unlabeled versions in JPEG format;** in many cases, the images from the textbook are followed by detailed breakout figures
- **All illustrations and photos from the textbook in customizable PowerPoint® format with the Label Edit function;** in many cases, the images from the textbook are followed by detailed breakout figures
- **All tables from the textbook**
- **The brand-new 3D movie-quality A&P Flix animations** organized by chapter. See detailed description under DVD 2: Additional Resources
- **Customizable PowerPoint lecture slides** that combine lecture notes, illustrations, photos, tables, and links to animations
- **Active Lecture Questions** (in PRS-enabled Clicker Question format) that stimulate effective classroom discussions and check comprehension
- **"Quiz Show" Chapter Review Questions** (in PRS-enabled Clicker Question format) that encourage student interaction
- **Lecture Outlines** in Microsoft® Word format
- **Test Bank** in Microsoft Word format

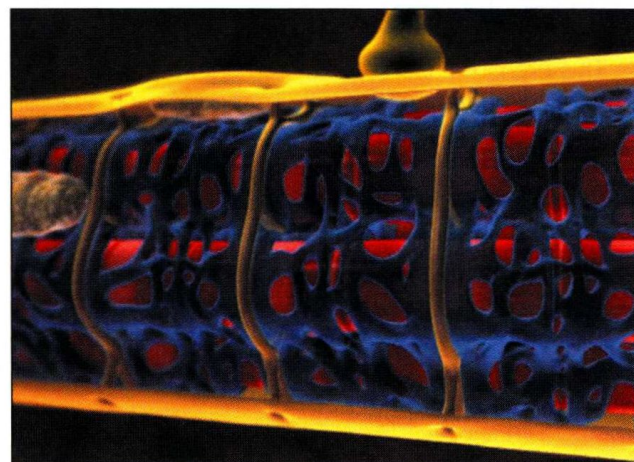
DVD 2: Additional Resources

- **The brand-new 3D movie-quality A&P Flix animations** accompanied by Quizzes in PRS-enabled Clicker Question format:
 - 3D physiology animations that focus on the toughest topics in physiology—including the cross-bridge cycle, excitation-contraction coupling of skeletal muscle, and generation of an action potential
 - 65+ 3D anatomy animations of origins, insertions, actions, and innervations of individual muscles
 - 50+ 3D anatomy animations of joint movements and actions of group muscles
- **More than 550 images from the Practice Anatomy Lab (PAL™) 2.0** media program
- *Interactive Physiology® (IP) Worksheets*
- All images from *Martini's Atlas of the Human Body*
- All images from *Martini's A&P Applications Manual*
- MRI/CT scans, histology slides, and muscle origins and insertions images

CD-ROM: The Computerized Test Bank



Images from the **new** A&P Flix



SUPPLEMENTS

• Instructor Supplements

Instructor's Resource DVDs/CD-ROM

978-0-321-57652-1 | 0-321-57652-7

This media tool organizes all instructor media resources by chapter into one convenient and easy-to-use package:

- **A DVD of all chapter-specific material**
- **A DVD of Additional Resources**
- **A CD-ROM of the Computerized Test Bank** (on the TestGen® platform) for all chapters
- **A fold-out Quick Reference Guide** that displays all media assets by chapter

Instructor's Manual

978-0-321-56977-6 | 0-321-56977-6

This guide makes it easy to **see content at a glance** in detailed lecture outlines for each chapter. **Unique analogies** and **useful teaching techniques** help instructors engage students and promote lively classroom discussion.

Printed Test Bank

978-0-321-57412-1 | 0-321-57412-5

The Test Bank has been **reorganized by Learning Outcomes** to correspond to the new chapter organization and to tie the Learning Outcomes into assessments. Each question has also been tagged with a **skill and difficulty rating**.

Transparency Acetates

978-0-321-57651-4 | 0-321-57651-9

More than 400 images from the text make up this outstanding transparency set. Figures and labels are enlarged for easy visibility. Complex figures are broken out for enlarged projected display.

Website and Course Management Programs

The Anatomy & Physiology Place Website

www.anatomyandphysiology.com

CourseCompass™

www.coursecompass.com

This premium course management system contains all of the website content plus premium media, such as Interactive Physiology® (IP) and the A&P Flix.

WebCT

www.pearsonhighered.com/webct

Blackboard

www.pearsonhighered.com/blackboard

These open-access course management systems contain preloaded content such as testing and assessment question pools.

• Student Supplements

Interactive Physiology® 10-System Suite (IP-10) with the new **Immune System** module comes packaged as a CD-ROM with the book. References to it appear in the Summary Outline in each chapter.

Practice Anatomy Lab (PAL™) 2.0 is an indispensable virtual anatomy practice tool that gives students 24/7 access to the most widely used lab specimens including **human cadaver, anatomical models, histology, cat, and fetal pig**. The PAL 2.0 CD-ROM can be added to the book package for no additional charge.

Get Ready for A&P, Second Edition

by Lori K. Garrett

This workbook saves classroom time and frustration by helping students quickly prepare for their A&P course. The hands-on workbook gets students up to speed with basic study skills, math skills, anatomical terminology, basic chemistry, cell biology, and other basics of the human body. Each topic area includes a pre-test, guided explanation, interactive quizzes and exercises, and end-of-chapter cumulative tests. The workbook can be added to the book package for no additional charge.

Martini Study Card: Body System Overview

978-0-321-53601-3 | 0-321-53601-0

The updated Study Card is a six-panel laminated card showing all body systems and their organs and functions.

Study Guide for Essentials of Anatomy & Physiology

by Charles M. Seiger

978-0-321-56980-6 | 0-321-56980-6

Designed to help students master the topics and concepts covered in the textbook, the Study Guide includes a variety of review questions, including labeling, multiple choice, concept mapping, and crossword puzzles. It is keyed to each chapter's Learning Outcomes and the three-level learning system in the textbook.