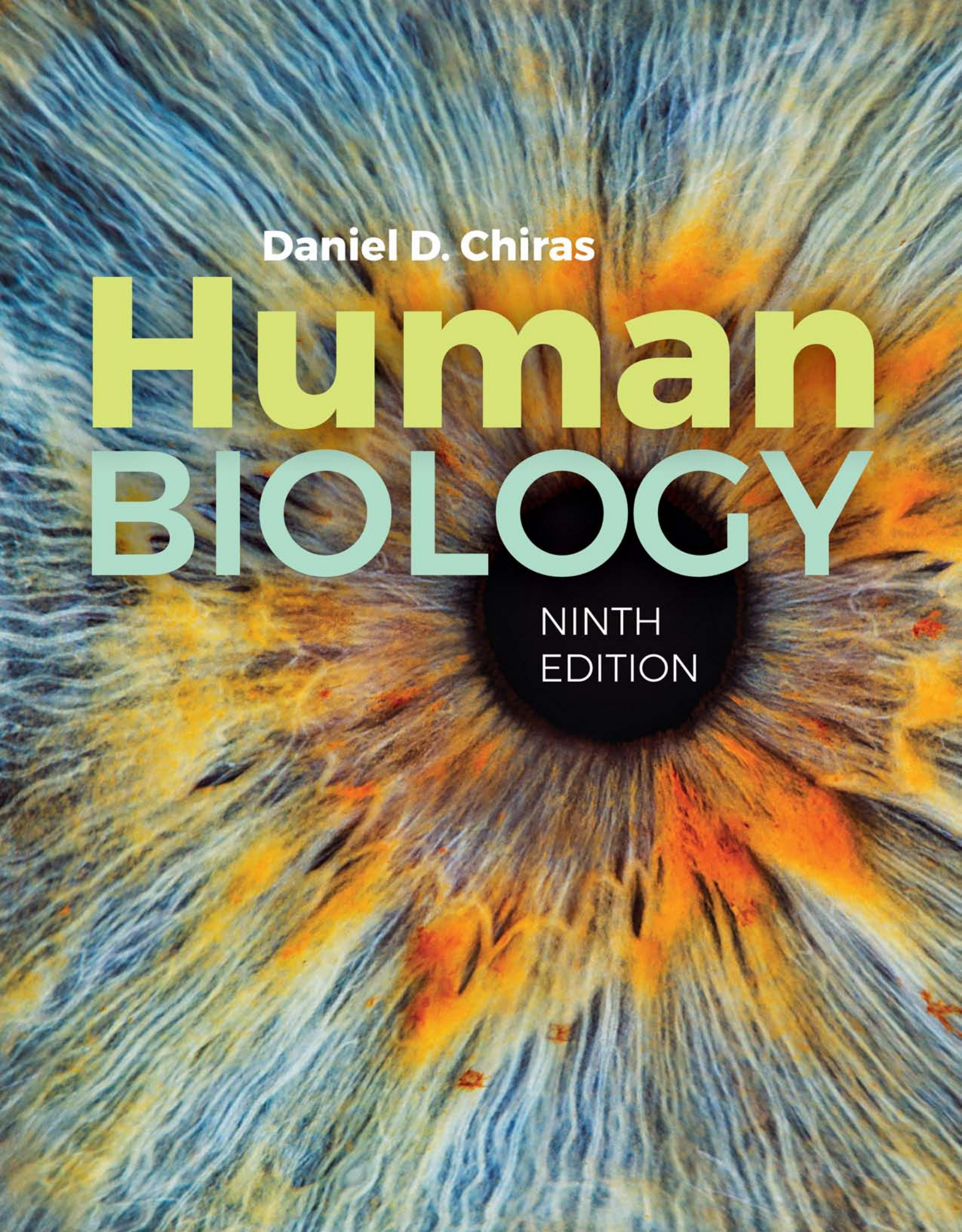
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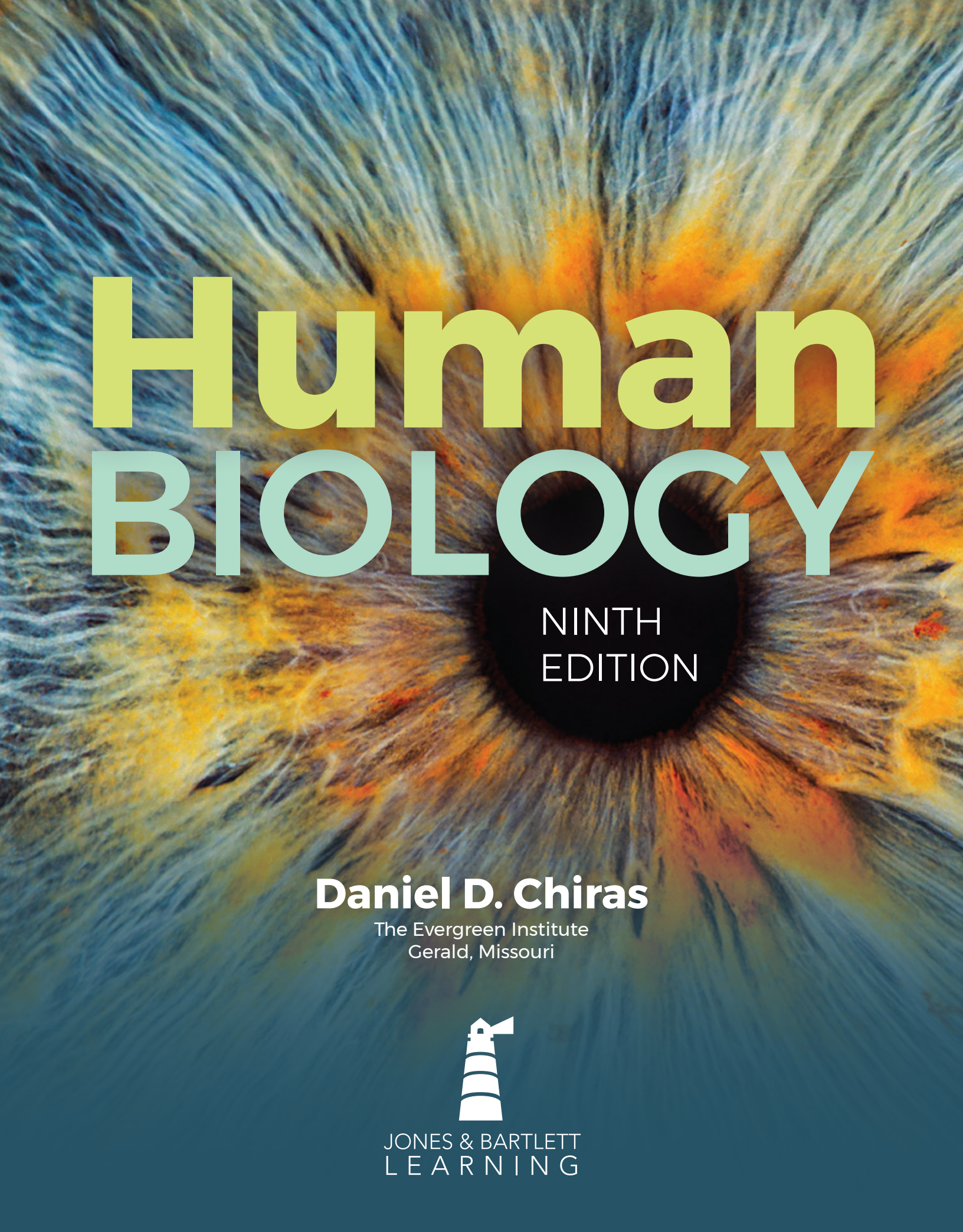

Human BIOLOGY

NINTH EDITION

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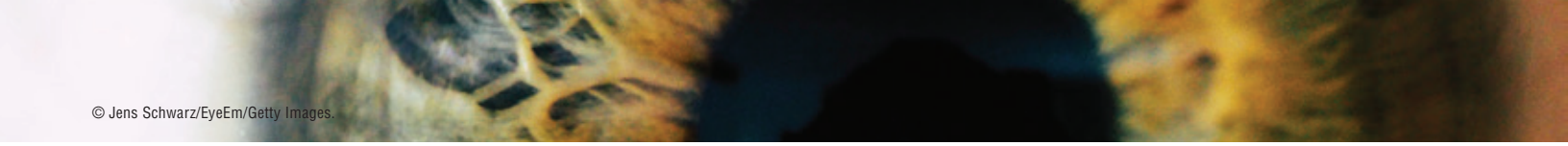
Dedicated to my two sons, Skyler and Forrest,
who continue to amaze me with their love, talent, and wisdom.



Brief Contents

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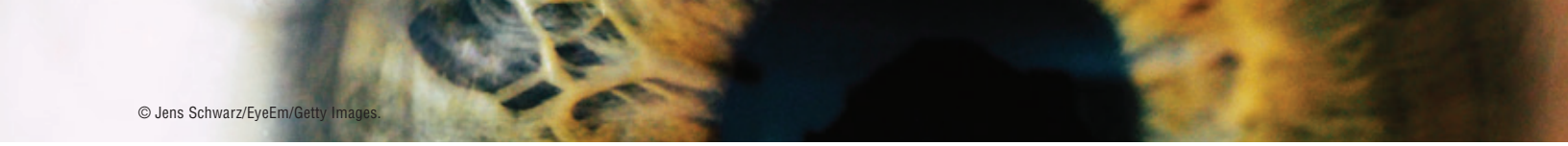

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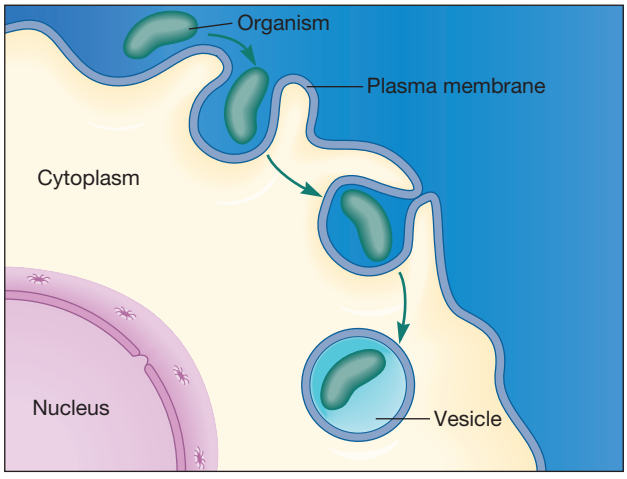
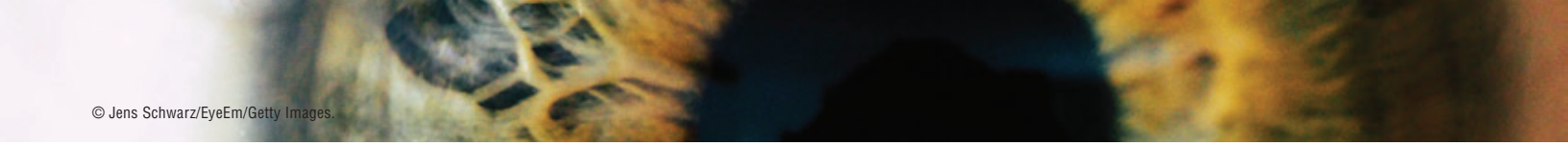
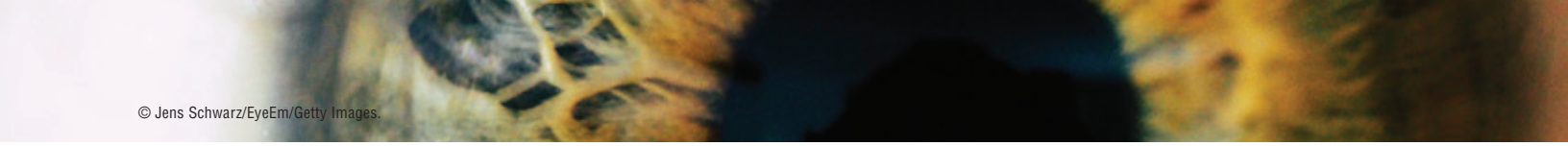
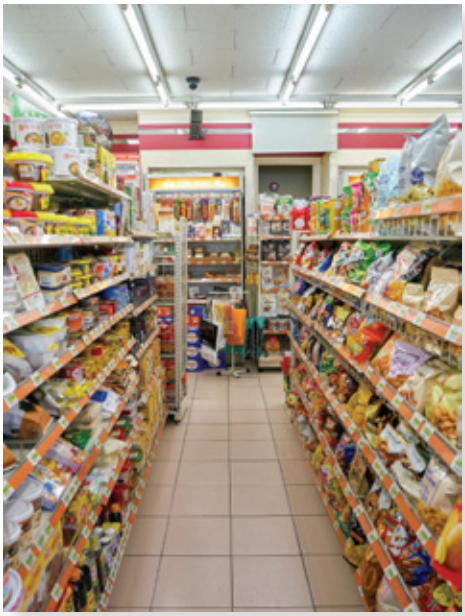
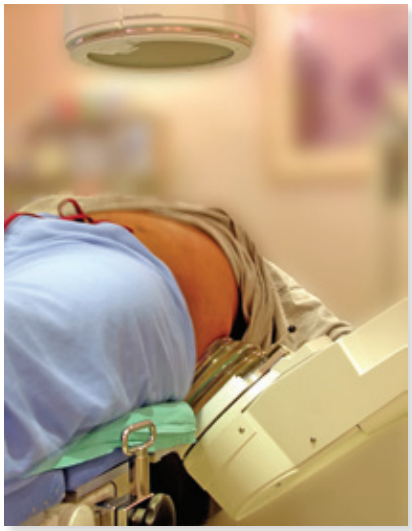


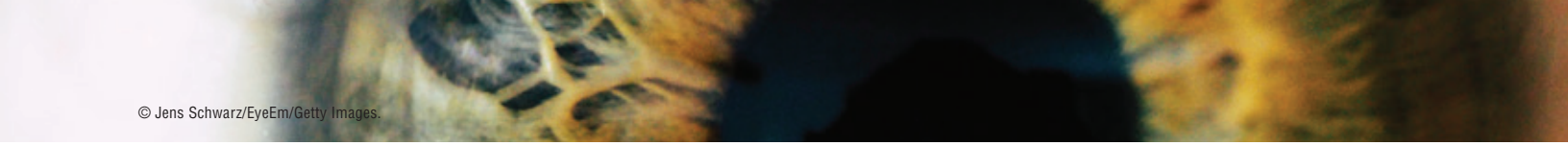


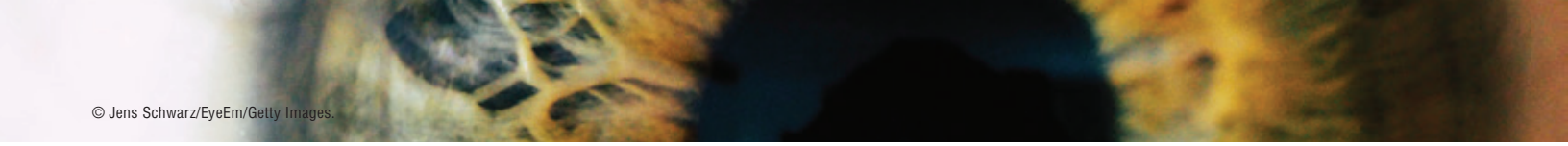
PART 2 Human Body Systems: Homeostasis and Health



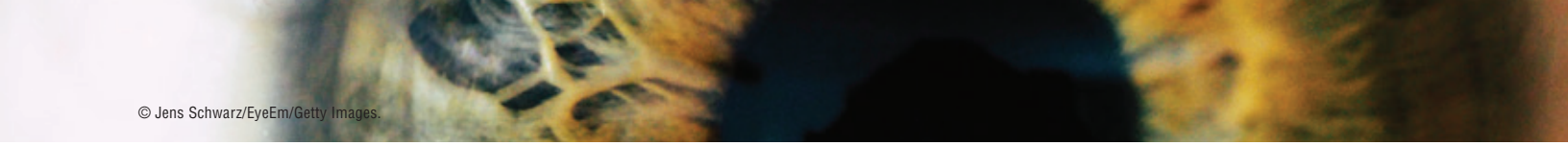




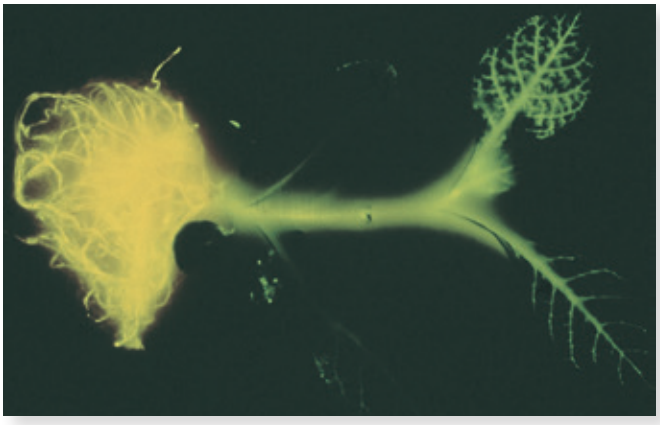




Courtesy of Dr. N.J. Fiumara and Dr. Gavin Hart/CDC.



PART 3 Cell Division and Human Heredity



Courtesy of Lian Bruno.

PART 4 Infectious Disease, Evolution, and Ecology

Chapters 23, 24, and 25 are available online with access code.

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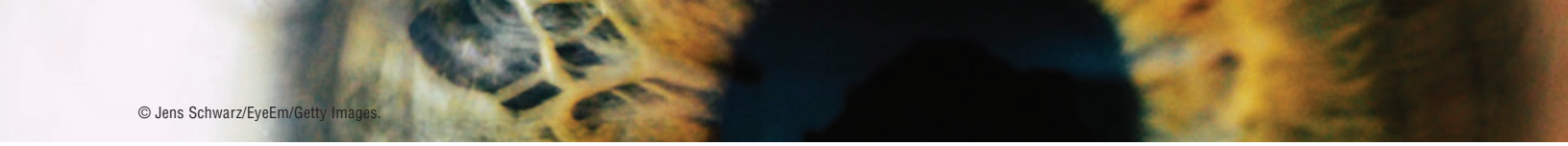

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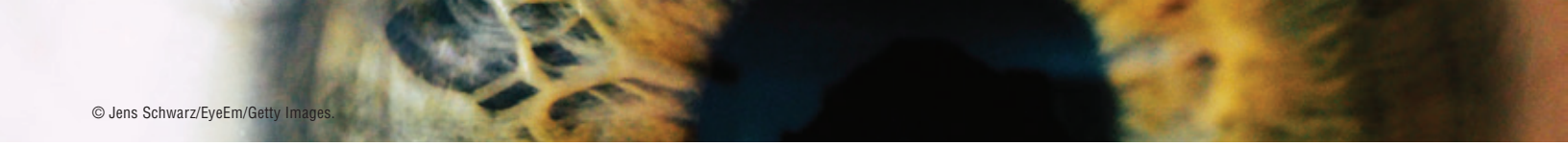


Preface

Human Biology, Ninth Edition, is written specifically with the undergraduate, non-science major in mind. The text contains an abundance of timely and important information about the structure and function of the human body, exploring the world from the cellular level, then the level of tissues and organs. This book also introduces readers to common diseases they are likely to encounter during their lives as well as an abundance of information on ways to prevent disease and live long, healthy lives.

The central organizing theme of the book—homeostasis—illustrates the internal balancing act that has evolved over the history of humankind, allowing our bodies to regulate conditions integral to our survival. For our bodies to achieve homeostasis and maintain health, they must regulate their temperature, levels of chemicals in the blood, as well as a host of cellular functions. Homeostasis and health also depend on our bodies' external environment—the quality of the air we breathe, the water we drink, and the foods we eat.

When I began writing this book, many years ago, I had several goals in mind. The first was to educate you about your body and the ways to take good care of it. The more you know about how your body works, the more able you are to make healthy decisions now and in the future. The book is also meant to teach you about scientific literacy—how scientists gather information, analyze it, and come to conclusions about it—which will make you a more informed citizen. When you read about a scientific discovery in the news, you will be able to make better decisions about how reliable the information might be and how it might affect your life. This knowledge will also help you understand difficult and controversial political issues, like stem cell research (why it's controversial and why many people feel it is important). Finally, this book encourages you to think critically about the human body and health, looking at the body as a system—a collection of organs and molecules working together, influenced by stimuli inside and out.

Organization

Human Biology is divided into four parts:

Part 1: Organization of Life
Part 2: Human Body Systems
Part 3: Cell Division and Human Heredity
Part 4: Evolution and Ecology (Available online)

Part 1 outlines the fundamental biological and chemical principles you need to know to understand the human body, as well as introducing the cell, the unit of all life. You will also read about the scientific method and critical thinking, both of which are applied throughout the book. I've also added material to explain the organization of life.

In Part 2, you'll learn about basic tissues that make up the organs of the body. You'll study all the vital organs systems of the human body, including the circulatory system, the digestive system, the skin, and the respiratory system. You'll learn about the bones and muscles that allow us to move about in our environment and perform many important tasks. You'll study the systems that help control these systems, including the endocrine and nervous systems. You'll learn how the body rids itself of waste and protects itself from infectious agents like bacteria and viruses. You'll study reproduction, embryonic development, and aging.

In this section, you'll explore the structure and function of these systems, especially how they help maintain homeostasis. You'll also learn about diseases that many of you will encounter over your lifetime. You'll also learn a great deal about safeguarding your health – living a long healthy, disease-free life.

In Part 3, we'll delve into human heredity. You'll learn how cells divide during development and the production of sperm and ova. You'll study how genes control the structure and function of the body and important developments in genetic engineering.

In Part 4, which is available online for all users, we'll explore evolution, ecology, and the environment.

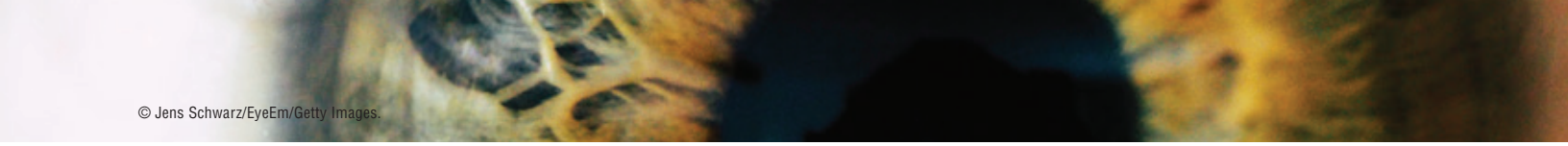
An Integrated Approach to Teaching Chemistry

Human Biology uses a bold method of teaching chemistry: rather than discussing all of the chemistry you need to know in one chapter early in the book, I introduce the basics of chemistry in Chapter 2, with a brief overview of major biological molecules. Then, throughout the book, more specific information on important molecules (carbohydrates, lipids, proteins, amino acids, and nucleic acids) is given as you need it. For example, you'll learn about proteins and lipids when we discuss the plasma membrane in Chapter 3. Later on in that chapter, you'll learn about carbohydrates when we cover energy and metabolism, and we'll go into more detail on protein, lipids, and carbohydrates in Chapter 7, Nutrition and Digestion. Nucleic acids are presented in detail in the discussion of molecular genetics in Part 4.

This approach has two chief benefits: (1) It prevents you from becoming overwhelmed by a deluge of seemingly unconnected facts that many students find difficult to grasp and impossible to remember if not given in proper context, and (2) it shows you that the chemistry you are learning is relevant to your understanding of human biology.

New to the *Ninth Edition*

The primary emphasis of this edition, as in previous editions, is to help you better understand your body and to highlight the steps you can take to improve your health and fitness. Essential to this goal is the understanding of the body's systems and the many ways in which they are



affected by our diets and lifestyle. This edition has undergone extensive revision and updating. With the assistance of my dedicated production team, I have added new photographs and art to better illustrate new and existing material. I have revised much of the existing art to make it more visually appealing.

Chapter on the Integumentary System

With urging of perceptive users and reviewers, I have included a chapter on the skin and associated structures such as hairs, nails, and sweat glands – components of the integumentary system.

Much overlooked in human biology and physiology books, the integumentary system serves many important purposes. For example, it helps regulate body temperature, excrete wastes, and provides multiple protections.

Muscle and Skeleton Systems Covered Separately

For years, I have covered the muscular and skeletal systems in one chapter. In this edition, however, I elected to create separate chapters for each topic. This has allowed me to add more important information lacking in previous editions like muscle groups and diseases of muscle and bone.

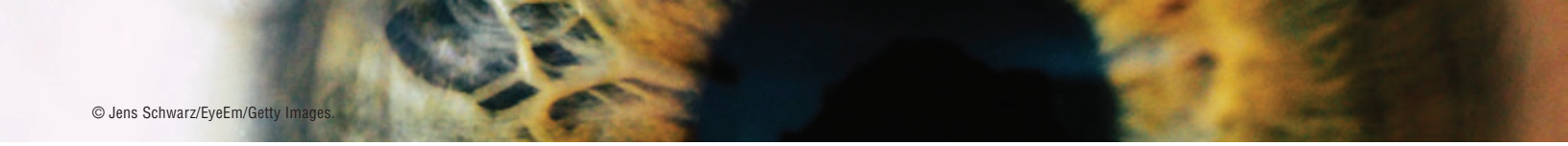
Online Chapters

Recognizing that certain subjects like human infectious diseases, evolution, and ecology are not covered in many human biology courses, and wishing to help hold down the cost of this book, I have moved three chapters to the eBook. These chapters are available to professors and students who need them, but by repositioning these chapters, my publisher and I hoped that we could help make college a little more affordable – and save a few trees along the way!

New Material

Below is a partial list of some of the new topics I've added to this edition.

- Organization of life
- How evolution works
- Domains and kingdoms
- Cool laser fat removal
- HealthNote: Eating a Healthy Diet
- Bone formation and elongation
- Muscle groups
- Flexion and extension
- Autonomic nervous system
- Common recreational drug use
- Brachial and cervical plexuses
- Sacral plexus and lumbar plexuses
- Sciatic nerve and sciatica
- Brain diseases
- Hearing loss and ways to prevent it
- Vertigo
- Hormone action at the cellular level
- Additional hormone-producing cells, tissues, and organs
- New treatments for cancer
- Immunotherapy
- Prostate cancer
- Hernias and hernia repair
- Erectile dysfunction
- Diseases of male and female reproductive systems
- Male contraception

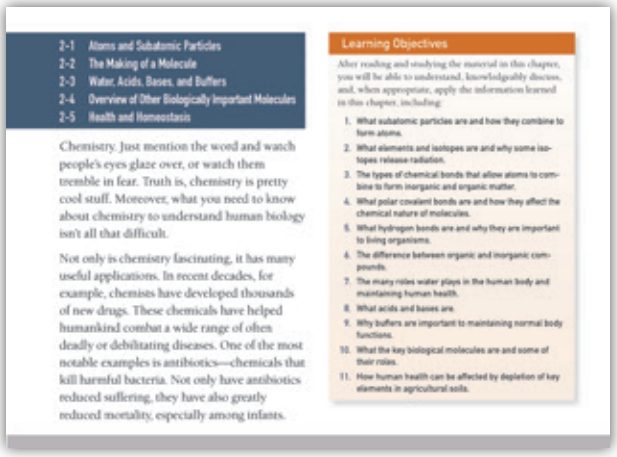


The Student Experience

I hope you find this to be a user-friendly book. In this edition, as in previous ones, I have tried hard to ensure that the material is easy to understand. I've simplified complex subjects to some degree and have used examples and analogies to make some concepts easier to understand. For the most part, *Human Biology* concentrates on basic information, the key facts and concepts that you need to know. I've clearly defined key terms and added pronunciations of some of the more difficult ones. Additionally, the following features are here to make your learning experience fun, interesting, and memorable.

Learning Objectives and Chapter Outlines

Each chapter opens with a list of Learning Objectives and a Chapter Outline to help you plan your studying. Material is much easier to learn when you know what to expect.



2-1 Atoms and Subatomic Particles
2-2 The Making of a Molecule
2-3 Water, Acids, Bases, and Buffers
2-4 Overview of Other Biologically Important Molecules
2-5 Health and Homeostasis

Chemistry. Just mention the word and watch people's eyes glaze over, or watch them tremble in fear. Truth is, chemistry is pretty cool stuff. Moreover, what you need to know about chemistry to understand human biology isn't all that difficult.

Not only is chemistry fascinating, it has many useful applications. In recent decades, for example, chemists have developed thousands of new drugs. These chemicals have helped humankind combat a wide range of often deadly or debilitating diseases. One of the most notable examples is antibiotics—chemicals that kill harmful bacteria. Not only have antibiotics reduced suffering, they have also greatly reduced mortality, especially among infants.

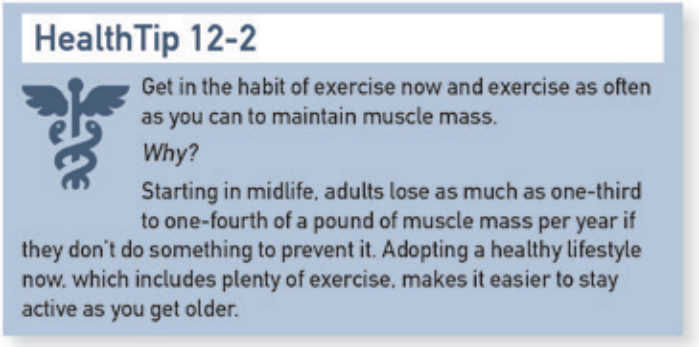
Learning Objectives

After reading and studying the material in this chapter, you will be able to understand, knowledgeably discuss, and, when appropriate, apply the information learned in this chapter, including:

1. What subatomic particles are and how they combine to form atoms.
2. What elements and isotopes are and why some isotopes release radiation.
3. The types of chemical bonds that allow atoms to combine to form inorganic and organic matter.
4. What polar covalent bonds are and how they affect the chemical nature of molecules.
5. What hydrogen bonds are and why they are important to living organisms.
6. The difference between organic and inorganic compounds.
7. The many roles water plays in the human body and maintaining human health.
8. What acids and bases are.
9. Why buffers are important to maintaining normal body functions.
10. What the key biological molecules are and some of their roles.
11. How human health can be affected by depletion of key elements in agricultural soils.

Practical Pointers to Increase Health and Fitness

The **HealthTips** included in each chapter offer you sound advice on some of the many ways you can improve your life, often requiring very little change in your daily routine. The tips offer nutrition information and suggestions for increasing your physical fitness. A brief description of the reasoning and scientific evidence behind each tip is also presented. All HealthTips have been derived from the latest research published in reputable scientific journals.



HealthTip 12-2

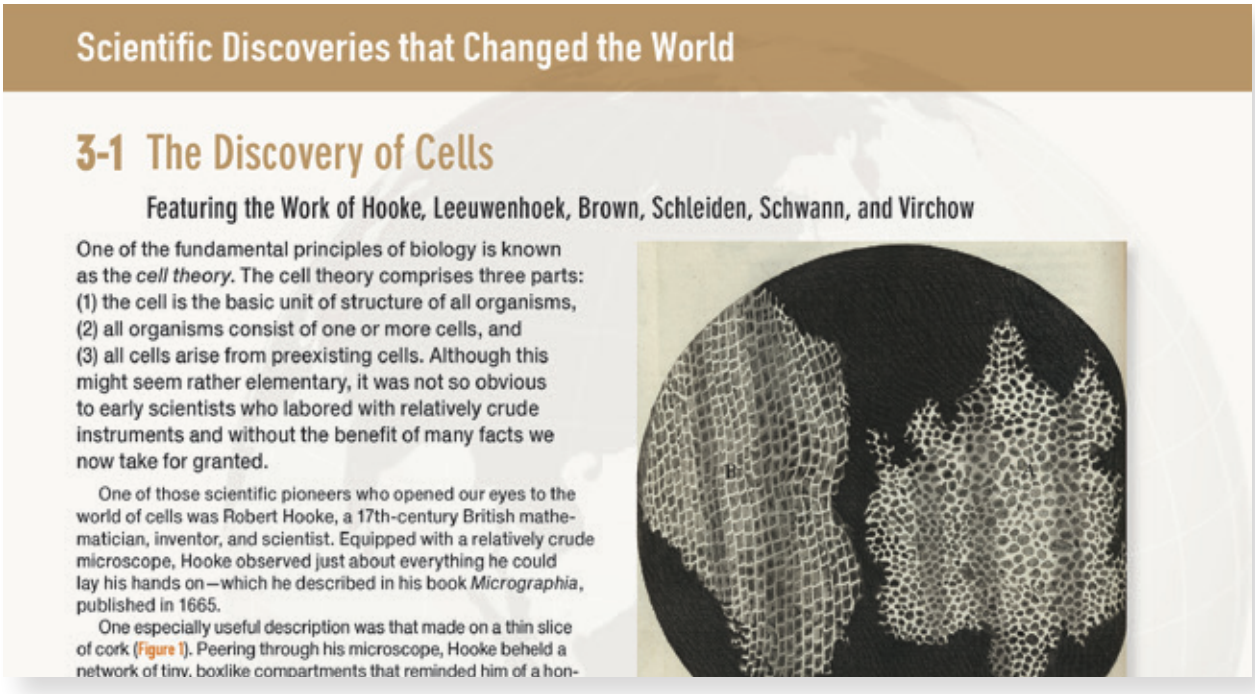
Get in the habit of exercise now and exercise as often as you can to maintain muscle mass.

Why?

Starting in midlife, adults lose as much as one-third to one-fourth of a pound of muscle mass per year if they don't do something to prevent it. Adopting a healthy lifestyle now, which includes plenty of exercise, makes it easier to stay active as you get older.

Learning the Process of Science

When studying science, we explore numerous facts that make up our knowledge. But just as important as these facts is the way we came to know them. To highlight some of the key discoveries that have been made in the field of human biology, I've included numerous essays called **Scientific Discoveries that Changed the World**. They discuss breakthroughs such as Robert Hooke's first description



Scientific Discoveries that Changed the World

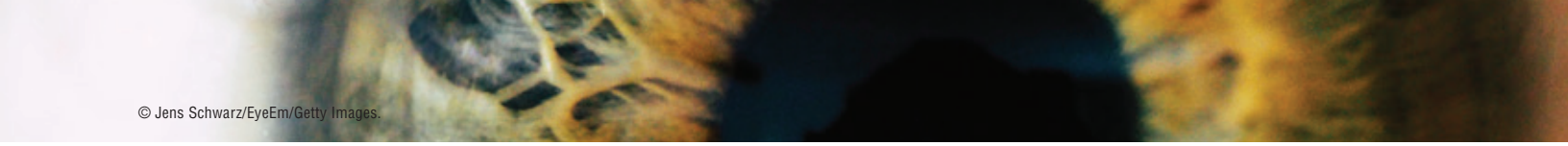
3-1 The Discovery of Cells

Featuring the Work of Hooke, Leeuwenhoek, Brown, Schleiden, Schwann, and Virchow

One of the fundamental principles of biology is known as the *cell theory*. The cell theory comprises three parts: (1) the cell is the basic unit of structure of all organisms, (2) all organisms consist of one or more cells, and (3) all cells arise from preexisting cells. Although this might seem rather elementary, it was not so obvious to early scientists who labored with relatively crude instruments and without the benefit of many facts we now take for granted.

One of those scientific pioneers who opened our eyes to the world of cells was Robert Hooke, a 17th-century British mathematician, inventor, and scientist. Equipped with a relatively crude microscope, Hooke observed just about everything he could lay his hands on—which he described in his book *Micrographia*, published in 1665.

One especially useful description was that made on a thin slice of cork (Figure 1). Peering through his microscope, Hooke beheld a network of tiny, boxlike compartments that reminded him of a hon-



of cells in 1665; William Harvey's seventeenth-century studies of the circulation of blood; Louis Pasteur, Robert Koch, and the germ theory of disease; and Watson, Crick, Wilkins, and Franklin's work on the structure and function of DNA. In this way, we are able to highlight the work of some of history's most important scientists *and* to illustrate how scientific discoveries can drastically change our view of the world. These essays will also illuminate the scientific method and demonstrate the fact that scientific advances usually require the efforts of many people, sometimes working in what seem like very different areas. Cooperation and the exchange of information are key to scientific progress.

How to Live a Healthier Life

To help make the study of human biology even more relevant, I have included numerous **HealthNotes** that present information vital to your current and future health and wellness. They present advice on proper diet, exercise, and stress management—always important, and especially while you're in school!—as well as hair loss, heart disease, breast augmentation, cancer prevention, the dangers of recreational drug use, and aging. This is a book to hold onto and refer back to throughout your life!

Learning How to Think Critically

Chapter 1 of *Human Biology* presents a number of guidelines for improving your critical thinking skills, making you a more discerning thinker in all of your classes and a more informed citizen. While critical thinking is encouraged throughout the text, I emphasize it at the finish of each chapter with a **Thinking Critically** exercise. Each chapter ends with the description of a problem or the conclusion of a scientific study to which I ask you to apply your critical thinking. In Appendix C, I present my own analysis of the subject.

Each of these exercises underscores one or two of the critical thinking guidelines outlined in Chapter 1.

THINKING CRITICALLY

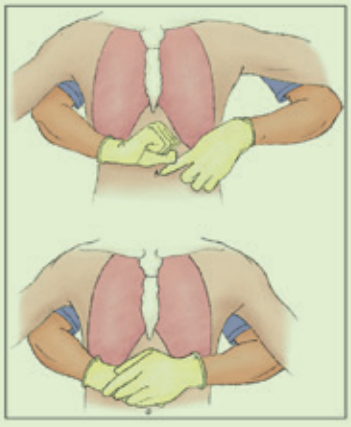
Thanks to improvements in medicine, people are living longer. You may have heard this statement dozens of times in one form or another. It is repeated so often that most of us believe it implicitly. But is it true? Are people really living longer than they used to?

HealthNote 9-1 First Aid for Choking That May Save Someone's Life

What do you do if you encounter a person who is choking? If the person can cough, speak, or breathe, do not interfere. Encourage the individual to continue coughing. If he or she cannot cough, speak, or breathe, CALL OR HAVE SOMEONE CALL 911 OR YOUR LOCAL EMERGENCY NUMBER IMMEDIATELY.

If the person is conscious:

- Stand behind him and wrap your arms around his waist.
- Make a fist with one hand (thumb outside the fist), and place the fist just above the navel in the middle of the abdomen. Be sure that your fist is well below the lower tip of the sternum.
- Wrap the other hand around the fist and perform cycles of five quick inward and upward thrusts. After every five thrusts, check the person and repeat the cycles until the person begins to cough, speak, or breathe on his own.



Adult Chest Thrust

If the person is unconscious:

- Carefully position her on her back.
- Open the airway by placing one hand on the forehead and one hand on the chin
- Return to the victim's head: perform a finger sweep of her mouth, searching for a dislodged object; perform a head-tilt/chin-lift; and give one slow breath.
- If the breath will not go in, give five more abdominal thrusts, followed by a finger sweep, and one breath.
- Continue this cycle until the victim begins to cough, speak, or breathe on his or her own.
- Perform the same technique for children as you would for an adult. Children are considered those who are over 1 year of age and under the age of 8. The size of the child must also be a consideration.

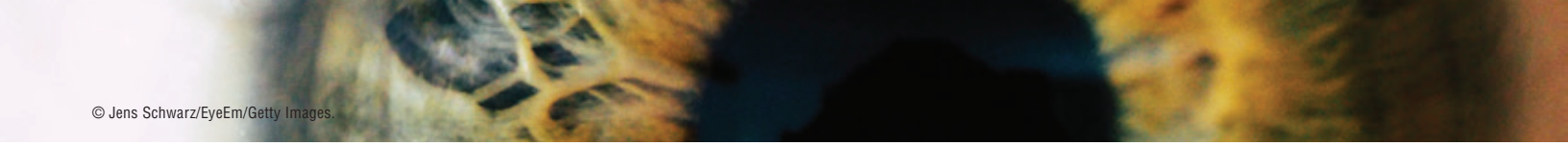
For infants and very small children who cannot cough, speak, or breathe:

- Pick up the infant and place her face down on your forearm.
- Give the infant five back blows with the heel of your hand between the shoulder blades.
- Reposition the infant face up on the opposite forearm and give five chest thrusts using the pads of two or three fingers in the lower half of the sternum.
- Continue this cycle until the infant can breathe on her own or until the infant goes unconscious.

Infants and Small Children, Back Blows

If the infant is unconscious:

- Perform a head-tilt/chin-lift and look, listen, and feel for air exchange.
- If no exchange is present, seal your mouth around



Understanding Nature's Balancing Act

Human health depends on homeostasis. Homeostasis, in turn, depends on many other factors, which are described in the **Health and Homeostasis** sections at the conclusion of many chapters. These passages will help you gain a broader understanding of how your diet, stress levels, and level of physical activity affect your health and your body's attempts to maintain balance.

15-9 Health and Homeostasis

Hormones orchestrate an incredible number of body functions and help to create a dynamic balance that's vital for human health. Hormones influence homeostasis primarily by controlling the rate of various metabolic reactions and by regulating ionic balance. When this balance is altered, our health suffers (Table 15-4).

The endocrine system, like other systems, is sensitive to outside factors. Stress, for example, can lead to an imbalance in adrenal hormones, resulting in high blood

Boiling It Down to Essentials

Nearly all chapter sections are followed by summary statements that stress the key concepts covered in that section. These **Key Concepts** are a great study tool to review major concepts as you read and prepare for exams.

KEY CONCEPTS

Homeostasis is a state of relative constancy that helps to ensure human health; it is achieved automatically by numerous physiological processes in the body that respond to internal and external changes.

Summing It All Up

An extensive ***Study Guide*** appears at the end of every chapter, including a chapter summary, a list of key terms and concepts, a numbered review of all key topics covered, a set of review questions, and a self-quiz so you can test yourself and see how much of the chapter's contents you've retained. An analysis of the **Thinking Critically** exercises for each chapter can be found in Appendix C.

Making Each Concept Visible

Human Biology contains a remarkable collection of illustrations and photographs to bring each concept to life before your eyes. In this edition, my publisher and I have revised many illustrations to enhance the visual and educational experience you'll have with the book.

Teaching Tools

Jones & Bartlett Learning offers an impressive variety of traditional print and interactive multimedia supplements to assist instructors and to aid students in mastering human biology. Additional information and review copies of any of the following items are available through your Jones & Bartlett Learning account specialist.

For Instructors

PowerPoint® Lecture Outline Slides. This ancillary material provides lecture notes and images from the text for each chapter of *Human Biology, Ninth Edition*. Instructors with the Microsoft® PowerPoint software can customize the outlines, images, and order of presentation.

PowerPoint Image Bank. This provides the illustrations, photographs, and tables (to which Jones & Bartlett Learning holds the copyright or has permission to reproduce digitally) inserted into PowerPoint slides. With the Microsoft PowerPoint program, instructors can quickly and easily copy individual images into their existing lecture slides.

The following online instructor's resources are available for qualified instructors to download from go.jblearning.com/HumanBiology.

Instructor's Manual. This guide is provided as a text file containing chapter outlines, learning objectives, key terms, concept questions, and teaching tips.

Test Bank. This reserve of over 2200 exam questions is available in multiple formats.

For Students and Teachers

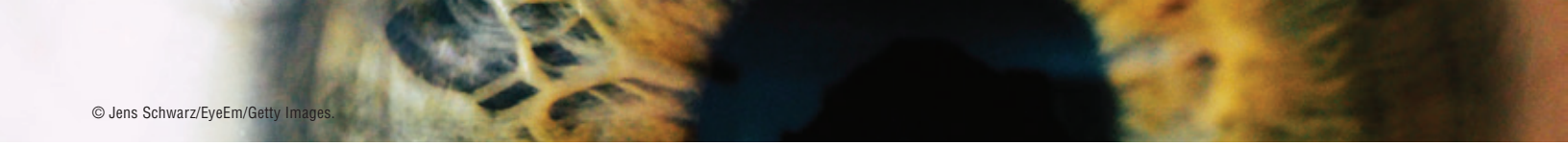
Case Studies for Understanding the Human Body, Second Edition, by Stanton Braude, Deena Goran, and Alexander P. Miceli of Washington University. This supplementary case studies workbook is available both in print and as a customizable electronic product. It provides exercises that lend themselves to a cooperative learning setting where students work together to review and solve open-ended questions pertaining to the human body in health and disease. The case studies link directly back to content covered in *Human Biology, Ninth Edition*, making these two books a truly integrative teaching and learning tool.

Human Biology Lab Manual by Charles Welsh of LaRoche College. This laboratory manual contains 18 exercises that may be taught in any order, offering instructors flexibility to mold the text to the specific needs of their students.

Guide to Infectious Diseases by Body System, Second Edition, by Jeffrey C. Pommerville of Glendale Community College. This excellent tool guides students through the microbial diseases that affect the human body. Each of the 16 units offers a brief introduction to the human anatomical systems and the bacterial, viral, fungal, or parasitic agents that infect each system, as well as the diseases they cause and therapies that may be used to treat them. Anatomical illustrations are captioned with the diseases' signs and symptoms.

Human Anatomy Flash Cards: Skeletal and Muscular Systems. This set of flash cards is a valuable and convenient tool designed to test and reinforce students' knowledge of the skeletal and muscular systems described in the text.

Daniel D. Chiras
Gerald, Missouri



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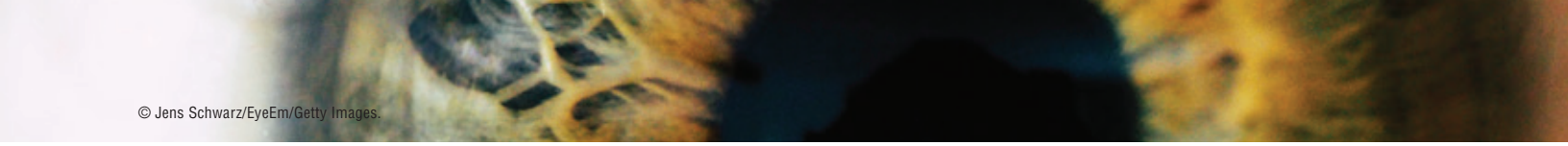


About the Author

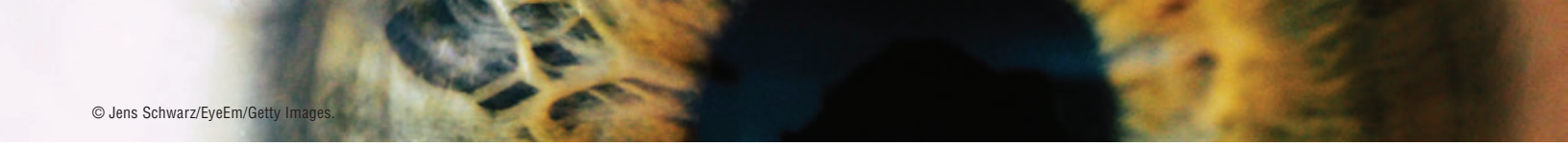
Dr. Chiras received his Ph.D. in reproductive physiology from the University of Kansas Medical School in 1976. In September 1976, Dr. Chiras joined the Biology Department at the University of Colorado in Denver in a teaching and research position. Since then, he has taught numerous undergraduate and graduate courses, including general biology, cell biology, histology, endocrinology, and reproductive biology. Dr. Chiras also has a strong interest in environmental issues and has taught a variety of courses on the subject. He has served as a visiting professor at Colorado College in Colorado Springs, Colorado and the University of Denver in Denver, Colorado. He is also the founder and director of The Evergreen Institute Center for Renewable Energy and Green Building, where he teaches classes on residential solar electricity, wind energy, home energy efficiency, self-sufficiency natural building, and more (www.evergreeninstitute.org).

Dr. Chiras is the author of numerous technical publications on ovarian physiology, critical thinking, sustainability, environmental education, green building, and renewable energy. He has also written numerous articles for newspapers and magazines on environmental issues. Dr. Chiras wrote the environmental pollution section for World Book's annual publication *Science Year in Review* from 1993 through 2012 and has written numerous articles on human biology and environmental issues for *World Book Encyclopedia, Encyclopedia Americana,* and *Grolier's Multimedia Encyclopedia*.

Dr. Chiras has published five college and high school textbooks, including *Environmental Science* (Jones & Bartlett Learning) and *Natural Resource Conservation: Management for a Sustainable Future* (with John P. Reganold and Oliver S. Owen; Prentice Hall).

Dr. Chiras's books include *Lessons from Nature: Learning to Live Sustainably on the Earth* (Island Press), *Study Skills for Science Students* (West) and *Essential Study Skills* (Brooks Cole). His books also include *The Natural House* (Chelsea Green), *The Solar House* (Chelsea Green), *The New Ecological Home* (Chelsea Green), *Superbia! 31 Ways to Create Sustainable Neighborhoods* (New Society), *EcoKids: Raising Children Who Care for the Earth* (New Society), *The Homeowner's Guide to Renewable Energy* (New Society), *Power from the Wind, Power from the Sun; Green Home Improvement; Wind Energy Basics;* and *Solar Electricity Basics* and *Games for the Classroom*, which he wrote with Ed Evans, Jr., his 9th grade physics and chemistry science teacher. His newest books include The Scoop on Poop, High-performance Off-Grid Chinese Greenhouses, Living Comfortably Off Grid, and Survive in Style.

Dr. Chiras enjoys biking, organic gardening, hiking, canoeing, and music. He lives on a 60-acre farm in Gerald, Missouri, in a passive solar home supplied by solar and wind power. He raises grass-fed beef and free-range ducks and chickens with his wife Linda.



Study Skills

College is a demanding time. For many students, term papers, tests, reading assignments, and classes require a new level of commitment to their education. At times, the workload can become overwhelming.

Fortunately, there are many ways to lighten the load and make time spent in college more fun and fruitful. This section offers some helpful tips on ways to enhance your study skills. It teaches you how to improve your memory, how to become a better note taker, and how to get the most out of what you read. It also helps you prepare better for tests and become a better test taker.

Mastering these study skills will require some work, mostly to break old, inefficient habits. In the long run, though, the additional time you spend now learning to become a better learner will pay huge dividends. Over the long haul, improved study skills will save you lots of time and help you improve your knowledge of facts and concepts. That will, no doubt, lead to better grades and very likely a more successful life.

General Study Skills

- Study in a quiet, well-lighted space. Avoid noisy, distracting environments.
- Turn off televisions and radios.
- Turn off your cell phone or return calls and text messages after your scheduled study time.
- Work at a desk or table. Don't lie on a couch or bed.
- Establish a specific time each day to study, and stick to your schedule.
- Study when you are most alert. Many students find that they retain more if they study in the evening a few hours before bedtime.
- Take frequent breaks—one every hour or so. Exercise or move around during your study breaks to help you stay alert.
- Reward yourself after a study session with a mental pat on the back or a snack.
- Study each subject every day to avoid cramming for tests. Some courses may require more hours than others, so adjust your schedule accordingly.
- Look up new terms or words whose meaning is unclear to you in the glossaries in your textbooks or in a dictionary.

Improving Your Memory

You can improve your memory by following the PMC method. The PMC method involves three simple learning steps: (1) paying attention, (2) making information memorable, (3) correlating new information with facts you already know.

Step 1 Paying attention means taking an active role in your education—taking your mind out of neutral. Eliminate distractions when you study. Review what you already know and formulate questions about what you are going to learn *before* a lecture or *before* you read a chapter in the text. Reviewing and questioning help prime the mind.

Step 2 Making information memorable means finding ways to help you retain information in your memory. Repetition, mnemonics, and rhymes are three helpful tools.

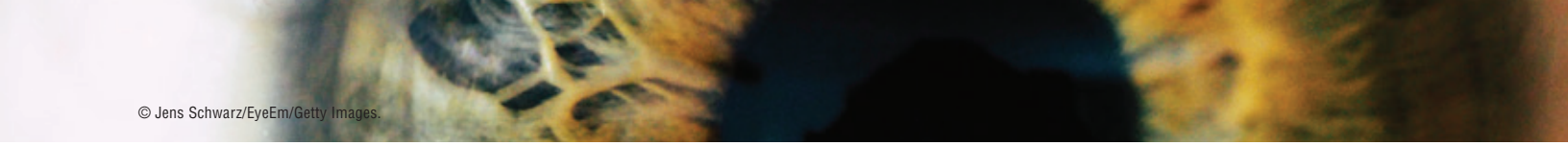
- Repetition can help you remember things. The more you hear or read something, the more likely you are to remember it, especially if you're paying attention. Jot down important ideas and facts while you read or study to involve all of the senses.
- Mnemonics are useful learning tools to help remember lists of things. I use the mnemonic CARRRP to remember the biological principles of sustainability: conservation, adaptability, recycling, renewable resources, restoration, and population control.
- Rhymes and sayings can also be helpful when trying to remember lists of facts.
- If you're having trouble remembering key terms, look up their roots in the dictionary. This often helps you remember their meaning.
- You can also draw pictures and diagrams of processes to help remember them.

Step 3 Correlating new information with the facts and concepts you already know helps tie facts together, making sense out of the bits and pieces you are learning.

- Instead of filling your mind with disjointed facts and figures, try to see how they relate with what you already know. When studying new concepts, spend some time tying information together to get a view of the big picture.
- After studying your notes or reading your textbook, go back and review the main points. Ask yourself how this new information affects your view of life or critical issues and how you may be able to use it.

Becoming a Better Note Taker

- Spend 5 to 10 minutes before each lecture reviewing the material you learned in the previous lecture. This is extremely important!
- Know the topic of each lecture before you enter the class and spend a few minutes reflecting on facts you already know about the subject about to be discussed.
- If possible, read the text before each lecture. If not, at least look over the main headings in the chapter, read the topic sentence of each paragraph, and study the figures. If your chapter has a summary, read it too.
- Develop a shorthand system of your own to facilitate note taking. Symbols such as = (equals), > (greater than), < (less than), w/ (with), and w/o (without) can



save lots of time so you don't miss the main points or key facts.
- Develop special abbreviations to cut down on writing time. "M" might stand for "muscle," "T" might be used for "trachea," and "NI" could be used to signify "nerve impulse."
- Omit vowels and abbreviate words to decrease writing time (for example: omt vwls & abbrvte wrds to dcrs wrtng tme). This will take some practice.
- Don't take down every word your professor says, but be sure your notes contain the main points, supporting information, and important terms.
- Watch for signals from your professor indicating important material that might show up on the next test (for example, "This is an extremely important point . . .").
- If possible, sit near the front of the class to avoid distractions.
- Politely ask your professor to repeat key points you didn't have a chance to jot down in your notes.
- Review your notes soon after the lecture is over while they're still fresh in your mind. Be sure to leave room in your notes written during class so you can add material you missed. If you have time, recopy your notes after each lecture.
- Compare your notes with those of your classmates to be sure you understood everything and did not miss any important information.
- Attend all lectures.
- Use a tape recorder if you have trouble keeping up.
- If your professor talks too quickly, politely ask him or her to slow down.
- If you are unclear about a point, ask during class. Chances are other students are confused as well. If you are shy, go up after the lecture and ask, or visit your professor during his or her office hours.

How to Get the Most Out of What You Read

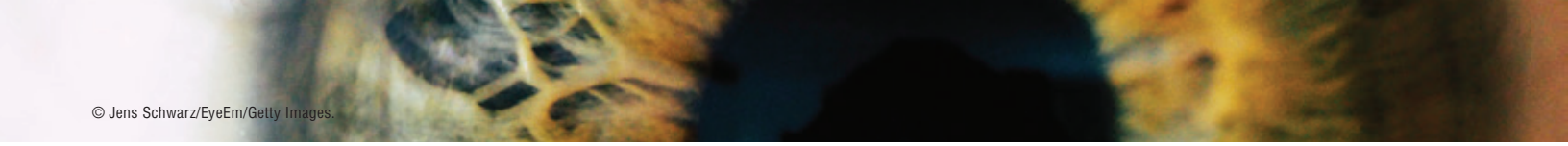
- Before you read a chapter or other assigned readings, preview the material by reading the main headings or chapter outline to see how the material is organized.
- Pause over each heading and ask a question about it.
- Next, read the first sentence of each paragraph. When you have finished, turn back to the beginning of the chapter and read it thoroughly.
- Take notes in the margin or on a separate sheet of paper. Underline or highlight key points. You can save a lot of time by simply putting a check mark at the beginning of key sentences.
- Don't skip terms that are confusing to you. Look them up in the glossary or in a dictionary. Make sure you understand each term before you move on.
- Use the study aids in your textbook, including summaries and end-of-chapter questions. Don't just look over the questions and say, "Yeah, I know that." Write out the answer to each question as if you were turning it in for a grade, and save your answers for later study. Look up answers to questions that confuse you. This book has questions that test your understanding of facts and concepts. Critical thinking questions are also included to sharpen your skills in this area.

Preparing for Tests

- Don't fall behind on your reading assignments.
- Review lecture notes as often as possible.
- If you have the time, you may want to outline your notes and assigned readings.
- Space your study to avoid cramming. One week before your exam, go over all of your notes. Study for two nights, then take a day off from that subject. Study again for a couple of days. Take another day off from that subject. Then make one final push before the exam, being sure to study not only the facts and concepts but also how the facts are related. Unlike cramming, which puts a lot of information into your brain for a short time, spacing will help you retain information for the test and for the rest of your life.
- Be certain you can define all terms and give examples of how they are used.
- You may find it useful to write flash cards to review terms and concepts.
- After you have studied your notes and learned the material, look at the big picture—the importance of the knowledge and how the various parts fit together.
- You may want to form a study group to discuss what you are learning and to test one another.
- Attend review sessions offered by your instructor or by your teaching assistant, but study before the session and go to the session with questions.
- See your professor or class teaching assistant with questions that arise during study.
- Take advantage of free or low-cost tutoring offered by your school or, if necessary, hire a private tutor to help you through difficult material. Get help quickly, though. Don't wait until you are hopelessly lost. Remember that learning is a two-way street. A tutor won't help unless you are putting in the time.
- If you are stuck on a concept, it may be that you have missed an important point in earlier material. Look back over your notes or ask your tutor or professor what facts might be missing and causing you to be confused.
- If you have time, write and take your own tests. Include all types of questions working with a couple other students will increase the value of this experience.
- Study tests from previous years, if they are available legally.
- Determine how much of a test will come from lecture notes and how much will come from the textbook.

Taking Tests

- Eat well and get plenty of exercise and sleep before tests.



- Try to remain calm during the test by deep breathing.
- Arrive at the exam on time or early.
- If you have questions about the wording of a question, ask your professor.
- Skip questions you can't answer right away, and come back to them at the end of the session if you have time.
- Read each question carefully and be sure you understand its full meaning before answering it.
- For essay questions and definitions, organize your thoughts on the back of the test before you start writing.

Now take a few moments to go back over the list. Check off those things you already do. Then, mark the new ideas you want to incorporate into your study habits. Make a separate list, if necessary, and post it by your desk or on the wall and keep track of your progress.

Part 1

Organization of Life: From Molecules to Humankind

U.S. Fish and Wildlife Service.

Principles of Human Biology, Science, and Critical Thinking

Three to four million years ago, humanlike organisms roamed the grasslands of Africa (Figure 1-1). Scientists dubbed them *Australopithecus afarensis* (aus-TRAL-owe-PITH-a-CUSS A-far-EN-suss). Standing only three feet tall and walking upright, these creatures, one of our early ancestors, subsisted in large part on a diet of roots, seeds, nuts, and fruits. Studies suggest that they supplemented their primarily vegetarian diet with **carrion**, animals that had been killed by **predators** or that had died from other causes. Our early ancestors also may have captured and killed animals for meat, but very likely were primarily gatherers and scavengers.

Learning Objectives

After reading and studying the material in this chapter, you will be able to understand, knowledgeably discuss, and, when appropriate, apply the information learned in this chapter, including:

1. What homeostasis is and why it is important to human health.
2. Different levels of homeostasis—organismic and ecosystem.
3. Why a clean, healthy environment is critical to maintaining homeostasis and human health.
4. What it means to be truly healthy.
5. What evolution is.
6. Common characteristics of all living organisms.
7. Factors that make humans unique among the living world.
8. The importance of science to our lives, including shaping our values.
9. How scientific knowledge is gained (the scientific method).
10. What critical thinking is and how one goes about critical thinking.

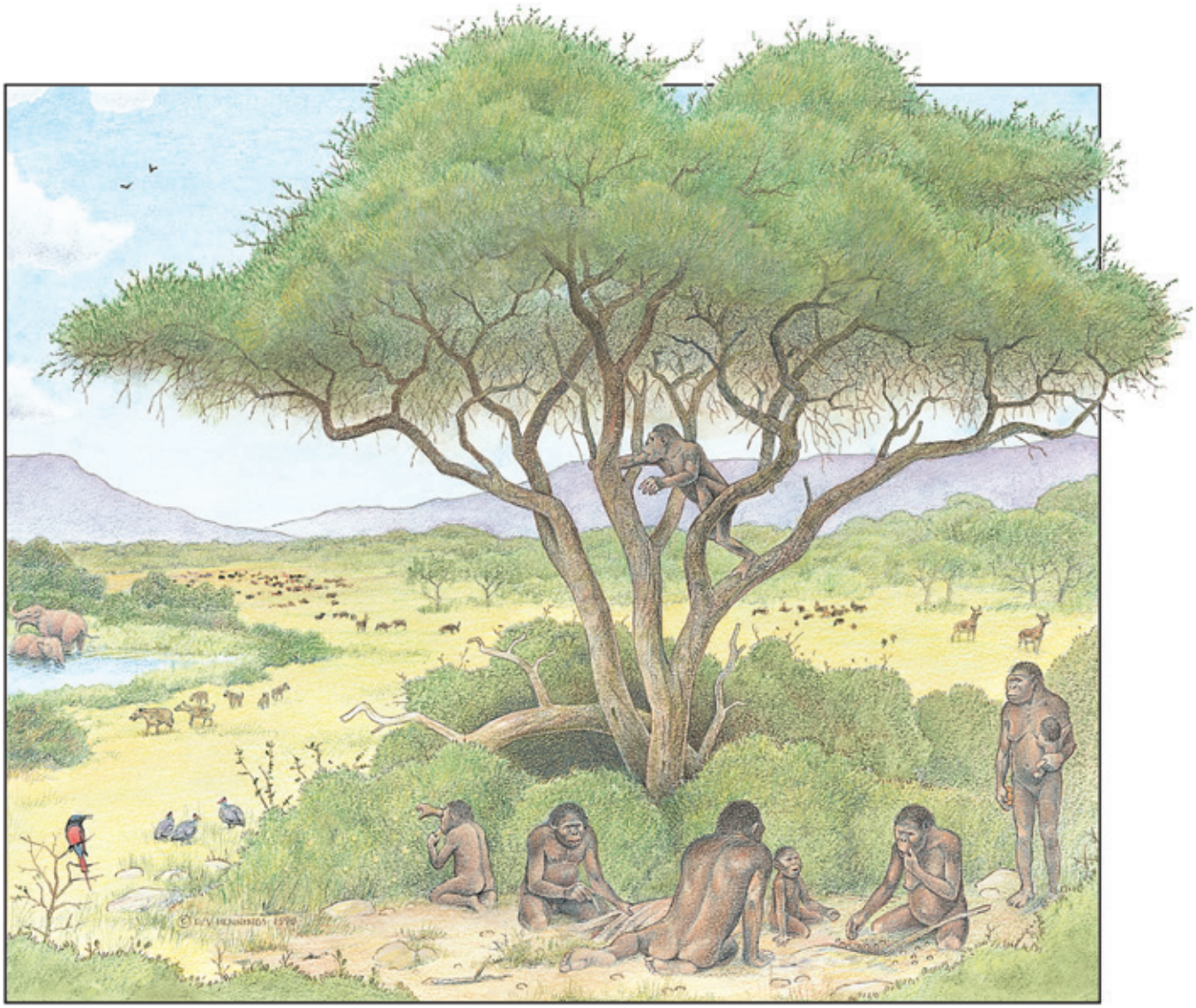


FIGURE 1–1 Australopithecus afarensis Current scientific evidence suggests that *A. afarensis* was the first humanlike ape. Its skeletal remains indicate that it walked upright.

Weak and slow compared to other large animals, our early ancestors could have easily ended up as an evolutionary dead end. Fortunately, though, they possessed several anatomical features that tipped the scales in their favor. Undoubtedly, one of the most important characteristics was their brain.

Thanks in large part to our brains, human beings have not only survived but flourished. Today, humans inhabit a world of marvelous technologies, which make our lives easier, more convenient, and more fun. Rather than roaming in small bands, as our early ancestors did, the majority of the world's people today live in cities and towns that offer amenities our ancestors never would have dreamed possible. Rather than collecting nuts and berries from the plants around us, most people in the modern world purchase their food from grocery stores supplied by highly mechanized farms. Many farmers are now using satellites and remote sensing devices as well as computerized machinery to produce food for the more than seven billion human inhabitants. Today, thanks to advances in genetics, scientists have begun to alter the genetic material of the cells of plants and animals to increase food production. They have even developed tissues and organs that could be transplanted into human beings, replacing worn out or damaged body parts. Scientists have even begun to manipulate our hereditary material in an attempt to cure diseases long thought to be untreatable.

For better or for worse, humans have become a major player in evolution, a process of genetic change that results in structural, functional, and behavioral changes in groups of organisms known as populations. These changes, in turn, result in organisms better equipped to cope with their environment—that is, better able to survive and reproduce.

From most perspectives, the human experiment has been an overwhelming success. However, a growing body of evidence shows that human success has its price. As society

advances, we are also causing considerable damage to the life-support system of the planet upon which we—and all other species—depend. Some changes, scientist warn us, are already affecting human health and well-being.

Like other texts on human biology, the bulk of this book will take you on a very important journey through the human body, while demonstrating many practical applications. On this journey, you will learn a great deal about yourself—how you got here, how you inherited certain characteristics from your parents, and how your body functions. You will learn how broken bones mend and study the basics of nutrition. You will discover how your immune and nervous systems operate. You will learn about many common diseases and—more important—how to prevent them. In the HealthTip boxes like the one on this page, you will learn about the many things you can do to live a long and healthy life.

As you will soon see, the information you learn from this book will prove useful to you in many ways. It will also help you understand important political debates over issues such as genetic engineering, stem cell research, vaccination, and even energy and pollution. It will help you understand injuries and diseases from which you and your loved ones might suffer. Human biology is also a fascinating subject. As you proceed through this book, be sure to take time to marvel at the human body—the intricate details of the cell, the structure and function of organs, and the intriguing manner in which the various parts work together.

HealthTip 1-1

To learn more quickly, perform better in school, live a more emotionally stable life, and reduce your chances of getting sick, be sure to get plenty of sleep.

Why?

Inadequate sleep not only impairs memory, it makes it more difficult to learn. Inadequate sleep can also result in emotional instability and lowers immune defenses, increasing the likelihood that you will contract the common cold or the flu. Lack of sleep is one reason why college students often suffer from one cold after another.

1-1 Health and Homeostasis

Most of us want to live a long, healthy life. Human health depends on numerous biological mechanisms that evolved over many millions of years. These internal biological processes help to maintain a fairly constant internal condition within our bodies, a state often referred to as **homeostasis** (home-e-oh-STAY-siss).

What Is Homeostasis?

The term homeostasis comes from two Greek words, homeo, which means "the same," and stasis, which means "standing." Literally translated, homeostasis means "staying the same." Some people refer to homeostasis as a state of internal constancy. In reality, however, homeostasis is not a static state; it is a dynamic (ever-changing) state. To understand what I mean, consider a familiar example, body temperature.

Humans are warm-blooded creatures. What that means is that we generate body heat internally and thus maintain a fairly constant body temperature—about 37°C (98.6°F). If you were to measure your body temperature through the day, however, you would find that it varies. Body temperature, for instance, falls slightly at night when you are asleep and rises during daylight hours. It increases even more—sometimes a lot more—when you participate in strenuous physical activity.

Like many other internal conditions, then, body temperature fluctuates within a range. This is what is meant when we say that body temperature is in homeostasis: It changes a bit from time to time, but remains more or less constant.

Homeostasis is achieved through a variety of automatic mechanisms that compensate for internal bodily changes and external changes—changes in our environment (Figure 1-2). Homeostatic mechanisms require **sensors**, structures that detect internal and external change—for example, temperature sensors in the skin that keep track of air temperature. These sensors elicit a response that offsets the change, helping to maintain a fairly constant state. On very cold days, for example, sensors in our skin detect the cold, chilly air. If it is cold enough, they stimulate shivering, a rhythmic contraction of muscles that generates body heat, compensating for low temperatures. This is just one of many homeostatic mechanisms in our bodies.

Homeostatic mechanisms also maintain fairly constant levels of nutrients as well as other chemicals like salts and hormones in our blood. Maintaining constant levels of dozens of chemicals within our bodies is vital for maintaining human health, survival, and reproduction.

Homeostatic mechanisms also exist in ecosystems. An **ecosystem** is a biological system consisting of organisms and their environment. Homeostatic mechanisms help achieve balance in ecosystems.

FIGURE 1-2 **Keeping Warm** The human body is remarkably able to tolerate a wide variety of conditions thanks to mechanisms that maintain relatively constant internal conditions. (© cglade/iStock/Getty Images.)

FIGURE 1–3 Predator Control Foxes play an important role in controlling rodent populations, thus helping to maintain ecosystem homeostasis. (© rpbirdman/iStock/Getty Images.)

A highly simplified example illustrates the point. In the grasslands of Kansas, rodent populations generally remain fairly constant from one year to the next. This phenomenon results, in part, from predators—animals that hunt and kill other organisms. Predators such as snakes, coyotes, foxes, and hawks feed on rodents and, thus, help to control rodent populations (Figure 1-3).

Although predators are a crucial element in maintaining environmental homeostasis in these grasslands and virtually all other natural systems, a host of other factors also contribute to it, such as weather and food supplies. It is the net effect of these factors that determines population sizes.

In this book, the term homeostasis is used to refer to the balance that occurs at all levels of biological organization—from cells to organisms to ecosystems. The abundance of homeostatic mechanisms in nature suggests their importance to life on Earth. These mechanisms are just one of the many positive outcomes of **evolution**.

Maintaining "balance" is essential to the health and welfare of all organisms, humans included, at many levels. Without it, cells would fall into disarray, organisms would perish, and ecosystems would collapse.

KEY CONCEPTS

Homeostasis is a state of relative constancy that helps to ensure human health; it is achieved automatically by numerous physiological processes in the body that respond to internal and external changes.

Healthy Environments

As you might suspect, the health of our environment and the health of the organisms that live in the environment, including us human beings, are closely linked. Changes in the chemical composition of the air we breathe caused by pollution, for instance, can have significant negative impacts on human health. Only recently, scientists discovered that certain emissions from trucks, buses, cars, and coal-fired power plants (called polycyclic aromatic hydrocarbons, or PAHs) can result in lower birth weight and impaired mental development in young children who were exposed while still in their mother's womb.

The health of an organism is also affected by less tangible, but very real, changes in our social and psychological environment. Highly stressful environments, for example, can lead to more frequent colds and other serious ailments. *Health and Homeostasis* sections in this text outline some of the connections between human health and the health of our environment.

Although humans are the central focus of this text, it is important to note that many of the species that share this world with us are affected by the condition of the environment. Scientists, for instance, are finding that many drugs that people take, such as those chemicals found in birth control pills, are excreted in their urine and end up in the effluent of sewage treatment plants. From there, they enter rivers, lakes, and streams. These chemicals are having profound effects on the growth, reproduction, and survival of aquatic species, especially fish. Scientists are concerned that one class of chemicals, antibiotics, in our waterways such as lakes and streams could result in antibiotic-resistant bacteria. Humans who ingest these bacteria in drinking water could become deathly ill. Doctors worry that they won't have antibiotics to treat the resistant strains. An even greater problem might be the extensive use of antibiotics—and lots of them—in the production of poultry and livestock for human consumption.

KEY CONCEPTS

Human health depends on a healthy chemical, physical, and psychological environment.

Dimensions of Health

For many years, human health was defined as the absence of disease (Figure 1-4a). As long as a person had no obvious symptoms of a disease, that person was considered healthy. Although such a person might have had clogged arteries from a lifetime of fatty hamburgers and snack foods, it wasn't until symptoms of heart disease—for example, chest pain—became apparent that the patient was considered unhealthy.

HealthTip 1-2

To lose or maintain weight, eat larger portions of vegetables and whole grains and cut way back on meat and fats.

Why?

Vegetables and whole grains contain a lot less fat—and, therefore, fewer calories—than meats. Whole grains, surprisingly enough, also contain proteins that your body needs. Vegetables provide many nutrients not found in meats that the body requires for long-term health. Vegetables also contain fiber that is important for health. Remember, only a small portion of meat is needed to satisfy the body's need for protein.

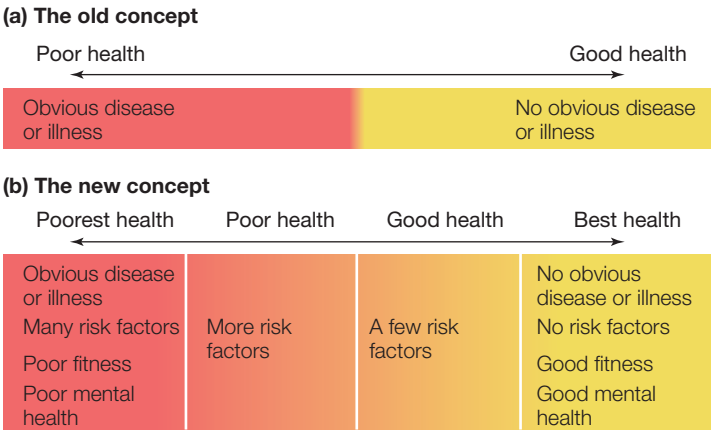


FIGURE 1–4 Old and New Concepts of Health (Left, © Caiaimage/Paul Bradbury/OJO+/Getty Images; Right, © Aleksandr Fostic/Shutterstock.)

Today, health experts rely on a more comprehensive definition of health. It takes into account *both* physical and emotional well-being.

Physical health refers to the state of the body—how well it is working. We can measure physical health by checking temperature, blood pressure, blood sugar levels, and a number of other variables. Abnormalities in these measurements might be a signal that one's physical health is in jeopardy, even though there are no obvious symptoms of illness. Medical scientists use the term **risk factor** to refer to abnormal conditions such as high blood pressure or high blood cholesterol levels that put a person at risk for disease. The presence of one or more risk factors is a sign of less-than-perfect health. Obviously, the more risk factors there are, the worse one's physical health is (Figure 1-4b).

As shown in Figure 1-4b, the absence of risk factors indicates the best health. A few risk factors indicate that your health is less than optimum—just good. More risk factors indicate your health is poor. Even in poor health, you might not exhibit any symptoms—at least not yet. A friend of mine who exhibited no signs of heart disease at age 50 put her children to bed, went downstairs to the couch, and then suffered a fatal heart attack. Under the new and more realistic concept of health, then, even though you might feel okay and not exhibit obvious signs of disease, such as a failing heart, the presence of risk factors indicates that your health is compromised.

Scientists also use the term risk factor to refer to activities that make an individual more likely to develop diseases. Smoking, lack of exercise, and a high-meat, fat-rich, low-vegetable diet, for example, are risk factors for heart and artery disease. Many people today lack exercise and eat poorly, putting them at risk for a wide assortment of diseases, including heart attack and late-onset diabetes.

Physical health is also measured by one's level of physical fitness. If you can't walk up a set of stairs without gasping for air, you're not considered very physically fit. You're more likely to have other problems later in life—for example, heart disease.

Emotional well-being also factors into an assessment of a person's health. Especially relevant is your ability to cope with stress. Inability to cope can lead to physical problems, such as high blood pressure and heart disease.

Mental and physical fitness are measures of our abilities to meet the demands of life. Fit people are able to cope with daily psychological stresses and are able to move about without becoming short of breath. They're also better employees, less likely to take days off because of illness. For that and other reasons, some companies are now paying employees to adopt more healthy lifestyles. IBM, for instance, offers financial incentives to employees who exercise, lose weight, and stop smoking. Some employees receive an extra $600 a year in incentives for pursuing a path to a healthier life. Why would a company do this?

IBM estimates that for every dollar it spends on promoting wellness, it saves $3 in health care costs. Employees require much less sick time, too, which enhances productivity. Currently, more than half of IBM's workforce has signed up for the program. Maintaining good health is a lifelong job that is best begun early in life, but it is never too late to steer onto a healthy path. Table 1-1 lists numerous healthy habits. By incorporating these habits into your lifestyle, you can increase your chances of living a long, healthy life. You might want to begin slowly, incorporating one idea after another.

HealthTip 1-3

Regular exercise is essential to good health, so, try to get at least 30 minutes of aerobic exercise (running, riding a bike, or swimming) at least three times a week. More is better.

Why?

Exercise helps us maintain a healthy weight. Being overweight increases the risk of many diseases, from heart attack and stroke to late-onset diabetes, to breast cancer in women. It is important to remember that exercise burns calories directly but also builds muscle mass. Muscle has a higher metabolic rate than fat, and it continues to burn calories after we're done exercising, providing prolonged benefits! The cool thing about staying in shape is you might be able to eat more and not gain weight!

TABLE 1-1 Healthy Habits

Sleep seven to eight hours per day*
Eat a healthy breakfast every day
Eat a healthy diet with lots of fruits and vegetables
Avoid snacking on junk food (sweets or fatty foods) between meals
Maintain ideal weight
Do not smoke
Avoid alcohol or use it moderately
Exercise regularly
Manage stress in your life

*Not all people need this much sleep. If you're one of them, don't try to force yourself to sleep more than you need.

KEY CONCEPTS

Human health is a state of physical and mental well-being characterized by absence of disease and risk factors that could lead to problems in the future.

Health and Homeostasis

As just pointed out, your mental and physical health depends on homeostatic mechanisms. When these mechanisms are out of whack or break down completely, illness results. Persistent stress, for example, can disrupt several of the body's homeostatic mechanisms, leading to disease. It also weakens the immune system, making us more prone to viruses and bacteria. According to a recent study, people under stress are twice as likely to suffer from colds and the flu as those who are not. If it is prolonged, stress can increase the risk of diseases of the heart and arteries. Fortunately, stress can be dramatically reduced by exercise, relaxation training, massage, acupuncture, and a number of other measures discussed in HealthNote 1-1.

KEY CONCEPTS

Human health is dependent on properly functioning homeostatic systems; damage to these systems lead to many common diseases.

1-2 Evolution and the Characteristics of Life

Life is an amazing product of evolution. All living things are made up of chemical compounds, both organic and inorganic. As shown in Figure 1-5, these compounds are made up of atoms. Atoms are made up of subatomic particles, specifically electrons, protons, and neutrons, a subject you will study in more detail in Chapter 2. Organic molecules and inorganic compounds, in turn, are the main components of cells. Cells, themselves, are the building blocks of organs like the heart and lungs. Organs are typically organized into organ systems like the respiratory and digestive systems. All of these organ systems make up living organisms like you and me.

Organisms, in turn, form populations that mingle with populations of other organisms—for example, people live among birds, plants, and fish. Together, they form biological communities. A biological community consists of living organisms as well as the chemical and physical environment.

HealthNote 1-1 Maintaining Balance: Reducing Stress in Your Life

Stress is a normal occurrence in everyday life. But just what is it?

Stress is a psychological and physical reaction people have when we are exposed to certain stimuli. Stress can be elicited by non–life-threatening situations such as a blind date or a final exam. It also can be caused by potentially life-threatening situations such as exposure to dangerous machinery in a factory.

Stressful stimuli can be real or imagined. Either way, they elicit the same response in the body: an increase in heart rate, an increase in blood flow to the muscles and a decrease in blood flow to the digestive system, a rise in blood sugar (glucose), and a dilation of the pupils of the eyes. These physical changes in the body help us to respond to the stress. They can, for instance, help us flee from a stressful stimulus. After the stimulus is gone, though, the body typically returns to normal.

How stress affects us, however, depends on how long we're exposed to it. If the stressful stimulus is short-lived, our bodies recover nicely. Some argue that a little stress might actually improve a person's performance.

Long-term exposure to stressful stimuli, however, can have serious consequences. As a result, a prolonged period of stress might lead to disease. One reason this happens is that the body's immune system is often depressed by stress. The immune system protects us from bacteria and viruses that cause colds and flu and other diseases. Prolonged stress also results in changes in the blood vessels. These changes can accelerate the accumulation of cholesterol, which clogs the arteries and can eventually result in strokes and heart attacks.

Stress doesn't affect all people in the same way. Some people recognize the stress they're feeling and channel its energies into productive work. They are better able to cope with stress. Psychologists believe that people who handle stress the best have a sense of being in control, despite the stress of their work. They typically have clear objectives and a strong sense of purpose. They view their jobs and life as a challenge, not a threat.

Unfortunately, not all people are so lucky. Many of us are not in a position of control; we feel expendable and often view ourselves as victims. What can be done to deal with stress?

One of the most important strategies is preventive: selecting an environment and creating a lifestyle that is as stress-free as possible. As a college student, for instance, you might want to select a realistic class load. If you must work to pay your way through college or if you're taking very difficult courses like physics or chemistry, sign up for a lighter class load—one you can handle more easily. Coping with stress might also require physical and mental strategies. Let's consider the physical strategies first.

(continues)

(*continued*)

One of the easiest ways to lessen the impact of stress is exercise. Studies show that a single workout at the gym, a bike ride, a swim, or going skiing reduces tension for 2 to 5 hours. A regular exercise program, however, reduces the overall stress in one's life. Individuals who are easily stressed usually find that stress levels decline after two weeks of aerobic exercise.

Exercise can be supplemented by relaxation training. As you prepare for a difficult test or get ready for a date that you are nervous about, tension often builds in your muscles. Periodically stopping to release that tension helps to reduce physical stress. Stretching or taking a walk can help. Some people find it useful to tighten their muscles forcefully and then let them relax. Massage therapy and acupuncture can also be used to reduce stress. Stress-reduction programs on CDs, videos, and DVDs can teach relaxation methods, as can trained therapists.

Psychological factors can also play a role in stress. In many instances, people have an exaggerated response to a stressful stimulus. Dealing with the thoughts that exaggerate your stress can help you better control your stress. Start paying attention to the thoughts that provoke anxiety in your life. Are they exaggerated? If so, why? For example, are you nervous before exams? Why? Would better preparation reduce your anxiety? You might remind yourself that you've been through stressful situations before and always triumphed. This could help you better cope with stress.

Finding the source of your anxiety and taking positive action to alleviate it are helpful ways of reducing stress. However, stress reduction is not always easy. Test anxiety, for example, might be deeply rooted in feelings of inadequacy. Many people struggle with low self-esteem. A trained psychologist can help you find the causes and assist you in learning to feel better about yourself. Psychological help is as important as medical help these days, given the complexity and pace of our society. There is no shame in seeking counseling.

Meditation has also been shown to be highly effective in reducing stress when regularly practiced. Numerous scientific studies of transcendental meditation indicate that the benefits go beyond relieving chronic stress and anxiety. It helps reduce insomnia, high blood pressure, heart attack, and stroke (Figure 1). Transcendental meditation is practiced by many noteworthy individuals including Ellen DeGeneres, Jim Carey, and Jerry Seinfield.

Biofeedback is another form of stress relief. A trained healthcare worker places sensors on you and connects them to a machine that monitors heart rate, breathing, muscle tension, or some other physiological indicator of stress. During a biofeedback session, your trainer first will help you relax, and then discuss a stressful situation. When one of the indicators shows that you are suffering from stress, a signal is given off. Your goal is to consciously reduce the frequency of the signal. For example, if your heart started beating faster when you thought about taking an exam, the machine will make a clicking sound. By breathing deeply and relaxing, you consciously slow down your heart rate; at that point the clicking sound slows down and then disappears.

FIGURE 1 **Meditation** Student.
(© m-imagephotography/iStock/Getty Images.)

Learning to recognize the symptoms of stress and to counter them is the goal of biofeedback. Eventually, you should be able to do it without the aid of a machine.

You can also reduce tension by managing your time and your workload efficiently. Numerous books on this subject can help you learn to budget your time more effectively. See the Study Skills section at the beginning of this book for ideas on ways to be a more efficient learner. These ideas, for example, could help you prepare better for exams, making you more confident on test day.

If these techniques don't work, you might want to see a doctor, who can prescribe medications that relieve anxiety and muscle tension, help you sleep, or combat depression. Herbal remedies such as valerian root are also available.

Relieving stress in our lives helps us reduce the risk of disease and enables us to relax and enjoy life. It also makes us more pleasant to be around. All in all, it is best to begin learning early in life how to reduce or cope with stress. Lessons learned now will be useful for many years to come.

Large relatively uniform areas occupied by a common set of organisms is known as a **biome**. Deserts and grasslands are examples of biomes. Together all the biomes of planet earth (also called life zones), including aquatic ones, form the living skin of planet earth: the **biosphere**.

Maintaining life in this complex assemblage of organisms is possible in large part because of intricate stabilizing mechanisms that evolved over several billions of years. These mechanisms help maintain conditions suitable for organisms. Maintaining conditions conducive to life exist at the cellular, organismic, and environmental levels, and are known as *homeostasis*.

Homeostasis is a central theme of this book because it is so essential to maintaining health and to the continuation of life. It is also important because so many human activities upset homeostatic mechanisms—to the detriment of humans and all living beings. Another key concept of biology and a subtheme of this book is evolution. A few words on the subject are essential to your understanding of human biology.

All life forms alive today exist because of evolution. In fact, every cell and every organ in the human body is a product of millions of years of evolution. As just noted, even the intricate homeostatic mechanisms evolved over long periods. How did life evolve?

If you watch any of the amazing animal or nature programs on television these days, you have undoubtedly discovered that life exists in a profusion of forms. For example, you've no doubt seen that there are plants, animals, and fungi. There are also many single-celled organisms. Each of

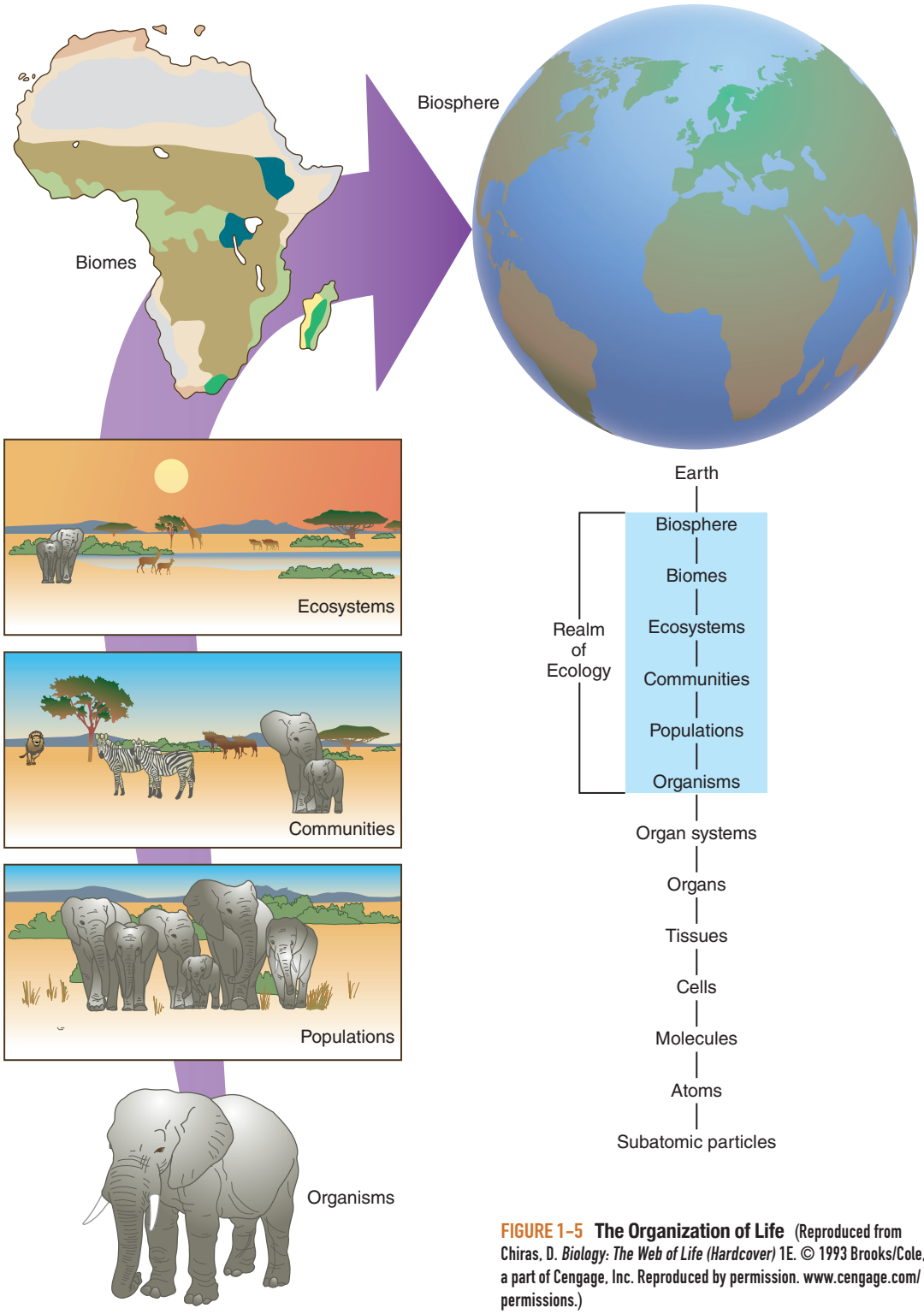


FIGURE 1–5 The Organization of Life (Reproduced from Chiras, D. *Biology: The Web of Life (Hardcover)* 1E. © 1993 Brooks/Cole, a part of Cengage, Inc. Reproduced by permission. www.cengage.com/permissions.)

these groups consists of a diverse array of species—often colorful, sometimes bizarre, and always intriguing.

Biologists who classify organisms by common characteristics have divided the living world into three broad groups, which they call **domains**, as illustrated in Figure 1–6. All organisms belong to one of these three groups.

Humans, for instance, belong to the domain given the name Eukarya. This domain gets its name because all the organism are **eukaryotes** (you-care-E-oats). What that means is that these organisms are made of cells that have true nuclei; that is, nuclei bounded by membranes. The nuclei are organelles where the genetic material (DNA) resides.

Within this domain are four **kingdoms**:

- *Protists* Single-celled organisms like amoebas.
- *Plants* Photosynthetic organisms like flowers, trees, and grasses.
- *Fungi* Organisms like toadstools and mushrooms.