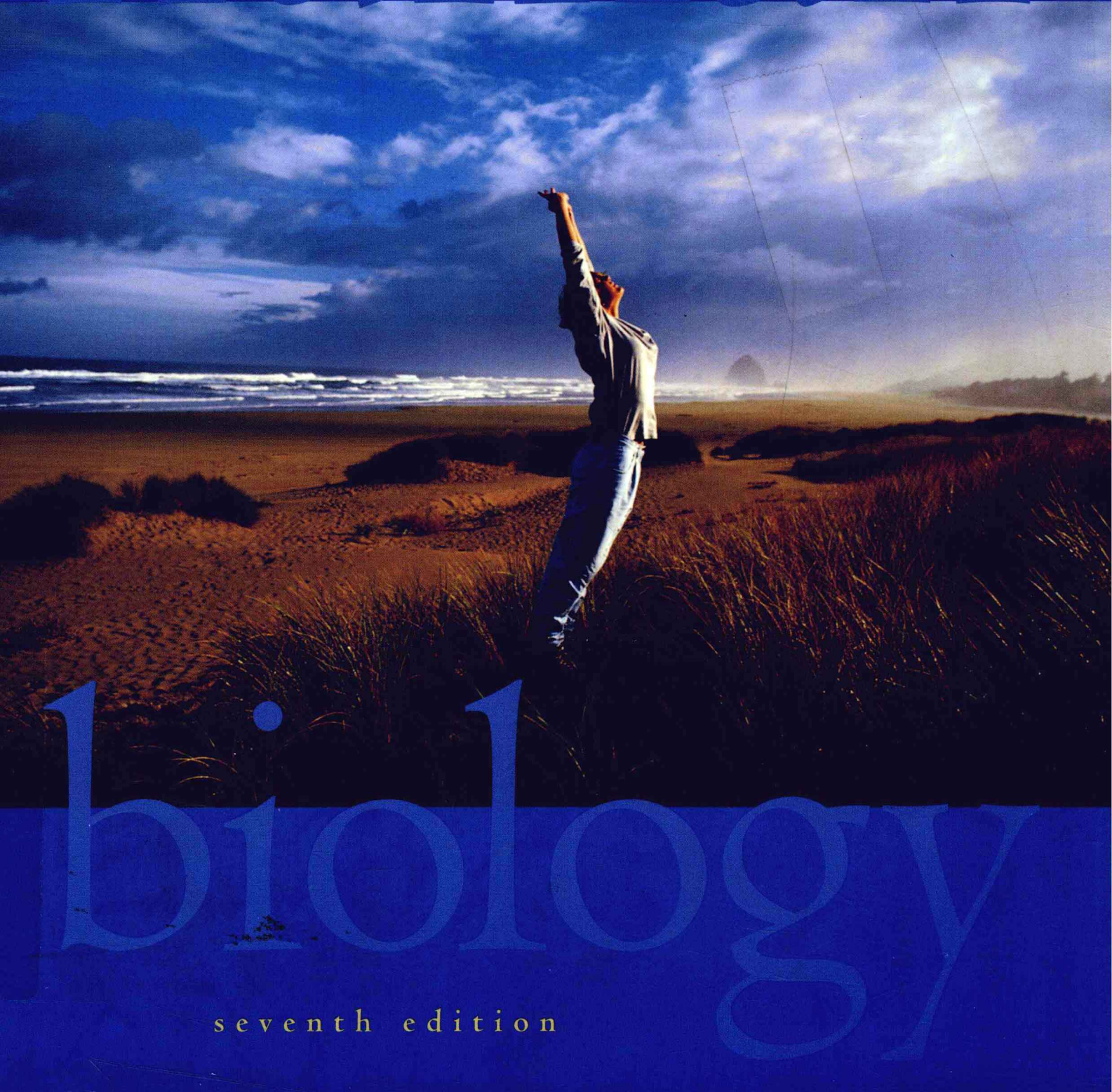


sylvia s. mader

human



biology

seventh edition



# human biology

seventh edition

sylvia s. mader



Boston Burr Ridge, IL Dubuque, IA Madison, WI New York  
San Francisco St. Louis Bangkok Bogotá Caracas Kuala Lumpur  
Lisbon London Madrid Mexico City Milan Montreal New Delhi  
Santiago Seoul Singapore Sydney Taipei Toronto

# McGraw-Hill Higher Education

A Division of The McGraw-Hill Companies

HUMAN BIOLOGY, SEVENTH EDITION

Published by McGraw-Hill, a business unit of The McGraw-Hill Companies, Inc.,  
1221 Avenue of the Americas, New York, NY 10020. Copyright © 2002, 2000, 1998, 1995, 1992, 1990, 1988 by The McGraw-Hill Companies, Inc.  
All rights reserved. No part of this publication may be reproduced or distributed in any form or by any means,  
or stored in a database or retrieval system, without the prior written consent of The McGraw-Hill Companies, Inc.,  
including, but not limited to, in any network or other electronic storage or transmission, or broadcast for distance learning.

Some ancillaries, including electronic and print components, may not be available to customers outside the United States.



This book is printed on recycled, acid-free paper containing 10% postconsumer waste.

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

ISBN 0-07-232481-3

ISBN 0-07-112245-1 (ISE)

Sponsoring editor: *Patrick E. Reidy*  
Developmental editor: *Anne L. Melde*  
Senior marketing manager: *Lisa L. Gottschalk*  
Senior project manager: *Jayne Klein*  
Senior production supervisor: *Sandy Ludovissy*  
Designer: *K. Wayne Harms*  
Cover designer: *Kaye Farmer*  
Cover image: *PhotoDisc Volume 38 Weekend Living*  
Senior photo research coordinator: *Lori Hancock*  
Photo researcher: *Connie Mueller*  
Supplement producer: *Tammy Juran*  
Executive producer: *Linda Meehan Avenarius*  
Compositor: *GTS Graphics, Inc.*  
Typeface: *10/12 Palatino*  
Printer: *Quebecor World Dubuque, IA*

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

## Library of Congress Cataloging-in-Publication Data

Mader, Sylvia S.

Human biology / Sylvia S. Mader. — 7th ed.

p. cm.

Includes bibliographical references and index.

ISBN 0-07-232481-3

1. Human biology. I. Title.

QP36 .M2 2002

612—dc21

00-136453

CIP

INTERNATIONAL EDITION ISBN 0-07-112245-1

Copyright © 2002. Exclusive rights by The McGraw-Hill Companies, Inc., for manufacture and export.

This book cannot be re-exported from the country to which it is sold by McGraw-Hill.

The International Edition is not available in North America.



# Preface

---

**H**uman Biology introduces students to the anatomy and physiology of the human body. All systems of the body are represented and each system has its own chapter. The text can also be used to help students understand the role that humans play in the biosphere. All of us need to realize how human activities threaten ecosystems, and seek ways to lessen our impact on the biosphere.

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

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

## Pedagogical Features

*Human Biology* excels in pedagogical features. Each chapter begins with an integrated chapter outline that lists the chapter's concepts according to numbered sections of the chapter. This numbering system is continued in the chapter and summary so that instructors can assign just certain portions of the chapter, if they like.

The text is paged so that major sections start at the top of the page and illustrations are on the same or facing page to their reference. The illustrations are visually motivating, and the art program has many features that students will find helpful. Color coordination includes assigning colors to the various classes of organic molecules and to the different human tissues and organs. Visual focus illustrations give a conceptual overview that relates structure to function.

The questions at the end of the chapter are of both the essay and objective type. Studying the Concepts reviews the content of the chapter and requires that students write out their answers. Testing Your Knowledge of the Concepts includes multiple choice questions, fill in the blanks, and true-false questions. Understanding Key Terms lists the major terms in the chapter and page references the term to where it is defined in the chapter.

## Revised Chapters

Every chapter in *Human Biology* has been revised or is new. The systems chapters have been fine-tuned and the illustrations in these chapters have been improved to better present the concepts. Students should have no difficulty in following the text, understanding the concepts, and applying them to their everyday lives.

Part VII of the text contains new chapters. Students learn best when the content applies to themselves, and these chapters are faithful to this educational maxim. Chapter 23 is now entitled "Human Evolution." This unique chapter teaches the principles of evolution, while at the same time reviewing human evolution from the origin of the first cell(s) to the rise of modern humans. Chapter 24, which is called "Ecosystems and Human Interferences" introduces the basics of ecology and shows how human activities have altered biogeochemical cycles to our own detriment. Chapter 25 is a new chapter entitled "Conservation of Biodiversity." We all need to be aware that other living things are valuable to the human species and to recognize that our activities threaten their very existence. In preserving other species we are ultimately preserving our own species.

## Focus Readings

Health and ecological concerns are carried through the text by Health Focus readings, which help students cope with common health problems, and Ecology Focus readings, which draw attention to a particular environmental problem.

As in the previous edition, students are asked to apply the concepts to the many and varied perplexing bioethical issues that face us every day. In this edition, each bioethical issue is featured in a Bioethical Focus box which asks students to develop a point of view by answering a series of questions on such topics as genetic disease testing, modern reproductive technologies, human cloning, AIDS vaccine trials, animal rights, and fetal research. The Online Learning Center will help students fine-tune their opinion with these activities:


**Taking Sides.** Students answer a series of questions and their answers are tallied so that their original position is revealed.

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

**Explain Your Position.** Students are asked to defend their position in writing. They can e-mail their essay to their professor.



## Homeostasis

This edition of *Human Biology* again places an emphasis on homeostasis. An icon  calls attention to those portions of each chapter that discuss homeostasis. The chapter entitled "Organization and Regulation of Body Systems" discusses the principles of homeostasis and the contributions of the various systems to keeping the internal environment relatively constant. Well-designed illustrations, especially in the endocrine chapter, show how negative feedback control is essential to homeostasis. The Human Systems Work Together box in each systems chapter describes how that organ system works with other systems to achieve homeostasis.

## Applications

Each chapter begins with a short story that applies chapter material to real-life situations. The readings stress applications and so does the running text material. This edition features expanded treatment of such topics as eating disorders, allergies, pulmonary disorders, hepatitis infections, modern reproductive technologies, the human genome project, and gene therapy. Other topics such as the cloning of humans and xenotransplantation are also included.


## Technology

There are many resources that students can utilize in order to understand the content of this textbook. In addition to the end of the chapter questions and printed study guide, the Online Learning Center at [www.mhhe.com/biosci/genbio/maderhuman7](http://www.mhhe.com/biosci/genbio/maderhuman7) contains readings, quizzes, animations, and other activities to help students master the concepts. New to this edition there is more integration between text material and technology. For example, Bioethical Focus boxes and Human Systems Work Together boxes have an associated online exercise that helps students make better use of these stimulating features.

Also, new to this edition, each chapter ends with an e-Learning Connection page. This page organizes the relevant technological material by major sections, helping to create a stronger association between available study activities and text material. Because this design is mimicked on the Online Learning Center the student can now easily find the appropriate learning experience.

A complete explanation of the technology package available with this textbook for students and instructors, is explained fully on pages xvi through xx of the preface.

# An Overview of This Edition

- Part VII contains new chapters. "Human Evolution" traces human evolution from the origin of cell(s) to the evolution of modern humans. This unique chapter presents the principles of evolution, while at the same time reviewing human evolution. "Ecosystems and Human Interferences" presents the principles of ecology and shows how human activities disrupt biogeochemical cycles, leading to untoward effects including pollution. "Conservation of Biodiversity" explores the current biodiversity crisis and shows how the loss of so many species can be detrimental to humankind.
- Technology aids are organized according to the major sections on the e-Learning Connection page found at the end of each chapter. Students can easily determine the available resources to help explain difficult concepts. The same design is utilized for the Online Learning Center, so that students can quickly find an activity of interest. Other activities help students make full use of the Bioethical Focus boxes and Human Systems Work Together boxes.
- Relevancy of the text is enhanced due to the inclusion of such topics as sexually transmitted diseases, eating disorders, allergies, pulmonary disorders, hepatitis infections, xenotransplantation, modern reproductive technologies, human cloning, the human genome project, and gene therapy to treat cancer.
- Health Focus and Ecology Focus readings support the two major themes of the text; the study of human anatomy and physiology and the role of humans in the biosphere. A new Bioethical Focus box found throughout the text introduces students to many of the bioethical questions that face us every day. Challenging questions are provided that can be used as a basis for class discussion. The Online Learning Center allows students to further explore these issues by taking a quiz, reading articles, and writing an essay explaining their point of view.
- The vibrant art program adds vitality to illustrations and enhances the appeal of the text. Micrographs are integrated into illustrations and provide realism. Visual focus illustrations give a pictorial overview of key topics. Color coding is used both for biological molecules and for human tissues and organs.
- Homeostasis is again emphasized in this edition. An icon  calls attention to those portions of the text that discuss homeostasis. Each systems chapter has a major section that discusses how that system works with other systems of the body to achieve homeostasis. This section is supported by a Human Systems Work Together box, which also shows how that organ system works with the other systems making homeostasis possible.



## Acknowledgments

To produce a text requires a concerted effort by many and it is a pleasure to thank everyone who made this edition of *Human Biology* so special. My editor Patrick Reidy and my developmental editor Anne Melde fulfilled every expectation. They planned well and supplied creativity, advice, and support whenever it was needed.

Jayne Klein, the project manager, although new to the book team, stepped right in and made the project move along smoothly. Kennie Harris did a superb job as the copy editor; Lori Hancock and Connie Mueller found just the right photographs. Again, Wayne Harms developed a design that is both beautiful and useful to students.

In my office Jo Hebert has consistently provided support and was just as diligent working on this edition as the others. I also want to take this opportunity to thank my husband and children for their continual patience and encouragement.

## The Reviewers

Many instructors have contributed not only to this edition of *Human Biology* but also to previous editions. I am extremely thankful to each one, for they have all worked diligently to remain true to our calling to provide a product that will be the most useful to our students.

It is appropriate to acknowledge the help of the following individuals for the seventh edition.

David H. Arnold  
*University of Texas-Austin*  
Amir M. Assadi-Rad  
*San Joaquin Delta College*  
Ellen Baker  
*Santa Monica College*  
Linda M. Banta  
*Sierra College*  
Angela Bauer-Dantoin  
*University of Wisconsin-Green Bay*  
Cindy Beck  
*The Evergreen State College*  
George C. Boone  
*Susquehanna University*  
Judith Byrnes-Enoch  
*SUNY - Empire State College*  
Judson J. Calhoun  
*Mohave Community College*  
Joseph P. Caruso  
*University of the South*  
Debra Chapman  
*Wilkes University*  
Richard Connett  
*Monroe Community College*  
David Constantinos  
*Savannah State University*  
Charles J. Dick  
*Pasco-Hernando Community College*

Marirose T. Ethington  
*Genesee Community College*  
Richard H. Falk  
*University of California-Davis*  
Steve Fields  
*Winthrop University*  
Dalia Giedrimiene  
*Saint Joseph College*  
Mary Louise Greeley  
*Salve Regina University*  
Kenneth W. Gregg  
*Winthrop University*  
Ryan M. Harden  
*Central Lakes College*  
Janice L. Haws  
*Delaware Valley College*  
Chris G. Haynes  
*Shelton State Community College*  
Danette I. Haynes  
*Shelton State Community College*  
Clare Hays  
*Metropolitan State College of Denver*  
Janice Ito  
*Leeward Community College*  
Dennis Jackson  
*Mount Aloysius College*  
Pushkar N. Kaul  
*Clark Atlantic University*  
Suzanne Kempke  
*Armstrong Atlantic State University*  
Michelle Kettler  
*University of Wisconsin-Eau Claire*  
Patricia Klopfenstein  
*Edison Community College*  
Troy A. Ladine  
*Bethel College*  
Thomas M. Lancraft  
*St. Petersburg Junior College*  
Michael Lentz  
*University of North Florida*  
Mary Katherine K. Lockwood  
*University of New Hampshire*  
William J. Mackay  
*Edinboro University of Pennsylvania*  
Morris V. Maniscalco  
*LeTourneau University*  
Joseph A. Mannino  
*University of Wisconsin-Green Bay*  
Vicki J. Martin  
*Appalachian State University*  
Patricia Matthews  
*Grand Valley State University*  
Elizabeth McMahon  
*Warren County Community College*  
Tekie Mehary  
*University of Washington*  
William Millington  
*Albany College of Pharmacy of Union University*  
Aaron J. Moe  
*Concordia University*



Michele Morek  
*Brescia University*

Robert A. Morgan  
*Southwestern University*

Richard Mortensen  
*Albion College*

Don Naber  
*University College, University of Maine*

Jon R. New  
*Vernon Regional Junior College*

Emily C. Oaks  
*SUNY at Oswego*

Richard O'Lander  
*St. John's University*

Sidney L. Palmer  
*Ricks College*

Jeff Parmelee  
*Simpson College*

Mason Posner  
*Ashland University*

Darryl Ritter  
*Okaloosa-Walton Community College*

Connie Rizzo  
*Pace University*

Michael W. Ruhl  
*Vernon Regional Junior College*

Mary Ellen St. John  
*Central Ohio Technical College*

Don Sanders  
*Harding Academy of Memphis*

Soma Sanyal  
*Penn State Altoona College*

John W. Sherman  
*Erie Community College-North Campus*

Kristin Siewert  
*Des Moines Area Community College at Newton*

Jeff S. Simpson  
*Metropolitan State College of Denver*

Timothy A. Stabler  
*Indiana University Northwest*

W. Robert Stamper  
*Muhlenberg College*

Steve K. Stocking  
*San Joaquin Delta Community College*

Robert S. Sullivan  
*Marist College*

Jacqueline Tanaka  
*University of Pennsylvania*

William J. Tarutis, Jr.  
*Lackawanna Junior College*

Kent R. Thomas  
*Wichita State University*

Timothy S. Wakefield  
*Auburn University*

Curt Walker  
*Dixie State College*

Rod Waltermeyer  
*York College of Pennsylvania*

Linda Wells  
*California State University-Bakersfield*

Frank P. Wray  
*University of Cincinnati*

Joyce A. Wren  
*Surry Community College*

Kathryn Yarkany  
*Villa Julie College*

Martin D. Zahn  
*Thomas Nelson Community College*

Nina C. Zanetti  
*Siena College*

Henry H. Ziller  
*Southeastern Louisiana University*

Brenda Zink  
*Northeastern Junior College*



## Chapter 21

### DNA and Biotechnology

#### Chapter Concepts

##### 21.1 DNA and RNA Structure and Function

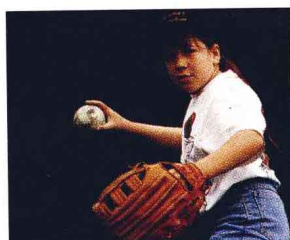
- DNA is the genetic material, and therefore, its structure and function constitute the molecular basis of inheritance. 422
- When DNA replicates, two exact copies result. RNA structure is similar to, but also different from, that of DNA. RNA occurs in three forms, each with a specific function. 424-25

##### 21.2 Gene Expression

- Proteins are composed of amino acids, and they function, in particular, as enzymes and as structural elements of membranes and organelles in cells. 426
- DNA's genetic information codes for the sequence of amino acids in a protein during protein synthesis. 426
- There are various levels of genetic control in human cells. 431

##### 21.3 Biotechnology

- Recombinant DNA technology is the basis for biotechnology, an industry that produces many products. 432
- Modern-day biotechnology is expected to produce many products and to revolutionize agriculture and animal husbandry. It also permits gene therapy and the mapping of human chromosomes. 434



**Figure 21.1** Cindy Cutshall.

Cindy was sick and couldn't play baseball until she underwent gene therapy. She doesn't like to talk about the procedure. She says, "It's too weird."

Cindy Cutshall was born with a rare immune disorder called SCID (severe combined immunodeficiency). Her white blood cells were ineffective because they couldn't produce a critical enzyme known as ADA. She was in and out of the hospital with infections, and her parents feared she would die young.

And so, in 1993, the Cutshalls agreed to let Cindy undergo gene therapy, sponsored by the National Institutes of Health (NIH), the top biomedical funding agency in the United States. Gene therapy is based on the idea that it is possible to supply a patient with a missing or defective gene. NIH researchers took white blood stem cells from Cindy, added the gene that specifies ADA, and injected the improved cells back into her. Stem cells for white blood cells were chosen because they reside in the bone marrow where they continually produce more white blood cells. Combined with drug treatment, the therapy apparently worked. Today, Cindy is well, and her white blood cells contain functioning ADA genes.

Like Cindy, over 600 patients have now received some form of gene therapy in treatment for AIDS, cancer, cystic fibrosis, and other diseases. In many cases, the patient's cells have not received an adequate number of working genes to make a difference. But once efficient

421

Each chapter in *Human Biology* is constructed of basic features that serve as the pedagogical framework for the chapter. Before you begin reading the text, spend a little time looking over these pages. They provide a quick guide to the learning tools found throughout the text that have been designed to enhance your understanding of biology.

#### Chapter Concepts

The chapter begins with an integrated outline that numbers the major sections of the chapter and lists the concepts that support each section.

### Homeostasis Icon

*Human Biology* emphasizes homeostasis through Working Together boxes, separate discussion in each human system chapter, and through the use of an icon 🔄. The homeostasis icon has been placed adjacent to text material that discusses homeostasis.

### Internal Summary Statements

Internal summaries stress the chapter's key concepts. These appear at the ends of major sections and help focus students' study efforts on the most important concepts.

134 Part 2 Maintenance of the Human Body

#### 7.4 The Vascular Pathways

The cardiovascular system, which is represented in Figure 7.12, includes two circuits: the **pulmonary circuit**, which circulates blood through the lungs, and the **systemic circuit**, which serves the needs of body tissues. Both circuits, as we shall see, are necessary to homeostasis. 🔄

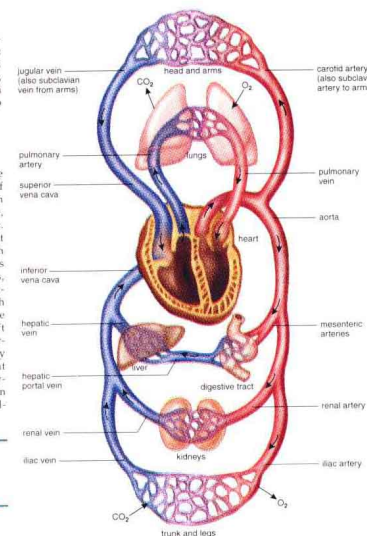
##### The Pulmonary Circuit

The path of blood through the lungs can be traced as follows. Blood from all regions of the body first collects in the right atrium and then passes into the right ventricle, which pumps it into the pulmonary trunk. The pulmonary trunk divides into the right and left pulmonary arteries, which branch as they approach the lungs. The arterioles take blood to the pulmonary capillaries, where carbon dioxide is given off and oxygen is picked up. Blood then passes through the pulmonary venules, which lead to the four pulmonary veins that enter the left atrium. Since blood in the pulmonary arteries is O<sub>2</sub>-poor but blood in the pulmonary veins is O<sub>2</sub>-rich, it is not correct to say that all arteries carry blood that is high in oxygen and all veins carry blood that is low in oxygen. It is just the reverse in the pulmonary circuit.

The pulmonary arteries take O<sub>2</sub>-poor blood to the lungs, and the pulmonary veins return blood that is O<sub>2</sub>-rich to the heart.

##### The Systemic Circuit

The systemic circuit includes all of the arteries and veins shown in Figure 7.13. The largest artery in the systemic circuit is the **aorta**, and the largest veins are the **superior and inferior vena cavae**. The superior vena cava collects blood from the head, the chest, and the arms, and the inferior vena cava collects blood from the lower body regions. Both enter the right atrium. The aorta and the vena cavae serve as the major pathways for blood in the systemic circuit.



**Figure 7.12** Cardiovascular system diagram.

The blue-colored vessels carry O<sub>2</sub>-poor blood, and the red-colored vessels carry O<sub>2</sub>-rich blood; the arrows indicate the flow of blood. Compare this diagram, useful for learning to trace the path of blood, to Figure 7.13 to realize that arteries and veins go to all parts of the body. Also, there are capillaries in all parts of the body. No cell is located far from a capillary.

The path of systemic blood to any organ in the body begins in the left ventricle, which pumps blood into the aorta. Branches from the aorta go to the organs and major body regions. For example, this is the path of blood to and from the lower legs:



## Summarizing the Concepts

The numbered concepts, introduced on the chapter-opening page and explained in the body of the chapter, form the basis for the summary. This repetition helps reinforce key concepts for the student.

### Summarizing the Concepts

#### 1.1 Biologically Speaking

Human beings, like other living things, are highly organized. Cells form tissues, which form organs that function in organ systems. Human beings come into existence through reproduction, growth, and development.

Unlike other living things, human beings have a cultural heritage that sometimes hinders the realization that they are the product of an evolutionary process. Human beings are vertebrates closely related to the apes. Human beings are also a part of the biosphere where populations interact with the physical environment and with one another.

Human activities threaten the existence of ecosystems like tropical rain forests. Biodiversity is now being reduced at a rapid rate.

#### 1.2 The Process of Science

When studying the world of living things, biologists, like other scientists, use the scientific method, which consists of these steps: making an observation, formulating a hypothesis, carrying out an experiment or simply making further observations, and coming to a conclusion.

#### 1.3 Science and Social Responsibility

It is the responsibility of all to make ethical and moral decisions about how best to make use of the results of scientific investigations.

## Studying the Concepts

This page-referenced question set reviews the concepts presented in the chapter.

### Studying the Concepts

1. Name five characteristics of human beings, and discuss each one. 2-4
2. What is homeostasis, and how is it maintained? Choose one organ system and tell how it helps maintain homeostasis. 2
3. Give evidence that human beings are related to all other living things. 2
4. Describe the five-kingdom system of classification, and name types of organisms in each kingdom. 3
5. Human beings are dependent upon what services performed by plants? 4
6. Discuss the importance of scientific theory, and name several theories that are basic to understanding biological principles. 8
7. Name the steps of the scientific method, and discuss each one. 8
8. How do you recognize a control group, and what is its purpose in an experiment? 10
9. What is our social responsibility in regard to scientific findings? 11

### Testing Your Knowledge of the Concepts

In questions 1-4, match the human characteristics to the descriptions below.

Human beings:

- a. are organized.
  - b. reproduce and grow.
  - c. have a cultural heritage.
  - d. are the product of evolutionary process.
  - e. are a part of the biosphere.
- \_\_\_\_\_ 1. Humans are related to all other living things.
- \_\_\_\_\_ 2. The human population encroaches on natural habitats.
- \_\_\_\_\_ 3. Like cells form tissues in the human body.
- \_\_\_\_\_ 4. We learn how to behave from our elders.

In questions 5-7, indicate whether the statement is true (T) or false (F).

- \_\_\_\_\_ 5. Once a scientist formulates a hypothesis, he or she tests it by observation and/or experimentation.
- \_\_\_\_\_ 6. The theory of evolution is so poorly supported that many scientists feel it should be discarded.
- \_\_\_\_\_ 7. When an experiment has a control group, it lends validity to the resulting data.

In questions 8-10, fill in the blanks.

8. To reproduce is to make a \_\_\_\_\_ of one's self.
9. \_\_\_\_\_ has a responsibility to decide how scientific knowledge should be used.
10. \_\_\_\_\_ is a concept consistent with conclusions based on a large number of experiments and observations.

## Understanding Key Terms

Key terms are listed with page references that indicate where the term is defined in the chapter.

### Understanding Key Terms

biodiversity 5	organ 2
biosphere 2	organ system 2
cell 2	population 4
conclusion 8	principle 8
control group 10	reproduce 2
data 8	science 8
ecosystem 4	scientific method 8
evolution 2	scientific theory 8
experiment 10	tissue 2
homeostasis 2	variable 10
hypothesis 8	vertebrate 2
kingdom 2	

## Testing Your Knowledge of the Concepts

This section consists of objective questions that test the student's ability to answer recall-based questions. Answers to these questions are given in Appendix A.



## Bioethical Focus

### Animals in the Laboratory

Some people believe that animals should be protected in every way, and should not be used in laboratory research. In our society as a whole, the trend is toward a growing recognition of what is generally referred to as animal rights. In 1985, 63% of Americans polled agreed that "scientists should be allowed to do research that causes pain and injury to animals like dogs and chimpanzees if it produces new information about human health problems." That consensus dropped to 53% in 1995. Psychologists with Ph.D.s earned in the 1990s are half as likely to express strong support for animal research as those who earned their Ph.D.s before 1970.

Those who approve of laboratory research involving animals give examples to show that even today it would be difficult to develop new vaccines and medicines against infectious diseases, new surgical techniques for saving human lives, or new treatments for spinal cord injuries without the use of animals. Even so, most scientists today are in favor of what is now called the "three Rs": replacement of animals by in vitro, or test-tube, methods whenever possible; reduction of the numbers of animals used in experiments; and refinement of experiments to cause less suffering to animals. In the Netherlands, all scientists starting research that involves animals are well trained in the three Rs. After designing an experiment that uses animals, they are asked to find ways to answer the same questions without using animals.

F. Barbara Orlans of the Kennedy Institute of Ethics at Georgetown University says, "It is possible to be both pro-research and pro reform." She feels that animal activists need to accept that sometimes animal research is beneficial to humans, and all scientists need to consider the ethical dilemmas that arise when animals are used for laboratory research.

### Decide Your Opinion

To develop your opinion, answer either question 1 or question 2, and then question 3.

1. Are you opposed to the use of animals in laboratory experiments? Always or under certain circumstances? Explain.
2. Do you favor using animals in the laboratory? Always or under certain circumstances? Explain.
3. Do you feel that it would be possible for animal activists and scientists to find a compromise they could both accept? Discuss.



**Figure 1C Caged animals.** These animals are used in laboratory research to help develop an AIDS vaccine for humans.

### Looking at Both Sides [www.mhhe.com/biosci/genbio/maderhuman7/](http://www.mhhe.com/biosci/genbio/maderhuman7/)

Every bioethical issue has at least two sides. Even if you already have an opinion, it is important to explore the opposite opinion before finalizing your position. The Online Learning Center at [www.mhhe.com/biosci/genbio/maderhuman7/](http://www.mhhe.com/biosci/genbio/maderhuman7/) will help you fine-tune your initial opinion, explore both sides, and finalize your position. You may acquire new arguments for your original opinion, or you may even change your opinion. Be sure to complete these activities in sequence:

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

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

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

Technology has become an increasingly potent force in teaching and learning. For that reason the seventh edition of *Human Biology* puts an even greater emphasis on technology by integrating it more fully with text material. Students can access the material described on these pages by going to [www.mhhe.com/biosci/genbio/maderhuman7](http://www.mhhe.com/biosci/genbio/maderhuman7).

## Bioethical Focus Boxes

The popular Bioethical Focus boxes introduced in the sixth edition have now been expanded into a full page feature. To help students further explore the complicated issues discussed in the Bioethical Focus boxes, an online feature called Looking at Both Sides has been added. Students go to the Online Learning Center where they find the following activities:

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

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

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

## Human Systems Work Together Boxes

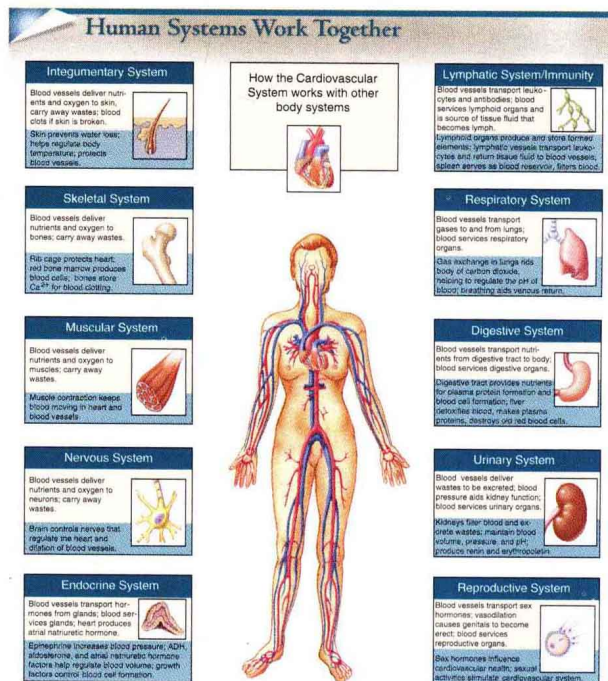
These helpful boxes were developed to illustrate for students how the systems in their own bodies are working together to achieve homeostasis. An online component has been developed to further emphasize this vital concept:

**Systems Scramble** is a matching exercise based on the Human Systems Work Together box.

**Watch It Happen** shows the student an animation of a process occurring in the highlighted system.

**Systems Review** follows up the animation with questions that require students to integrate what they have learned about the body systems.

140 Part 2 Maintenance of the Human Body





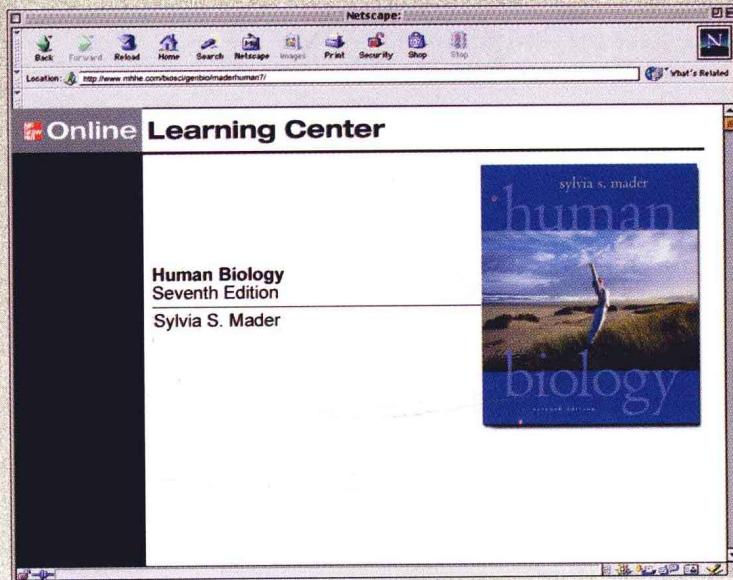
## e-Learning Connection

These pages, found at the end of each chapter, tie technology directly to the major sections found within the chapter. Students are shown which McGraw-Hill study aids are available on the Online Learning Center to help them understand the concepts in each section. An icon tells the student at a glance what type of resource is being cited.

## Online Learning Center

The e-Learning Connection page is duplicated on the Online Learning Center where it serves as navigation for the online chapter content. The student need only click on a link to go to the resource that is listed. This helps students find the information they need more quickly, increasing the effectiveness of their study time.

Go to [www.mhhe.com/biosci/genbio/maderhuman7](http://www.mhhe.com/biosci/genbio/maderhuman7) to see the many resources available for students on the *Human Biology* Online Learning Center.



### e-Learning Connection

[www.mhhe.com/biosci/genbio/maderhuman7/](http://www.mhhe.com/biosci/genbio/maderhuman7/)

#### 4.1 Types of Tissues



Epithelial Tissue Essential Study Partner  
Connective Tissue Essential Study Partner  
Muscle Tissue Essential Study Partner  
Nervous Tissue Essential Study Partner



Histology Quiz practice identifying tissue types

#### 4.2 Body Cavities and Body Membranes



Mammalian Body Cavities art labeling activity

#### 4.3 Organ Systems



Human Skin Anatomy I art labeling activity  
Human Skin Anatomy II art labeling activity  
Human Skin Anatomy III art labeling activity

#### 4.4 Homeostasis



Working Together to Achieve Homeostasis

#### Chapter Summary



Key Term Flashcards vocabulary quiz  
Chapter Quiz objective quiz covering all chapter concepts

## Icons

These icons are used on the e-Learning Connection page and the Online Learning Center to denote types of content.



### Activity

Activities are hands-on exercises that engage students in a learning experience.



### Animation

Animations help students visualize how a process occurs.



### Essential Study Partner Module

Modules combine text screens and activities to help students master difficult concepts.



### Reading

Readings give students the opportunity to explore a topic further.



### Quiz

Quizzes allow students to test themselves on the topics presented in the chapter.



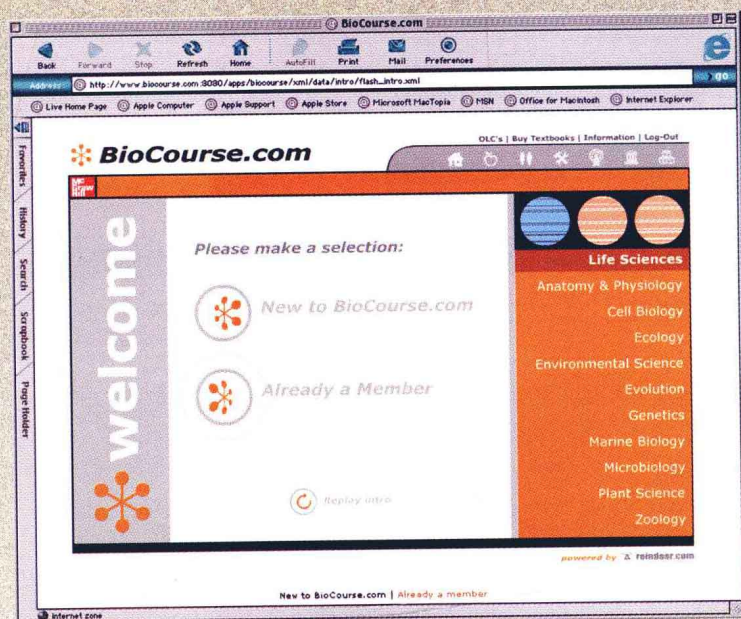
# TECHNOLOGY FOR THE INSTRUCTOR

Increasingly, instructors are demanding visual resources and the versatility to use them according to their needs. By adopting *Human Biology* for use in their course, instructors gain access to technological resources that can revolutionize the way information is presented to their students.

## Incredible Online Resources

At the *Human Biology* Online Learning Center, you will have access to images from the textbook, case studies, chapter outlines, the Instructor's Manual, and text-specific PowerPoint presentations.

[www.mhhe.com/biosci/genbio/maderhuman7](http://www.mhhe.com/biosci/genbio/maderhuman7)

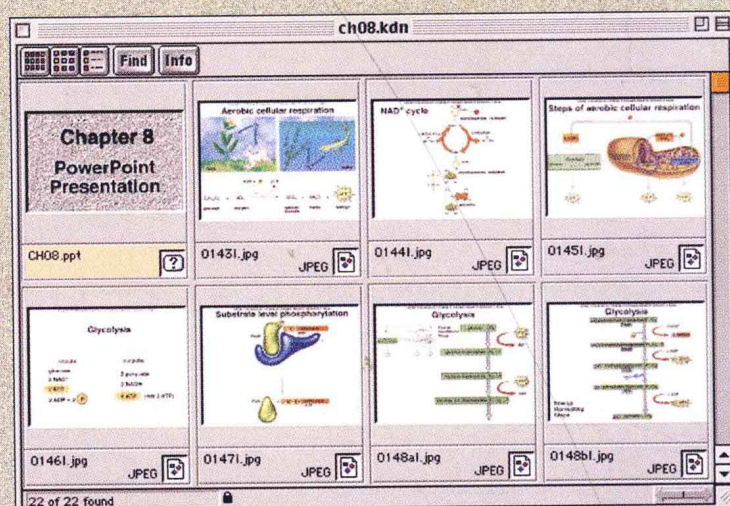


**BioCourse.com** is a new resource for instructors using a McGraw-Hill textbook in their course. BioCourse.com offers instructors over 10,000 images, animations, and case studies for use in their course. Visitors to BioCourse.com can check out the latest science headlines, read commentaries from McGraw-Hill authors and guests, take part in discussion boards, find relevant materials for lab courses, and much more.

## Wake Up Your Lectures

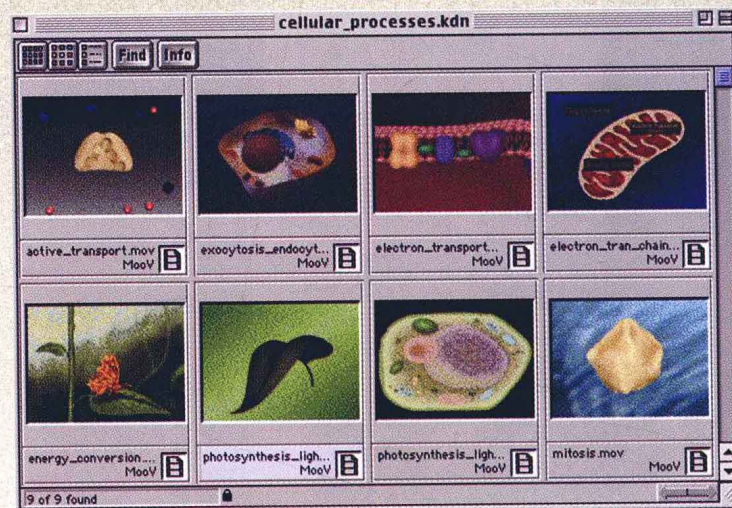
Create dynamic PowerPoint presentations using art from the *Human Biology* textbook. Approximately 800 labeled and unlabeled images, including all of the illustrations and photos from the text, are available for your use on CD-ROM or by using the *Human Biology* Online Learning Center. The Visual Resource Library allows you to search and sort through a catalog of images by chapter, or by using keywords, and then place the images into your own lecture notes.

## Human Biology Visual Resource Library CD-ROM



## Life Science Animations Visual Resource Library CD-ROM

The Life Science Animations 2.0 CD-ROM contains over 300 animations of complex biological processes. Help your students visualize the mechanisms at work within their own cells by incorporating these animations into your lecture presentations. Step-by-step instructions are provided to help you get the most out of this powerful resource.



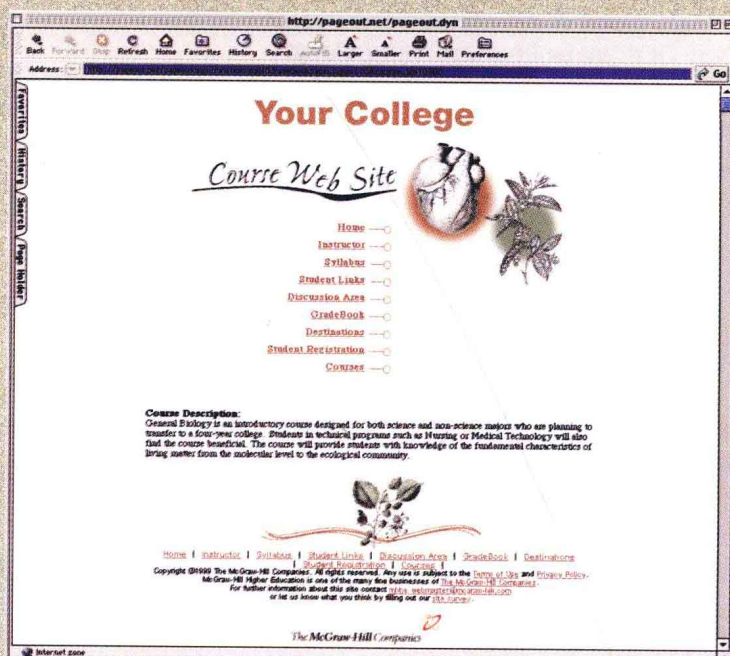


## Need a Course Website?

PageOut™ makes it easy to provide class materials online by creating your own course website. Using PageOut™ you can post an interactive syllabus containing class notes, practice exercises, helpful figures, and links to relevant McGraw-Hill web content. Student registration and grade book features assist with course management.

If your time is limited you can simply copy a site from the McGraw-Hill PageOut™ library, or let the McGraw-Hill service team do the work for you. They will call you for a 30-minute consultation, create your PageOut™ website, and provide training to get you up and running.

For more information on PageOut™ contact your McGraw-Hill sales representative or go to [www.pageout.net](http://www.pageout.net).

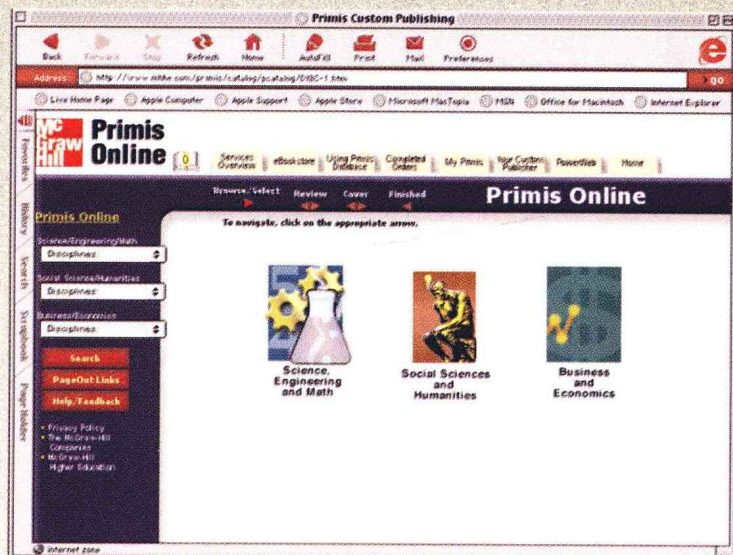


## You Can Have What You Want

Since 1990 Primis Custom Publishing has made it possible for instructors to create their ideal textbooks. Now, in addition to printed texts, Primis custom textbooks can be made available to your students online as eBooks.

Select from over 35,000 pages of online content, then move, add, or delete materials until you are happy with your text. Once you submit your new book to the eBookstore, your students only need to go to the site to buy their download of the text. By adding a link to the eBookstore from your PageOut™ website, students have everything they need for your course in one place. Best of all, your students save money since they are only paying for the content you choose to include in the course textbook.

To find out more about customizing *Human Biology* or any other McGraw-Hill text please contact your McGraw-Hill sales representative or visit [www.mhhe.com/primis/online](http://www.mhhe.com/primis/online).





# New Technology

## Human Biology Online Learning Center

McGraw-Hill text-specific websites allow students and instructors from all over the world to communicate. By visiting this site, students can access additional study aids, including quizzes and animations, explore links to other relevant biology sites, and catch up on current information. Log on today!

[www.mhhe.com/biosci/genbio/maderhuman7](http://www.mhhe.com/biosci/genbio/maderhuman7)

## BioCourse.com

*BioCourse.com* provides a comprehensive set of resources in one place that is up-to-date and easy to navigate. Here is what you will find:

- The **Faculty Club** includes teaching tips, classroom activities, reference searches, presentation tools, and much more.
- The **Student Center** contains a wide range of materials to help biology students improve their study skills and achieve success in college and beyond.
- The **Briefing Room** offers instructors and students up-to-date news articles, a selection of background readings, and links to journal search tools and biology magazines.
- **BioLabs** features materials for lab students and instructors, including equipment tutorials, lab support, and simulations.
- The **Quad** is a powerful indexing tool and hierarchical outline of content resources for searching by students and faculty.
- The **R & D Center** features our newest simulations, animations, and other teaching tools.



## Primis Custom Publishing

Now it is incredibly easy to create a content-rich textbook or lab manual

tailored to your exact needs. Choose from our library of content, your materials, or both. Your customized course materials are delivered to your students immediately in color, online, and at a substantial savings. Customization allows you to tailor your classroom tools to meet your course needs, follow your syllabus, and teach like you do. All you need to do is log on to [www.mhhe.com/primis/online](http://www.mhhe.com/primis/online) and go to your discipline area. Simply view, select, review, and submit. Students can then easily and conveniently access the site on the Internet, reference their school and course, and purchase their "e-Book" online. Immediately, the electronic book is downloaded to their computer's hard drive.

**PageOut™** Put together your own customized website with the use of PageOut™, a program designed specifically for instructors wanting to put course information on the web. No experience in web publishing is necessary; just choose from a collection of templates to create your class website.



## Visual Resource Library CD-ROM

This helpful CD-ROM contains approximately 800 images, including all of the photos and line art from the text, that can be easily imported into PowerPoint to create multimedia presentations. Or, you may use the already prepared PowerPoint presentations.

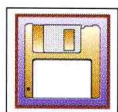
## Life Science Animations CD-ROM 2.0

This two CD-ROM set contains more than 200 animations of important biological concepts and processes. These animations can be imported into your PowerPoint presentations.



## Life Science Animations Videotape Series

Animations of key biological processes are available on seven videotapes. The animations bring visual movement to biological processes that are difficult to understand on the text page.



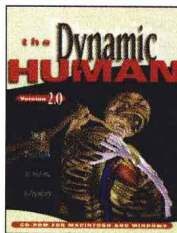
## Classroom Testing Software (MicroTest III)

This helpful testing software provides well-written and researched book-specific questions featured in the Test Item File.



## Microbes in Motion CD-ROM, Version 2.0, by Delisle and Tomalty

This interactive CD-ROM allows students to actively explore microbial structure and function. Great for self-study, preparation for class or exams, or for classroom presentations.



## The Dynamic Human CD-ROM, Version 2.0

This guide to anatomy and physiology interactively illustrates the complex relationships between anatomical structures and their functions in the human body. Realistic, three-dimensional visuals are the premier feature of this exciting learning tool.

## Dynamic Human Videodisc

Enhance your classroom presentations with movement, sound, and motion of internal organs, cells, and systems. More than 80 premier 3-D animations covering all body systems from the outstanding *Dynamic Human CD-ROM* are included.



# Other Available Supplements

## Instructor's Manual

The *Instructor's Manual* is designed to assist instructors as they plan and prepare for classes using **Human Biology**. The *Instructor's Manual* contains both an extended lecture outline and lecture enrichment ideas, which together review in detail the contents of the text chapter. The technology section lists relevant assets from McGraw-Hill.

## Student Study Guide

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

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

## Laboratory Manual

Dr. Mader has also written the *Laboratory Manual* to accompany **Human Biology**. With few exceptions, each chapter in the text has an accompanying laboratory exercise in the manual (some chapters have more than one accompanying exercise). In this way, instructors are better able to emphasize particular portions of the curriculum. The 19 laboratory sessions in the manual are designed to further help students appreciate the scientific method and to learn the fundamental concepts of biology and the specific content of each chapter. All exercises have been tested for student interest, preparation time, and feasibility. This lab manual can be customized to fit your lab course. Contact your McGraw-Hill representative for details.

## Transparencies

This set of transparency acetates to accompany the text has been expanded to 400 full-color acetates, including all of the art from the textbook.

## Micrograph Slides

This ancillary provides a boxed set of 100 color slides of photomicrographs and electron micrographs from the text.

## HealthQuest CD-ROM

ISBN 0-697-29723-3 (Windows)  
ISBN 0-07-039335-4 (Macintosh)

## Virtual Biology Laboratory CD-ROM

ISBN 0-697-37991-4

## Life Science Living Lexicon CD-ROM

ISBN 0-697-37993-0

## How to Study Science, Third Edition, by Fred Drewes

ISBN 0-697-36051-2

## Basic Chemistry for Biology, Second Edition, by Carolyn Chapman

ISBN 0-697-36087-3

## Schaum's Outlines: Biology

ISBN 0-07-022405-6

## Understanding Evolution, by Volpe and Rosenbaum

ISBN 0-697-05137-4

## AIDS Booklet, by Frank Cox

ISBN 0-697-29428-5

## The Internet Primer

ISBN 0-07-303203-4

## Critical Thinking Case Study Workbook, by Robert Allen

ISBN 0-697-14556-5

## How Scientists Think, by George Johnson

ISBN 0-697-27875-1

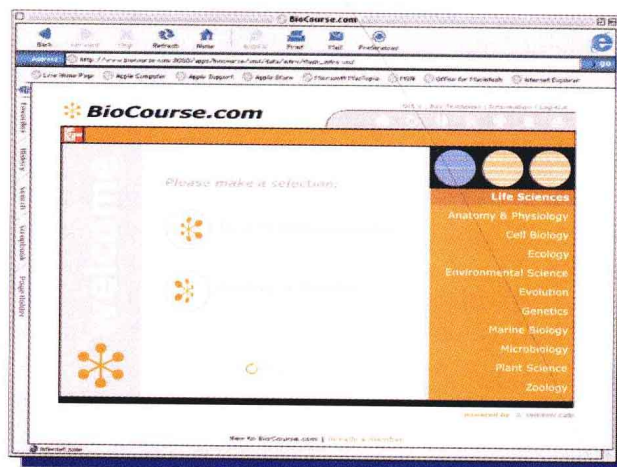
To order any of these study tools, contact your bookstore manager or call McGraw-Hill Customer Service at 800-338-3987.



# BioCourse.com

The number one source for your biology course.

**BioCourse.com** is an electronic meeting place for students and instructors. It provides a comprehensive set of resources in one place that is up-to-date and easy to navigate. You can access **BioCourse.com** from *Human Biology's* Online Learning Center.



## Here is what you will find at [BioCourse.com](http://www.biorcourse.com):

**Faculty Club** is an array of information and links to related sites for instructors. Resources that you will find include:

- Teaching tips and basic information on pedagogy, assessment, etc.
- Suggestions for classroom and lecture activities.
- Reference searches and literature for faculty.
- Presentation tools.
- Test bank.
- Help for new instructors and teaching assistants.
- Information on available jobs, grant writing, and available funding.
- Case studies.

**Student Center** contains a wide range of materials to help biology students improve their study skills and achieve success in college and beyond. Examples of materials that will be available:

- Study aids.
- Résumé writing and information on jobs and internships.
- Graduate school options.
- Information for MCAT and other tests.
- Links to content websites by topic.

**Briefing Room** offers instructors and students up-to-date news articles, a selection of background readings and links to journal search tools and biology magazines. Users can e-mail articles to others, link to search engines, and read primary sources online.

**BioLabs** features materials for lab students and instructors. Some tools you will find include:

For students:

- Dissection techniques.
- Equipment tutorials.
- Safety and setup procedures.

For instructors:

- Lab preparations.
- Lab support.
- Simulations.

**The Quad** is a powerful indexing tool and hierarchical outline of content resources for searching by students and faculty. Users can search by topic through a "content warehouse" featuring text material, activities, visuals, and animations to learn more about a selected topic.

**R & D Center** features our newest simulations, animations, and other teaching and learning tools. This portion of our site will allow faculty members and students to try out our materials as they are being developed.



Contact your McGraw-Hill sales representative for more information or visit [www.mhhe.com](http://www.mhhe.com).



# Other Available Supplements

## Instructor's Manual

The *Instructor's Manual* is designed to assist instructors as they plan and prepare for classes using *Human Biology*. The *Instructor's Manual* contains both an extended lecture outline and lecture enrichment ideas, which together review in detail the contents of the text chapter. The technology section lists relevant assets from McGraw-Hill.

## Student Study Guide

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

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

## Laboratory Manual

Dr. Mader has also written the *Laboratory Manual* to accompany *Human Biology*. With few exceptions, each chapter in the text has an accompanying laboratory exercise in the manual (some chapters have more than one accompanying exercise). In this way, instructors are better able to emphasize particular portions of the curriculum. The 19 laboratory sessions in the manual are designed to further help students appreciate the scientific method and to learn the fundamental concepts of biology and the specific content of each chapter. All exercises have been tested for student interest, preparation time, and feasibility. This lab manual can be customized to fit your lab course. Contact your McGraw-Hill representative for details.

## Transparencies

This set of transparency acetates to accompany the text has been expanded to 400 full-color acetates, including all of the art from the textbook.

## Micrograph Slides

This ancillary provides a boxed set of 100 color slides of photomicrographs and electron micrographs from the text.

## HealthQuest CD-ROM

ISBN 0-697-29723-3 (Windows)

ISBN 0-07-039335-4 (Macintosh)

## Virtual Biology Laboratory CD-ROM

ISBN 0-697-37991-4

## Life Science Living Lexicon CD-ROM

ISBN 0-697-37993-0

## How to Study Science, Third Edition, by Fred Drewes

ISBN 0-697-36051-2

## Basic Chemistry for Biology, Second Edition, by Carolyn Chapman

ISBN 0-697-36087-3

## Schaum's Outlines: Biology

ISBN 0-07-022405-6

## Understanding Evolution, by Volpe and Rosenbaum

ISBN 0-697-05137-4

## AIDS Booklet, by Frank Cox

ISBN 0-697-29428-5

## The Internet Primer

ISBN 0-07-303203-4

## Critical Thinking Case Study Workbook, by Robert Allen

ISBN 0-697-14556-5

## How Scientists Think, by George Johnson

ISBN 0-697-27875-1

To order any of these study tools, contact your bookstore manager or call McGraw-Hill Customer Service at 800-338-3987.