

HUMAN BIOLOGY

SYLVIA S. MADEIRA

dition



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HUMAN BIOLOGY

Eighth Edition

SYLVIA S. MADER

For My Family

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Higher Education

HUMAN BIOLOGY, EIGHTH EDITION

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International 1 2 3 4 5 6 7 8 9 0 QPD/QPD 0 9 8 7 6 5 4 3
Domestic 1 2 3 4 5 6 7 8 9 0 QPD/QPD 0 9 8 7 6 5 4 3

ISBN 0-07-234732-5

ISBN 0-07-121486-0 (ISE)

Publisher: *Martin J. Lange*

Senior sponsoring editor: *Patrick E. Reidy*

Developmental editor: *Margaret B. Horn*

Director of development: *Kristine Tibbetts*

Marketing manager: *Tamara Maury*

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Cover/interior designer: *Nathan Bahls*

Cover images: Large image from *Photodisc*, smaller images from *Corbis* and *Photodisc*

Senior photo research coordinator: *Lori Hancock*

Photo research: *Connie Mueller*

Supplement producer: *Brenda A. Ernzen*

Compositor: *The GTS Companies*

Typeface: *10/12 Palatino*

Printer: *Quebecor World Dubuque, IA*

The credits section for this book begins on page C-1 and is considered an extension of the copyright page.

Library of Congress Cataloging-in-Publication Data

Mader, Sylvia S.

Human biology / Sylvia S. Mader. — 8th ed.

p. cm.

Includes bibliographical references and index.

ISBN 0-07-234732-5

1. Human biology. I. Title.

QP36.M2 2004

612—dc21

2003004741

CIP

INTERNATIONAL EDITION ISBN 0-07-121486-0

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Preface

Human Biology introduces students to the anatomy and physiology of the human body. All systems of the body are represented, and each system has its own chapter. The text also helps students understand that humans are a part of the biosphere and that human activities can have environmental consequences.

This eighth edition is particularly exciting because two new chapters have been added and the sequence of chapters has been reorganized. Chapter 21, "Parasites and Pathogens," considers selected human diseases. I was prompted to add this chapter now that emerging diseases, antibiotic resistance, and pathogens as weapons have become topics of increasing human concern. Only through knowledge can students know how to protect themselves. Chapter 26, "Population, Resources, and Pollution," emphasizes that human population size and resource consumption go hand in hand with pollution. Students need a global perspective of environmental problems, especially since the countries of the world now convene regularly to try to solve these problems.

The Birth of Human Biology

When I was teaching general biology, it became apparent to me that students were very interested in how their bodies worked, how to keep them healthy, and how they can occasionally malfunction. Students also found environmental concepts intriguing. I decided it would be possible to write a text and develop a course for nonmajors that built on these interests while teaching biological concepts and how scientists think and carry out research.

The application of biological principles to practical human concerns is now widely accepted as a beneficial approach to the study of biology. Students should leave college with a firm grasp of how their bodies normally function and how the human population can become more fully integrated into the biosphere. We are frequently called upon to make health and environmental decisions. Wise decisions require adequate knowledge and can help ensure our continued survival as individuals and as a species.

In this edition, as in previous editions, each chapter presents concepts clearly, simply, and distinctly so that students will feel capable of achieving an adult level of understanding. Detailed, high-level scientific data and terminology are not included because I believe that true knowledge consists of having a working understanding of concepts rather than technical facility.

Pedagogical Features

Human Biology excels in pedagogical features. Each part opens by highlighting the central ideas of the chapters within that part and telling the reader how the topics contribute to biological understanding.

Each chapter begins with an integrated outline that numbers the chapter's sections and, new to this edition, utilizes questions rather than statements to introduce concepts. The questions are meant to stimulate student interest in finding the answers within the chapter. The Online Learning Center supplies the answers if students are having difficulty. Each chapter also features an opening vignette that tells a human interest story designed to intrigue students so that they want to learn more.

The numbering system in the chapter outline is continued in the chapter itself and in the summary so that instructors can assign only certain portions of a chapter if they wish. As you may know, my staff and I page the book before it goes to the publisher. We make sure that each new section starts at the top of a page and that each illustration is on the same page as its reference or on the facing page. Therefore, a student never needs to turn the page to find an illustration!

Questions at the end of the chapters are of both the essay and objective type:

- **Studying the Concepts** reviews the content of the chapter and requires students to write out their answers.
- **Testing Your Knowledge of the Concepts** includes only objective questions, and their number has been substantially increased.
- **Understanding Key Terms** lists the boldfaced terms in the chapter and gives the page number where each term is defined. Following the list is a matching exercise that allows students to test their understanding of the terms.

Illustrations

The illustrations are not only visually motivating but also have many other features that students will find helpful. Students who are visual learners will particularly appreciate the care with which each illustration has been developed and executed. Color coordination includes assigning colors to the various classes of organic molecules and to the different human tissues and organs.

Visual Focus illustrations provide a conceptual overview that relates structure to function. Step-by-step descriptions take a concept that could be difficult to understand and turn it into one that students can readily grasp. For example, in Figure 12.5, boxed statements explain synapse structure and function, from the complete neuron to an enlargement of a receptor for a neurotransmitter. As with many other illustrations, a micrograph is included. In this case, the micrograph illustrates that many axons communicate with a cell body.

This edition increasingly uses icons, small drawings that help students see how a particular structure is part of a bigger one. For example, the icon of an eye reminds students of the overall location of the retina as its structure is discussed in detail.

New Parts and Chapters

As mentioned, the sequence of chapters has been reorganized. Part VII, "Human Disease," is a new part that brings together chapters formerly widely separated and also includes one of the new chapters. This part begins with Chapter 20, "Defenses Against Disease," which now concentrates solely on immunity. The new chapter, entitled "Parasites and Pathogens," occurs next, and is followed by Chapter 22, "Sexually Transmitted Diseases," which now includes the information that was formerly in the AIDS supplement. Concluding Part VII is an updated Chapter 23, "Cancer."

Part VIII, "Human Evolution and Ecology," has been expanded with the addition of Chapter 26, "Population, Resources, and Pollution," a new chapter that considers these topics from a global perspective. This chapter discusses five resources—land, water, food, energy, and minerals—and of utmost interest, includes a forecasting of the hydrogen-solar revolution. Chapter 25, "Global Ecology," explains the fundamentals of ecology with the entire biosphere in mind, while Chapter 27, "Saving the World's Biodiversity," concentrates on how we can preserve other species of the world and why we should.

Bioethical Issues

As in the previous edition, students are asked to apply the biological concepts to the many and varied perplexing bioethical issues facing society every day. A multistep process that involves the Online Learning Center is designed to help them develop a strategy for thinking through issues and coming to a decision after studying conflicting opinions. First, each issue is featured in a Bioethical Focus text box, which presents both sides of an issue and asks a series of thoughtful questions that can serve as the basis for class discussion. Then students are directed to the Online Learning Center where more information is available on

such topics as genetic disease testing, modern reproductive technologies, human cloning, AIDS vaccine trials, animal rights, and fetal research. There, students have the opportunity to carry out the following activities:

Taking Sides. Students answer a series of questions, and their answers are tallied so that their original positions are revealed.

Further Debate. Students are directed to read articles on both sides of the issue.

Explain Your Position. Students are asked to defend their positions in writing. They can e-mail their essays to their professor.

Applications

The human applications featured in *Human Biology* are many and varied. Some topics are integrated into the running text, and others are discussed more fully in boxed readings of two types: Health Focus and Ecology Focus. Throughout the text, the focus readings carry the two themes of preserving our bodies and preserving the biosphere.

Among the applications are such topics as eating disorders, allergies, pulmonary disorders, hepatitis infections, modern reproductive technologies, the Human Genome Project, and gene therapy. Other topics, such as the cloning of humans and xenotransplantation, are also included. Of particular interest to students will be two Health Focus boxes new to this edition: "Living with Klinefelter Syndrome" and "New Cures on the Horizon"; the latter pertains to the benefits of the Human Genome Project.

Homeostasis

This edition of *Human Biology* again places an emphasis on homeostasis. The revised Chapter 4, entitled "Organization and Regulation of Body Systems," discusses the principles of homeostasis and the contributions of the various systems to keeping the internal environment relatively constant. Well-designed illustrations, especially in Chapter 14, "The Endocrine System," show how negative feedback control is essential to homeostasis. In each systems chapter, a Human Systems Work Together feature describes how the particular organ system being discussed works with other systems to achieve homeostasis.

Technology

Many resources are available to help students understand the content of this textbook. In addition to the end-of-chapter questions and a printed study guide, the Online

Learning Center at www.mhhe.com/maderhuman8 contains readings, quizzes, animations, and other activities to help students master the concepts. As with the previous edition, text material and technology complement one another.

For example, Bioethical Focus and Human Systems Work Together features have an associated online exercise that helps students make better use of these stimulating features.

Overview of Changes to *Human Biology* Eighth Edition

New Parts and Chapters

The sequence of chapters has been reorganized, and a new part and two new chapters have been added. Part VII "Human Disease" is a new part and includes a new chapter, "Parasites and Pathogens." Part VIII "Human Evolution and Ecology" includes the new chapter "Population, Resources, and Pollution."

Chapter Opening Page

The chapter outline now contains questions listed according to the major sections instead of statements. The questions are designed to start students thinking about and learning concepts.

Illustrations

Many new illustrations have been added. Visual Focus pieces that cover a process from start to finish with boxed explanations have been revised.

Bioethical Focus

As before, most chapters include a bioethical issue, which is also discussed in the Online Learning Center. New to this edition are issues entitled Cloning of Humans, Stopping the Spread of Emerging Diseases, and Oil Drilling in the Arctic Wildlife Refuge.

e-Learning Connection

Online study aids are organized in a new format according to major sections of a chapter on the Online Learning Center. Students can easily determine what resources are available for help with difficult concepts. Visit www.mhhe.com/maderhuman8

Testing Your Knowledge of the Concepts

Each chapter now contains 25–40 mainly multiple choice questions to better prepare students for exams.

LEARNING SUPPLEMENTS FOR THE STUDENT

Student Study Guide

To ensure close coordination with the text, Dr. Sylvia Mader has written the *Student Study Guide* that accompanies the text. Each text chapter has a corresponding study guide chapter that includes a listing of objectives, study questions, and a chapter test. Answers to the study questions and the chapter tests are provided to give students immediate feedback.

The concepts in the study guide are the same as those in the text, and the questions in the study guide are sequenced according to those concepts. Instructors who make their choice of concepts known to the students can thereby direct student learning in an efficient manner. Students who make use of the *Student Study Guide* should find that performance increases dramatically. ISBN 0-07-234733-3

Online Learning Center

The *Human Biology* Online Learning Center (OLC) at www.mhhe.com/maderhuman8 offers access to a vast array of premium online content to fortify the learning and teaching experience for students and instructors.

Student Edition. The Student Edition of the OLC features a wide variety of tools to help students learn biological concepts and to reinforce their knowledge:

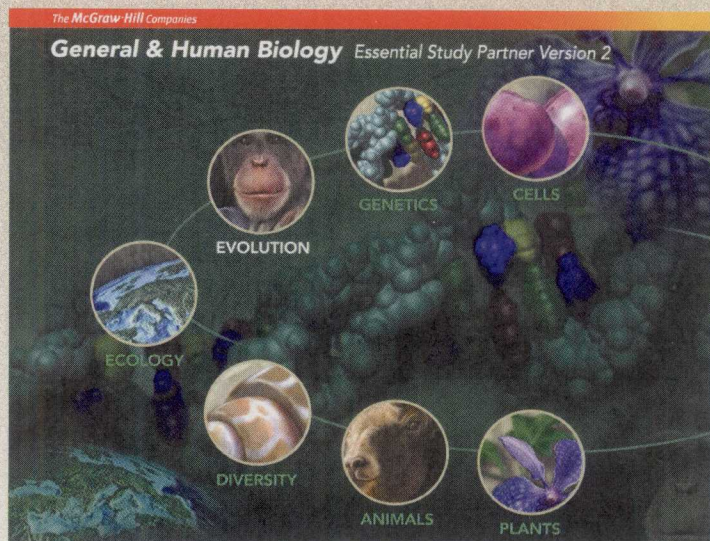
Online Tutoring This tutorial service is moderated by qualified instructors. Help with difficult concepts is only an e-mail away!

e-Learning Connection Online study aids are organized according to the major sections of each chapter. Practice quizzes, interactive activities, animations, labeling exercises, flashcards, and much more will complement the learning and understanding of human biology.

e-Learning Connection		
Concepts	Questions	Media Resources
4.1 Types of Tissues <ul style="list-style-type: none"> Animal tissues can be categorized into four major types: epithelial, connective, muscular, and nervous tissues. Epithelial tissues line body cavities and cover surfaces. Connective tissues protect, support, and bind other tissues. Muscular tissues make body parts move. Nervous tissues coordinate the activities of the other tissues and body parts. 	<ol style="list-style-type: none"> What are the four major tissue types found in the human body? How is epithelial tissue classified? Where do you find epithelial tissues, and what are their functions? What tissue type binds and supports other body tissues? What are some examples of this type of tissue? Which type of tissue is responsible for body movements? What are some examples of this type of tissue? Which tissue type coordinates the activities of the other tissue types in the body? 	Essential Study Partner <ul style="list-style-type: none"> Epithelial Tissue Connective Tissue Muscle Tissue Nervous Tissue Histology Quiz
4.2 Body Cavities and Body Membranes <ul style="list-style-type: none"> The internal organs occur within cavities lined by membranes that also cover the organs themselves. 	<ol style="list-style-type: none"> What are the two major body cavities? What two cavities are in each of these? What are the four types of body membranes? 	Art Labeling Activity <ul style="list-style-type: none"> Mammalian Body Cavities
4.3 Organ Systems <ul style="list-style-type: none"> Organs are grouped into organ systems, each of which has specialized functions. 	<ol style="list-style-type: none"> What is the overall function of each of the body systems? What is the integumentary system? 	Art Labeling Activity <ul style="list-style-type: none"> Human Skin Anatomy I Human Skin Anatomy II Human Skin Anatomy III

AccessScience is the online version of McGraw-Hill's Encyclopedia of Science & Technology. Link to this site free of charge from the Online Learning Center.

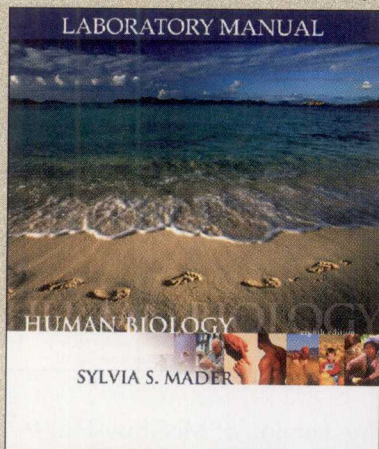
Essential Study Partner This collection of interactive study modules contains hundreds of animations, learning activities, and quizzes designed to help students grasp complex concepts.



TEACHING SUPPLEMENTS FOR THE INSTRUCTOR

McGraw-Hill offers a variety of tools and technology products to support the eighth edition of *Human Biology*. Instructors can obtain teaching aids by calling the Customer Service Department at (800) 338-3987 or by contacting their local McGraw-Hill sales representative.

Human Biology Laboratory Manual

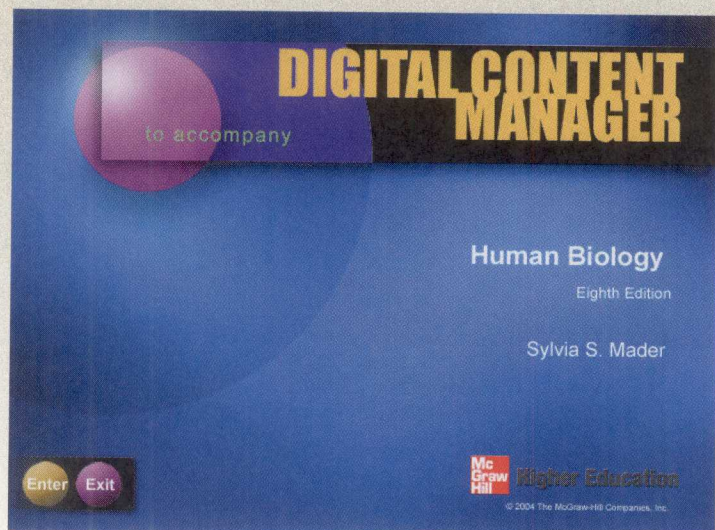


The *Human Biology Laboratory Manual*, eighth edition, is written by Dr. Sylvia Mader. With few exceptions, each chapter in the text has an accompanying laboratory exercise in the manual. Every laboratory has been written to help students learn the fundamental concepts of human biology and the specific content of the chapter to

which the lab relates, as well as gain a better understanding of the scientific method. ISBN 0-07-242100-2

Digital Content Manager

This collection of multimedia resources provides tools for rich visual support of your lectures. You can utilize artwork from the text in multiple formats to create customized classroom presentations, visually based tests and quizzes, dynamic course website content, or attractive printed support materials. The digital assets on this cross-platform CD-ROM are grouped within the following easy-to-use folders:



Active Art Library Illustrations depicting key processes have been converted to a format that allows each figure to be broken down to its core elements, thereby allowing the instructor to manipulate the art and adapt the figure to meet the needs of the lecture environment.

Animations Library Harness the visual impact of key physiological processes in motion by importing these full-color animations into classroom presentations or course websites.

Art Libraries Full-color digital files of all illustrations in the book, plus the same art saved in unlabeled and gray scale version, can be readily incorporated into lecture presentations, exams, or custom-made classroom materials.

Tables Library Every table that appears in the text is provided in electronic format.

Photos Libraries All photos from the text are available on this CD-ROM. A separate folder contains hundreds of additional photos relative to the study of human biology.

PowerPoint Lecture Outlines A ready-made presentation that combines lecture notes and art is written for each chapter. They can be used as they are, or the instructor can tailor them to preferred lecture topics and sequences.

PowerPoint Art Slides Art, photographs, and tables from each chapter have been pre-inserted into blank PowerPoint slides.

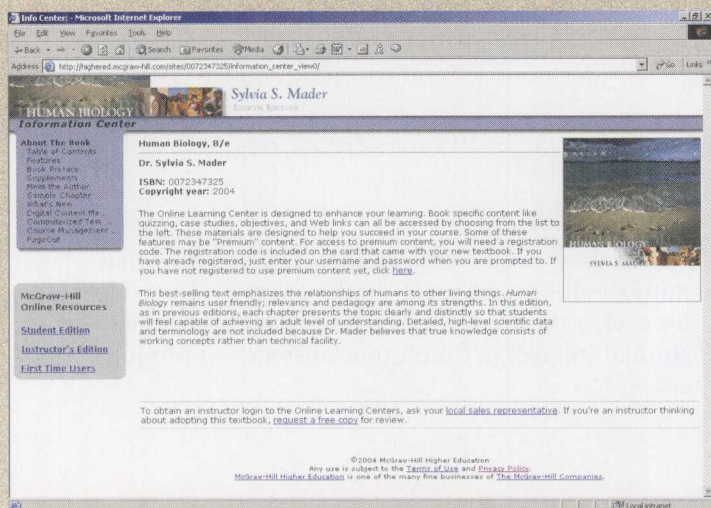
Instructor's Testing and Resource CD-ROM

This cross-platform CD-ROM provides a wealth of resources for the instructor:

Computerized Test Bank utilizes Brownstone Diploma[®] testing software to quickly create customized exams. This user-friendly program allows instructors to search for questions by topic or format; edit existing questions or add new ones; and scramble questions and answer keys for multiple versions of the same test. Word files of the test bank are included for those instructors who prefer to work outside of the test-generator software.

Instructor's Manual provides behavioral objectives, extended lecture outlines, and student activities. In addition, there is an explanation of text changes and reorganization as well as information on new and revised illustrations and tables.

Online Learning Center



The *Human Biology* Online Learning Center (OLC) at www.mhhe.com/maderhuman8 offers access to a vast array of premium online content to fortify the learning and teaching experience for students and instructors.

Instructor Edition. In addition to all of the resources for students, the Instructor Edition of the Online Learning Center has these assets:

- **Laboratory Resource Guide** A preparation guide that provides set-up instructions, sources for materials and supplies, time estimates, special requirements, and suggested answers to all questions in the laboratory manual.
- **PageOut** McGraw-Hill's exclusive tool for creating your own website for your general biology course. It requires no knowledge of coding and is hosted by McGraw-Hill.
- **Course Management System** OLC content is readily compatible with online course management software such as WebCT and Blackboard. Contact your local McGraw-Hill sales representative for details.

Transparencies

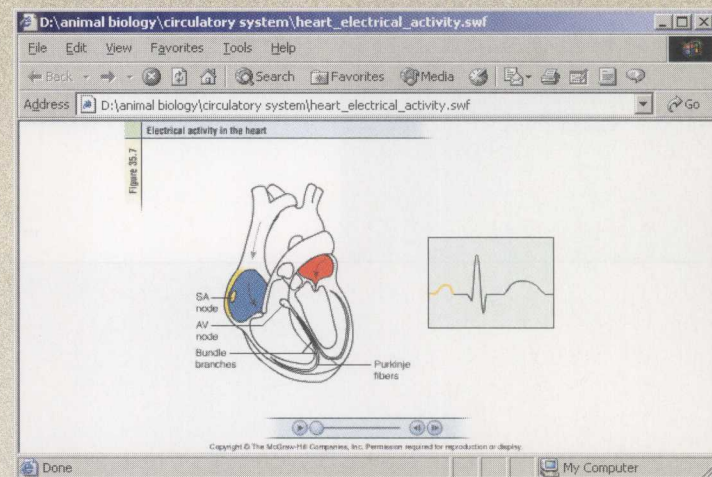
This set of overhead transparencies includes all line art in the textbook plus tables. Images are printed with better visibility and contrast than ever before, and labels are large and bold for clear projection.

Mader Micrograph Slides

This set contains one hundred 35mm slides of many of the photomicrographs and electron micrographs in the text. ISBN 0-07-239977-5

Life Science Animations Library 3.0 CD-ROM

This CD-ROM contains over 600 full-color animations of biological concepts and processes. Harness the visual impact of processes in motion by importing these files into classroom presentations or online course materials. ISBN 0-07-248438-1



Chapter 7

Cardiovascular System

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Figure 7.1 Heart transplant operation.

Will it be safe one day to use pigs' hearts for human transplant operations? Pigs have been genetically engineered to be immunocompatible with humans, but there is the possibility of acquiring a virus unique to pigs.

Dolores Manning, a 50-year-old mother of six, had congestive heart failure. Her heart was unable to beat effectively; blood was backing up in blood vessels, and fluids were collecting in her lungs. She might suffocate. A diuretic helped rid her body of excess fluid, but she was still sick. Dolores needed a heart transplant (Fig. 7.1). Doctors didn't know when a heart might become available, so in the meantime they gave Dolores an LVAD (left ventricular assist device). This device takes over some of the heart's pumping functions so that the heart doesn't have to work so hard. Surgeons implanted the device in an abdominal "pocket" of skin they created. It was run by a small electric generator. The device worked so well that Dolores was able to exercise and increase her fitness. But she still felt constrained by not having a fully functioning heart. Everyone said the improvement in her general health was bound to increase the chance of a successful heart transplant. Still there was a problem. No one knew when a heart might become available.

While Dolores was waiting, she came across an article about pigs whose tissues had been genetically altered to be compatible with those of any human being. The idea is that some day pigs will be a source of organs for transplantation into humans. Dolores was desperate to lead a normal life with her children, so she asked the doctors if she could have a pig's heart. "It's experimental right now," the doctors said. "Some investigators are afraid that the tissue of a pig might give the human recipient a virus present now only in pigs." "I'm willing to take a chance," Dolores said.

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Chapter Concepts

The chapter begins with an integrated outline that numbers the major topics of the chapter. The concepts for each topic are in a question format to stimulate student interest in finding the answers within the chapter.

Internal Summary Statements

A summary statement appears at the end of each major section of the chapter to reinforce the concepts just discussed and help focus students' efforts on the most important concepts.

Occasionally, peristalsis begins even though there is no food in the esophagus. This produces the sensation of a lump in the throat.

The esophagus plays no role in the chemical digestion of food. Its sole purpose is to conduct the food bolus from the mouth to the stomach. **Sphincters** are muscles that encircle tubes and act as valves; tubes close when sphincters contract, and they open when sphincters relax. The entrance of the esophagus to the stomach is marked by a constriction, often called a sphincter, although the muscle is not as developed as in a true sphincter. Relaxation of the sphincter allows the bolus to pass into the stomach, while contraction prevents the acidic contents of the stomach from backing up into the esophagus.

Heartburn, which feels like a burning pain rising up into the throat, occurs during reflux when some of the stomach contents escape into the esophagus. When vomiting occurs, a contraction of the abdominal muscles and diaphragm propels the contents of the stomach upward through the esophagus.

The air passage and food passage cross in the pharynx, which takes food to the esophagus. The esophagus conducts the bolus of food from the pharynx to the stomach. Peristalsis begins in the esophagus and occurs along the entire length of the digestive tract.

The Wall of the Digestive Tract

The wall of the esophagus in the abdominal cavity is comparable to that of the digestive tract, which has these layers (Fig. 5.4):

Mucosa (mucous membrane layer) A layer of epithelium supported by connective tissue and smooth muscle lines the **lumen** (central cavity) and contains glandular epithelial cells that secrete digestive enzymes and goblet cells that secrete mucus.

Submucosa (submucosal layer) A broad band of loose connective tissue that contains blood vessels lies beneath the mucosa. Lymph nodules, called Peyer's patches, are in the submucosa. Like the tonsils, they help protect us from disease.

Muscularis (smooth muscle layer) Two layers of smooth muscle make up this section. The inner, circular layer encircles the gut; the outer, longitudinal layer lies in the same direction as the gut. (The stomach also has oblique muscles.)

Serosa (serous membrane layer) Most of the digestive tract has a serosa, a very thin, outermost layer of squamous epithelium supported by connective tissue. The serosa secretes a serous fluid that keeps the outer surface of the intestines moist so that the organs of the abdominal cavity slide against one another. The esophagus has an outer layer composed only of loose connective tissue called the adventitia.

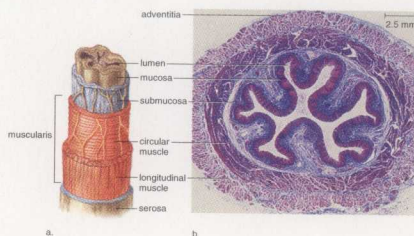


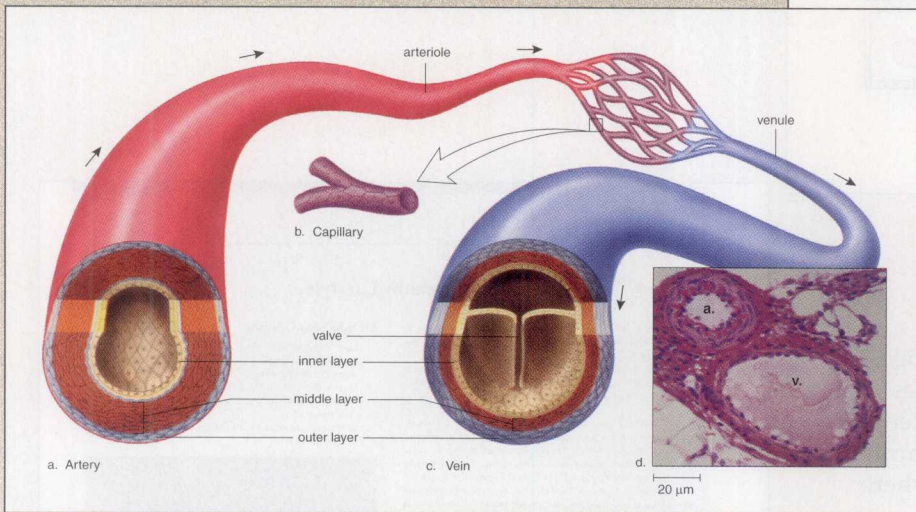
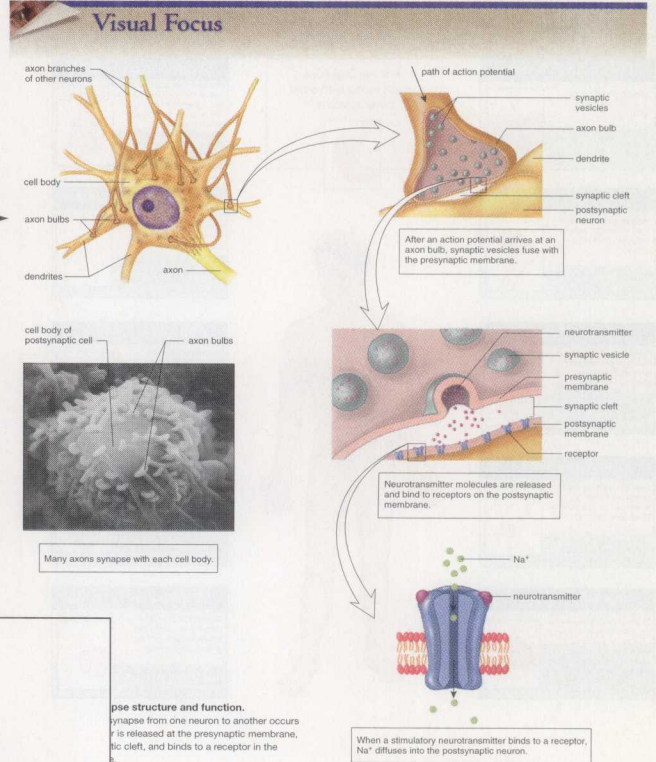
Figure 5.4 Wall of the digestive tract.

a. Several different types of tissues are found in the wall of the digestive tract. Note the placement of circular muscle inside longitudinal muscle.
b. Micrograph of the wall of the esophagus.

Illustrations

Visual Focus

These illustrations provide a conceptual overview that relates structure to function, using step-by-step descriptions.

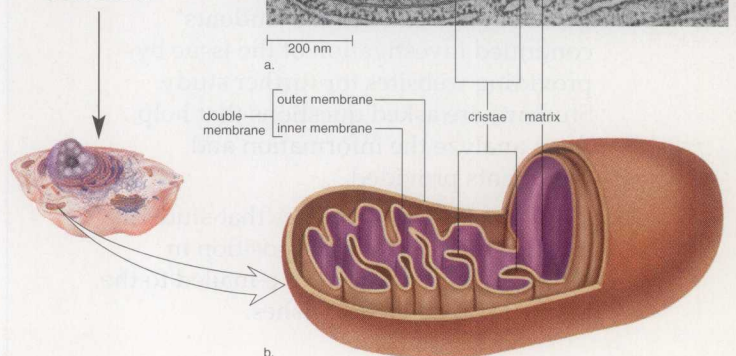


These illustrations provide a conceptual overview that relates structure to function, using step-by-step descriptions.

Combination Art

Drawings of structures are often paired with micrographs to enhance visualization.

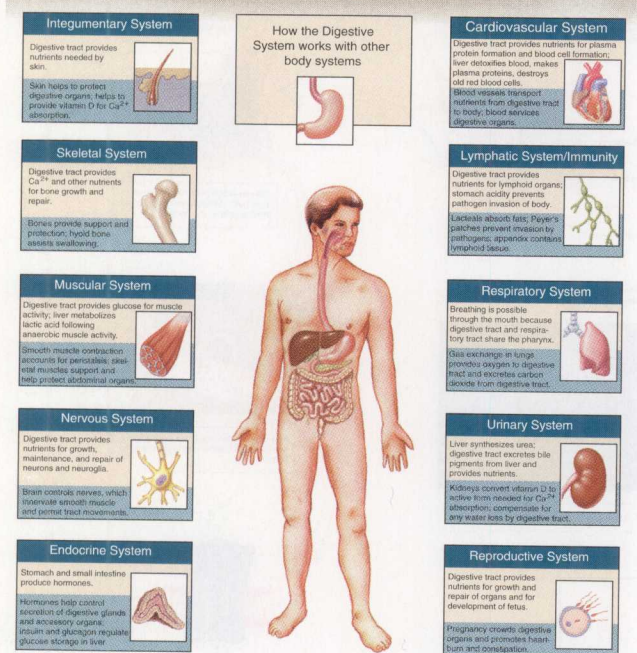
Cell Icon



Icons

Icons help orient students to the whole structure or process.

Human Systems Work Together



Bioethical Focus Boxes

Looking at Both Sides is an online feature to help students further explore the complicated issues discussed in the Bioethical Focus boxes. Students go to the Bioethical Focus activity in the e-Learning Connection on the Online Learning Center, where they find the following activities:

Taking Sides is a short quiz that helps students decide which side of the issue they identify with at the outset.

Further Debate facilitates the students' continued investigation of the issue by providing websites for further study. Students are asked questions that help them analyze the information and arguments provided.

Explain Your Position requires that students express and defend their position in writing. Responses can be e-mailed to the instructor if he or she wishes.

Human Systems Work Together

These helpful boxes illustrate how the system being discussed works with the other systems of the body to achieve homeostasis. An online component further emphasizes this vital concept:

- **Systems Scramble** is a matching exercise based on the Human Systems Work Together boxes.
- **Systems Review** follows with questions that require students to integrate what they have learned about the body systems.

Bioethical Focus

A Healthy Lifestyle

According to a 1993 study, about one million deaths a year in the United States could be prevented if people adopted the healthy lifestyle described in the Health Focus on page 134. Tobacco, lack of exercise, and a high-fat diet probably cost the nation about \$200 billion per year in health-care costs. To what lengths should we go to prevent these deaths and reduce health-care costs?

E.A. Miller, a meat-packing entity of ConAgra in Hymn, Utah, charges extra for medical coverage of employees who smoke. Eric Falk, Miller's director of human resources, says, "We want to teach employees to be responsible for their behavior." Anthem Blue Cross-Blue Shield of Cincinnati, Ohio, takes a more positive approach. They give insurance plan participants \$280 a year in extra benefits, such as additional vacation days, if they get good scores in five out of seven health-related categories. The University of Alabama, Birmingham, School of Nursing has a health-and-wellness program that counsels employees about how to get into shape in order to keep their insurance coverage. Audrey Brantley, a participant in the program, has mixed feelings. She says, "It seems like they are trying to control us, but then, on the other hand, I know of folks who found out they had high blood pressure or were borderline diabetics and didn't know it."

Another question is, Does it really work? Turner Broadcasting System in Atlanta has a policy that affects all employees hired after 1986. They will be fired if caught smoking—whether at work or at home—but some admit they still manage to sneak a smoke.

Decide Your Opinion

1. Do you think employers who pay for their employees' health insurance have the right to demand, encourage, or support a healthy lifestyle?
2. Do you think all participants in a health insurance program should qualify for the same benefits, regardless of their lifestyle?
3. What steps are ethical to encourage people to adopt a healthy lifestyle?



Figure 7B Eating habits.
Does an employer who provides you with health insurance have the right to require you to have a healthy lifestyle?

Looking at Both Sides www.mhhe.com/maderhuman8

Every bioethical issue has at least two sides. Even if you already have an opinion, it is important to explore the opposite opinion before finalizing your position. The Online Learning Center at www.mhhe.com/maderhuman8 will help you fine-tune your initial opinion, explore both sides, and finalize your position. You may acquire new arguments for your original opinion, or you may even change your opinion. Be sure to complete the following activities in sequence:

Taking Sides Decide your initial opinion by answering a series of questions. Then see if your opinion changes after completing the next two activities.

Further Debate Read opposing articles that give you further information on this particular bioethical issue.

Explain Your Position Answer another series of questions, and then defend your original or changed opinion. You can e-mail your position to your instructor if he or she wishes.

Summarizing the Concepts

The summary is organized according to the major sections in the chapter and helps students review the important topics and concepts.

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Summarizing the Concepts

7.1 The Blood Vessels

Blood vessels include arteries (and arterioles) that take blood away from the heart; capillaries, where exchange of substances with the tissues occurs; and veins (and venules) that take blood to the heart.

7.2 The Heart

The heart has a right and left side and four chambers. On the right side, an atrium receives O_2 -poor blood from the body, and a ventricle pumps it into the pulmonary circuit. On the left side, an atrium receives O_2 -rich blood from the lungs, and a ventricle pumps it into the systemic circuit. During the cardiac cycle, the SA node (pacemaker) initiates the heartbeat by causing the atria to contract. The AV node conveys the stimulus to the ventricles, causing them to contract. The heart sounds, "lub-dup," are due to the closing of the atrioventricular valves, followed by the closing of the semilunar valves.

7.3 Features of the Cardiovascular System

The pulse rate indicates the heartbeat rate. Blood pressure caused by the beating of the heart accounts for the flow of blood in the arteries, but because blood pressure drops off after the capillaries, it cannot cause blood flow in the veins. Skeletal muscle contraction, the presence of valves, and respiratory movements account for blood flow in veins. The reduced velocity of blood flow in capillaries facilitates exchange of nutrients and wastes.

7.4 The Cardiovascular Pathways

The cardiovascular system is divided into the pulmonary circuit and the systemic circuit. In the pulmonary circuit, the pulmonary trunk from the right ventricle and the two pulmonary arteries take O_2 -poor blood to the lungs, and four pulmonary veins return O_2 -rich blood to the left atrium. To trace the path of blood in the systemic circuit, start with the aorta from the left ventricle. Follow its path until it branches to an artery going to a specific organ. It can be assumed that the artery divides into arterioles and capillaries, and that the capillaries lead to venules. The vein that takes blood to the vena cava most likely has the same name as the artery that delivered blood to the organ. In the adult systemic circuit, unlike the pulmonary circuit, the arteries carry O_2 -rich blood, and the veins carry O_2 -poor blood.

7.5 Lymphatic System

The lymphatic system is a one-way system taking excess tissue fluid (lymph) to the subclavian veins. The lymphatic vessels are constructed similarly to the cardiovascular system and contain valves to keep lymph moving from the tissues to the veins. The

7.7 Homeostasis

Homeostasis is absolutely dependent upon the cardiovascular system because it serves the needs of the cells. However, several other body systems are critical to the functioning of the cardiovascular system. The digestive system supplies nutrients, and the respiratory system supplies oxygen and removes carbon dioxide from the blood. Like the heart, the nervous and endocrine systems are involved in maintaining the blood pressure that moves blood in the arteries and arterioles. The lymphatic system returns tissue fluid to the veins where blood is propelled by skeletal muscle contraction and breathing movements.

Studying the Concepts

1. What types of blood vessels are there? Discuss their structure and function. 122–23
2. Trace the path of blood through the heart, mentioning the vessels attached to, and the valves within, the heart. 125
3. Describe the cardiac cycle (using the terms systole and diastole), and explain the heart sounds. 126
4. Describe the cardiac conduction system and an ECG. Tell how an ECG is related to the cardiac cycle. 127
5. In what type of vessel is blood pressure highest? Lowest? Why is the slow movement of blood in capillaries beneficial? 128–29
6. What factors assist venous return of blood? 129
7. Trace the path of blood in the pulmonary circuit as it travels from and returns to the heart. 130
8. Trace the path of blood to and from the kidneys in the systemic circuit. 130–31
9. List three functions of the lymphatic system, and tell how these functions are carried out. How is a lymphatic vessel like a cardiovascular vein? 132
10. What is atherosclerosis? Name two illnesses associated with hypertension and thromboembolism. 135
11. Discuss the medical and surgical treatment of cardiovascular disease. 135–37
12. How does the cardiovascular system help maintain homeostasis? 137–38
13. How does the liver assist the cardiovascular system in maintaining homeostasis? 137–38

Testing Your Knowledge of the Concepts

Choose the best answer for each question.

In questions 1–4, match the descriptions to the circuit in the key. Answers may be used more than once.

- Key:
a. pulmonary circuit
b. both pulmonary and systemic
c. systemic circuit
d. lymphatic system
- Arteries carry O_2 -rich blood.
Carbon dioxide leaves the capillaries, and oxygen enters the capillaries.
Arteries carry blood away from the heart, and veins carry blood toward the heart.
Contains the renal arteries and veins.

Studying the Concepts

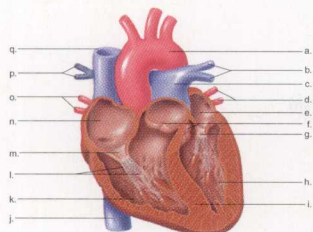
This page-referenced question set follows the sequence of the chapter and reviews the concepts that are presented.

Testing Your Knowledge of the Concepts

These objective questions allow students to test their ability to answer recall-based questions. Answers to these questions are given in the Appendix.

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15. Which of these statements is true of lymph nodes?
a. Lymph nodes occur in particular regions of the body.
b. Lymph nodes contain lymphocytes.
c. Lymph nodes filter the lymph.
d. All but d are true.
16. All arteries in the body contain oxygen-rich blood, with the exception of the
a. aorta.
b. pulmonary arteries.
c. renal arteries.
d. coronary arteries.
17. The cardiac veins directly enter the
a. inferior vena cava.
b. superior vena cava.
c. right atrium.
d. left atrium.
18. The "lub," the first heart sound, is produced by the closing of
a. the aortic semilunar valve.
b. the pulmonary semilunar valve.
c. the right tricuspid (atrioventricular) valve.
d. the left bicuspid (atrioventricular) valve, or mitral valve.
e. both atrioventricular valves.
19. The QRS wave of an ECG should be associated with
a. systole of the atria.
b. diastole of the atria.
c. systole of the ventricles.
d. diastole of the ventricles.
20. Label this diagram of the heart.



Understanding Key Terms

- aneurysm 135
angina pectoris 135
angioplasty 136
aorta 130
arteriole 122
artery 122
atherosclerosis 135
atrioventricular bundle 126
atrioventricular valve 124
atrium 124
AV (atrioventricular) node 126
blood pressure 128
capillary 122
cardiac cycle 126
chordae tendineae 124
congestive heart failure 136
coronary artery 131
diastole 126
diastolic pressure 128
edema 132
electrocardiogram (ECG) 127
embolus 135
heart 124
heart attack 135
hemorrhoids 137
hepatic portal system 131
hepatic portal vein 131
hepatic vein 131
hypertension 135
inferior vena cava 130
lymph 132
lymphatic system 132
lymphatic vessels 132
lymph nodes 133
myocardium 124
pacemaker 126
pericardium 124
phlebitis 137
plaque 135
pulmonary artery 125
pulmonary circuit 130
pulmonary vein 125
pulse 128
Purkinje fibers 126
SA (sinoatrial) node 126
semilunar valve 124
septum 124
spleen 133
stroke 135
superior vena cava 130
systemic circuit 130
systole 126
systolic pressure 128
thromboembolism 138
thrombus 135
valve 123
varicose veins 137
vein 122
ventricle 124
venule 123

Match the key terms to these definitions.

- Relaxation of a heart chamber.
- Large systemic vein that returns blood from body areas below the diaphragm.
- Rhythmic expansion and recoil of arteries resulting from heart contraction; can be felt from outside the body.
- Abnormal accumulation of fluid in the tissues; can lead to a swelling of a body part.
- That part of the cardiovascular system that serves body parts and does not include the gas-exchanging surfaces in the lungs.

Online Learning Center

www.mhhe.com/maderhuman8

The Online Learning Center provides a wealth of information fully organized and integrated by chapter. You will find practice quizzes, interactive activities, labeling exercises, flashcards, and much more that will complement your learning and understanding of human biology.

Understanding Key Terms

The boldface terms in the chapter are page referenced, and a matching exercise allows students to test their knowledge of the terms.

Website Reminder

Located at the end of each chapter is this reminder that quiz questions and additional learning activities are on the Online Learning Center.

Acknowledgments

To produce *Human Biology* requires the constant and concerted effort of many, and it is a pleasure to thank everyone who made this edition so special. First, I want to thank the dedicated professionals I work with at McGraw-Hill. Michael Lange, Editor-in-Chief, has long given me his support and encouragement. My editor, Patrick Reidy, and my developmental editor, Margaret Horn, worked tirelessly to help me bring you a text and ancillaries that will serve your needs in every way. They planned well and supplied creativity, advice, and support whenever it was needed. Rose Koos, my production manager, ushered the book through production, never failing to keep everyone on track. Kennie Harris, as always, was relentless in her efforts to make sure the text was consistent, on target, and punctuated correctly. We all owe her our thanks.

Wayne Harms was the designer who chose everything from the different type styles, to the colors of the opening pages, to the cover of the book. Also, Wayne is always willing to lend a hand at designing illustrations that delight and please the viewer. Lori Hancock and Connie Mueller found just the right photographs and micrographs for the many illustrations in the text.

In my office, Beth Butler, although new to the task, proved that she was capable of shouldering the load, from preparing illustration grid sheets to paging the book. I would be remiss if I did not also take this opportunity to thank my husband and children for their continued patience and encouragement. Their interest in my work has always touched me greatly.

Contributors and Reviewers

The content of *Human Biology* is not due to my efforts alone. This edition of the text had two contributors who wrote the first draft of the two new chapters. Dr. Mark Schneegeurt responded to my appeal and wrote Chapter 21, "Parasites and Pathogens." Dr. Richard Jurin contributed to Chapter 26, "Population, Resources, and Pollution." And I am certainly thankful to Dr. Patrick Galliard for revising and composing many questions at the ends of the chapters. Pat also served as an accuracy checker to keep the book as free of error as possible.

As with previous editions, many instructors contributed creative ideas, corrections, and suggestions for improvement. I am extremely thankful to each one, for they have all worked diligently to remain true to our calling—to provide a product that will be the most useful to our students.

It is appropriate to acknowledge the help of the following reviewers of the eighth edition:

Jason Arnold
Hopkinsville Community College

Ellen Baker
Santa Monica College

Dale P. Barnard
Utah State University

Jane Bradley
Des Moines Area Community College

Thomas Butler
SUNY Rockland Community College

David Byman
Penn State Worthington/Scranton

Chrysan Cronin
Muhlenberg College

Mary L. Crooks
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Penn State Erie, The Behrend College

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Scott Zimmerman
University of Wisconsin – Stout

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