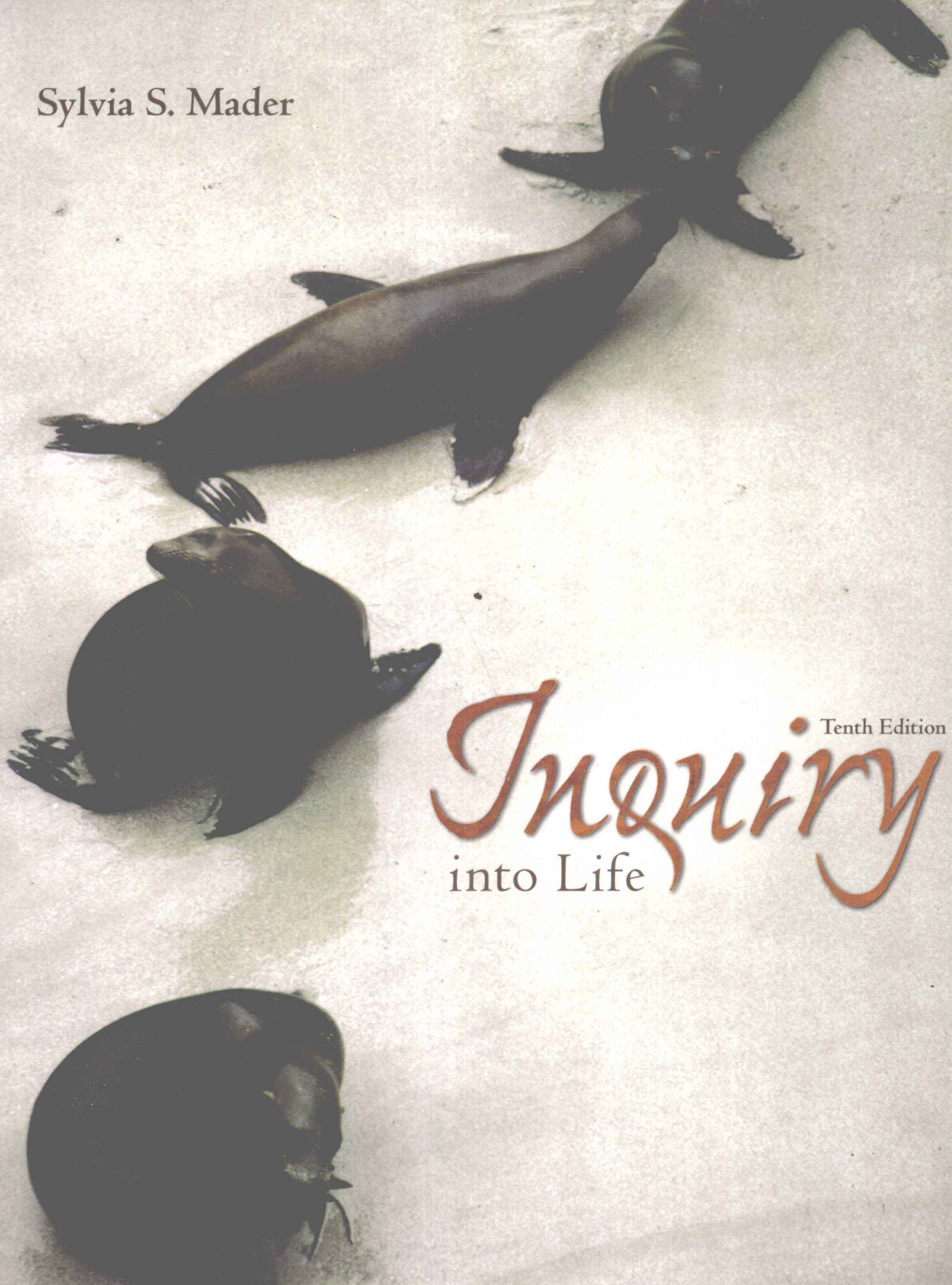


Sylvia S. Mader



Tenth Edition

Inquiry

into Life

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Sylvia S. Mader

For My Children



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INQUIRY INTO LIFE, TENTH EDITION

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Preface

Inquiry into Life is written for the introductory-level student who would like to develop a working knowledge of biology. While the text covers the whole field of general biology, it emphasizes the application of this knowledge to human concerns. Along with this approach, concepts and principles are stressed, rather than detailed, high-level scientific data and terminology. Each chapter presents the topic clearly, simply, and distinctly so that the student can achieve a thorough understanding of basic biology. As with previous editions, the central themes of *Inquiry into Life* are understanding the workings of the human body and how humans fit into the world of living things.

Pedagogical Features

Educational theory tells us that students are most interested in knowledge of immediate practical concern. This text is consistent with and remains true to this approach. The running text and the readings stress applications to everyday life. Such topics as eating disorders, allergies, stem cell research, cloning of animals, and xenotransplantation are integral to the chapter.

As before, the chapter outline numbers the major sections of the chapter. New to this edition, instead of listing statements, students are asked questions according to the chapter outline. The questions are designed to stimulate inquisitive thinking and develop better study skills. The general nature of these questions will encourage students to concentrate on concepts and how concepts relate to one another.

The numbering system in the chapter outline is continued throughout the chapter and is repeated in the summary so that instructors can assign just certain portions of the chapter, if they like. The text is paged so that major sections begin at the top of a page and illustrations are on the same or facing page as its reference.

Each chapter begins with a vignette, a short story that applies chapter material to a real-life situation. To increase student interest, I have moved the opening vignette to the chapter opening page where it is accompanied by a photograph.

The summary at the end of the chapter also assists students in learning the concepts discussed in the chapter. New to this edition, "Testing Yourself" has been expanded to include fifteen to twenty objective style questions. "Studying the Concepts," which are essay-type questions, and "Thinking Scientifically," which are critical thinking questions, have been moved to the Online Learning Center. The last page of each chapter instructs student how best to use the Online Learning Center for that chapter.

Boxed Readings

Inquiry into Life has four types of readings. "Health Focus" readings review procedures and technology that can contribute to our well being. "Science Focus" readings describe how experimentation and observations have contributed to our knowledge about the living world. "Ecology Focus" readings show how the concepts of the chapter can be applied to ecological concerns. "Bioethical Focus" readings describe a modern 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 pertain to the issue.

The text contains many new Focus readings. Students will be delighted to consider "Do Animals Have Emotions?" They will be fascinated to know that the Human Genome Project will result in "New Cures on the Horizon," and intrigued by "The United States Population," a reading based on the 2000 census. New bioethical issues include the use of "Stem Cells" to treat our ills, and whether we should allow "Cloning of Humans." At adopters' requests, the bioethical focus readings now bear a title, which will facilitate their use for classroom discussions.

Revised Chapters

Inquiry into Life remains forever new and vital because it is revised from the first to the last page of every edition. These changes may be of special interest:

The introductory chapter, "The Study of Life" was rewritten to strengthen the presentation of the characteristics of life, the organization of the biosphere, and the scientific process. Feedback from many adopters allowed me to vastly improve the scientific process section so that it is useful to everyone.

In Part I, Cell Biology, Chapter 5 opens with a more lucid discussion of the cell cycle and its relevance to cancer. In Chapter 7, "Cellular Metabolism," the first illustration became an icon for the revised illustrations in the chapter.

In Part II, Plant Biology, all three chapters were rewritten. Icons are now strategically placed in Chapter 8, "Photosynthesis." Instructors will be especially pleased with the rewrite of Chapter 9, Plant Organization, which is more thorough than before. Chapter 10, now entitled "Plant Reproduction, Growth, and Development" was reorganized, and the plant hormone discussion was improved.

In Parts III and IV, the systems chapters were fine-tuned and the illustrations were 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.

In Part V, Continuation of the Species, the genetics chapters received special attention. The new illustrations in this part will make it easier for students to study Punnett squares. New to this edition, all chromosome mutations now have an accompanying illustration.

In Part VI, Evolution and Diversity, the three-domain system of classification has replaced the five-kingdom system. The classification tables throughout these chapters have been revised to better assist students in learning the major groups of organisms. The evolution of humans was revised to reflect the latest findings.

In Part VII, Behavior and Ecology, a new chapter called “Ecosystems and Human Interferences” introduces the basics of ecology and shows how human activities have altered biogeochemical cycles to our own detriment. Another new chapter entitled “Conservation of Biodiversity” closes the text. 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.

Online Learning Center

Students can utilize many technological resources in order to understand the content of this textbook. In addition to end of chapter questions and the printed study guide, the Online Learning Center at www.mhhe.com/maderinquiry10 contains readings, quizzes, animations, and other activities to help students master the concepts.

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

New to this edition, the Careers pages from the previous edition, the “Studying the Concepts” questions, and the “Thinking Scientifically” questions have been moved to the Online Learning Center. Also, Further Readings now are a part of the Online Learning Center.

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

New to This Edition

- Online study aids are organized according to the major sections of the chapter on the e-Learning Connection page found at the end of each chapter. In this way, students can easily determine the available resources that help explain difficult concepts. The same design is utilized at the Online Learning Center, and this allows students to quickly find an activity of interest.
- The chapter opening page has been revised. The chapter outline now contains questions listed according to the major sections, instead of statements. The questions are designed to start students thinking about and learning the concepts. The opening vignette now appears on this page and is accompanied by a photograph.
- Although all chapters were revised, some changes are of particular interest. Illustrations in Part I and II have new icons to assist student learning. Also, the plant chapters have been completely revised and are now more thorough. The genetics chapters have been rewritten and are supported by new art. Two new chapters—“Ecosystems and Human Interferences” and “Conservation of Biodiversity”—strengthen the ecology section of the text.
- The classification system of the text has been modernized. The three-domain system of classification based on molecular biology replaces the five-kingdom system of classification based on structure and adaptations to the environment.
- The revised 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 for both molecular structures and for human tissues and organs.
- Relevancy of the text is increased with the inclusion or expanded treatment of topics such as eating disorders, allergies, stem cell research, hepatitis infections, xenotransplantation, human cloning, the human genome project, and gene therapy to treat cancer.

The Reviewers

Many instructors have contributed not only to this edition of *Inquiry into Life* but also to previous editions. I am extremely thankful to each one, for they have all worked diligently to

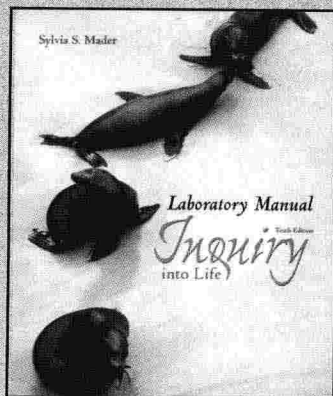
remain true to our calling to provide a product that will be the most useful to our students.

In particular, it is appropriate to acknowledge the following individuals for their help on the tenth edition:

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TEACHING AND LEARNING SUPPLEMENTS

McGraw-Hill offers a variety of tools and technology products to support the tenth edition of *Inquiry into Life*. Students can order supplemental study materials by contacting the McGraw-Hill Customer Service Department at (800) 338-3987. Instructors can obtain teaching aids by calling the Customer Service Department or by contacting your local McGraw-Hill sales representative.



Inquiry into Life Laboratory Manual

The *Inquiry into Life Laboratory Manual*, written by Dr. Sylvia Mader, has an accompanying laboratory exercise for most chapters in the text. Every laboratory has been written to help students learn the fundamental concepts of biology and the specific

content of the chapter to which the lab relates, as well as gain a better understanding of the scientific method. The *Laboratory Resource Guide* is now available on the Instructor Center of the Online Learning Center at www.mhhe.com/maderinquiry10.

Student Study Guide

Dr. Sylvia Mader has written the *Student Study Guide* that accompanies the tenth edition of *Inquiry into Life*. Each text chapter has a corresponding study guide chapter that includes a chapter review, study questions for each section of the chapter, a chapter test, and thought-provoking essay questions. Answers for all questions are provided to give students immediate feedback.

Transparencies

Every piece of line art in the textbook is included, with better visibility and contrast than ever before. Labels are large and bold for clear projection.

100 Micrograph Slides

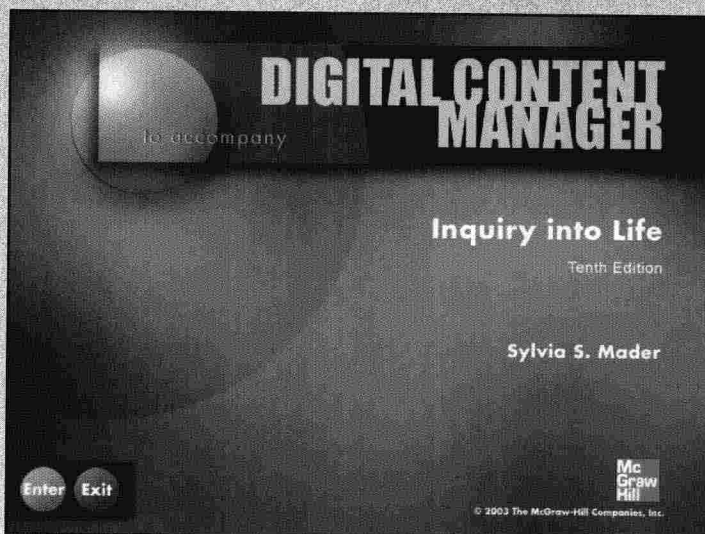
This set contains 35mm slides of many of the photomicrographs and electron micrographs in the text.







Computerized Test Bank

Available on CD-ROM in both Mac and Windows platforms, this test bank utilizes Brownstone Diploma® testing software. This user-friendly program allows instructors to search for questions using multiple criteria, edit or add questions, and scramble questions to create customized exams.

Digital Content Manager

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



-  **Active Art Library.** Illustrations depicting key processes have been converted to a format that allows each figure to be broken down to its core elements, thereby allowing the instructor to manipulate the art and adapt the figure to meet the needs of the lecture environment
-  **Animations Library.** Harness the visual impact of key physiological processes in motion by importing these full-color animations into classroom presentations or course websites.
-  **Art Libraries.** Full color digital files of all illustrations in the book, plus the same art saved in unlabeled and gray scale version, can be readily incorporated into lecture presentations, exams, or custom-made classroom materials.
-  **Tables Library.** Every table that appears in the text is provided in electronic format.
-  **PowerPoint Lecture Outlines.** A ready-made presentation that combines lecture notes and art is written for each chapter. They can be used as they are, or the instructor can tailor them to preferred lecture topics and sequences.
-  **PowerPoint Art Slides.** Art, photographs, or tables from each chapter that have been pre-inserted into blank PowerPoint slides



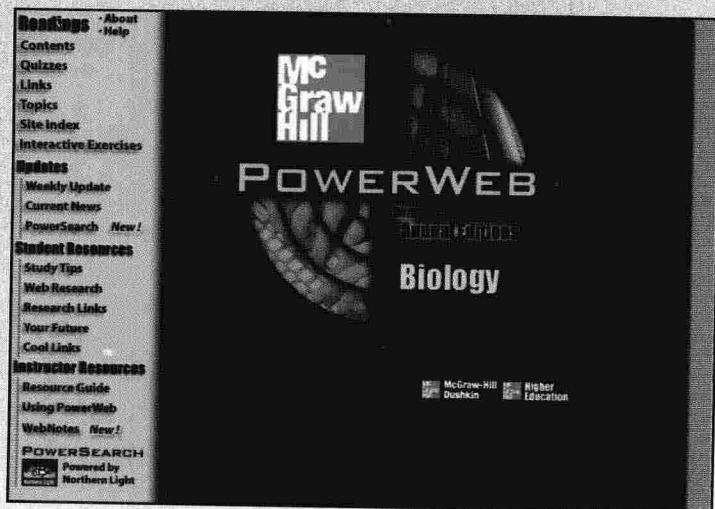
Interactive Laboratories and Biological Simulations, or iLaBS, teach students real-life biomolecular applications and techniques using fun, web-based programs. These labs provide students the opportunity for repetitive practice in techniques that they would be limited to doing only once in a normal lab setting. iLaBS also allow students to virtually perform time-consuming or hazardous techniques that they would not otherwise be able to experience.

Online Learning Center

The *Inquiry into Life* Online Learning Center (OLC) at www.mhhe.com/maderinquiry10 offers access to a vast array of premium online content to fortify the learning and teaching experience.

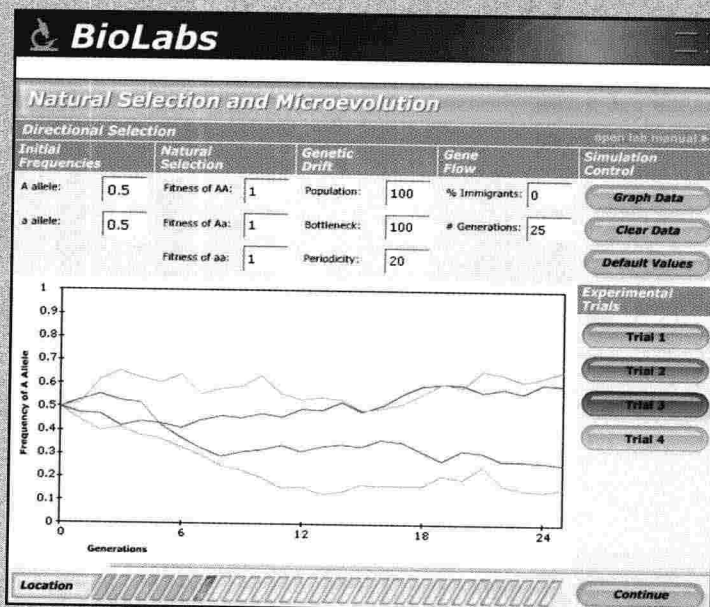
Student Center. The Student Center of the OLC features the e-Learning Connection from the end of each chapter in the textbook. This page, which correlates online study tools such as quizzes and interactive activities to each section of the chapter, is expanded on the OLC. In addition, the following online resources are available:

- **Essential Study Partner** A collection of interactive study modules that contains hundreds of animations, learning activities, and quizzes designed to help students grasp complex concepts.
- **PowerWeb** An online supplement that offers access to current course-specific articles, news, research links, journals, and much more.



- **BioCourse.com** Accessed through the OLC, this site for students and instructors provides an exhaustive set of up-to-date resources pertaining to the life sciences.
- **Online Tutoring** A 24-hour tutorial service moderated by qualified instructors. Help with difficult concepts is only an email away!

- **BioLabs** Students can master skills vital to success in the laboratory by using these online simulations.

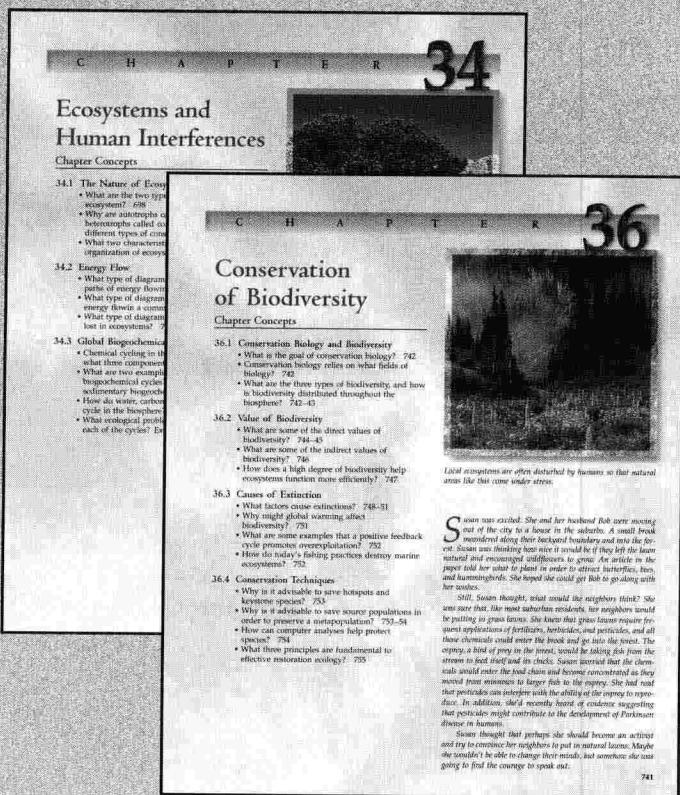


Instructor Center. The Instructor Center is an online repository for teaching aids. It houses downloadable and printable versions of traditional ancillaries plus a wealth of online content.

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

Life Science Animations Library 3.0 CD-ROM

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



New to *Inquiry into Life*, Tenth Edition!

New Chapters in Ecology Section

Chapter 34, Ecosystems and Human Interferences, introduces the basics of ecology and shows how human activities have altered biogeochemical cycles.

Chapter 36, Conservation of Biodiversity, demonstrates that by preserving other species, we ultimately preserve our own species.

Botany Chapters Extensively Revised
New icons throughout Chapter 8 help clarify material for students. Chapter 9 has been rewritten, with new sections and new art. Chapter 10 was reorganized, and plant hormones are better represented.



Time-Proven Features That Will Enhance Your Understanding of Biology

Chapter Concepts

The chapter outline contains questions to encourage students to concentrate on concepts and how concepts relate to one another.

Opening Vignette

A short, thought-provoking vignette applies chapter material to a real-life situation.

14.7

B Cells and Antibody-Mediated Immunity

A toxin is a chemical (produced by bacteria, for example) that is poisonous to other living things. When a B cell in a lymph node or the spleen encounters a bacterial cell or a toxin bearing a specific antigen, it becomes activated to divide many times. Most of the resulting cells are plasma cells. A **plasma cell** is a mature B cell that mass-produces antibodies in the lymph node and to the spleen.

The **clonal selection theory** states that the antigen selects which lymphocyte will undergo clonal expansion and produce more lymphocytes bearing the same type of antigen receptor (Fig. 14.5). Notice that a B cell does not divide until a specific antigen is present and binds to its receptors. B cells are stimulated to divide and become plasma cells by helper T cell secretions called cytokines, as discussed in the next section. Some members of the clone become memory cells, which are the means by which long-term immunity is possible. If the same antigen enters the system again, memory B cells quickly divide and give rise to more lymphocytes capable of quickly producing antibodies.

Once the threat of an infection has passed, the development of new plasma cells ceases, and those present undergo apoptosis. Apoptosis is a process of programmed cell death (PCD) involving a cascade of specific cellular events leading to the death and destruction of the cell. The methodology of PCD is still being worked out, but we know it is an essential physiological mechanism regulating the cell population within an organ system. PCD normally plays a central role in maintaining tissue homeostasis.

Defense by B cells is called **antibody-mediated immunity** because the various types of B cells produce antibodies. It is also called **humoral immunity** because these antibodies are present in blood and lymph. A humoral is any fluid normally occurring in the body.

Characteristics of B Cells

- Antibody-mediated immunity against bacteria
- Produced and mature in bone marrow
- Reside in spleen and lymph nodes, circulate in blood and lymph
- Directly recognize antigen and then undergo clonal selection
- Clonal expansion produces antibody-secreting plasma cells as well as memory B cells

14.1 The Lymphatic System

The lymphatic system consists of lymphatic vessels and the lymphoid organs. This system, which is closely associated with the cardiovascular system, has three main functions that contribute to homeostasis: (1) lymphatic capillaries take up excess tissue fluid and return it to the bloodstream; (2) lymph nodes filter out foreign particles and transport them to the bloodstream (see Fig. 5.3a); and (3) the lymphatic system works with the immune system to help defend the body against disease.

Lymphatic Vessels

Lymphatic vessels are quite extensive; most regions of the body are richly supplied with lymphatic capillaries (Fig. 14.1). The construction of the larger lymphatic vessels is similar to that of cardiovascular vessels, including the presence of valves. Also, the movement of lymph within these vessels is dependent upon skeletal muscle contraction. When the muscles contract, the lymph is squeezed past a valve that closes, preventing the lymph from flowing backward.

The lymphatic system is a one-way system that begins with lymphatic capillaries. These capillaries take up fluid that has diffused from and not been reabsorbed by the blood capillaries. Edema is swelling caused by the accumulation of tissue fluid. This can happen if too much tissue fluid is made and/or not enough of it is drained away. Once tissue fluid enters the lymphatic vessels, it is called **lymph**. The lymphatic capillaries join to form lymphatic vessels that merge before entering one of two ducts: the thoracic duct or the right lymphatic duct. The thoracic duct is much larger than the right lymphatic duct. It serves the lower extremities, the abdomen, the left arm, and the left side of both the head and the neck. The right lymphatic duct serves the right arm, the right side of both the head and the neck, and the right thoracic area. The lymphatic ducts enter the subclavian veins, which are cardiovascular veins in the thoracic region.

Lymph flows one way from a capillary to ever-larger lymphatic vessels and finally to a lymphatic duct, which enters a subclavian vein.

Lymphoid Organs

The lymphoid organs of special interest are the lymph nodes, the tonsils, the spleen, the thymus gland, and the red bone marrow (Fig. 14.2).

Lymph nodes, which are small (about 1–25 mm in diameter) oval or round structures, are found at certain points along lymphatic vessels. A lymph node is composed

Figure 14.1 Lymphatic system. Lymphatic vessels drain excess fluid from the tissues and return it to the cardiovascular system. The enlargement shows that lymphatic vessels, like cardiovascular vessels, have valves to prevent backflow. The lymph nodes, tonsils, spleen, thymus gland, and red bone marrow are the main lymphoid organs that assist immunity.

Figure 14.5 Clonal selection. When an antigen combines with a B cell receptor, the result is many clones of plasma cells, which secrete antibodies.

e-Learning Connection

Each chapter ends with an e-Learning Connection page, which organizes relevant online study materials by major sections. This page is repeated and expanded on the Online Learning Center at www.mhhe.com/maderinquiry10, where a click of the mouse takes you to a specific study aid.

CHAPTER 14

Lymphatic and Immune Systems

Chapter Concepts

14.1 The Lymphatic System

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- What parts of the body are considered lymphoid organs? 262–63

14.2 Nonspecific Defenses

- What does immunity mean? How does nonspecific defense differ from specific defense? 264
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14.3 Specific Defenses

- Which blood cells are mainly responsible for specific defense and how do they function? 266–71

14.4 Induced Immunity

- What is induced immunity? What are the different types of induced immunity, and what are some examples of each? 272–74

14.5 Immunity: Side Effects

- What types of complications and disorders are associated with the functioning of the immune system? 274–77

It's easy to spread germs from hand to face. Frequent washing of hands assists the immune system in protecting us from disease.

Karin casually licks her finger, unaware she is infecting herself with a flu virus picked up when helping her small son blow his nose. The viral particles slip past the protective mucous barrier of her digestive tract, enter cells, and begin to make copies of themselves. Just before the infected cells succumb, they secrete chemicals that alert her immune system to the invaders.

The immune system reacts to antigens, any substance, usually protein or carbohydrate, that the system is capable of recognizing as being "foreign." Get a bacterial infection, and certain lymphocytes start producing antibodies. An antibody combines with the antigen, and later the complex is phagocytized by a macrophage. In Karin's case, however, macrophages devour viruses and prevent their release to infect lymphocytes that go on to kill any cells that are infected with the virus. Whereas you can take an antibiotic to help cure a bacterial infection, often there is nothing to do for a viral infection but wait for the immune system to join the battle.

Under the immune system of many others, Karin's immune system mistakenly reacts to harmless antigens, and this causes her to have allergies. Otherwise, though, it does a magnificent job of keeping her well.

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Internal Summary Statements

A summary statement appears at the end of each major section of the chapter to help students focus on the key concepts.

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e-Learning Connection www.mhhe.com/maderinquiry10

Concepts	Questions	Media Resources	
22.1 Early Developmental Stages	<ul style="list-style-type: none"> • Development begins when a sperm fertilizes an egg. • The first stages of embryonic development in animals lead to the establishment of the embryonic germ layers. • The proximity of cells affects the manner in which animal embryos go through the early developmental stages. • In vertebrates, the nervous system develops above the notochord after formation of a neural tube. 	<ul style="list-style-type: none"> 1. What is the role of the notochord during embryonic development? 2. In what way does the amount of cells in an egg make a difference during development? 	<ul style="list-style-type: none"> Essential Study Partner: Fertilization Cell Differentiation: Art Quiz Contribution: Mammal General Biology WebLinks: Developmental Biology Case Study: Development
22.2 Developmental Processes	<ul style="list-style-type: none"> • Cephalization, segmentation and induction help bring out cellular differentiation and morphogenesis. • Developmental genetics has benefited from research into the development of <i>Caenorhabditis elegans</i>, a nematode, and <i>Drosophila melanogaster</i>, a fly. • Homeotic genes are involved in shaping the outward appearance of animals. 	<ul style="list-style-type: none"> 1. Explain what is meant by "cellular differentiation" and "morphogenesis." 2. What is the function of homeotic genes? 	<ul style="list-style-type: none"> Art Quiz: Embryonic and Evolutionary History Allosteric Growth McCourse Study Guide: Mammalian Development I
22.3 Human Embryonic and Fetal Development	<ul style="list-style-type: none"> • Humans, like chicks, are dependent upon extraembryonic membranes that perform various services that contribute to development. • Human development consists of embryonic and fetal development. • Humans are placental mammals; the placenta is a unique organ where exchange between fetal blood and mother's blood takes place. • Birth is a multistage process that includes delivery of the child and the extraembryonic membranes. 	<ul style="list-style-type: none"> 1. In what way are extraembryonic membranes evolutionarily significant? 2. During what stage of development are all vertebrate organ systems present if not fully developed? 	<ul style="list-style-type: none"> Essential Study Partner: Early Development Human Development: Hormones and Pregnancy Developmental Biology: Embryonic and Fetal Development Parturition Art Quiz: Placenta Embryonic Membranes: Mammalian Embryo I Extraembryonic Membranes: Mammalian Embryo II Labeling Exercise: Human Extraembryonic Membranes Anatomy of the Fetus Case Studies: Embryonic Stem Cells: The Future of Organ Transplants The Case of the Embryo: William Fawcett Frozen Embryo

Health Focus

Nutrition Labels

As of May 1994, packaged foods have a nutrition label like the one depicted in Figure 20. The nutrition information given on this label is for a serving of 1 gram of food. It is important to know the amount of fat, cholesterol, and sodium in the food you eat.

Science Focus

How Memories Are Made

Neurobiologists want to understand higher mental functions like memory from the behavioral to the molecular level. They believe that the process of memory is related to the structure of the brain. It is possible that a monkey brain may be different from a human brain. But only the introduction of high-speed computers can help us understand the process of memory.

Ecology Focus

Photochemical Smog Can Kill

Most industrialized cities have photochemical smog at least occasionally. Photochemical smog arises when primary pollutants cannot disperse, and the results can be disastrous. In 1963, about 300 people died, and in 1966, about 168 people died in London.

Bioethical Focus

Clinical Trials

The United Nations estimates that 16,000 people become newly infected with the human immunodeficiency virus (HIV) each day, or 5.8 million per year. Ninety percent of these infections occur in the less-developed countries where infected persons do not have access to antiretroviral therapy. In Uganda, for example, there is only one physician per 100,000 people, and only \$6.00 is spent annually on health care, per person. In contrast, in the United States \$12,000–\$15,000 is sometimes spent on treating an HIV infected person per year.

The only methodology to prevent the spread of HIV in a developing country is counseling against behaviors that increase the risk of infection. Clearly an effective vaccine would be most beneficial to these countries. Several HIV vaccines are in various stages of development, and all need to be clinically tested in order to see if they are effective. It seems reasonable to carry out such trials in developing countries, but there are many ethical questions.

A possible way to carry out the trial is this: vaccinate the uninfected sexual partners of HIV-infected individuals. After all, if the uninfected partner remains free of the disease, then the vaccine is effective. But is it ethical to allow a partner identified as having an HIV infection to remain untreated for the sake of the trial?

And should there be a placebo group—a group that does not get the vaccine? After all, if a greater number of persons in the placebo group become infected than those in the vaccine group, then the vaccine is effective. But if members of the placebo group become infected, shouldn't they be given effective treatment? For that matter, even participants in the vaccine group might become infected. Shouldn't any participant of the trial be given proper treatment if they become infected? Who would pay for such treatment when the trial could involve thousands of persons?

Decide Your Opinion

- Should HIV vaccine trials be done in developing countries, which stand to gain the most from an effective vaccine? Why or why not?
- Should the trial be carried out using the same standards as in developed countries? Why or why not?
- Who should pay for the trial—the drug company, the participants, or the country of the participants?

1. Country that has only low to moderate industrialization; usually located in the southern hemisphere.

Readings

Inquiry into Life has four types of boxed readings.

- Health Focus readings review procedures and technology that can contribute to our well-being.
- Science Focus readings describe how experimentation and observations have contributed to our knowledge about the living world.
- Ecology Focus readings show how the concepts of the chapter can be applied to ecological concerns.
- Bioethical Focus readings describe modern situations that call for value judgments and challenge students to develop a point of view.

Chapter Summary

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

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Testing Yourself

Choose the best answer for each question.

- Which of the following is needed for glycolysis to occur?
 - pyruvate
 - glucose
 - NAD⁺
 - ATP
- All of the above are needed except a.
 - carbon dioxide
 - ATP
 - pyruvate
 - FADH₂
- How many ATP molecules are produced from the oxidation and reduction of one molecule of NADH?
 - 1
 - 3
 - 10
 - 30
- How many NADH molecules are produced during the complete breakdown of one molecule of glucose?
 - 2
 - 10
 - 30
 - 36
- What is the name of the process that adds the third phosphate to an ADP molecule using the flow of hydrogen ions?
 - substrate-level phosphorylation
 - fermentation
 - oxidation
 - chemosynthesis
- What are possible products of fermentation?
 - lactic acid
 - alcohol
 - all of the above
 - none of the above
- The metabolic process that produces the most ATP molecules is
 - glycolysis
 - electron transport system
 - citric acid cycle
 - fermentation
- The oxygen required by cellular respiration is reduced and becomes part of which molecule?
 - ATP
 - H₂O
 - pyruvate
 - CO₂

For questions 9–11, identify the pathway involved by matching them to the terms in the key.

Key:

- glycolysis
- citric acid cycle
- electron transport system
- Carbon dioxide (CO₂) given off
- PCoA
- Citric acid cycle
- The greatest contribution of electrons to the electron transport system is
 - oxygen
 - glycolysis
 - the citric acid cycle
 - the transition reaction
 - fermentation

Summarizing the Concepts

14.1 The Lymphatic System

The lymphatic system consists of lymphatic vessels and lymphoid organs. The lymphatic vessels receive lipoproteins at intestinal villi and excess tissue fluid at blood capillaries, and carry these to the bloodstream.

Lymphocytes are produced and accumulate in the lymphoid organs (red bone marrow, lymph nodes, tonsils, spleen, and thymus glands). Lymph is cleansed of pathogens and/or their toxins in lymph nodes, and blood is cleansed of pathogens and/or their toxins in the spleen. T lymphocytes mature in the thymus, while B lymphocytes mature in the red bone marrow where all blood cells are produced. White blood cells are necessary for nonspecific and specific defenses.

14.2 Nonspecific Defenses

Immunity involves nonspecific and specific defenses. Nonspecific defenses include barriers to entry, the inflammatory reaction, natural killer cells, and protective proteins.

14.3 Specific Defenses

Specific defenses require B lymphocytes and T lymphocytes, also called B cells and T cells. B cells undergo clonal selection with production of plasma cells and memory B cells after their antigen receptors combine with a specific antigen. Plasma cells secrete antibodies and eventually undergo apoptosis. Plasma cells are responsible for antibody-mediated immunity. The IgG antibody is a Y-shaped molecule that has two binding sites for a specific antigen. Memory B cells remain in the body and produce antibodies if the same antigen enters the body at a later date.

T cells are responsible for cell-mediated immunity. The two main types of T cells are cytotoxic T cells and helper T cells. Cytotoxic T cells

kill virus-infected or cancer cells on contact because they bear a nonspecific protein. Helper T cells produce cytokines and stimulate other immune cells. Like B cells, each T cell bears antigen receptors. However, for a T cell to recognize an antigen, the antigen must be presented by an antigen-presenting cell (APC), usually a macrophage, along with an HLA (human leukocyte-associated antigen). Thereafter, the activated T cell undergoes clonal expansion until the illness has been stemmed. Then most of the activated T cells undergo apoptosis. A few cells remain, however, as memory T cells.

14.4 Induced Immunity

Active (long-lived) immunity can be induced by vaccines when a person is well and in no immediate danger of contracting an infectious disease. Active immunity is dependent upon the presence of memory cells in the body.

Passive immunity is needed when an individual is in immediate danger of succumbing to an infectious disease. Passive immunity is short-lived because the antibodies are administered to and not made by the individual.

Cytokines, including interferon, are used in attempts to treat AIDS and to promote the body's ability to recover from cancer.

Monoclonal antibodies, which are produced by the same plasma cell, have various functions, from detecting infections to treating cancer.

14.5 Immunity Side Effects

Allergic responses occur when the immune system reacts vigorously to substances not normally recognized as foreign. Immediate allergic responses, usually consisting of coldlike symptoms, are due to the activity of antibodies. Delayed allergic responses, such as contact dermatitis, are due to the activity of T cells. Immune side effects also include blood-type reactions, tissue rejection, and autoimmune diseases.

Objective Test Questions

A full page of challenging objective questions now closes each chapter.

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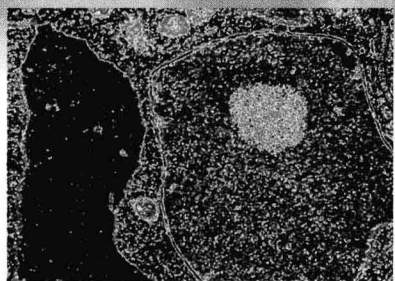
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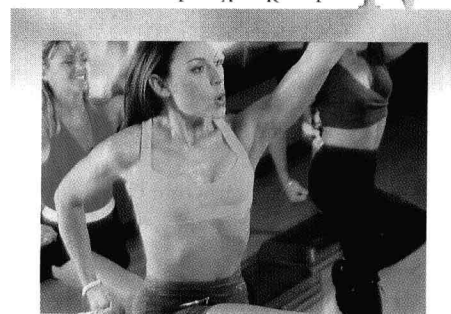
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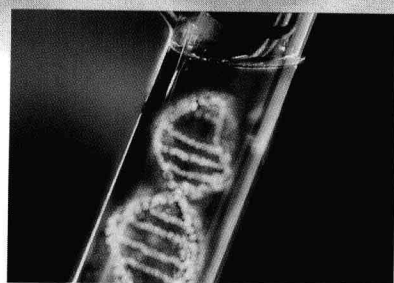
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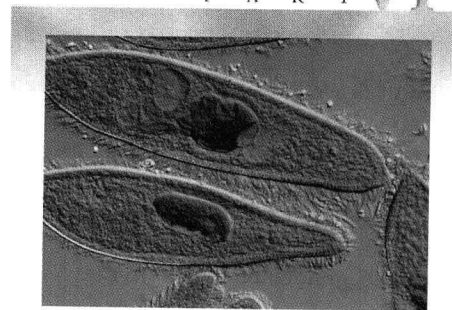
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