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Sylvia S. Mader

HUMAN BIOLOGY

SIXTH EDITION

Sixth Edition

HUMAN BIOLOGY

Sylvia S. Mader

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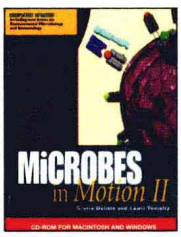

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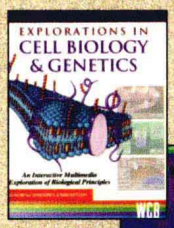

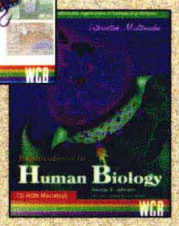

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Animations of key biological processes are available on seven videotapes. The animations bring visual movement to biological processes that are difficult to understand on the text page.

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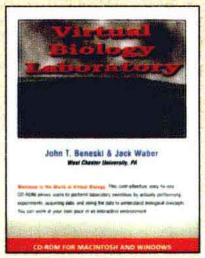

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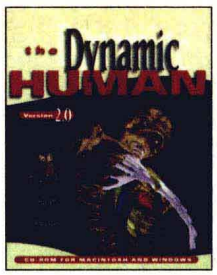


The Dynamic Human CD-ROM, Version 2.0

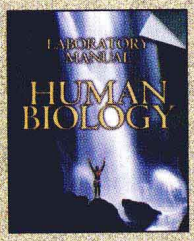
This guide to anatomy and physiology interactively illustrates the complex relationships between anatomical structures and their functions in the human body. Realistic, three-dimensional visuals are the premier feature of this exciting learning tool.

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.

AIDS Booklet

This booklet describes how AIDS and related diseases are commonly spread so that readers can protect themselves and their friends against this debilitating and deadly disease.



Human Biology Laboratory Manual

Known for its human emphasis and self-contained content, this laboratory manual, written by Dr. Sylvia S. Mader, with contributions by Nancy Segsworth, helps students understand how the human body works and the relationship of humans to other living things in the biosphere. With few exceptions, each chapter in the text has an accompanying laboratory exercise in the manual.

Laboratory Resource Guide

More extensive information regarding preparation is found in this helpful guide. The guide includes suggested sources for materials and supplies, directions for making up solutions and otherwise setting up the laboratory, expected results for the exercises, and suggested answers to questions in the laboratory manual.

Student Study Guide

Study Tips, Study Questions, Definitions, Chapter Tests, and Answer Key will help your students solidify ***Human Biology*** concepts.

200 Transparencies

A set of 200 full-color transparency acetates accompanies ***Human Biology.*** These acetates contain key illustrations from the text.

100 Micrograph Slides

This ancillary provides 35mm slides of many photomicrographs and all electron micrographs in the text.

Instructor's Manual with Test Item File

The *Instructor's Manual*, prepared by Dr. Steve Badger, includes features such as: Behavioral Objectives, Extended chapter lecture outlines, Teaching Strategies, Discussion Activities, Demonstration Activities, additional Critical Thinking questions, and a Technology Correlation Guide. The *Test Item File*, prepared by Dr. Thomas Pitzer, includes a classification system for difficulty level and type of question.

Classroom Testing Software (MicroTest)

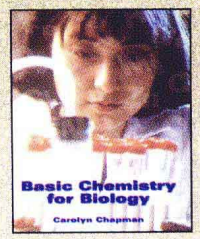
This helpful testing software—available in either Macintosh or Windows format—provides well-written and researched book-specific questions featured in the Test Item File.

How to Study Science, Third Edition

This excellent workbook offers students helpful suggestions for meeting the considerable challenges of a college science course. It offers tips on how to take notes, how to get the most out of laboratories, and how to overcome science anxiety.

Schaum's Outlines: Biology

Updated to include the latest advances, *Schaum's Outlines: Biology*, features detailed illustrations of complex biologic systems and processes, ranging from the smallest elements of life to primates. Hundreds of problems with fully explained solutions cut down on study time and make important points easy to remember.



Basic Chemistry for Biology, Second Edition

Basic Chemistry for Biology is a self-paced supplement for students who need additional material to understand the basic concepts of chemistry. This text leads biology students through fundamental chemical concepts.

Critical Thinking Case Study Workbook

This ancillary provides 34 critical thinking case studies that are designed to immerse students in the "process of science" and challenge them to solve problems in the same way biologists do. An answer key accompanies this workbook.

Biology Start-up Software

This software is a five-disk Macintosh tutorial that helps nonmajors master challenging biological concepts such as basic chemistry, photosynthesis, and cellular respiration.

Readings

Ecology Focus

Health Focus

Visual Focus

Preface

Human Biology is suitable for use in one-semester biology courses that emphasize human physiology and the role that humans play in the biosphere. 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. This knowledge can be applied daily and helps assure our continued survival as individuals and as a species. 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. Human beings are frequently called upon to make decisions about their bodies and their environment. Wise decisions require adequate knowledge.

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.

Homeostasis

This edition has a renewed emphasis on homeostasis. The last chapter in Part 1 is entitled "Introduction to Homeostasis". The principles of homeostasis are discussed and the contributions of the various systems to homeostasis are outlined before a feature of the text called a Working Together box is introduced. Working Together boxes throughout the text describe how each organ system works with other systems to achieve homeostasis. In each chapter, an icon calls attention to those portions of the text which discuss homeostasis. Applying Your Knowledge to the Concepts questions at the end of chapter pertain to the maintenance of homeostasis.

The urinary system chapter and the endocrine system chapter were rewritten to better emphasize the contribution of these systems to homeostasis.

Vibrant, New Illustration Program

Almost every illustration in the text is new or has been revised to better engage students in the study of human biology. Students are visually motivated, and the new art program has many features they will find helpful. Visual Focus illustrations give a conceptual overview that relates structure to function. Color coordination includes assigning colors to the various classes of organic molecules and to the different human tissues and organs.

Readings

As in the previous edition, health and ecology concerns are carried through the book by Health Focus and Ecology Focus readings. The Health Focus readings are designed to help students cope with common health problems. The Ecology Focus readings draw attention to a particular environmental problem.

In this edition, students are asked to apply the concepts to the many and varied perplexing bioethical issues that face us every day. Each chapter ends with a description of a bioethical situation that calls for a value judgement on the part of the reader. Students are challenged to develop a point of view by answering a series of questions that deal with the issue. The myriad of issues considered include genetic disease testing, modern reproductive technologies, human cloning, AIDS vaccine trials, animal rights, responsibility for one's health, and fetal research.

Technology

New to this edition, the free *Essential Study Partner* CD-ROM, accompanies the text. A CD-ROM icon has been placed throughout each chapter to remind students that this important learning tool can assist them in reviewing the concepts. *The Dynamic Human 2.0*, which offers a pictorial review of each human system, has been revised to have even more student appeal. The Mader Home Page contains interactive exercises to help students master the objective of each chapter and provides further information on most topics discussed in the text.

Pedagogical Features

As before, *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 its reference.

The questions at the end of the chapter are of both the essay and objective type. New to this edition, the Testing Your Knowledge of the Concepts questions include multiple choice, fill in the blanks, and true-false questions. The questions called Applying Your Knowledge to the Concepts help stress the homeostasis theme of the text. All the boldfaced terms in the chapter are listed and page referenced. A matching exercise tests student comprehension of the terms.

Revised Chapters

Almost every chapter in *Human Biology* has been revised. Every systems chapter now has a major section entitled Homeostasis, which outlines how that system works with other systems to maintain homeostasis. The nervous system chapter describes new findings in the field of memory and learning. The cardiovascular system chapter has a new section which pulls together material on pulse rate, blood pressure, and blood flow. In the lymphatic system chapter, the inflammatory reaction has been rewritten. The respiratory system chapter now includes a greater number of respiratory tract infections and disorders. In the chapter on senses, the mechanism of smelling and tasting has been updated. The AIDS Supplement and the chapter on cancer include the latest information on these disorders.

Applications

Educational theory tells us that students are most interested in knowledge of immediate practical application. This text is consistent with and remains true to this approach.

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. Some topics such as the cloning of animals, xenotransplantation, and gene therapy to treat cancer are new.

New to This Edition

- Homeostasis has a renewed emphasis. 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, and Applying Your Knowledge to the Concepts contains questions that pertain to homeostasis.
- Revised Working Together boxes appear in each of the system chapters. These illustrations describe how each organ system works with the other systems to achieve homeostasis, which is also discussed in a major section of the chapter.
- Technology aids are described at the end of each chapter. The *Essential Study Partner* CD-ROM tutorial which supports and enhances the concepts presented is offered free with the text. A CD-ROM icon is used throughout the chapter to remind students to consult this useful learning tool. *The Dynamic Human 2.0* CD-ROM is an interactive three-dimensional visual guide to human anatomy and physiology. The Mader Home Page provides interactive study exercises and further information for each chapter of the text.
- Health Focus and Ecology Focus readings support the two major themes of the text. A new bioethical issue is discussed in a featured section at the end of each chapter. Challenging questions are provided that can be used as a basis for class discussion.
- A new illustration program adds vitality to the art and enhances the appeal of the text. Many new micrographs provide realism. Visual Focus illustrations give a pictorial overview of key topics. Color coding is used both for molecular structures and for human tissues and organs.
- Relevancy of the text is increased with the inclusion or expanded treatment of such topics as eating disorders, allergies, pulmonary disorders, hepatitis infections, xenotransplantation, modern reproductive technologies, human cloning, the human genome project, and gene therapy to treat cancer.

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The personnel at WCB/McGraw-Hill have always lent their talents to the success of *Human Biology*. My publisher Michael Lange was always there to offer advice and my editor Patrick Reidy stepped in when needed to encourage us all. Suzanne Guinn, my developmental editor, served as a liaison between me and everyone else on the book team. Suzanne had many creative suggestions and was an inspiration to us all despite the long hours she labored.

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In my office Evelyn Jo Hebert has consistently provided support through several editions of the text, and Norma Costain's contributions have also made the success of *Human Biology,* sixth edition, possible. Kathleen Hagelston has been a wonderful resource for creative and expert input on illustrations through the editions of *Human Biology*.

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.

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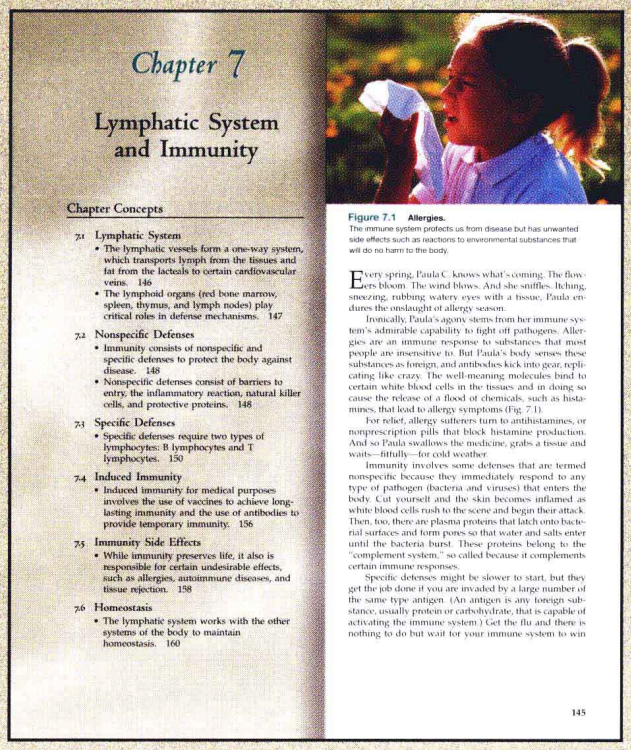


Chapter 7

Lymphatic System and Immunity

Chapter Concepts

7.1 Lymphatic System
- The lymphatic vessels form a one-way system, which transports lymph from the tissues and fat from the lacteals to certain cardiovascular veins. 146
- The lymphoid organs (red bone marrow, spleen, thymus, and lymph nodes) play critical roles in defense mechanisms. 147

7.2 Nonspecific Defenses
- Immunity consists of nonspecific and specific defenses to protect the body against disease. 148
- Nonspecific defenses consist of barriers to entry, the inflammatory reaction, natural killer cells, and protective proteins. 148

7.3 Specific Defenses
- Specific defenses require two types of lymphocytes: B lymphocytes and T lymphocytes. 150

7.4 Induced Immunity
- Induced immunity for medical purposes involves the use of vaccines to achieve long-lasting immunity and the use of antibodies to provide temporary immunity. 156

7.5 Immunity Side Effects
- While immunity preserves life, it also is responsible for certain undesirable effects, such as allergies, autoimmune diseases, and tissue rejection. 158

7.6 Homeostasis
- The lymphatic system works with the other systems of the body to maintain homeostasis. 160

Figure 7.1 **Allergies.**
The immune system protects us from disease but has unwanted side effects such as reactions to environmental substances that will do no harm to the body.

Every spring, Paula C. knows what's coming. The flowers bloom. The wind blows. And she sniffles. Itching, sneezing, rubbing watery eyes with a tissue, Paula endures the onslaught of allergy season.

Ironically, Paula's agony stems from her immune system's admirable capability to fight off pathogens. Allergies are an immune response to substances that most people are insensitive to. But Paula's body senses these substances as foreign, and antibodies kick into gear, replicating like crazy. The well-meaning molecules bind to certain white blood cells in the tissues and in doing so cause the release of a flood of chemicals, such as histamines, that lead to allergy symptoms (Fig. 7.1).

For relief, allergy sufferers turn to antihistamines, or nonprescription pills that block histamine production. And so Paula swallows the medicine, grabs a tissue and waits—fitfully—for cold weather.

Immunity involves some defenses that are termed nonspecific because they immediately respond to any type of pathogen (bacteria and viruses) that enters the body. Cut yourself and the skin becomes inflamed as white blood cells rush to the scene and begin their attack. Then, too, there are plasma proteins that latch onto bacterial surfaces and form pores so that water and salts enter until the bacteria burst. These proteins belong to the "complement system," so called because it complements certain immune responses.

Specific defenses might be slower to start, but they get the job done if you are invaded by a large number of the same type antigen. (An antigen is any foreign substance, usually protein or carbohydrate, that is capable of activating the immune system.) Get the flu and there is nothing to do but wait for your immune system to win

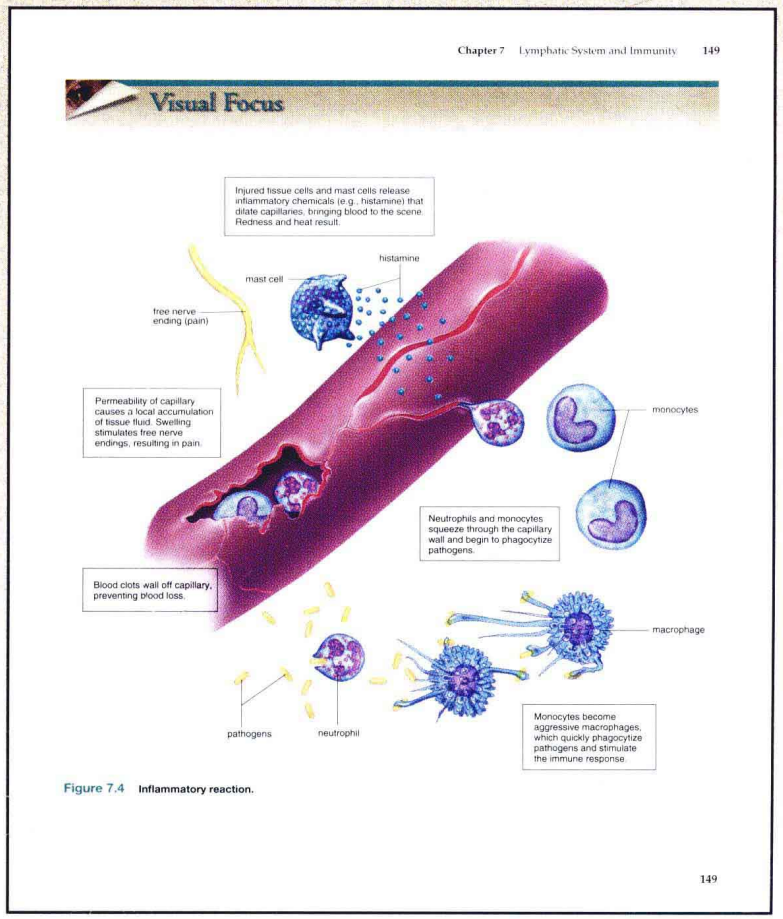
145

Before you begin, spend a little time looking over the next few pages. They provide a quick guide to the learning tools found throughout the text that have been designed to enhance your understanding of biology.

Concepts are Stressed

In this edition, the major topics are numbered, and the concepts listed on the chapter's opening page are grouped according to these topics. This numbering system, which is used in the text material and in the summaries, allows instructors to assign specific portions of the chapter. It also allows students to study the chapter in terms of the concepts presented.

In addition, ***Human Biology*** now has a further enhanced art and pedagogical system. Improved page layout, an outstanding art program, revised charts, and rewritten and reorganized chapters ensure that ***Human Biology*** will continue to be a winner in the classroom.



Chapter 7 Lymphatic System and Immunity 149

Visual Focus

Injured tissue cells and mast cells release inflammatory chemicals (e.g., histamine) that dilate capillaries, bringing blood to the scene. Redness and heat result.

histamine

mast cell

free nerve ending (pain)

Permeability of capillary causes a local accumulation of tissue fluid. Swelling stimulates free nerve endings, resulting in pain.

monocytes

Neutrophils and monocytes squeeze through the capillary wall and begin to phagocytize pathogens.

Blood clots wall off capillary, preventing blood loss.

macrophage

pathogens

neutrophil

Monocytes become aggressive macrophages, which quickly phagocytize pathogens and stimulate the immune response.

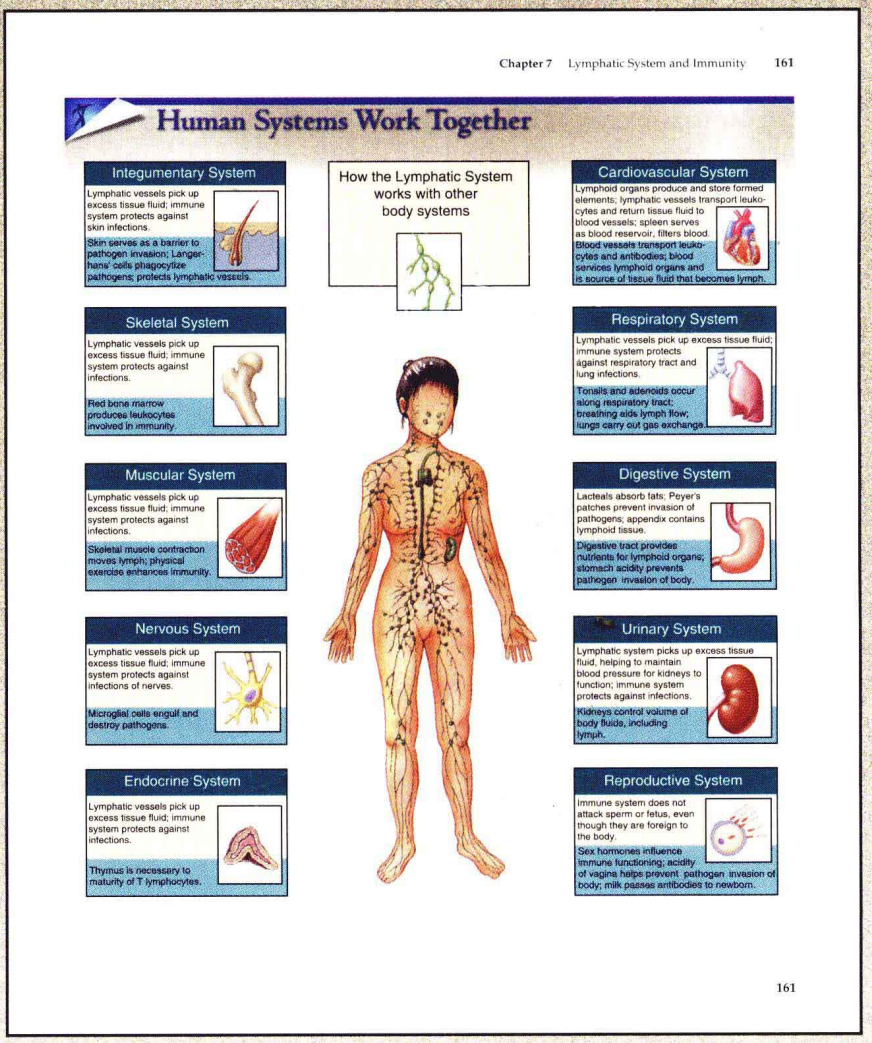
Figure 7.4 **Inflammatory reaction.**

149

Working Together

Human Biology emphasizes human physiology and the role humans play in the biosphere. Each chapter presents topics clearly, simply, and distinctly using a concepts approach. For example, homeostasis is emphasized throughout the text (shown by an icon) and each systems chapter has its own main section explaining, in depth, how that particular system helps maintain homeostasis.

In addition, full-page illustrations entitled "Working Together" visually summarize and describe how each organ system interacts with other body systems. This is featured in every systems chapter.



Chapter 7 Lymphatic System and Immunity 161

Human Systems Work Together

Integumentary System
Lymphatic vessels pick up excess tissue fluid; immune system protects against skin infections.
Skin serves as a barrier to pathogen invasion; Langerhans' cells phagocytize pathogens; protects lymphatic vessels.

Skeletal System
Lymphatic vessels pick up excess tissue fluid; immune system protects against infections.
Red bone marrow produces leukocytes involved in immunity.

Muscular System
Lymphatic vessels pick up excess tissue fluid; immune system protects against infections.
Skeletal muscle contraction moves lymph; physical exercise enhances immunity.

Nervous System
Lymphatic vessels pick up excess tissue fluid; immune system protects against infections of nerves.
Microglial cells engulf and destroy pathogens.

Endocrine System
Lymphatic vessels pick up excess tissue fluid; immune system protects against infections.
Thymus is necessary to maturity of T lymphocytes.

How the Lymphatic System works with other body systems

Cardiovascular System
Lymphoid organs produce and store formed elements; lymphatic vessels transport leukocytes and return tissue fluid to blood vessels; spleen serves as blood reservoir, filters blood.
Blood vessels transport leukocytes and antibodies; blood services lymphoid organs and is source of tissue fluid that becomes lymph.

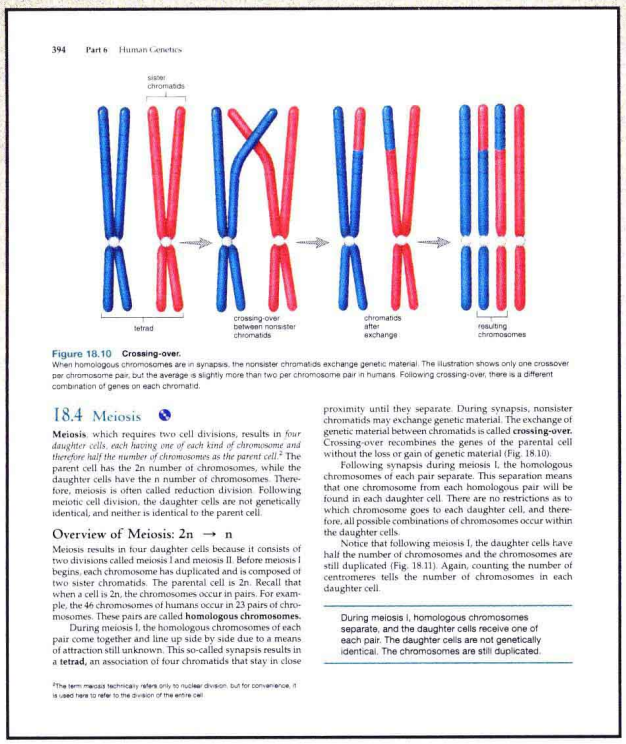
Respiratory System
Lymphatic vessels pick up excess tissue fluid; immune system protects against respiratory tract and lung infections.
Tonsils and adenoids occur along respiratory tract; breathing aids lymph flow; lungs carry out gas exchange.

Digestive System
Lacteals absorb fats; Peyer's patches prevent invasion of pathogens; appendix contains lymphoid tissue.
Digestive tract provides nutrients for lymphoid organs; stomach acidity prevents pathogen invasion of body.

Urinary System
Lymphatic system picks up excess tissue fluid, helping to maintain blood pressure for kidneys to function; immune system protects against infections.
Kidneys control volume of body fluids, including lymph.

Reproductive System
Immune system does not attack sperm or fetus, even though they are foreign to the body.
Sex hormones influence immune functioning; acidity of vagina helps prevent pathogen invasion of body; milk passes antibodies to newborn.

161



394 Part 6 Human Genetics

Figure 18.10 Crossing-over.
When homologous chromosomes are in synapsis, the nonsister chromatids exchange genetic material. The illustration shows only one crossover per chromosome pair, but the average is slightly more than two per chromosome pair in humans. Following crossing-over, there is a different combination of genes on each chromatid.

18.4 Meiosis

Meiosis, which requires two cell divisions, results in *four daughter cells, each having one of each kind of chromosome and therefore half the number of chromosomes as the parent cell.*[1] The parent cell has the 2n number of chromosomes, while the daughter cells have the n number of chromosomes. Therefore, meiosis is often called reduction division. Following meiotic cell division, the daughter cells are not genetically identical, and neither is identical to the parent cell.

Overview of Meiosis: 2n → n

Meiosis results in four daughter cells because it consists of two divisions called meiosis I and meiosis II. Before meiosis I begins, each chromosome has duplicated and is composed of two sister chromatids. The parental cell is 2n. Recall that when a cell is 2n, the chromosomes occur in pairs. For example, the 46 chromosomes of humans occur in 23 pairs of chromosomes. These pairs are called **homologous chromosomes.**

During meiosis I, the homologous chromosomes of each pair come together and line up side by side due to a means of attraction still unknown. This so-called synapsis results in a **tetrad,** an association of four chromatids that stay in close proximity until they separate. During synapsis, nonsister chromatids may exchange genetic material. The exchange of genetic material between chromatids is called **crossing-over.** Crossing-over recombines the genes of the parental cell without the loss or gain of genetic material (Fig. 18.10).

Following synapsis during meiosis I, the homologous chromosomes of each pair separate. This separation means that one chromosome from each homologous pair will be found in each daughter cell. There are no restrictions as to which chromosome goes to each daughter cell, and therefore, all possible combinations of chromosomes occur within the daughter cells.

Notice that following meiosis I, the daughter cells have half the number of chromosomes and the chromosomes are still duplicated (Fig. 18.11). Again, counting the number of centromeres tells the number of chromosomes in each daughter cell.

During meiosis I, homologous chromosomes separate, and the daughter cells receive one of each pair. The daughter cells are not genetically identical. The chromosomes are still duplicated.

[1]The term meiosis technically refers only to nuclear division, but for convenience, it is used here to refer to the division of the entire cell.

The Essential Study Partner CD-ROM is an interactive student study tool referenced in the text and packed with over 100 animations and more than 200 learning activities. From quizzes to interactive diagrams, you will find that there has never been a more exciting way to study biology. A self-quizzing feature allows users to test their knowledge of a topic before moving on to a new module. Additional unit exams provide the opportunity to review an entire subject area. The quizzes and unit exams hyperlink back to tutorial sections so students can easily review coverage.

Summarizing the Concepts

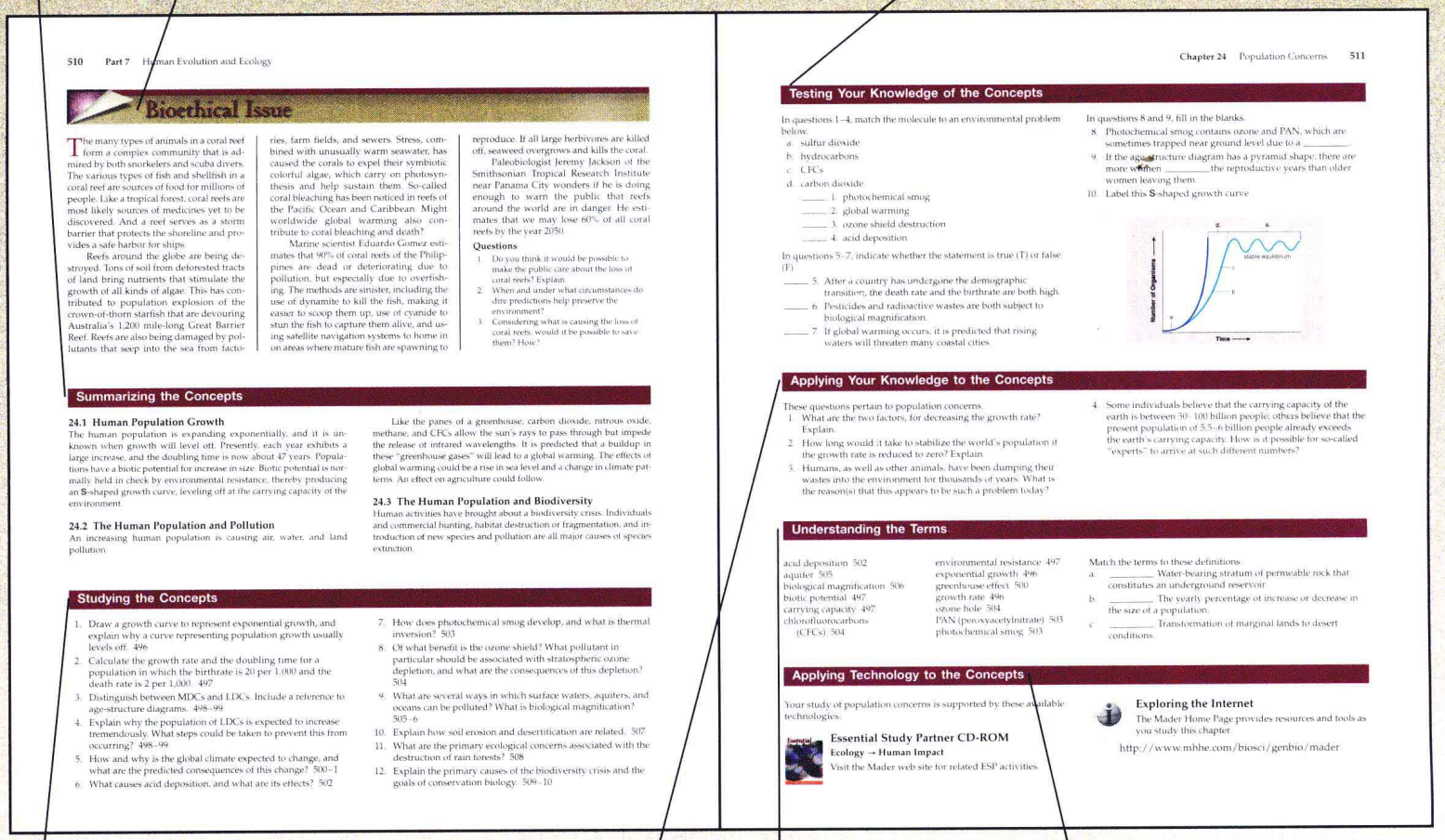
These summaries help students review the important concepts and topics discussed in the chapter.

Bioethical Issue

Students are challenged to read the bioethical issue, then give a point of view by answering a series of questions that pertain to the issue. Issues include genetic disease testing, human cloning, AIDS vaccine trials, animal rights, responsibility for one's health, and fetal research.

Testing Your Knowledge of the Concepts

These objective questions allow students to test their ability to answer recall-based questions. At least one question requires that students label a diagram or fill in a table. Answers to *Testing Your Knowledge of the Concepts* appear in the appendix.



510 Part 7 Human Evolution and Ecology

Bioethical Issue

The many types of animals in a coral reef form a complex community that is admired by both snorkelers and scuba divers. The various types of fish and shellfish in a coral reef are sources of food for millions of people. Like a tropical forest, coral reefs are most likely sources of medicines yet to be discovered. And a reef serves as a storm barrier that protects the shoreline and provides a safe harbor for ships.

Reefs around the globe are being destroyed. Tons of soil from deforested tracts of land bring nutrients that stimulate the growth of all kinds of algae. This has contributed to population explosion of the crown-of-thorn starfish that are devouring Australia's 1,200 mile-long Great Barrier Reef. Reefs are also being damaged by pollutants that seep into the sea from factories, farm fields, and sewers. Stress, combined with unusually warm seawater, has caused the corals to expel their symbiotic colorful algae, which carry on photosynthesis and help sustain them. So-called coral bleaching has been noticed in reefs of the Pacific Ocean and Caribbean. Might worldwide global warming also contribute to coral bleaching and death?

Marine scientist Eduardo Gomez estimates that 90% of coral reefs of the Philippines are dead or deteriorating due to pollution, but especially due to overfishing. The methods are sinister, including the use of dynamite to kill the fish, making it easier to scoop them up, use of cyanide to stun the fish to capture them alive, and using satellite navigation systems to home in on areas where mature fish are spawning to reproduce. If all large herbivores are killed off, seaweed overgrows and kills the coral.

Paleobiologist Jeremy Jackson of the Smithsonian Tropical Research Institute near Panama City wonders if he is doing enough to warn the public that reefs around the world are in danger. He estimates that we may lose 60% of all coral reefs by the year 2050.

Questions

1. Do you think it would be possible to make the public care about the loss of coral reefs? Explain.
2. When and under what circumstances do dire predictions help preserve the environment?
3. Considering what is causing the loss of coral reefs, would it be possible to save them? How?

Summarizing the Concepts

24.1 Human Population Growth

The human population is expanding exponentially, and it is unknown when growth will level off. Presently, each year exhibits a large increase, and the doubling time is now about 47 years. Populations have a biotic potential for increase in size. Biotic potential is normally held in check by environmental resistance, thereby producing an S-shaped growth curve, leveling off at the carrying capacity of the environment.

24.2 The Human Population and Pollution

An increasing human population is causing air, water, and land pollution.

Like the panes of a greenhouse, carbon dioxide, nitrous oxide, methane, and CFCs allow the sun's rays to pass through but impede the release of infrared wavelengths. It is predicted that a buildup in these "greenhouse gases" will lead to a global warming. The effects of global warming could be a rise in sea level and a change in climate patterns. An effect on agriculture could follow.

24.3 The Human Population and Biodiversity

Human activities have brought about a biodiversity crisis. Individuals and commercial hunting, habitat destruction or fragmentation, and introduction of new species and pollution are all major causes of species extinction.

Studying the Concepts

1. Draw a growth curve to represent exponential growth, and explain why a curve representing population growth usually levels off. 496
2. Calculate the growth rate and the doubling time for a population in which the birthrate is 20 per 1,000 and the death rate is 2 per 1,000. 497
3. Distinguish between MDCs and LDCs. Include a reference to age-structure diagrams. 498–99
4. Explain why the population of LDCs is expected to increase tremendously. What steps could be taken to prevent this from occurring? 498–99
5. How and why is the global climate expected to change, and what are the predicted consequences of this change? 500–1
6. What causes acid deposition, and what are its effects? 502
7. How does photochemical smog develop, and what is thermal inversion? 503
8. Of what benefit is the ozone shield? What pollutant in particular should be associated with stratospheric ozone depletion, and what are the consequences of this depletion? 504
9. What are several ways in which surface waters, aquifers, and oceans can be polluted? What is biological magnification? 505–6
10. Explain how soil erosion and desertification are related. 507
11. What are the primary ecological concerns associated with the destruction of rain forests? 508
12. Explain the primary causes of the biodiversity crisis and the goals of conservation biology. 509–10

Chapter 24 Population Concerns 511

Testing Your Knowledge of the Concepts

In questions 1–4, match the molecule to an environmental problem below.

a. sulfur dioxide
b. hydrocarbons
c. CFCs
d. carbon dioxide

____ 1. photochemical smog
____ 2. global warming
____ 3. ozone shield destruction
____ 4. acid deposition

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

____ 5. After a country has undergone the demographic transition, the death rate and the birthrate are both high.
____ 6. Pesticides and radioactive wastes are both subject to biological magnification.
____ 7. If global warming occurs, it is predicted that rising waters will threaten many coastal cities.

In questions 8 and 9, fill in the blanks.

8. Photochemical smog contains ozone and PAN, which are sometimes trapped near ground level due to a _____.
9. If the age-structure diagram has a pyramid shape, there are more women _____ the reproductive years than older women leaving them.
10. Label this S-shaped growth curve.

Applying Your Knowledge to the Concepts

These questions pertain to population concerns.

1. What are the two factors, for decreasing the growth rate? Explain.
2. How long would it take to stabilize the world's population if the growth rate is reduced to zero? Explain.
3. Humans, as well as other animals, have been dumping their wastes into the environment for thousands of years. What is the reason(s) that this appears to be such a problem today?
4. Some individuals believe that the carrying capacity of the earth is between 50–100 billion people; others believe that the present population of 5.5–6 billion people already exceeds the earth's carrying capacity. How is it possible for so-called "experts" to arrive at such different numbers?

Understanding the Terms

acid deposition 502
aquifer 505
biological magnification 506
biotic potential 497
carrying capacity 497
chlorofluorocarbons (CFCs) 504
environmental resistance 497
exponential growth 496
greenhouse effect 500
growth rate 496
ozone hole 504
PAN (peroxyacetylnitrate) 503
photochemical smog 503

Match the terms to these definitions.

a. _____ Water-bearing stratum of permeable rock that constitutes an underground reservoir.
b. _____ The yearly percentage of increase or decrease in the size of a population.
c. _____ Transformation of marginal lands to desert conditions.

Applying Technology to the Concepts

Your study of population concerns is supported by these available technologies.

Essential Study Partner CD-ROM
Ecology → Human Impact
Visit the Mader web site for related ESP activities.

Exploring the Internet
The Mader Home Page provides resources and tools as you study this chapter.
http://www.mhhe.com/biosci/genbio/mader

Applying Your Knowledge to the Concepts

In this section, three or four questions ask students to relate concepts they have learned to matters of practical concern. Answers to these questions appear in the appendix.

Applying Technology to the Concepts

References to McGraw-Hill technology point students to other sources for more information.

Studying the Concepts

These questions, which are page-referenced and organized according to the major sections of the chapter, review important chapter material.

Understanding the Terms

A matching exercise ensures that students understand the chapter's terms before proceeding to the next chapter.

Brief Contents

Contents