

Human BIOLOGY

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Daniel D. Chiras

The Evergreen Institute
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Jones & Bartlett Learning
5 Wall Street
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978-443-5000
info@jblearning.com
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**Dedicated to my two sons, Skyler and Forrest,
who continue to amaze me with their love, talent, and wisdom.**



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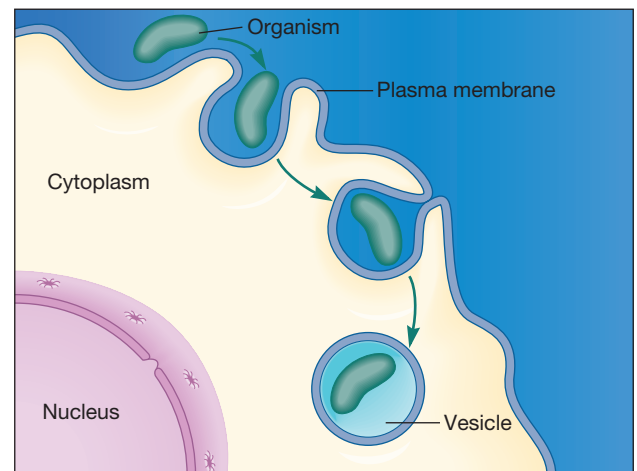
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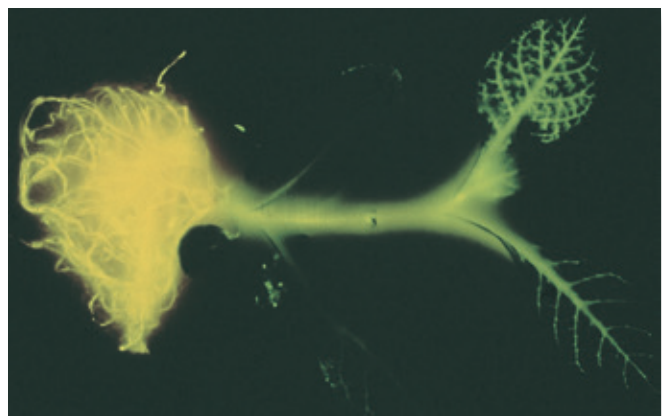
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Preface

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.

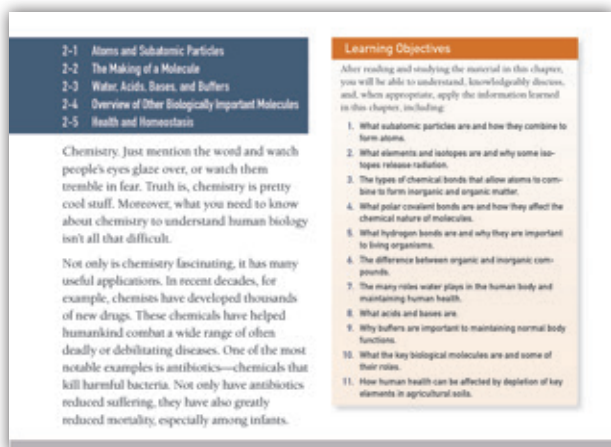
- Organization of life
- How evolution works
- Domains and kingdoms
- Cool laser fat removal
- HealthNote: Eating a Healthy Diet
- Bone formation and elongation
- Muscle groups
- Flexion and extension
- Autonomic nervous system
- Common recreational drug use
- Brachial and cervical plexuses
- Sacral 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.



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

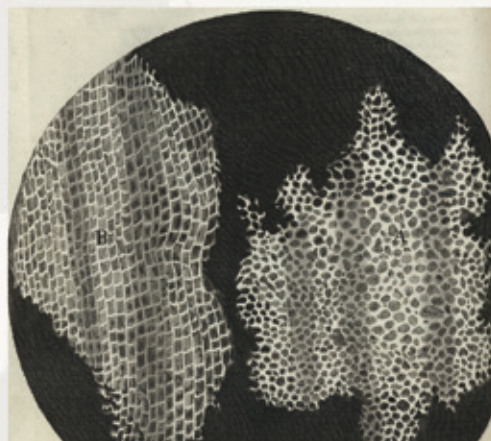
3-1 The Discovery of Cells

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

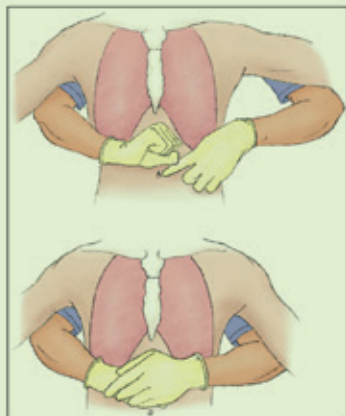
Thanks to improvements in medicine, people are living longer. You may have heard this statement dozens of times in one form or another. It is repeated so often that most of us believe it implicitly. But is it true? Are people really living longer than they used to?

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 the mouth and nose of the



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

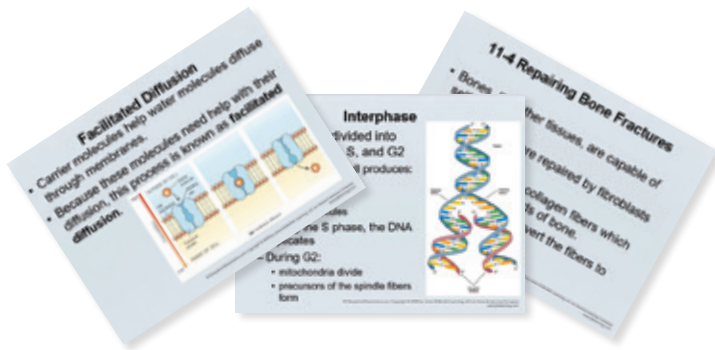
Human Biology contains a remarkable collection of illustrations and photographs to bring each concept to life before your eyes. In this edition, my publisher and I have revised many illustrations to enhance the visual and educational experience you'll have with the book.

Teaching Tools

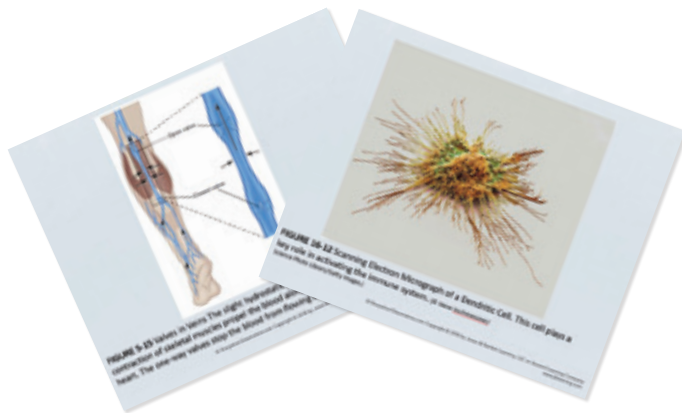
Jones & Bartlett Learning offers an impressive variety of traditional print and interactive multimedia supplements to assist instructors and to aid students in mastering human biology. Additional information and review copies of any of the following items are available through your Jones & Bartlett Learning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

Acknowledgments

A project of this magnitude is the fruit of a great many people. I wish to thank the thousands of scientists and teachers who have contributed to our understanding of human biology. A special thanks to the extraordinary teachers who have made tremendous contributions to my education, especially the late Weldon Spross, Ed Evans, the late Dr. H. T. Gier, the late Dr. Gilbert Greenwald, the late Dr. Howard Matzke, and Dr. Douglas Poorman. Their teaching techniques made me a better teacher and textbook author, and for that I'm extremely grateful.

I am also deeply indebted to many people for their assistance during the writing of this book. A great debt of gratitude goes to the folks at Jones & Bartlett Learning. Many thanks to those who assisted with the production of the book, including my talented editor Matt Kane, associate editor Audrey Schwinn, production editor Dan Stone, photo researcher Wes DeShano, copyeditor Charlotte Zuccarini, proofreaders

Elizabeth Hamblin and Linda DeBruyn, and artist Troy Liston. I greatly appreciate the efforts of the Jones & Bartlett Learning account specialists who have helped make this book a success. It has been a pleasure and an honor to have worked with such a fine and talented group of people.

Throughout this time, my two delightful sons, Skyler and Forrest, have offered considerable support and a counterbalance to the stresses and strains of a project of this magnitude. You're the light of my life, guys. A world of thanks to my sweetheart, Linda, for her continuous support, inspiration, guidance, and unwavering love.

Finally, a special thanks to all the reviewers on this and previous editions who offered many useful comments throughout this project. Their insight and attention to detail have been greatly appreciated. Below is a list of those who have reviewed the manuscripts.

- | | | |
|---|---|---|
| D. Darryl Adams, Mankato State University | John Cummings, Waynesburg College | Charles Mays, DePauw University |
| Donald K. Alford, Metropolitan State College | Jeffrey Dean, Vanderbilt University | David Mork, St. Cloud State University |
| David R. Anderson, Pennsylvania State University–Fayette Campus | Debby Dempsey, Northern Kentucky University | Donald J. Nash, Colorado State University |
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| Richard Crosby, Treasure Valley Community College | | Jay Zimmer, Gardner-Webb University |

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 dcrr 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.