

LEARN **WHY** THIS MATTERS

NEW! Chapter-opening Why This Matters videos describe how the material applies to your future career. Scan the QR codes to see brief videos of real health care professionals discussing how they use the chapter content every day in the field.



SEE WHERE YOU

NEW! Key concept organization presents the material in manageable chunks and helps you easily navigate the chapter. Each section header states the key concept of that section.

5

The Integumentary System



Overview of Key Concepts

Key Concept section header

KEY CONCEPTS

- 5.1 The skin consists of two layers: the epidermis and dermis **134**
- 5.2 The epidermis is a keratinized stratified squamous epithelium **135**
- 5.3 The dermis consists of papillary and reticular layers **138**
- 5.4 Melanin, carotene, and hemoglobin determine skin color **140**
- 5.5 Hair consists of dead, keratinized cells **141**
- 5.6 Nails are scale-like modifications of the epidermis **144**
- 5.7 Sweat glands help control body temperature, and sebaceous glands secrete sebum **144**
- 5.8 First and foremost, the skin is a barrier **146**
- 5.9 Skin cancer and burns are major challenges to the body **148**

Would you be enticed by an ad for a coat that is waterproof, stretchable, washable, and air-conditioned, that automatically repairs small cuts, rips, and burns? How about one that's guaranteed to last a lifetime? Sounds too good to be true, but you already have such a coat—your skin.

The skin and its derivatives (sweat and oil glands, hairs, and nails) make up a complex set of organs that serves several functions, mostly protective. Together, these organs form the **integumentary system** (in-teg'ū-men'tar-e).

5.1 The skin consists of two layers: the epidermis and dermis

→ Learning Objective

- List the two layers of skin and briefly describe subcutaneous tissue.

The skin receives little respect from its inhabitants, but architecturally it is a marvel. It covers the entire body, has a surface area of 1.2 to 2.2 square meters, weighs 4 to 5 kilograms (4–5 kg = 9–11 lb), and accounts for about 7% of total body weight in the average adult. Also called the integument (“covering”), the skin multitasks. Its functions go well beyond serving as a bag for body contents. Pliable yet tough, it takes constant punishment from external agents. Without our skin, we would quickly fall prey to bacteria and perish from water and heat loss.

Varying in thickness from 1.5 to 4.0 millimeters (mm) or more in different parts of the body, the skin is composed of two distinct layers (**Figure 5.1**):

- The *epidermis* (ep'i-der'mis), composed of epithelial cells, is the outermost protective shield of the body (*epi* = upon).
- The underlying *dermis*, making up the bulk of the skin, is a tough, leathery layer composed mostly of dense connective tissue.

Only the dermis is vascularized. Nutrients reach the epidermis by diffusing through the tissue fluid from blood vessels in the dermis.

The variation in skin tone shown here is primarily due to varying concentrations of the pigment melanin.



ARE HEADED

Check Your Understanding questions end each section and allow you to assess your understanding of the concept before moving on.

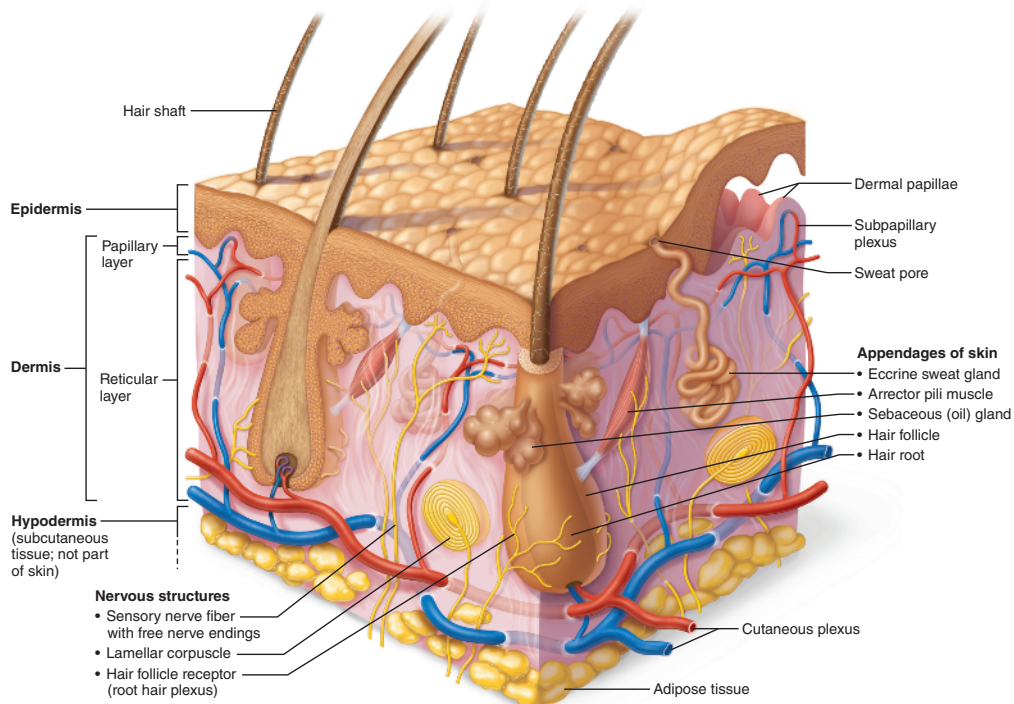


Figure 5.1 Skin structure. Three-dimensional view of the skin and underlying subcutaneous tissue. The epidermal and dermal layers have been pulled apart at the upper right corner to reveal the dermal papillae.

and accounts for about 7% of total body weight in the average adult. Also called the integument (“covering”), the skin multitasks. Its functions go well beyond serving as a bag for body contents. Pliable yet tough, it takes constant punishment from external agents. Without our skin, we would quickly fall prey to bacteria and perish from water and heat loss.

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Only the dermis is vascularized. Nutrients reach the epidermis by diffusing through the tissue fluid from blood vessels in the dermis.

The subcutaneous tissue just deep to the skin is known as the **hypodermis** (Figure 5.1). Strictly speaking, the hypodermis is not part of the skin, but it shares some of the skin’s protective functions. The hypodermis, also called **superficial fascia** because it is superficial to the tough connective tissue wrapping (fascia) of the skeletal muscles, consists mostly of adipose tissue.

Besides storing fat, the hypodermis anchors the skin to the underlying structures (mostly to muscles), but loosely enough that the skin can slide relatively freely over those structures. Sliding skin protects us by ensuring that many blows just glance off our bodies. Because of its fatty composition, the hypodermis also acts as a shock absorber and an insulator that reduces heat loss.

Check Your Understanding

1. Which layer of the skin—dermis or epidermis—is better nourished?

For answers, see *Answers Appendix*.

Check Your Understanding
self-assessment

TOOLS TO HELP YOU

NEW! Find study tools online with references to MasteringA&P® in the book. Visit **MasteringA&P** for self-study modules, interactive animations, virtual lab tools, and more!



[Practice art labeling](#)
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Figure 10.26 Summary: Actions of muscles of the thigh and leg.

NEW! Easily find clinical examples to help you see how A&P concepts apply to your future career. The clinical content—including the Homeostatic Imbalance sections, clinical content modules, and the chapter-ending At the Clinic Case Study—has a unified new look and feel.

12.9 Brain injuries and disorders have devastating consequences

CLINICAL

→ Learning Objectives

- Describe the cause (if known) and major signs and symptoms of cerebrovascular accidents, Alzheimer's disease, Parkinson's disease, and Huntington's disease.
- List and explain several techniques used to diagnose brain disorders.

Brain dysfunctions are unbelievably varied and extensive. We have mentioned some of them already, but here we will focus on traumatic brain injuries, cerebrovascular accidents, and degenerative brain disorders.



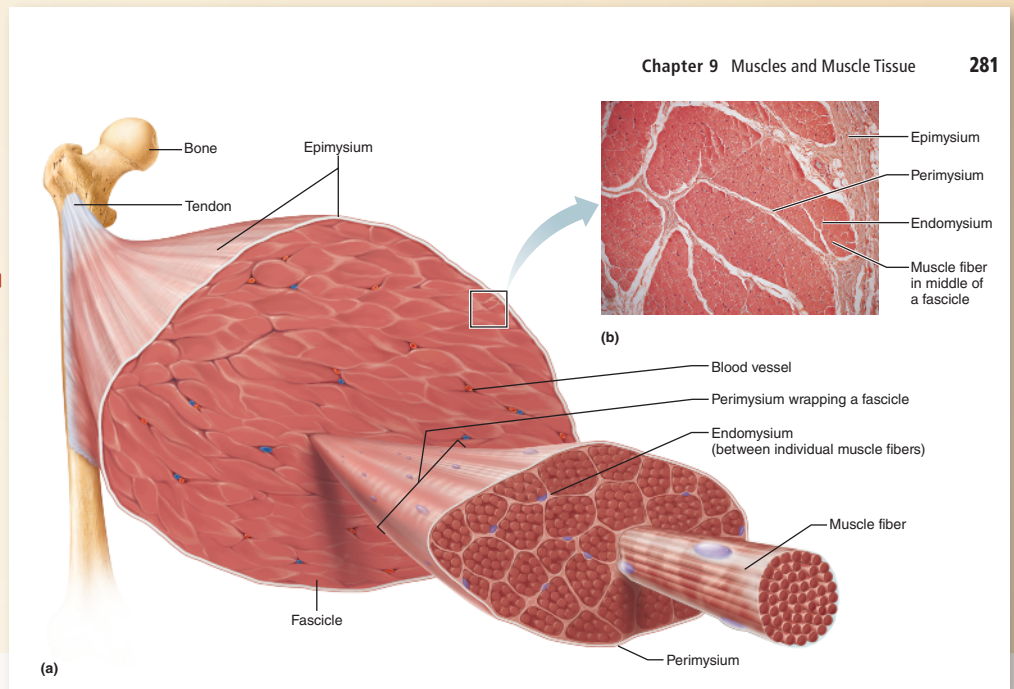
HOMEOSTATIC IMBALANCE 22.3

CLINICAL

Mumps, a common children's disease, is an inflammation of the parotid glands caused by the mumps virus (*myxovirus*), which spreads from person to person in saliva. If you check the location of the parotid glands in Figure 22.10a, you can understand why people with mumps complain that it hurts to open their mouth or chew. Other signs and symptoms include moderate fever and pain when swallowing acidic foods (pickles, grapefruit juice, etc.). Mumps in adult males carries a 25% risk of infecting the testes too, leading to sterility. + _____

ON YOUR JOURNEY

Stunning 3-D art with vibrant colors appears on every page to help you better visualize and understand key anatomical structures and their functions.



NEW! Making Connections questions in each chapter ask you to apply what you've learned across different body systems and chapters so that you build a cohesive understanding of the body.

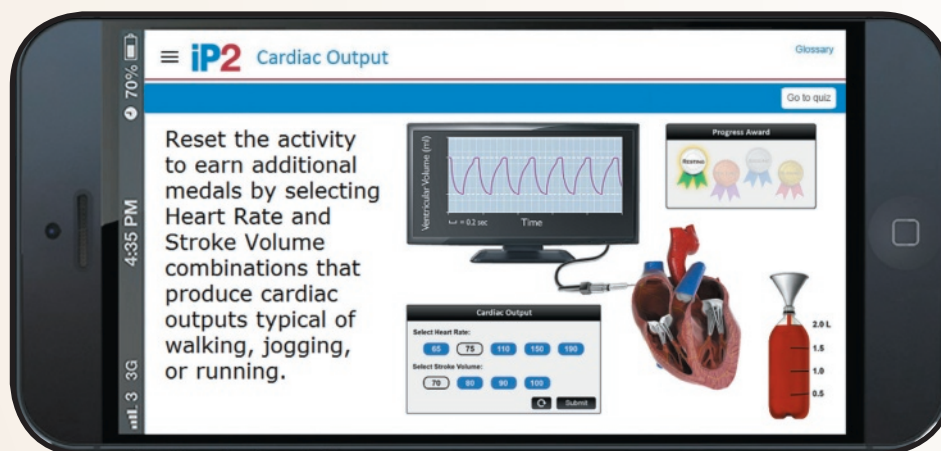
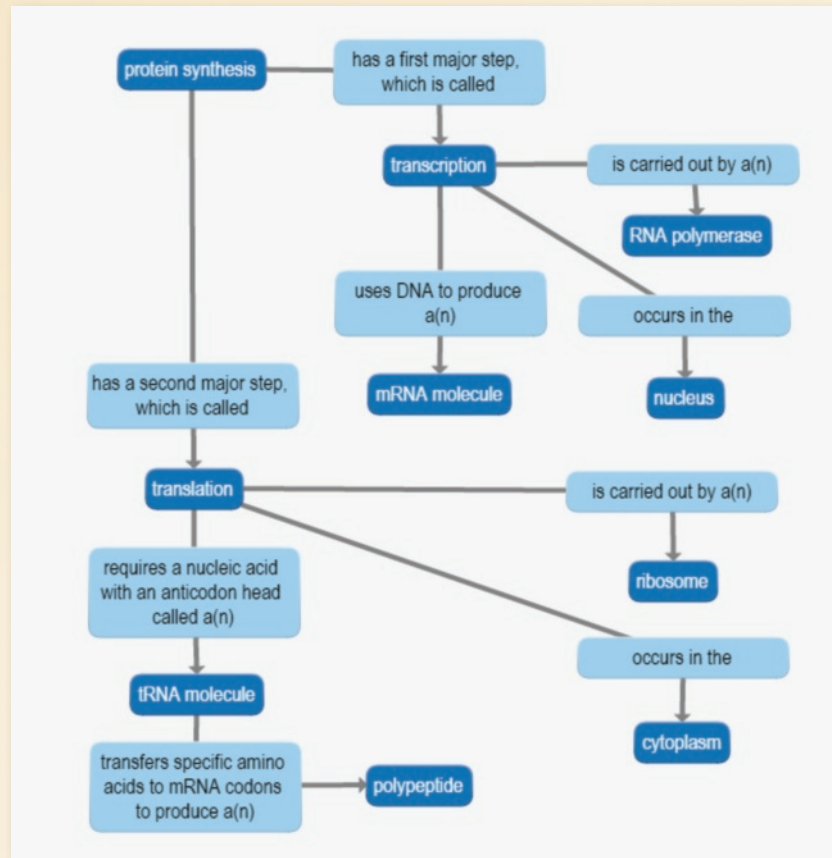
✓ Check Your Understanding

21. What chemicals produced in the skin help provide barriers to bacteria? List at least three and explain how the chemicals are protective.
22. Which epidermal cells play a role in body immunity?
23. How is sunlight important to bone health?
24. **MAKING connections** When blood vessels in the dermis constrict or dilate to help maintain body temperature, which type of muscle tissue that you learned about (in Chapter 4) acts as the effector that causes blood vessel dilation or constriction?

For answers, see Answers Appendix.

PRACTICE MAKES PERFECT

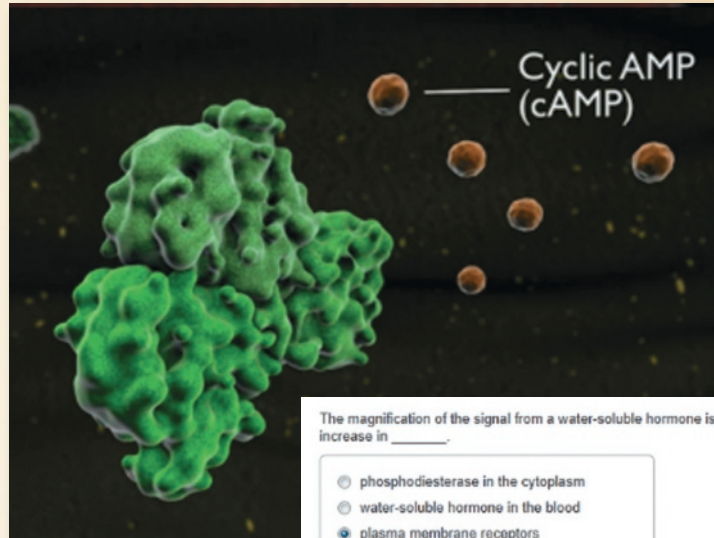
NEW! Concept Maps are fun and challenging activities that help you solidify your understanding of a key course concept. These fully mobile activities allow you to combine key terms with linking phrases into a free-form map for topics such as protein synthesis, events in an action potential, and excitation-contraction coupling.



NEW! Interactive Physiology® 1.0 and 2.0 help you understand the hardest part of A&P: physiology. Fun, interactive tutorials, games, and quizzes give you additional explanations to help you grasp difficult concepts. IP 2.0 includes topics that have been updated for today's technology, such as **Resting Membrane Potential, Cardiac Output, Electrical Activity of the Heart, Factors Affecting Blood Pressure, and Cardiac Cycle.**

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A&P Flix™ are 3-D movie-quality animations with self-paced tutorials and gradable quizzes that help you master the toughest topics in A&P.



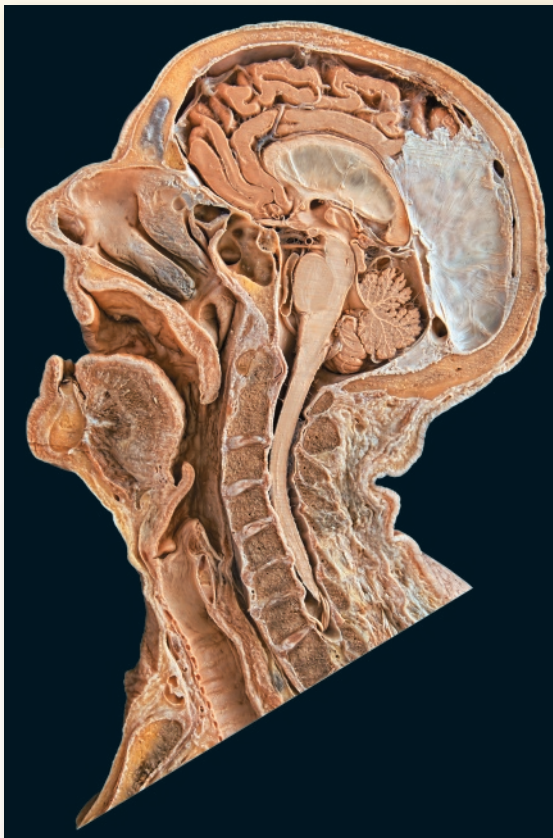
The magnification of the signal from a water-soluble hormone is achieved through an increase in _____.

- phosphodiesterase in the cytoplasm
- water-soluble hormone in the blood
- plasma membrane receptors
- adenylate cyclase in the plasma membrane
- cAMP in the cytoplasm

[Submit](#) [Hints](#) [My Answers](#) [Give Up](#) [Review Part](#)

Try Again

Magnification of the hormone signal involves the cells response to the hormone, not its sensitivity to the hormone.



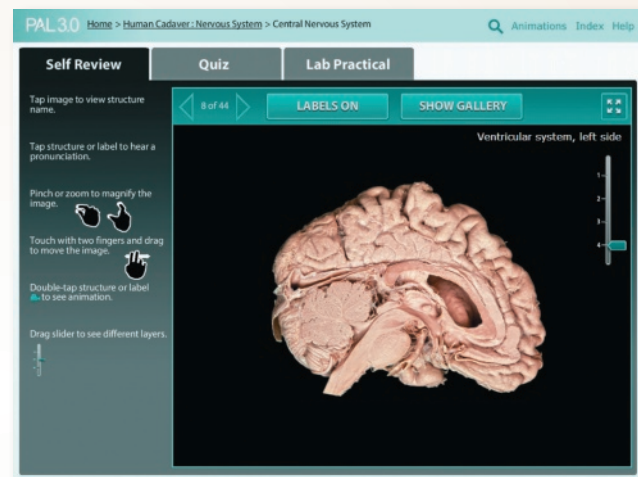
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STUDY ON THE GO WITH THESE MOBILE TOOLS

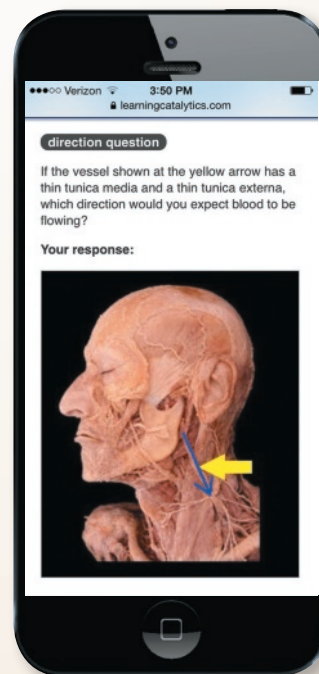
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The PAL 3.0 App lets you access PAL 3.0 on your iPad or Android tablet. Enlarge images, watch animations, and study for your lab practicals with multiple-choice and fill-in-the-blank quizzes—all while on the go!



Learning Catalytics is a “bring your own device” (laptop, smartphone, or tablet) engagement, assessment, and classroom intelligence system. Use your device to respond to open-ended questions, and then discuss your answers in groups based on responses.



Anatomy & Physiology

Sixth Edition

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About the Authors



We dedicate this work to our students both present and past, who always inspire us to “push the envelope.”

Elaine N. Marieb

For Elaine N. Marieb, taking the student’s perspective into account has always been an integral part of her teaching style. Dr. Marieb began her teaching career at Springfield College, where she taught anatomy and physiology to physical education majors. She then joined the faculty of the Biological Science Division of Holyoke Community College in 1969 after receiving her Ph.D. in zoology from the University of Massachusetts at Amherst. While teaching at Holyoke Community College, where many of her students were pursuing nursing degrees, she developed a desire to better understand the relationship between the scientific study of the human body and the clinical aspects of the nursing practice. To that end, while continuing to teach full time, Dr. Marieb pursued her nursing education, which culminated in a Master of Science degree with a clinical specialization in gerontology from the University of Massachusetts. It is this experience that has informed the development of the unique perspective and accessibility for which her publications are known.

Dr. Marieb has partnered with Benjamin Cummings for over 30 years. Her first work was *Human Anatomy & Physiology Laboratory Manual (Cat Version)*, which came out in 1981. In the years since, several other lab manual versions and study guides, as well as the softcover *Essentials of Human Anatomy & Physiology* textbook, have hit the campus bookstores. This textbook, now in its 10th edition, made its appearance in 1989 and is the latest expression of her commitment to the needs of students studying human anatomy and physiology.

Dr. Marieb has given generously to colleges both near and far to provide opportunities for students to further their education. She contributes to the New Directions, New Careers Program at Holyoke Community College by funding a staffed drop-in center and by providing several full-tuition scholarships each year for women who are returning to college after

a hiatus or attending college for the first time and who would be unable to continue their studies without financial support. She funds the E. N. Marieb Science Research Awards at Mount Holyoke College, which promotes research by undergraduate science majors, and has underwritten renovation and updating of one of the biology labs in Clapp Laboratory at that college. Dr. Marieb also contributes to the University of Massachusetts at Amherst where she generously provided funding for reconstruction and instrumentation of a cutting-edge cytology research laboratory. Recognizing the severe national shortage of nursing faculty, she underwrites the Nursing Scholars of the Future Grant Program at the university.

In 1994, Dr. Marieb received the Benefactor Award from the National Council for Resource Development, American Association of Community Colleges, which recognizes her ongoing sponsorship of student scholarships, faculty teaching awards, and other academic contributions to Holyoke Community College. In May 2000, the science building at Holyoke Community College was named in her honor.

Dr. Marieb is an active member of the Human Anatomy and Physiology Society (HAPS) and the American Association for the Advancement of Science (AAAS). Additionally, while actively engaged as an author, Dr. Marieb serves as a consultant for the Benjamin Cummings *Interactive Physiology*® CD-ROM series.

When not involved in academic pursuits, Dr. Marieb is a world traveler and has vowed to visit every country on this planet. Shorter term, she serves on the scholarship committee of the Women’s Resources Center and on the board of directors of several charitable institutions in Sarasota County. She is an enthusiastic supporter of the local arts and enjoys a competitive match of doubles tennis.



Katja Hoehn

Dr. Katja Hoehn is a professor in the Department of Biology at Mount Royal University in Calgary, Canada. Dr. Hoehn's first love is teaching. Her teaching excellence has been recognized by several awards during her 21 years at Mount Royal University. These include a PanCanadian Educational Technology Faculty Award (1999), a Teaching Excellence Award from the Students' Association of Mount Royal (2001), and the Mount Royal Distinguished Faculty Teaching Award (2004).

Dr. Hoehn received her M.D. (with Distinction) from the University of Saskatchewan, and her Ph.D. in Pharmacology from Dalhousie University. In 1991, the Dalhousie Medical Research Foundation presented her with the Max Forman (Jr.) Prize for excellence in medical research. During her Ph.D. and postdoctoral studies, she also pursued her passion for teaching by presenting guest lectures to first- and second-year medical students at Dalhousie University and at the University of Calgary.

Dr. Hoehn has been a contributor to several books and has written numerous research papers in Neuroscience and Pharmacology. She oversaw a recent revision of the Benjamin Cummings *Interactive Physiology*® CD-ROM series modules, and coauthored the newest module, *The Immune System*.

Following Dr. Marieb's example, Dr. Hoehn provides financial support for students in the form of a scholarship that she established in 2006 for nursing students at Mount Royal University.

Dr. Hoehn is also actively involved in the Human Anatomy and Physiology Society (HAPS) and is a member of the American Association of Anatomists. When not teaching, she likes to spend time outdoors with her husband and two sons, compete in triathlons, and play Irish flute.

Preface

As educators we continually make judgments about the enormous amount of information that besets us daily, so we can choose which morsels to pass on to our students. Yet even this refined information avalanche challenges the learning student's mind. What can we do to help students apply

the concepts they are faced with in our classrooms? We believe that this new edition of our textbook addresses that question by building on the strengths of previous editions while using new, innovative ways to help students visualize connections between various concepts.

Unifying Themes

Three unifying themes that have helped to organize and set the tone of this textbook continue to be valid and are retained in this edition. These themes are:

Interrelationships of body organ systems. This theme emphasizes the fact that nearly all regulatory mechanisms have interactions with several organ systems. The respiratory system, for example, cannot carry out its role of gas exchange in the body if there are problems with the cardiovascular system that prevent the normal delivery of blood throughout the body.

Homeostasis. Homeostasis is the normal and most desirable condition of the body. Its loss is always associated with past or present pathology. This theme is not included to emphasize pathological conditions but rather to illustrate what happens in the body when homeostasis is lost.



Whenever students see a red balance beam symbol accompanied by an associated clinical topic, their understanding of how the body works to stay in balance is reinforced.

Complementarity of structure and function. This theme encourages students to understand the structure of some bodily part (cell, bone, lung, etc.) in order to understand the function of that structure. For example, muscle cells can produce movement because they are contractile cells.

Changes Past and Present

Many of the changes made to the 5th edition have been retained and are reinforced in this 6th edition.

- There are more step-by-step blue texts accompanying certain pieces of art (blue text refers to the instructor's voice).
- The many clinical features of the book have been clearly identified to help students understand why this material is important.
- The "Check Your Understanding" questions at the end of each module reinforce understanding throughout the chapter.
- We have improved a number of our Focus Figures. (Focus Figures are illustrations that use a "big picture" layout and dramatic art to walk the student through difficult processes in a step-by-step way.)
- MasteringA&P continues to provide text-integrated media of many types to aid learning. These include *Interactive Physiology* (IP) tutorials that help students to grasp difficult concepts, *A&P Flix* animations that help students visualize tough A&P topics, and the PAL (Practice Anatomy Lab) collection of virtual anatomy study and practice tools focusing on the most widely used lab specimens. These are by no means all of the helpful tools to which students have access. It's just a smattering.

New to the Sixth Edition

So, besides these tools, what is really new to this textbook this time around? Each chapter's first page has a "Why This Matters" icon and QR code that links to a video of a health-care professional telling us why the chapter's content is important for his or her work.

Other new features include (1) declarative headers at the beginning of each chapter module so that the student can quickly grasp the "big idea" for that module, (2) more modularization (chunking) of the text so that students can tackle manageable pieces of information as they read through the material, (3) increased readability of the text as a result of more bulleted lists and shorter paragraphs, (4) more summary tables to help students connect information, (5) improvements to many of the figures so that they teach even more effectively, and (6) "Making Connections" questions in each chapter that ask students to incorporate related information from earlier chapters or earlier modules in the same chapter, helping students to see the forest, not just the trees, as they study.

Chapter-by-Chapter Changes

Chapter 1 The Human Body: An Orientation

- Updated Figure 1.8 for better teaching effectiveness.

Chapter 2 Chemistry Comes Alive

- Updated Figure 2.18 for better teaching effectiveness.

Chapter 3 Cells: The Living Units

- Updated statistics on Tay-Sachs disease.
- Updated information about riboswitches and added information about small interfering RNAs (siRNAs).
- Added summary text to Figure 3.3 for better pedagogy.
- Updated Focus Figure 3.4.

Chapter 4 Tissue: The Living Fabric

- New photos of simple columnar epithelium, pseudostratified ciliated columnar epithelium, cardiac muscle tissue, and smooth muscle tissue (Figures 4.3c, d and 4.9b, c).

Chapter 5 The Integumentary System

- Added information about the role of tight junctions in skin.
- New photo of stretch marks (Figure 5.5).
- New photo of cradle cap (seborrhea) in a newborn (Figure 5.9).
- New photo of malignant melanoma (Figure 5.10).

Chapter 6 Bones and Skeletal Tissues

- Revised Figure 6.9 for improved teaching effectiveness.
- New X rays showing Paget's disease and normal bone (Figure 6.16).

Chapter 7 The Skeleton

- Illustrated the skull bone table to facilitate student learning (Table 7.1).
- Added three new Check Your Understanding figure questions asking students to make anatomical identifications.
- New photos of humerus, radius, and ulna (Figures 7.28 and 7.29).

Chapter 8 Joints

- Updated statistics for osteoarthritis.
- Updated figure showing movements allowed by synovial joints (Figure 8.5).
- New photos of special body movements (Figure 8.6).

Chapter 9 Muscles and Muscle Tissue

- Updated Table 9.2 information on sizes of skeletal muscle fiber types in humans.

Chapter 10 The Muscular System

- New photos showing surface anatomy of muscles used in seven facial expressions (Figure 10.7).

Chapter 11 Fundamentals of the Nervous System and Nervous Tissue

- Added overview figure of nervous system (Figure 11.2).
- Improved Focus Figure 11.2 (*Action Potential*) for better student understanding.
- New image of a motor neuron based on a computerized 3-D reconstruction of serial sections.
- Converted Figure 11.17 to tabular head style to teach better.

Chapter 12 The Central Nervous System

- Updated mechanisms of Alzheimer's disease to include propagation of misfolded proteins.
- Updated information about gender differences in the brain.
- Streamlined discussion of sleep, memory, and stroke.
- New figure to show distribution of gray and white matter (Figure 12.3).
- Functional neuroimaging of the cerebral cortex (Figure 12.6).
- Improved reticular formation figure with "author's voice" blue text (Figure 12.18).
- New figure showing decreased brain activity in Alzheimer's (Figure 12.26).

Chapter 13 The Peripheral Nervous System and Reflex Activity

- Updated description of cytostructure of human cochlear hair cells (they have no kinocilia).
- New data on the number of different odors that humans can detect.
- Reorganized discussion of sound transmission to the inner ear. New numbered text improves text-art correlation.
- New figure teaches the function of the basilar membrane (Figure 13.26).
- New figure on how the hairs on the cochlear hair cells transduce sound (Figure 13.27).
- New figure shows the structure and function of the macula (Figure 13.28).
- Updated and expanded description of axon regeneration (in Figure 13.31).

Chapter 14 The Autonomic Nervous System

- Improved teaching effectiveness of Figure 14.3 (differences in the parasympathetic and sympathetic nervous systems).
- New summary table for autonomic ganglia (Table 14.2).

Chapter 15 The Endocrine System

- New information on actions of vitamin D and location of its receptors.
- New summary table showing differences between water-soluble and lipid-soluble hormones (Table 15.1).

- New summary flowchart shows the signs and symptoms of diabetes mellitus (Figure 15.19).

Chapter 16 Blood

- Improved teaching effectiveness of Figure 16.14 (intrinsic and extrinsic clotting factors).

Chapter 17 The Cardiovascular System: The Heart

- Rearranged topics in this chapter for better flow.
- New section and summary table (Table 17.1) teach key differences between skeletal muscle and cardiac muscle.
- New Making Connections figure question (students compare three action potentials).
- Rearranged material so that all electrical events are presented in one module.
- Added tabular headers, a photo, and bullets to more effectively teach ECG abnormalities (Figure 17.18).
- Streamlined figure showing effects of norepinephrine on heart contractility (Figure 17.22).

Chapter 18 The Cardiovascular System: Blood Vessels

- New information about pericytes (now known to be stem cells and generators of scar tissue in the CNS).
- New information that the fenestrations in fenestrated capillaries are dynamic structures.
- Rearranged topics in the physiology section of this chapter for better flow.
- New micrograph of artery and vein (Figure 18.2).
- Revised Figure 18.3 (the structure of different types of capillaries), putting all of the information in one place.
- New figure summarizes the major factors determining mean arterial pressure to give a “big picture” view (Figure 18.9).
- New figure illustrating active hyperemia (Figure 18.15).
- Updated Focus Figure 18.1 (*Bulk Flow across Capillary Walls*).
- New Homeostatic Imbalance feature on edema relates it directly to the preceding Focus Figure 18.1 and incorporates information previously found in Chapter 25.
- New photos of pitting edema (Figure 18.18).

Chapter 19 The Lymphatic System and Lymphoid Organs and Tissues

- Updated statistics on survival of non-Hodgkin’s lymphoma patients.
- Updated figure to improve teaching of primary and secondary lymphoid organs (Figure 19.4).

Chapter 20 The Immune System: Innate and Adaptive Body Defenses

- Updated information on aging and the immune system, particularly with respect to chronic inflammation.
- Added a new term, pattern recognition receptors, to help describe how our innate defenses recognize pathogens.
- Provided new research results updating the number of genes in the human genome to about 20,000.

Chapter 21 The Respiratory System

- New Check Your Understanding question with graphs reinforces concepts learned in Focus Figure 21.1 (*The Oxygen-Hemoglobin Dissociation Curve*).
- New figure illustrating pneumothorax (Figure 21.14).

Chapter 22 The Digestive System

- Updated information about the treatment of peptic ulcers.
- Updated information about the types and locations of epithelial cells of the small intestine.
- New information about roles of our intestinal flora.
- Updated hepatitis C treatment to include the new FDA-approved drug sofosbuvir.
- Added discussion of non-alcoholic fatty liver disease.
- New information about fecal transplants to treat antibiotic-associated diarrhea.
- Updated figure that compares and contrasts peristalsis and segmentation (Figure 22.3) for improved teaching effectiveness.
- Updated Figure 22.4 explaining the relationship between the peritoneum and the abdominal organs to improve teaching effectiveness.
- Enteric nervous system section rewritten and rearranged with new figure (Figure 22.6).
- Improved teaching effectiveness of Figure 22.14 (the steps of deglutition).
- Streamlined Figure 22.19 to enhance teaching of regulation of gastric secretion.
- Updated Figure 22.20 (the mechanism of HCl secretion by parietal cells) for improved teaching effectiveness.
- Improved the text flow by moving discussion of the liver, gallbladder, and pancreas before the small intestine.
- Improved teaching effectiveness of Figure 22.28 (mechanism promoting secretion and release of bile and pancreatic juice).
- Updated and revised sections about motility of the small and large intestines.
- Rearranged text to discuss digestion and absorption together for each nutrient. The figures for digestion and absorption of carbohydrates (Figure 22.35) and proteins (Figure 22.36) now parallel each other and appear together for easy comparison.
- Rearranged and rewrote lipid digestion and absorption text and updated Figure 22.37.

Chapter 23 Nutrition, Metabolism, and Energy Balance

- Chapter title changed from Nutrition, Metabolism, and Body Temperature Regulation in order to emphasize the concept of energy balance.
- Updated shape and mechanism of action of ATP synthase to reflect new research findings.
- Updated hypothalamic control of food intake per new research findings.
- Revised Figure 23.4 to enhance the ability of students to compare and contrast the mechanisms of phosphorylation that convert ADP to ATP.
- Revised figure describing ATP synthase structure and function (Figure 23.10).
- Revised Figure 23.13 to help students compare and contrast glycogenesis and glycogenolysis (Figure 23.12).
- Three new figures help students grasp the terms for key pathways in carbohydrate, protein, and fat metabolism (Figures 23.12, 23.14, and 23.18).

Chapter 24 The Urinary System

- New cadaver photo of urinary tract organs (Figure 24.2).
- New Check Your Understanding question for nephron labeling.
- Improved Focus Figure 24.1 (*Medullary Osmotic Gradient*) for better teaching effectiveness.
- Added new illustrations to improve teaching effectiveness of Figure 24.19 (the effects of ADH on the nephron).

Chapter 25 Fluid, Electrolyte, and Acid-Base Balance

- New Check Your Understanding figure question requires students to integrate information.

Chapter 26 The Reproductive System

- Updated screening recommendations for prostate cancer, as well as updated information on detection and treatment.

- Updated screening guidelines for cervical cancer.
- Updated breast cancer statistics.
- New Check Your Understanding figure labeling question.
- New figure teaches independent assortment (Figure 26.8).
- New photo of female pelvic organs (Figure 26.15c).
- New photos of mammograms showing normal and cancerous breast tissues (Figure 26.19).
- Revised Figure 26.23 to reflect recent research about follicular development in humans.
- Revised section describing the stages of follicle development to facilitate student learning and to incorporate recent research.

Appendices

- Added a table of the genetic code (Appendix B).

Acknowledgments

Each time we put this textbook to bed, we promise ourselves that the next time will be easier and will require less of our time. Now hear this! This is its 6th edition (and 30 years more or less) and fulfillment of this promise has yet to materialize. How could there be so much going on in physiology research and so many new medical findings? Wining through these findings to decide on the updates to include in this edition has demanded much of our attention. Many people at Pearson have labored with us to produce another fine text. Let's see if we can properly thank them.

As Katja and I worked on the first draft of the manuscript, Tanya Martin (our text Development Editor) worked tirelessly to improve the readability of the text, all the while trying to determine which topics could be shortened or even deleted in the 6th edition. After we had perused and acted on some of Tanya's suggestions, we forwarded the manuscript to Michele Mangelli who oversees everything having to do with getting a clean manuscript to production. Michele reviewed the entire revised manuscript. Nothing escaped her attention as she worked to catch every problem.

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Kudos to our entire team. We feel we have once again prepared a superb textbook. We hope you agree.

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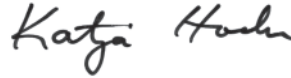
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