

*Cycles of Life*  
EXPLORING BIOLOGY

**TELECOURSE PREVIEW**

Distributed by  
**Coast Learning Systems**

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# Contents

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<b>Introduction</b>	<b>4</b>
<b>A Brief Description of <i>Cycles of Life</i>: EXPLORING BIOLOGY</b>	<b>4</b>
<b>Course Themes</b>	<b>4</b>
<b>Design and Production of the Telecourse</b>	<b>5</b>
Production Team	5
Academic Development Team	7
Academic Advisory Committee	8
<b>Components of the Telecourse</b>	<b>9</b>
Video Programs	9
Textbook	9
Telecourse Student Guide	10
Laboratory Component	10
Faculty Manual/Test Bank	11
<b>The Lessons</b>	<b>12</b>
Video Program Descriptions and Learning Objectives	12
<b>Sample Course Outline</b>	<b>40</b>
<b>Form for Ordering Preview Videocassette and Review Copies of Print Materials</b>	<b>43</b>

## Introduction

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The purpose of this preview is to provide those involved in the presentation of *Cycles of Life: EXPLORING BIOLOGY* with a basic understanding of the course and its components. It begins with a brief description of the course and its themes. Remaining information covers the design and production of the telecourse and provides information about the video programs, the textbook, and the student study guide. This preview concludes with summaries of each of the 26 video programs, accompanied by specific learning objectives and reading assignments for each lesson.

## A Brief Description of *Cycles of Life: EXPLORING BIOLOGY*

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*Cycles of Life: EXPLORING BIOLOGY* is a one-semester college-level telecourse in introductory biology. The telecourse not only brings you the latest biological discoveries and theories, it is also interesting, enriching, and inspiring. The course gives the student a breathtaking view of the origin and nature of life, from the simplest single-celled forms to complex plants and animals and human beings. As an introductory biology course, *Cycles of Life: EXPLORING BIOLOGY* goes beyond describing the subject matter of biology. It examines the scientific method and considers both its promises and limitations. It answers many of our questions and poses new ones time after time, so that we are continually probing into the innermost secrets of life.

*Cycles of Life: EXPLORING BIOLOGY* is designed for postsecondary students seeking to meet transfer and general education requirements or interested in personal enrichment. The telecourse can be offered by both two- and four-year institutions for three units of lower-division credit. The telecourse is also appropriate for use by individuals in self-paced instruction and in nontraditional learning situations such as those at off-campus educational sites at military bases, prisons, libraries, and other outreach locations.

## Course Themes

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From its inception, the goal of this biology course was to provide students with the most reliable knowledge about basic biology and an understanding of how that knowledge was gained. With that in mind, the national advisory committee developed the following principal themes for *Cycles of Life: EXPLORING BIOLOGY*.

1. Life is dynamic and continually evolving through time.
2. The living world exhibits both diversity and unity: organisms vary immensely, yet they also share many fundamental characteristics.
3. Life is a marvelously complex system of prolonging order, all sustained by energy.

4. There is continuity in the living world: Life presents a continuous stream of genetic information passed on through the ages.
5. The natural world exhibits organization: the different structures we see in nature tend to repeat themselves in different organisms and on different scales.
6. Life seeks stability: organisms work to maintain a stable internal environment despite changing external conditions.
7. Life is both interdependent and competitive: all organisms depend on the environment and one another for their basic needs, yet they must struggle against nature and each other to survive.
8. In biology, as in all the sciences, we must compare explicit hypotheses and predictions to evidence obtained from observations and experimental data.
9. Because biology is a human endeavor, it is subject to both the limitations and the inspirations of those who study it.

Guided by these course themes, the academic advisors and course creators developed specific instructional objectives for each of the twenty-six lessons. These learning objectives are listed in the Lessons section of this preview and provide the framework for the structure and content of each lesson.

## Design and Production of the Telecourse

*Cycles of Life: EXPLORING BIOLOGY* is the product of joint efforts of the Coast Community College District; the Office of Instructional Systems Development, Coastline Community College; KOCE-TV; Brooks/Cole Publishing Company; New Jersey Community College Telecommunications Consortium; NILRC; Oregon Community College Distance Education Consortium; and the Texas Consortium for Educational Telecommunications.

A carefully chosen team of production and media specialists was assembled to create this fascinating telecourse. Their efforts were guided by a national academic advisory committee that proposed the telecourse themes and objectives, reviewed the video programs as they were developed, and provided innumerable valuable suggestions on content and resources for the video programs.

### **Production Team**

**Executive Producer:** James E. LeMay. He performed this role while he was administrative dean for Instructional Systems Development at Coastline Community College. Previously, LeMay had headed Coast Telecourses and directed the marketing and distribution of the award-winning telecourses *UNIVERSE: The Infinite Frontier*, *Time to Grow*, *Psychology: The Study of Human Behavior*, and *Chinese Brush Painting*. Before joining Coastline, LeMay was executive vice president of The Media Guild in San Diego. From 1961 to 1981, he held positions in sales and general

management for Coronet Instructional Films in Chicago and was senior vice president and general manager of the film division for three years. LeMay received an M.A. from Indiana University and his B.A. from University of St. Thomas, St. Paul, Minnesota.

**Series Producer:** Marian Inova. She also served as writer and segment producer/director. Before joining KOCE-TV as editor/writer for *UNIVERSE: The Infinite Frontier*, Inova had directed and edited numerous broadcast television, corporate, and educational productions. She was production supervisor for an ABC television station and directed newscasts. For NASA's Jet Propulsion Laboratory, Inova directed video productions for unmanned space missions, notably the Voyager spacecraft encounters with Uranus and Neptune. Inova has received numerous awards including Cindys, Indys, and a Gold Screen Award. She holds an M.A. in film/television from the University of California, Los Angeles.

**Post-Production Supervisor:** Harry S. Ratner. He was also director for the telecourse *Time to Grow* and was involved in other award-winning programs such as *UNIVERSE: The Infinite Frontier*, *Psychology: The Study of Human Behavior*, *Focus on Watercolor*, *Faces of Culture*, *Jim Cooper's Orange County*, *Needlecraft*, and *Humanities through the Arts*. Ratner was staff producer/director at KCET-28, Los Angeles; associate professor of broadcasting, California State University, Los Angeles; and producer/director at KOCE-TV. He holds an M.A. in education and a general secondary credential from California State University, Los Angeles, a B.A. in radio-television from San Francisco State.

**Coordinating Producer:** Laurie Harer Melby. This course also includes her work as segment producer/director. Harer was coordinating producer for the telecourse *UNIVERSE: The Infinite Frontier* and production manager on the telecourses *Psychology: The Study of Human Behavior* and *Time to Grow*. A graduate of California State University, Fullerton, Melby holds a B.A. in communications with an emphasis in television production. After graduation, she worked in post-production at Prime Time Post, Hollywood, and in syndication and distribution for Telepictures. Since then, she has held a variety of positions on feature films and corporate television productions, including writer, producer, and field director. Melby is now Director of Production in Coastline's Office of Instructional Systems Development.

**Segment Producer-Director:** Richard Jansen. He was one of two lead producers for *Cycles of Life*. He has a B.S. in television film from San Diego State University, was operations manager of KOCE-TV, and was involved in other telecourse productions. As an independent producer, Jansen specialized in corporate training, marketing, and broadcast films for companies such as McDonnell Douglas and Kaiser Permanente. In 1988, he won the International Television Association's Silver Angel Award for a film about patients with Alzheimer's disease. Jansen serves on the Board of Trustees of the ITVA Educational Foundation.

**Segment Producer-Director:** Richard J. Wells. The other lead producer for *Cycles of Life* is a producer-director-writer who has won numerous awards, including seven Emmys, for documentaries, educational films, and

investigative productions. Wells' most honored work was the documentary science series *Infinite Voyage*, which was syndicated by Fox Television. Episodes on the development and application of advanced materials and the role of zoos in conserving wildlife won CINE Golden Eagle awards and Chris awards. A cum laude University of California at Los Angeles graduate, Wells has been a corporate filmmaker for companies such as Hughes Aircraft and Mattel Toys.

**Segment Producer-Director:** Robert D. Nash. For this project, Nash served in the dual capacity of segment producer-director and writer. He was also script editor/writer for *UNIVERSE: The Infinite Frontier*. Nash began his career in television as a researcher and writer for Corniche Productions, a company specializing in programming for public television and cable television. These programs include *The Moneymakers*, a series on personal financial planning, and *The Babe*, a one-man teleplay on the life of Babe Ruth. Nash has worked as a free-lance writer specializing in video scriptwriting for corporate training for such companies as Hughes Aircraft Company, Mitsubishi, and Rain Bird Sprinkler Manufacturing Corporation. He is a Phi Beta Kappa graduate of the University of California, Berkeley.

**Animation Graphics:** Tim Doherty. He created original state-of-the-art animation and computer graphics to illustrate fundamental concepts, principles, and theories of astronomy. In many cases, Doherty's graphics portray phenomena and events that cannot be observed or recorded on film or other media. A computer animator since 1987, Doherty's broadcast work has appeared on NBC, The Disney Channel, public television, and cable systems. He has conducted seminars on desktop animation and has written articles on the subject for a national magazine. Doherty received a bachelor of arts from the College of Wooster, Wooster, Ohio.

**Animation Graphic Artists:** Joe Clasen, Susan Ishida.

**Captioning/Transcripts:** Dixie Deckard.

### Academic Development Team

**Text Author:** Cecie Starr. Her book, *Biology: Concepts and Applications*, offers a complete overview of biology and is written with the nonscience major in mind. *Biology: The Unity and Diversity of Life*, written by Starr and Ralph Taggart, may also be used with the telecourse. Both books showcase the science of biology as a dynamic process of inquiry and they reflect years of valuable comments from faculty and offer numerous learning aids.

**Science Advisor:** Robert Egan. He is professor of biology at Golden West College, Huntington Beach, California. He served as consultant for the video programs, reviewed and revised individual lesson learning objectives, and developed questions for the test bank. Egan received a B.A. from Catholic University of America, Washington, D.C. and his M.S. in biological science from Purdue University.

**Science Advisor:** Bonita Roohk. She is professor of biology at Golden West College, Huntington Beach, California. She also served as consultant for the video programs, reviewed and revised individual lesson learning

objectives, and developed questions for the test bank. Roohk received her B.S. in biological science and M.S. in human physiology from the University of California, Davis.

**Student Guide Author:** Gerald L. Kellogg. He is an experienced instructional designer and designer of learning systems and materials, including health science projects with the California State University, Dominguez Hills and Long Beach. He has a B.A. from the University of California, Riverside, and an M.A. from the University of California, Los Angeles.

**Student Guide Reviewer, first edition:** Randall Warwick. Professor of bioscience/quality science at Coastline Community College, he served as content reviewer throughout the development of the telecourse student guide. He received his A.S. from San Francisco City College, his A.B. from the University of California at Berkeley, and his M.S. from the University of California, Los Angeles, School of Medicine, Department of Anatomy.

**Student Guide Reviewer, second edition:** Brent G. DeMars, Ph.D. An assistant professor of biology at Lakeland Community College in Kirtland, Ohio, DeMars provided invaluable assistance in updating and correcting the contents of the second edition of the telecourse student guide. A member of Lakeland's faculty since 1995, DeMars serves as an instructor of the *Cycles of Life* telecourse offered through the college's Instructional Technologies Division.

### **Academic Advisory Committee**

An outstanding group of academics drawn from institutions participating in *Cycles of Life: EXPLORING BIOLOGY* and from other institutions provided content and instructional guidance based on their individual areas of specialization. The advisory committee reviewed and finalized course themes, lesson topics, specific instructional objectives, and reviewed treatments and scripts for content accuracy.

The committee included:

- Jerry Button, Portland Community College, Portland, Oregon
- Nancy Dengler, Professor, Department of Botany, University of Toronto, Toronto, Canada
- Brian Earle, Division of Natural and Applied Sciences, Cedar Valley Community College, Lancaster, Texas
- Jack Goldberg, Section NPB Division of Biological Sciences, University of California at Davis, Davis, California
- Samuel Huang, Professor of Biology, Riverside Community College, Riverside, California
- Gary H. Karpen, Molecular Biology and Virology Laboratory, The Salk Institute for Biological Studies, La Jolla, California
- Carolyn Robertson, Director of Instructional Television and Extended Courses, Tarrant County Junior College, Fort Worth, Texas

- Tim Tirrell, Chairperson, New Jersey Community College Telecommunications Consortium, Inc., Cumberland County College, Vineland, New Jersey
- Randall Warwick, Professor, Coastline Community College, Fountain Valley, California

## Components of the Telecourse

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A multimedia course, *Cycles of Life: EXPLORING BIOLOGY* includes the following elements: video programs, textbook, telecourse student guide, laboratory component (optional), and faculty manual.

### Video Programs

The telecourse's 26 **half-hour broadcast-quality video programs** were designed and produced by academic and media production experts with the cooperation of KOCE-TV, an award-winning public television station. The video programs are available in all major videotape formats and can be presented on open broadcast, cable, and closed-circuit television and by video playback for groups or individuals. Individual programs can be used as audiovisual resources to enhance campus-based instruction.

The video component of *Cycles of Life: EXPLORING BIOLOGY* investigates a broad range of biology topics, concepts, and principles. The video programs feature leading practitioners, theoreticians, and academicians in fields ranging from anatomy to zoology, who describe and explain fundamental concepts of our living world. Using human experience as a focus for this exploration, the video programs take you to places you have never been and show you sights you could never see without the aid of microvideography or computer simulation. Using footage of actual laboratory experiments and interviews with biologists, microbiologists, and biochemists, the video programs also give you insights into the application of biological principles in research and development.

A special feature of the programs is scientifically accurate three-dimensional animation and computer graphics that illustrate complex concepts in biology. Detailed information on the content of each video program is presented in the Lessons section of this preview booklet.

### Textbook

The textbooks for *Cycles of Life: EXPLORING BIOLOGY* are *Biology: Concepts and Applications*, by Cecie Starr, and *Biology: The Unity and Diversity of Life*, by Starr and Ralph Taggart, both published by Brooks/Cole Publishing Company. The content of the textbooks parallels the content of the video programs.

### Telecourse Student Guide

The telecourse student guide for *Cycles of Life: EXPLORING BIOLOGY* assists students by coordinating all elements of the course and includes review activities and self-tests for each lesson.

The student guide was developed by the Office of Instructional Systems Development at Coastline Community College and is published by Brooks/Cole Publishing Company.

Written by Gerald L. Kellogg and reviewed by Brent G. DeMars, the student guide correlates and integrates the textbook, the video programs, and the objectives of the course. The twenty-six lessons of the student guide provide students with a methodical, organized, convenient, and easily understood approach to the course.

Lessons in the student guide parallel the video programs and contain the following elements:

**Assignments:** Detailed instructions on activities and reading assignments for the student to complete before and after viewing each video program.

**Overview:** An introduction to the main topics covered in the textbook and video program.

**Learning Objectives:** Statements of what students should learn from reading the textbook assignments, completing the activities in the student guide, and viewing the video program.

**Viewing Notes:** A capsule description of the video program for each lesson plus questions for students to consider while watching the program.

**Review Activities:** Matching and Completion exercises to help students review and reinforce their understanding of important terms and concepts.

**Self-Test:** A brief multiple-choice quiz that allows students to test their understanding of the material in the lesson.

**Using What You've Learned:** Many of the lessons include suggestions for additional activities to enhance students' understanding and knowledge of biology.

Answers for the Matching and Completion items and for the Self-Test questions appear in an answer key section at the end of the student guide.

### Laboratory Component

For institutions that want to offer *Cycles of Life: EXPLORING BIOLOGY* with a laboratory component, the *Biology Laboratory Manual for the Telecourse Cycles of Life: EXPLORING BIOLOGY* is available. It contains numerous fundamental exercises developed specifically for nonscience majors and particularly suited for independent study and distance learning. It offers step-by-step directions, reporting procedures, and forms that introduce the student to scientific laboratory procedures and hypothesis testing. There is also a laboratory kit, containing basic equipment and chemicals, which can be ordered from EDUTYPE+—call 714-962-4645 and ask for Dave Licata. The manual and lab kit are designed to enable distance-learning students to get a valid laboratory experience at home. Also recommended as part of the laboratory component is the optional *Photo Atlas for Biology*, by James W. Perry and David Morton, Brooks/Cole Publishing Company. It contains more than 600 full-color photographs that

give laboratory students a clearer, truer, picture of the material they are working on.

### **Faculty Manual/Test Bank**

The faculty manual contains specific information for the instructor who manages the course. It offers information about the course itself; suggestions for communicating with distance-learning students; checklists of tasks the instructor may wish to complete before, during, and after the course; ideas for additional activities; and descriptions of techniques for providing support to students. The final portion of the faculty manual contains a bank of objective questions that test students' achievement of individual lesson objectives. The test bank is a resource for the instructor to use in constructing quizzes, midterms, and final examinations.

# The Lessons

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To provide a convenient overview of the course, the following pages contain brief descriptions of the video programs, reading assignments, and student learning objectives. This section is not intended as a substitute for your own careful review of the video programs, the textbook, and the study guide. It does, however, provide a convenient summary of the basic content and objectives for the individual lessons of *Cycles of Life: EXPLORING BIOLOGY*.

## Lesson 1—Biological Concepts

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**Video Program:** “*The Unity and Diversity of Life*”

**Program Description.** Beginning with the features that distinguish living matter from nonliving matter, the program provides an overview of biology. Scientists expand on the theme of “What is life?” by bringing up new questions: What do we mean by unity? By diversity? Dr. Paul Saltman describes the flow of energy from the sun to living organisms, while Dr. Christopher Wills discusses sexual reproduction as a means of genetic diversification.

The next question explored is “What is scientific method?” Biologists Bonnie Roohk and John Moore outline the steps in the scientific method against the backdrop of a specific example: researchers apply the techniques in an investigation of pesticide resistance in mosquitoes.

In the third segment, paleontologist Blaire Van Valkenburgh uses scientific method to study the unity and diversity of life. By analyzing bone structure in fossilized saber-tooth cats, she traces the evolution and extinction of different species.

The ultimate goal is to inspire an appreciation for the processes that contributed to the amazing variety, yet common threads, of life.

### Learning Objectives

When you have completed all assignments for this lesson, you should be able to:

1. List the features that distinguish living organisms from nonliving matter.
2. Describe the general pattern of energy flow through the Earth’s life forms, and explain how their interactions help cycle the Earth’s resources.
3. Summarize how DNA can affect the traits of offspring from generation to generation.
4. List and generally describe the five *kingdoms* into which living organisms are classified.
5. Explain what is meant by the term *diversity*, and identify possible causes for the great diversity of life forms on Earth.
6. Explain what is meant by the term *unity*, and identify possible causes of similarities among Earth’s organisms.

7. Discuss briefly how scientists came to believe that the populations of organisms that inhabit Earth have evolved through time.
8. Generally describe how biologists proceed through a scientific investigation.
9. Distinguish between a scientific *hypothesis* and a *theory*.
10. Identify some limitations imposed on science and scientists.

## Lesson 2—Chemical Foundations

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### Video Program: “*Chemical Foundations of Life*”

**Program Description.** The composition matter is central to the understanding of life. The program details the functions and main forms of all matter, including atoms, molecules, elements, and compounds.

In the program’s first segment, Dr. Mark Poth documents the harmful effects of the prolonged exposure of pine trees to Southern California’s polluted air. In the process, he deals with the nature of the atom and introduces organic and inorganic compounds. The program goes on to explain how chemical reactions change compounds and how isotopes are used as a research tool.

In segment two, the process of desalination serves as the vehicle to describe the many properties of water and the importance of water to life. Animations illustrate how hydrogen and oxygen atoms bond together to form a polar molecule.

Segment three examines the work of Dr. Susan Taylor, who discovered the structure of the enzyme protein kinase, explaining how living beings are essentially chemical entities. The crucial role of complex shapes in organic molecules is also explained.

### Learning Objectives

When you have completed all assignments for this lesson, you should be able to:

1. Define the term *matter*, and distinguish between an atom, a molecule, an element, and a compound.
2. Describe how protons, electrons, and neutrons are arranged into atoms.
3. Define the terms *atomic symbol*, *atomic number* and *mass number* (or “*atomic weight*”), and use these concepts to describe the structure of selected elements that are significant to living things.
4. Define *isotope*, and identify possible uses for isotopes in scientific study.
5. Explain how electrons are distributed in atoms, and how this affects the number and types of chemical bonds that can be formed.
6. Describe the various types of chemical bonds, the circumstances under which each of them forms, and their relative strengths.
7. Identify the properties of water that make it vital for life.
8. Define the terms *organic* compound and *inorganic* compound, and give examples of each.
9. Understand how small organic molecules can be assembled into large macromolecules by *condensation* and how large macromolecules can be broken apart into their basic subunits by *hydrolysis*.
10. List the four large “molecules of life,” identify their composition and structure, and describe some of the functions they perform in the cell.

## Lesson 3—Cell Structure and Function

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### Video Program: “*Secrets of the Cell*”

**Program Description.** What is a cell and why is it crucial to the understanding of life processes? Dr. Dwayne Simmons describes how a vast universe of cells works together to form living beings. For example, a football player’s separate populations of cells in his ears and brain enable him to focus on important sounds amid the din of background noise from the crowd.

In the next segment, Dr. Robert Heath discusses the role of membranes in cells and the importance of molecular movements in plants.

Finally, the program compares wholly different types of cells: the cells of prokaryotes versus those of eukaryotes. Dr. Dennis Focht tells why bacteria are self-contained living cells that envelop and permeate almost everything around us. He also describes the incredibly complex world of prokaryotes. Included in the program are discussions of the various organelles found in eukaryotic cells.

### Learning Objectives

When you have completed all assignments for this lesson, you should be able to:

1. Understand the basic tenets of *cell theory*, and identify the scientific contributions that led to its development.
2. Use the term *fluid mosaic model* to describe the general structure and function of a cell’s membranes, and identify the importance of membranes as a structural component of cells.
3. Define the terms *solute*, *solvent*, and *solution*, and relate them to the concentration of a solution.
4. Describe *diffusion*, including *osmosis*. Explain what causes diffusion, and identify the factors that influence its rate.
5. Define and give examples of *hypertonic*, *hypotonic*, and *isotonic* solutions, and note the direction of solute and solvent movement when any two of these solutions are separated by a selectively permeable membrane.
6. Distinguish those mechanisms by which substances move across membranes passively (without the use of energy) from active mechanisms (that require energy).
7. Contrast the general features of *prokaryotic* and *eukaryotic* cells.
8. Describe the membranous and nonmembranous *organelles* found in eukaryotic cells, and tell the general function of each.
9. Identify those features that generally distinguish plant cells from animal cells.
10. Identify some of the variations that create diversity of cells between organisms or specialization within one organism.

## Lesson 4—Metabolism

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### Video Program: “*The Power of Metabolism*”

**Program Description.** Former Olympic gymnast Cathy Rigby relates how her body’s reactions changed when she denied it nutrients while competing as a teenager. Her condition, called bulimia, illustrates the importance of constantly supplying chemical reactions of cells with required ingredients. Among the topics covered in the first half of the program are metabolic pathways and the roles of enzymes, coenzymes, and cofactors.

Next, the program discusses bioluminescence as an example of a unique metabolic process. Using her study of bioluminescent fish, Dr. Margo Haygood relates how an enzyme that carries out a bioluminescent reaction is a luciferase.

In conclusion, Professors Saltman and Haygood summarize the first two laws of thermodynamics. As various animals, including humans, give a display of energy expenditure, the experts discuss the concepts of changing energy from one form to another and constantly using ATP to maintain order in metabolic systems.

### Learning Objectives

When you have completed all assignments for this lesson, you should be able to:

1. Summarize the two *laws of thermodynamics* that govern energy and its conversion from one form to another.
2. Identify the major reasons why cells use energy.
3. Describe the reorganization of atoms that occurs in a simple *reversible reaction* using equations and the principles of *equilibrium*.
4. Explain how *enzymes* speed up chemical reactions, and describe the mechanisms that regulate enzyme activity.
5. Describe the properties of *acids*, *bases*, and *buffers*. Offer an example of how each of them functions in the human body, and relate this to the concept of enzyme regulation.
6. Contrast the overall sequence of reactions in *linear* versus *cyclic* metabolic pathways, noting the roles of enzymes and cofactors (including some vitamins and minerals).
7. Describe the energy flow that occurs when energy-requiring reactions and energy-releasing reactions are coupled.
8. Use the ATP/ADP cycle as an example to explain how a cell can use a molecule to temporarily hold and transport energy for use in later reactions.
9. Describe some of the methods scientists use to investigate biochemical reactions.

## Lesson 5—Energy In—Energy Out

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**Video Program:** “*Energy In—Energy Out*”

**Program Description.** Life is a marvelous, complex system of prolonging order, all sustained by energy. The pathways by which cells trap and use this energy are photosynthesis and aerobic respiration. Dr. Jeanne Erickson relates her research of the photosynthetic process that splits water in the chloroplast of a single-cell alga. Along the way, the program explains the roles and importance of photoautotrophs, heterotrophs,

the light-dependent phase, carbon fixation, and the Calvin-Benson cycle.

Dr. Paul Saltman describes the three stages in aerobic respiration: glycolysis, Krebs cycle, and electron transport phosphorylation. He later explains another form of cellular respiration: fermentation. It is illustrated by active yeast in the beer-brewing process.

### Learning Objectives

When you have completed all assignments for this lesson, you should be able to:

1. Outline the general flow of energy and matter in the living world, noting the relationship between photosynthesis and aerobic cellular respiration that cycles carbon dioxide, oxygen, and water.
2. Describe the key steps of the light-dependent and light-independent reactions of *photosynthesis*, noting the raw materials required, the end products, and the location for each phase.
3. Describe basic leaf structure and the functional advantages it offers plants.
4. Compare *chemosynthesis* and photosynthesis as energy-acquiring processes.
5. Describe the three major stages of aerobic cellular respiration, noting the raw materials and products of each phase.
6. Distinguish between *aerobic* and *anaerobic* energy-releasing pathways, and identify the requirements and energy-producing efficiency of each process.
7. Understand how proteins and fats can be used as alternative energy sources in the aerobic respiration pathway.
8. Describe how the development of photosynthesis altered the evolution of life on Earth.
9. Describe some of the methods scientists use to study life’s energy-acquiring and energy-releasing pathways.

## Lesson 6—Mitosis and Meiosis

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**Video Program:** “*Generations: Mitosis and Meiosis*”

**Program Description.** Cell division is at the heart of all the stories in the program. They illustrate how this process powers a continuous stream of molecular messages that define each organism and how it grows, reproduces, and repairs itself. Dr. Christopher Wills and Dr. Gary Karpen explain how hereditary instructions contained in chromosomes dictate the physical and behavioral traits of organisms. For continuance, each species must pass on those instructions from one generation to the next.

The program reveals that each species has a specific number of chromosomes: Humans have 46, horsetail grass has 216, and pea plants have 14. As an organism develops, its cells begin to differentiate into various forms (e.g., nerve cells, muscle cells, and bone cells) that are not clones, although each cell in an organism does carry an exact copy of all chromosomes. The process of mitosis is illustrated by a trip to a winery, where grapes of prime stock are cloned to preserve genetic characteristics in each crop.

In contrast, meiosis produces cells, called gametes, with only half of the hereditary information of the parent germ cells. Researcher Arlene Kumamoto of the Center for Reproduction of Endangered Species discusses the implication of cell division on the reproductive patterns of dik-dik antelopes at the San Diego Zoo.

### Learning Objectives

When you have completed all assignments for this lesson, you should be able to:

1. Describe the basic features of chromosome structure and number in different organisms.
2. Understand what is meant by the *cell cycle*, and relate where *mitosis* fits into the cycle.
3. Summarize the events that occur during each phase of mitosis.
4. Explain how cytoplasm is divided between daughter cells after mitosis, contrasting the process in plant and animal cells.
5. Discuss the potential of the cell cycle to control events such as cancer formation and aging.
6. Contrast *asexual* and *sexual* types of reproduction that occur among unicellular and multicellular organisms.
7. Summarize the events that occur during each phase of *meiosis* and *gamete formation*.
8. Describe the events of meiosis and gamete formation that contribute to genetic variability among organisms.
9. Compare mitosis and meiosis with respect to overall purpose, where and when each occurs, and the resulting number of chromosomes.
10. Describe some of the methods and tools scientists use to study cell division.

## Lesson 7—Patterns of Inheritance

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### Video Program: “Patterns of Inheritance”

**Program Description.** Gregor Mendel’s theory of inheritance in the mid-1800s became the basis for predicting how characteristics are passed from one generation to another. Marvin Rosenberg discusses how modern-day experiments on strawberry plants carry on Mendel’s genetic theses and improve the productivity of commercially grown crops. In the animation sequences throughout the program, the Punnett Square is used to illustrate how genes are sorted in the second generation produced by two organisms.

To illustrate codominance, incomplete dominance, epistasis, and polygenic inheritance, Mel Carpenter details how his selective breeding of homing pigeons makes them look like pure white doves. This also covers the concept of pedigree.

Finally, Carol Kasper discusses hemophilia, a genetic disease passed from generation to generation in a sex-linked pattern of inheritance.

### Learning Objectives

When you have completed all assignments for this lesson, you should be able to:

1. Use Mendel’s experiments to illustrate terms commonly used in genetics and to explain the principles of *dominance*, *segregation*, and *independent assortment*.
2. Determine all the possible kinds of gametes that can be formed from a given *genotype*, and use this information with a Punnett square to predict the outcomes of *monohybrid* and *dihybrid* crosses.
3. Describe variations that occur in observable patterns of inheritance that cannot be explained by simple dominance or recessiveness.
4. State the relationship of genes to chromosomes, and use this information to describe the concept of *linkage* and the likelihood of “crossing over.”
5. Distinguish patterns of *autosomal inheritance* from those of *X-linked inheritance*.
6. Explain how changes can occur in chromosome structure and number, and understand how these changes can affect the outward appearance of organisms.
7. Identify and use the components of a simple *pedigree*.
8. Explain how modern methods of genetic screening can minimize potentially tragic events.

## Lesson 8—DNA: Structure and Function

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### Video Program: “DNA: Blueprint of Life”

**Program Description.** By mixing and matching animals or plants with desired characteristics, farmers and gardeners manipulate their heritable traits. They choose the features they want and attempt to eliminate the others. Today, with the advent of genetic engineering, we can tinker at a much deeper level with startling precision. The question arises: How far do we go?

The program initially looks at the question in a historical perspective. Dr. Inder Verma provides insights and descriptions relating to the discovery of the DNA molecule. This segment explores the research that led to the model of DNA structure presented by James Watson and Francis Crick.

Later, Dr. Leroy Hood discusses his efforts to decipher the DNA code and its implications. Also, Dr. John Wasmuth describes his search for the Huntington’s Disease gene, a task akin to finding a needle in 200 haystacks.

Highlighting the final segment is the story of a boy with a rare disease (severe combined immunodeficiency disease) caused by a missing gene for adenosine deaminase. The story unfolds to explain how doctors and a research team replaced the boy’s missing gene, one of the first times that genes have been inserted permanently into the blood-producing cells of a human. Recent tests indicate the gene replacement was successful because the boy’s blood cells are producing a necessary enzyme.

### Learning Objectives

When you have completed all assignments for this lesson, you should be able to:

1. Relate how past experiments demonstrated that instructions for producing inheritable traits are coded in DNA.
2. Describe the parts of a *nucleotide*, and explain how nucleotides are linked together to make DNA.
3. Explain how DNA is replicated and repaired, what materials are needed for replication, and the importance of that process to cell division.
4. Describe the organization of DNA in chromosomes, including the structural contribution of proteins.
5. Outline the mechanism through which DNA controls a cell’s structure and function.
6. Explain what *plasmids* are and how they may be used to make *recombinant DNA* molecules.
7. Describe in general terms how DNA can be cleaved, spliced, cloned, and sequenced.
8. Discuss some limits and possible applications of genetic engineering, and distinguish this process from the more traditional techniques of selective breeding.
9. Describe some of the methods scientists use to study DNA.

## Lesson 9—Proteins

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### **Video Program:** “*Proteins: Building Blocks of Life*”

**Program Description.** By examining proteins, Dr. James Lake believes he might find the tracks of evolution, the hereditary path of life back to the first cell. He explains the structure and order of proteins, along with a unique property of DNA and proteins to retain and replicate the genetic code through thousands of years with extraordinary fidelity.

In the next segment, a television meteorologist describes how he survived sickle-cell anemia. This often-fatal childhood disease illustrates how one small change in our genetic code causes drastic differences. One sickle-cell gene protects the body against malaria; two sickle-cell genes create a painful and deadly blood disease. Dr. Cage Johnson explains that research in genetic therapy may provide long-term help for patients.

Finally, the program looks at the curious case of slime mold, an organism that is a compelling example of how cells control protein production. Dr. Richard Firtel contrasts how simple prokaryotic cells use operons as “on-off” switches for proteins, while more complex eukaryotic cells differentiate their structures by utilizing proteins in a variety of ways.

### **Learning Objectives**

When you have completed all assignments for this lesson, you should be able to:

1. State the major differences between DNA and RNA, and describe how the structure of DNA determines the structure of the three forms of RNA during *transcription*.
2. Explain how the structure and function of the three forms of RNA determine the primary structure of polypeptide chains during *translation*.
3. Outline how *operons* regulate gene expression (the production of proteins) in prokaryotes.
4. Describe how cell differentiation proceeds in eukaryotes by selective gene expression during development.
5. Relate the concept of changes in gene controls to changes in protein. Note those changes that occur both naturally, as in some cancers, and those that can occur through genetic engineering.
6. Describe some of the experimental methods scientists use to investigate protein transcription and translation.

## Lesson 10—Microevolution

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### Video Program: “*Microevolution*”

**Program Description.** Charles Darwin’s theory of evolution by natural selection is presented by John Moore, who discusses its major concepts. Additional historical insight into the theory of evolution is discussed by Ernst Mayr who further defined “species” in the 1940s.

This introduction to the subject gives way to a story of unusual mosquitoes that have developed resistance, through mutation and natural selection, to most current forms of insecticides. How are mosquito populations affected by genetic and environmental conditions? In evaluating the insects’ response to the pressure of insecticides, the program discusses selection pressures.

Divergence and various forms of isolation—including geographic, reproductive, structural, and behavioral—are illustrated by plant and animal life on a California coastal island. Misty Gay and Allan Fone show examples of plants on Catalina Island that evolved differently from their counterparts on the mainland. Because of specific environmental pressures unlike those on the mainland, animals on the island evolved into various subspecies. Examples such as the Dwarf Gray Fox show mechanisms that prevent interbreeding, such as isolation of gametes and isolation through time.

### Learning Objectives

When you have completed all assignments for this lesson, you should be able to:

1. Outline the major elements of the theory of evolution by natural selection, and identify the ideas and observations that influenced Darwin as he developed the theory.
2. Describe mutation and the other events that contribute to variation within a population.
3. Describe a population in terms of its gene pool and allele (gene) frequency, and outline the major conditions required to maintain genetic equilibrium.
4. Explain how *gene flow*, *genetic drift* due to population size, and *natural selection* can influence the rate and direction of changes in a population’s allele frequencies.
5. Describe how patterns of environmental change and natural selection combine to shape a population’s range of traits, and explain how these patterns influence the direction for evolution.
6. Define the term *species*, and describe the different isolation mechanisms that can promote *speciation*.
7. Describe how scientists study evolutionary changes in species.

## Lesson 11—Macroevolution

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### Video Program: “*Macroevolution*”

**Program Description.** As a theory, evolution is constantly being tested and evaluated. Scientists explain that each piece of new evidence contributes to completing a picture of life as it developed from the beginning—a dynamic and continuing process over a vast span of time. Macroevolution is the larger picture of species’ changes over time, their patterns and trends. Evidence of this evolutionary connection is found in the fossil record.

Paleontologists Eric Scott and Kathleen Springer explain how discovering fossils gives one a “snapshot in time” of the animals and ecosystems of an era. Fossils give clues to phylogeny, how one animal species is related to another.

Next, the concepts of homologous structures and shared characteristics are described by Dr. Blaire Van Valkenburgh. By studying the teeth and bones of ancient wolves and saber-tooth cats, she is able to reconstruct these animals that disappeared long ago. Further, Dr. David Bottjer discusses extinctions in general—why they occur and why the history of life on Earth is dotted with mass extinctions.

In conclusion, Dr. Russell Doolittle and Dr. Stanley Miller explain the unique combination of chemical, temperature, and atmospheric conditions that became the criteria for the origin of life on Earth.

### Learning Objectives

When you have completed all assignments for this lesson, you should be able to:

1. List what biologists generally accept as evidence to support the theory of evolution, and explain how *paleontology*, *comparative morphology*, *comparative biochemistry* and other techniques and observations are used to reconstruct the past.
2. Contrast the primordial Earth atmosphere with that of today, and describe the modern experiments that suggest how life may have originated on Earth.
3. Discuss the reasons why, of all the planets in our solar system, only Earth is uniquely adapted to support life as we know it.
4. Describe the general movement of tectonic plates in the *Paleozoic*, *Mesozoic*, and *Cenozoic eras*, and relate this movement to changes in the fossil record.
5. Discuss the factors that encourage increased rates of speciation and the formation of larger taxonomic groups, and identify the factors that bring about extinction and replacement of species.
6. Identify some of the principal organisms associated with each of the five geologic eras.

## Lesson 12—Viruses, Bacteria, and Protistans

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### **Video Program:** “*Viruses, Bacteria, and Protistans*”

**Program Description.** The program begins with a historical view of the science of classification from the Carl Linnaeus-based system to the five kingdoms that are used in classification today.

The second segment examines bacterial and viral threats to the community through food. Bacteria account for half of the history of life on Earth. They are defined and the subkingdoms of archaeobacteria and eubacteria are described. An animation illustrates their incredibly swift reproductive processes. Further, Alex McPherson explains why viruses are not considered to be part of the five kingdoms of life.

Finally, in an exploration of the kingdom of protistans, Dr. Peter Franks discusses plankton, dinoflagellates, and phytoplankton. His work centers on studies of the algae that cause “Red Tide.”

### **Learning Objectives**

When you have completed all assignments for this lesson, you should be able to:

1. State the purpose of a *classification system*, and list—in sequence—the major units or groupings of the system we use today. Understand the difficulty of classifying organisms into any artificially derived scheme.
2. Name the five kingdoms into which living organisms are presently classified, and explain why viruses are not included in the scheme.
3. Identify the general characteristics of a virus, describe the basic steps of viral replication, and list examples of human illnesses caused by viral infection.
4. Describe the metabolic processes, structural features, and reproductive patterns of bacteria, and distinguish between the main groups.
5. Describe the characteristics unique to protistans, and distinguish between the major phyla.
6. Summarize the theory of *endosymbiosis*, and use a phylogenetic tree to explain the possible evolutionary relationships among the five kingdoms.

## Lesson 13—Fungi, Plants, and Animals

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**Video Program:** “*Fungi, Plants, and Animals*”

**Program Description.** With more than 1.5 million species of living entities on Earth, scientists must organize the life forms to make sense of their evolution and relationships. The program explains the basic biological classification system and gives an evolutionary overview of the characteristics found in three of the five kingdoms: fungi, plants, and animals.

In the first segment, Larry Beezley, curator of Quail Gardens, and Dr. Michael Simpson describe the evolution of plant species; their differing structures from bryophytes like mosses to angiosperms, the flowering plants. The program details how spore-bearing plants such as ferns quickly had competition from the wildly successful modern flowering plants.

In the second segment, Dr. Tom Bruns explains that fungi are decomposers and are necessary to recycle organic materials into the soil. The fascinating life cycle of the common button mushroom is illustrated by R. B. Crouch, who takes us on a tour of his mushroom farm.

Finally, Dr. David Resnick and Dr. James Lake explain the many phylogenetic branches of the animal kingdom. The role of distinct organs is contrasted between simpler and more complex animals.

### Learning Objectives

When you have completed all assignments for this lesson, you should be able to:

1. Describe the general body plan, modes of nutrition, and reproductive patterns of fungi, and distinguish between the groups of *true fungi*.
2. Outline the evolutionary advances that converted ancestors of marine algae into plant forms that could thrive on dry land.
3. Outline the major stages of a plant’s life cycle. Identify the cells at each stage as diploid or haploid and whether they are produced by mitosis or meiosis.
4. Identify the *gametophyte* and *sporophyte* stages of algae, mosses, ferns, gymnosperms, and angiosperms. Note the dominant stage in each by comparing the relative amount of time spent in the haploid and diploid states.
5. Compare the general characteristics of the major groups of green plants.
6. Identify the general characteristics of animals.
7. Describe the major evolutionary advances in animal body plans that led to increasingly large and complex organisms.
8. Produce a phylogenetic tree that expresses the evolutionary relationships between the major animal phyla, and describe distinguishing characteristics and example organisms of each.
9. Describe the adaptations that have contributed to the great success of *Arthropods*.
10. Using different classes of vertebrates as examples, provide a general survey of the trends that occurred during vertebrate evolution.

## Lesson 14—Plants: Tissues, Nutrition, and Transport

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### Video Program: “*Plant Structure*”

**Program Description.** For most people, few days pass without a significant encounter with plants. They stimulate our senses and sustain our bodies in a relationship that dates to the origins of humankind. Many plants also share a trait: flowers. Most of the 300,000-plus known species on Earth are flowering varieties called angiosperms. Dr. Ann Hirsch studies the roots of plants, which have the crucial job of collecting nutrients for plant growth and maintenance, and for processing nitrogen.

Looking deeper into plant tissues, the program indicates that primary growth originates at apical meristems and at meristematic tissues derived from them. Secondary growth includes the thickening of the stems and roots. Dr. Arthur Gibson tells us about the variety of stems, from grass to lumber, and explains why the differing meristem cells are necessary.

An animation illustrates the cohesion-tension theory of water transport. As water molecules exit the plant via transpiration, cohesion of water creates tension throughout the plant to pull water molecules into the roots and xylem. This type of movement and other crucial processes rely on the leaves, which are the organs for photosynthesis and balancing the outside environment and internal workings of the plant or tree. Dr. Robert Heath guides us through leaf structure and function.

### Learning Objectives

When you have completed all assignments for this lesson, you should be able to:

1. Describe the generalized body plan of a flowering plant.
2. Define and distinguish between the various types of *ground*, *vascular*, and *dermal* tissues.
3. Note the locations of *meristems*, explain how plant tissues develop from them, and distinguish *primary* growth from *secondary* growth.
4. Describe the various functions of stems, leaves, and roots.
5. Explain how secondary growth occurs in woody dicot roots and stems, and distinguish early (spring) wood from late (fall) wood.
6. Identify the nutrients which are essential to plant health, and describe how plant structures obtain these nutrients.
7. Explain how water is absorbed, transported through the *xylem*, and lost by a plant. Note the role of transpiration, osmotic pressure, and the cohesiveness of water.
8. Describe how a plant balances its need for gas exchange with the need to prevent water loss.
9. Explain how the translocation of organic substances occurs in *phloem*, according to the *pressure flow theory*.
10. Describe some of the methods and tools botanists use to study plant physiology.

## Lesson 15—Plants: Reproduction and Development

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### Video Program: “*Plant Reproduction*”

**Program Description.** Contributing to the success of plants is an intriguing combination of reproductive strategies that exploits and influences the anatomy and behavior of animals, including insects. Using the natural elements of wind, water, and fire, plants have evolved other remarkable mechanisms to maximize reproduction opportunities. For example, pollen size and flower-wall structures increasingly restrict pollen dispersal by wind, but more dispersal is facilitated by mobile pollinators such as butterflies, hummingbirds, bats, and bees. Seed dispersal and germination play major roles in the movement and continuation of plant species.

Regarding structural development of plants, scientists have discovered that hormones control it in much the same way they influence the shaping of animals. Dr. Elliot Meyerowitz discusses his research on the genetics of *Aribidopsis*—mouse ear cress—and establishes the action of hormones such as auxins, gibberellins, cytokinins, and ethylene. Applying microbiology to understanding plant reproduction promises greater production of the fruits and seeds that are most precious to us.

### Learning Objectives

When you have completed all assignments for this lesson, you should be able to:

1. Draw and label the parts of a *perfect* flower. Explain how gamete formation occurs in the male and female structures.
2. Define and distinguish between *pollination* and *fertilization*. Explain how the coevolution of flowering plants and certain animals has aided the pollination process.
3. Describe the components of a seed and list various methods of seed dispersal, including the role of fruit. Explain how the coevolution of some plants and animals has also aided in the dispersal process.
4. Identify the factors that cause plants to *germinate*, and describe the general pattern of early plant growth.
5. List the various *hormones* that regulate plant growth and metabolism, and describe their known effects on plants.
6. Explain how plants respond to stimuli or changes in their environment, and describe the factors that might cause a plant to flower, age, or enter *dormancy*.
7. Describe the techniques botanists use to investigate plant reproduction and development.

## Lesson 16—Animals: Structure and Movement

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### Video Program: “*Animal Structure*”

**Program Description.** All animals are collections of billions of different types of cells and tissues, each specially adapted to its specific function. But each animal has a commonality: It achieves motion promoted by a musculoskeletal system and maintains equilibrium through homeostasis and feedback.

The program touches on the similarities and differences of integument, from reptile to amphibian and, ultimately, to mammals. In the first segment, against the backdrop of a “tortoise refuge,” Dr. David Reznick explains the relationships between tissues, organs, and organ systems. An animation illustrates different tissues in a tiny bit of skin, an organ that serves similar functions of protection and temperature regulation in many animals.

In the second segment, muscle atrophy in astronauts is used as a vehicle to describe the muscle system. Physiologist Kenneth Baldwin describes what causes muscle contractions on a cellular level.

In the final segment, thoroughbred horse training leads to a discussion of the skeletal system. Dr. Reznick explains the dynamic nature of skeletal structure and bone cell structure.

### Learning Objectives

When you have completed all assignments for this lesson, you should be able to:

1. Define the terms *tissue*, *organ*, and *organ system*, and use them to describe the general structure of complex animals.
2. Describe the basic structure and function of the four types of animal tissues. Identify the types of cells that compose each tissue, and describe the location and function of each tissue in example organs.
3. Define *homeostasis*, and describe how *feedback control mechanisms* help maintain this condition.
4. Describe the structure of the human *integumentary system*, and discuss the skin’s role in maintaining homeostasis.
5. Identify the general functions of a vertebrate’s *skeletal system*, and describe the basic structure of a typical long bone.
6. Describe the structure of a freely-moving *joint*—noting the role of *cartilage*, *tendons*, and *ligaments*—and describe some disorders associated with joints.
7. Compare “skeletal” and “muscular” components of earthworms, crayfish, and humans, and describe how these components interact to produce movement.
8. Describe the composition and structure of muscles, and explain how muscle cells contract using the *sliding-filament model*.
9. Summarize the steps that lead to muscle contraction, noting the roles of *motor neurons*, calcium ions, and ATP molecules.
10. Compare the effects of aerobic and anaerobic activity in causing muscle soreness and fatigue, and describe how regular exercise can help muscles resist fatigue.

## Lesson 17—Animals: Circulation

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**Video Program:** “*Circulation: A River of Life*”

**Program Description.** To sustain life in complex organisms, food and chemical products and by-products must be moved rapidly to and from the body’s living cells. In animals, the transport medium is blood moving through the circulatory system.

The program cuts to a hospital emergency room as a trauma unit stabilizes a patient. The ER doctor narrates the scene and details the composition of circulatory systems that occupy most animals: the heart, blood, and a closed system of vessels, veins, and capillaries. Striking animation illustrates the typical circulatory system.

Interestingly, different animals have different types of hearts that are designed for their particular survival needs. This is the topic of the second segment, in which Dr. James Hicks discusses his study of alligator hearts and the reptilian ability to hold more oxygen in their blood.

Lastly, a case study of a heart attack victim is the context for an exploration of disorders of the cardiovascular system. The basic structure and function of the heart, the primary component of the circulatory system, are detailed by Dr. Shahbudin Rahimtoola. He explains the heart’s crucial timing mechanism and how the two coronary arteries branch off the aorta to cycle blood throughout the system.

### Learning Objectives

When you have completed all assignments for this lesson, you should be able to:

1. Describe the general function of a *circulatory system*, and identify its three principal components.
2. Compare *open* and *closed* circulatory systems with respect to structure and operation. Use different organisms as examples.
3. Describe the components of human blood, and list the basic functions of each.
4. Use the human heart to trace the path of blood flow through the *pulmonary* and *systemic circuits*, and compare this pathway with that of other vertebrates.
5. Describe the basic structure of the human heart, explain its operation through a complete *cardiac cycle*, and identify the heart’s mechanisms of contraction.
6. Compare the structure and function of *arteries*, *arterioles*, *capillaries*, *venules* and *veins*. Note the direction of blood flow through each and the degree of nutrient/waste exchange occurring through the walls.
7. Define the term *blood pressure*, and describe the mechanisms that regulate it.
8. Describe common disorders of the *cardiovascular system*, and discuss some possible causes of those disorders.
9. Outline the basic structure and function of the *lymphatic system*, and explain how it works with the cardiovascular system to recover *interstitial fluids*.
10. Describe how scientists examine cardiovascular systems.

## Lesson 18—Animals: Immunity

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### Video Program: “Immunity”

**Program Description.** All animals have a complex system of physical and chemical defenses to protect them against disease. The first line of defense, surface barriers, is explained in a story about injured birds. As veterinarian Scott Weldy describes how he treats wounded birds of prey, immunologist Edward Golub explains the process of inflammation.

Next, the program follows Dr. Jeff Galpin, a survivor of the polio epidemic of the 1950s, who is now a clinical researcher studying the AIDS virus. He explains how specialized T cells (helper and killer T cells) and other blood cells are the frontline soldiers of the immune system. Animation illustrates how macrophages usually engulf potentially harmful viruses and bacteria. Because this is not the case with AIDS, there is a further discussion of T cells, B cells, and antibodies.

In the final segment, we investigate an autoimmune disease, lupus, with Dr. Robin Dore. Her patient has an overactive immune system which attacks its own cells, causing chronic inflammation and fatigue. Although the cause of the disease remains a mystery, research continues into how cells recognize self and non-self in order to protect the body against harm.

### Learning Objectives

When you have completed all assignments for this lesson, you should be able to:

1. Describe typical surface barriers that vertebrates present to defend against invading *pathogens*.
2. Summarize the process of *acute inflammation*, describe its signs, and explain how this mechanism fights pathogens.
3. Generally compare the body's *nonspecific* and *specific* immune response, noting the basic features which distinguish the later.
4. Summarize how vertebrates (especially mammals) recognize and discriminate between self and non-self tissues.
5. Describe and distinguish between *cell-mediated* and *antibody-mediated* (humoral) immune response, noting the roles of the different white blood cells and any resulting antibodies.
6. Explain how the lymphatic system's fluid recovery function helps fight infectious agents.
7. Distinguish between the human body's *primary* and *secondary* immune response, noting the role of *macrophages* and various *lymphocytes*.
8. Distinguish between *active* and *passive* immunity, and identify examples of each in modern medical therapy.
9. Describe some examples of abnormal or deficient immune responses in humans, and identify which weapons in the immunity arsenal failed in each case.
10. Describe methods scientists use to study immunity.

## Lesson 19—Animals: Respiration

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### Video Program: “*Respiration*”

**Program Description.** Most animals exchange gas with their environment, taking in oxygen and giving off carbon dioxide. Respiratory adaptation depends on the evolution of the animal with respect to its size, need for energy, and environment. Dr. Karen Martin gives an overview of aerobic respiration, and graphic animation shows the diffusion of gases across a moist membrane with changing concentrations.

A tour of the human respiratory system highlights the middle segment of the program. Dr. Christopher Cooper discusses the process of breathing. The viewer actually follows one breath of air on inhale down the throat into the trachea and through the bronchial tree. The program branches off into the circulatory system as Dr. Gerald Kooyman explains how the physiology of seals and penguins in the Antarctica stores air for long periods as these animals dive for food.

### Learning Objectives

When you have completed all assignments for this lesson, you should be able to:

1. Identify the gases that most organisms exchange with their environment, discuss the different factors which affect the rate of this exchange, and describe the typical respiratory surface where the exchange occurs.
2. Compare gas exchange in unicellular and multicellular organisms, noting the challenges faced by larger body sizes.
3. Describe the different types of gas exchange structures, and match each of them with an animal that uses it.
4. Describe the structure of the human respiratory system, and explain how breathing cycles air to and from respiratory surfaces.
5. Explain how the respiratory system works with the circulatory system to transport gases to and from body tissues for cellular respiration.
6. Describe how different blood compounds assist gas transport, noting the role of hemoglobin and the bicarbonate reaction.
7. Discuss how the body’s nervous system monitors and regulates breathing.
8. Describe some common respiratory disorders, noting how smoke and other airborne pollutants can affect respiratory tissue.
9. Describe some of the methods and tools physiologists use to study respiratory systems.

## Lesson 20—Animals: Digestion and Fluid Balance

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### Video Program: “*Digestion and Fluid Balance*”

**Program Description.** The survival of organisms depends on the constant supply of fluids and nutritional elements. Once this supply is taken in and processed, the waste must be efficiently eliminated from the system. Without these properly functioning organ systems, animals would die of malnutrition or from the toxic buildup of waste products.

In the first segment, Dr. Carol Beuchat discusses the specialized fluid balance of hummingbirds and the role of the urinary tract in maintaining homeostasis in animals.

Next, the program explains the digestive system and the role of enzymes in digestion. Dr. James Sokolowski talks about pet food research, pointing out that familiar vertebrates like cats and dogs have very different nutritional needs, with dogs being more similar to humans than one might think.

The final story illustrates the crucial role of the kidney in maintaining homeostasis. A patient is followed through the grueling process of being connected to a dialysis machine for four hours every day. Animations explain how the kidneys act to filter fluids in the body.

### Learning Objectives

When you have completed all assignments for this lesson, you should be able to:

1. Define *ingestion*, *digestion* (physical and chemical), *absorption*, and *egestion*. Describe where each process occurs in single-celled organisms and in organisms with *incomplete* and *complete* digestive systems.
2. Describe the structure of the human digestive system and specify the function of each of its regions, giving special attention to the role of *villi*.
3. Identify each of the major digestive secretions, noting the enzymes and other chemicals of significance and their roles in digestion.
4. Explain the adaptive advantages of the specialized digestive organs of birds and ruminants.
5. Discuss the concept of the *food pyramid*, and explain how it would help an individual meet nutritional requirements for carbohydrates, proteins, fats, vitamins, and minerals.
6. Explain in general terms how the chemical composition of *extracellular fluid* is maintained by mammals, emphasizing the different routes for gains and losses, and identifying the most common metabolic wastes emitted.
7. Describe the gross anatomy of the *urinary system* and explain how the various components work together to filter, reabsorb, and secrete water and solutes to form urine.
8. Identify the location and parts of a *nephron*.
9. Discuss the kidney’s role in maintaining homeostasis using the examples of hormone-induced regulation of water and sodium levels.
10. Compare the human urinary system with that of other animals, noting the different composition of wastes excreted and how they are formed.

11. Describe some of the methods scientists used to study digestive and urinary systems.

## Lesson 21—Animals: The Neural Connection

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### Video Program: “*The Neural Connection*”

**Program Description.** Animals may sense their environment in unique and varied ways, but animal nervous systems share many characteristics at the biochemical and cellular level. Even humankind, with the highest level of brain development among animals, processes neural signals in the same manner as all other vertebrates. Dr. Peter Narins discusses sensory cells, or neurons, that allow animals to sense their environment: chemoreceptors (taste, smell), thermoreceptors (temperature), mechanoreceptors (touch, hearing, balance), nociceptors (pain), and photoreceptors (sight). He says that all animals larger than a single cell must have a system of transporting signals from the senses to other parts of the body.

Later, a polo player’s abilities to navigate a field and plan her game strategy demonstrate how she uses different parts of her brain. The player also experiences exhilaration from the game, a response Dr. Chris Evans relates to endorphins released in the brain. Chemical comparisons are made between endorphins and morphine to explain the chemical workings at the level of the synapse.

This leads to a segment at a pistol firing range, where a student shooting for the first time exhibits numerous responses triggered directly by sensory stimuli: reflex actions. Dr. James McGaugh touches on the role of the nervous system and on the integration of stimuli into the brain as part of learning.

### Learning Objectives

When you have completed all assignments for this lesson, you should be able to:

1. Describe the general purpose and structure of *neurons*, and state their relationship to a *nerve*.
2. Explain how a neuron “at rest” maintains a voltage difference across its membrane and how this changes during an *action potential* (nerve impulse). Note how conduction is modified with the presence of *myelin*.
3. Describe the general structure of a *synapse*, and explain how it transmits information.
4. Identify the components and operation of a *reflex pathway*, including receptor, sensory neuron, interneuron, motor neuron and effector (muscle or gland). Using an example reflex, explain how sensory inputs are relayed to the *central nervous system*.
5. Describe the organization and structure of the vertebrate nervous system, and contrast the basic roles of its major divisions and subdivisions.
6. Identify the different types of *sensory receptors* found in the animal kingdom, and offer examples of each.
7. Describe how the brain and sense organs interact to interpret sensations and distinguish their relative intensity.
8. Summarize how the human ear captures sound waves and translates them into signals the brain can interpret.
9. Describe the structure of the vertebrate eye, and explain how it focuses and translates light into signals the brain can interpret.
10. Discuss the methods and techniques scientists use to study the nervous system and to determine how it functions.

## Lesson 22—Animals: Endocrine Control

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**Video Program:** “*Endocrine Control: Systems in Balance*”

**Program Description.** Highlights include the role of the endocrine system in maintaining homeostasis in animals, the system’s relationship to the nervous system for regulation and feedback, and the essential organ systems and functions that are influenced by the small amounts of hormones released.

The story of environmental toxins that mimic hormones helps to define a hormone, describe hormone receptors, and illustrate how the receptors can be blocked by small amounts of the hormone-emulating toxins. Dr. George Hunt and Dr. Michael Fry research how seagulls were drastically affected by a hormone imbalance cause by toxic chemicals.

Next, Dr. Catherine Rivier, who studies the mechanisms that control the response of the pituitary gland to stress, focuses on the role of peripheral stimuli and brain factors in coordinating the release of various hormones in response to stress stimuli. The roles of the pituitary gland and hypothalamus are highlighted. Discussion touches on the roles of other glands, steroid and nonsteroid hormones, and how they affect cells.

Additionally, the story of a diabetes patient illustrates how an impaired endocrine affects the human body.

### Learning Objectives

When you have completed all assignments for this lesson, you should be able to:

1. Contrast the structure and general role of an *exocrine* gland with that of an *endocrine* gland.
2. Define a *hormone*, and describe in general how hormones and other *signaling* molecules integrate and control metabolic activities in animals.
3. Compare how the endocrine system and the nervous system control body functions, and describe how these systems interact.
4. Describe the relationship of the vertebrate hypothalamus to the *pituitary* gland, and discuss how this neuroendocrine center controls secretions from the *anterior* and *posterior* pituitary.
5. Describe how homeostatic feedback loops can help maintain normal hormone levels using examples from both pituitary-controlled and pituitary-independent systems.
6. Explain how blood sugar levels are regulated by hormones.
7. Using examples, describe some of the consequences of abnormal endocrine function in the human body.
8. Describe why hormones have an effect on some cells and not others, and compare how *steroid* and *nonsteroid* hormones act on target cells.
9. Describe some methods scientists use to study the endocrine system and the effects of hormones.

## Lesson 23—Animals: Reproduction and Development

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**Video Program:** “*Animal Reproduction and Development*”

**Program Description.** The continuation of life through the physical process of reproduction is explored. Using as a backdrop experimentation in avian embryos by Dr. Marianne Bronner-Fraser and her husband, Dr. Scott Fraser, the program covers cellular development and cell differentiation. Different modes of reproduction, from asexual reproduction of hydra to sexual reproduction in more complex animals, are compared. Included is a comparison of the avian and mammalian reproductive systems.

In exploring the female and male reproductive systems, the program focuses on human anatomy and physiology. The concepts are illustrated by a couple that goes through in-vitro fertilization successfully. A highlight of this segment is a graphic explanation of the menstrual cycle.

Later, Dr. Peggy Grau describes the stages of fetal development. A fetus is seen as it develops through the trimesters, and the concepts of migration and induction are explained.

### Learning Objectives

When you have completed all assignments for this lesson, you should be able to:

1. Compare *asexual* and *sexual* reproduction, and discuss the adaptive advantages and problems associated with having separate sexes.
2. Describe the key mechanisms of embryonic animal development, including *determination*, *differentiation*, and *morphogenesis*.
3. Describe the structure and function of the human male and female *reproductive systems*.
4. Describe the events of a typical human *menstrual cycle*, including hormones secreted from the pituitary and ovary, and the resulting physical changes at the ovary, uterus, and mammary glands.
5. Outline the principal events of prenatal human development, noting the major events of each *trimester*.
6. Identify the changes that occur in an individual from birth to death as a continuation of the development and aging processes, and note the possible causes of aging.
7. Discuss methods that can be used to control human fertility, and describe some modern techniques used to help couples who cannot have children through normal means.
8. Discuss the importance of the mother’s nutrition on fetal development, and identify the risks of taking drugs during pregnancy.
9. Describe some methods that scientists use to study animal reproduction and development.

## Lesson 24—Populations and Communities

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### Video Program: “Populations and Communities”

**Program Description.** Dr. Jack Burk and Dr. Gene Jones explain the importance of maintaining species, using as an example the Woolly Star, an endangered shrub in the alluvial fan of a river bed. Ultimately, every plant and animal in that community depends on the success of others for their survival. Keeping tabs on the population of the Woolly Star is the first step in protecting *all* of the organisms in the habitat.

In another relationship, an owl and a mouse illustrate predation in a grove of trees. Other examples of species interaction include commensalism and mutualism. The program explains the niches of the Great Horned Owl and the Common Barn Owl, which operate in an example of competitive exclusion.

Finally, Dr. Lynn Carpenter explains, the way humans operate and adapt has made them, biologically speaking, one of the most successful species on Earth. Dr. John Weeks tells how population growth is affected by the relationship between birth rates and death rates.

### Learning Objectives

When you have completed all assignments for this lesson, you should be able to:

1. Define the terms *population*, *community*, *ecosystem*, and *biosphere*, and note how they relate to each other.
2. Use a *growth curve* to describe the changes in an isolated bacteria population, and explain the cause for each stage of growth: lag, exponential growth, maximum stationary, and death.
3. Compare the isolated bacteria growth curve with the idealized *S-shaped* curve that many populations follow in nature, and discuss reasons for their similarities and differences.
4. Describe how *density-dependent* and *density-independent* controls might modify an S-shaped growth curve.
5. Describe the human growth curve, noting possible reasons for periods of growth and stability, and discuss where this curve may be headed in the future.
6. Note the relationship of birth rate and death rate to changes in total population size, and describe the basic principles of the *demographic transition model*.
7. Use an *age structure diagram* to determine how a population is changing in size, and discuss the reasons that a population will continue to grow for many decades even beyond the attainment of its *replacement rate*.
8. Identify and distinguish between different types of species interaction, noting the direct effect of each interaction on the species involved.
9. Define and give examples of *competitive exclusion*, and relate this principle to the diversification of species into different *niches*.
10. Describe how communities develop and diversify, noting the roles of *succession* and *disturbances*.

## Lesson 25—Ecosystems and the Biosphere

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### Video Program: “Ecosystems and the Biosphere”

**Program Description.** A quiet marsh or a forest may look peaceful, but a delicate balance of interactions that take place in ecosystems determines life and death for the inhabitants.

Dick Zembal reveals one such ecosystem as he struggles to save the Clapper Rail, an endangered bird species of the salt marsh. Further, salt marsh plants and animals are used as an example of a complex food web.

Delving further into an aspect of an ecosystem, a controlled “burn” in a forest illustrates the cycling of nutrients in an ecosystem. The story shows how carbon and nitrogen are released and reused by the environment after a forest fire, and how some plants depend on fires to trigger new growth.

Finally, Dr. Warren Blier explains the effect of global weather patterns on climate. Detailing the importance of precipitation zones, Dr. Mark Poth takes us on a tour of the ecosystems found at different elevations on a mountain.

### Learning Objectives

When you have completed all assignments for this lesson, you should be able to:

1. Describe the general pattern of energy flow through an ecosystem, and explain how an ecosystem’s nutrients are cycled between major groups of organisms.
2. Starting with *producers*, describe the feeding relationships and energy flow observed in ecosystems, using concepts such as *trophic levels*, *food chains* and *webs*, and *ecological pyramids*.
3. Describe the processes at work in *biogeochemical cycles*. Illustrate how organisms interact with chemical reservoirs in the environment, discussing the potential for deficits or excesses in various parts of each cycle.
4. Use an example to illustrate the concept of *biological magnification*.
5. Discuss how the different motions and physical characteristics of the Earth can affect climate on a global or regional level.
6. Define a *biome*, and describe how climate, topography, and other physical characteristics cause the unique plant and animal associations found in each region.
7. Describe the physical and chemical factors that influence *zonation* in water-based ecosystems.
8. Describe some of the methods scientists use to study ecosystems and the biosphere.

## Lesson 26—The Human Factor

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### Video Program: “*The Human Factor*”

**Program Description.** How humans use technology to affect ecosystems is central to the program’s stories. The possible effects of global warming on the environment are discussed in the first segment. Dr. John Roads explains how increased CO<sub>2</sub> might cause global warming, while Dr. Walter Oechel measures how CO<sub>2</sub> affects plant growth and predicts the potential impact changes might have on the atmosphere.

The second segment explores new non-carbon-based fuel supplies, hydrogen-powered vehicles, solar power, and fusion as possible solutions to a dependency on carbon fuels.

In the third segment, Dr. William Frankenberger illustrates an innovative way to clean up toxic wastes by using microorganisms that occur naturally in the environment. The concept of bioremediation is explained.

These stories help to illuminate balance in ecosystems and human beings’ role in the environment.

### Learning Objectives

When you have completed all assignments for this lesson, you should be able to:

1. Relate the first and second laws of thermodynamics to the use of world resources and food supplies, and discuss the potential for all people on Earth to enjoy the benefits of an industrialized lifestyle.
2. Discuss ways humans are and are not unique among organisms in their relationship to the environment, and generally discuss the impact of humans on the ability of ecosystems to be self-sustaining.
3. Identify the major classes of air pollutants and their sources, and discuss the effect of these pollutants on the Earth’s biosphere.
4. Identify the major sources of water pollution, describe their general effects on living organisms, and discuss the challenges of maintaining water quality in the modern world.
5. Examine the effects of human land use decisions on various ecosystems of the Earth, noting the roles of agriculture, *desertification* and *deforestation*.
6. Use the human growth curve and the need for increased agricultural productivity to show the interrelationship of changes in water use, land usability, atmosphere, ecosystem diversity, and energy consumption.
7. Distinguish between *renewable* and *nonrenewable* energy sources. Discuss the current level of use for each and the promise they hold for the future.
8. Describe how scientists study ecological changes, both on a small scale and in the biosphere as a whole.

## SAMPLE COURSE OUTLINE

Date: \_\_\_\_\_

Division: \_\_\_\_\_

Instructor: \_\_\_\_\_

I. **Course** \_\_\_\_\_

Name	Number	Units
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Descriptive Title: Cycles of Life: Exploring Biology

### II. Catalog Description

Prerequisite: None

*Cycles of Life: EXPLORING BIOLOGY* is a one-semester college-level telecourse in introductory biology. It gives students a breathtaking view of the origin and nature of life, from the simplest single-celled forms to complex plants and animals and human beings. As an introductory biology course, *Cycles of Life: EXPLORING BIOLOGY* goes beyond describing the subject matter of biology. It examines the scientific method and considers both its promises and limitations. It answers many questions and poses new ones, so that we are continually probing into the innermost secrets of life.

### III. Time Allocation

Lecture: \_\_\_\_\_

Lab: \_\_\_\_\_

Demonstration: \_\_\_\_\_

Other (specify): Twenty-six (26) half-hour television programs

### IV. Course Themes

The telecourse is organized around nine major themes:

1. Life is dynamic and continually evolving through time.
2. The living world exhibits both diversity and unity: organisms vary immensely, yet they also share many fundamental characteristics.
3. Life is a marvelously complex system of prolonging order, all sustained by energy.
4. There is continuity in the living world: Life presents a continuous stream of genetic information passed on through the ages.
5. The natural world exhibits organization: the different structures we see in nature tend to repeat themselves in different organisms and on different scales.
6. Life seeks stability: organisms work to maintain a stable internal environment despite changing external conditions.
7. Life is both interdependent and competitive: all organisms depend on the environment and one another for their basic needs, yet they must struggle against nature and each other to survive.
8. In biology, as in all the sciences, we must compare explicit hypotheses and predictions to evidence obtained from observations and experimental data.

9. Because biology is a human endeavor, it is subject to both the limitations and the inspirations of those who study it.

## V. Course Objectives

Specific student learning objectives have been identified for each lesson.

## VI. Purpose of the Course

<input checked="" type="checkbox"/> General Education	<input type="checkbox"/> Community Service	<input checked="" type="checkbox"/> Transfer
<input checked="" type="checkbox"/> Adult Education	<input type="checkbox"/> Occupational	<input type="checkbox"/> Remedial

## VII. Course Content

Lesson Titles

- |                                               |                                           |
|-----------------------------------------------|-------------------------------------------|
| 1. Biological Concepts                        | 15. Plants: Reproduction and Development  |
| 2. Chemical Foundations                       | 16. Animals: Structure and Movement       |
| 3. Cell Structure and Function                | 17. Animals: Circulation                  |
| 4. Metabolism                                 | 18. Animals: Immunity                     |
| 5. Energy In—Energy Out                       | 19. Animals: Respiration                  |
| 6. Mitosis and Meiosis                        | 20. Animals: Digestion and Fluid Balance  |
| 7. Patterns of Inheritance                    | 21. Animals: The Neural Connection        |
| 8. DNA: Structure and Function                | 22. Animals: Endocrine Control            |
| 9. Proteins                                   | 23. Animals: Reproduction and Development |
| 10. Microevolution                            | 24. Populations and Communities           |
| 11. Macroevolution                            | 25. Ecosystems and the Biosphere          |
| 12. Viruses, Bacteria, and Protistans         | 26. The Human Factor                      |
| 13. Fungi, Plants, and Animals                |                                           |
| 14. Plants: Tissues, Nutrition, and Transport |                                           |

## VIII. Learning Strategies or Teaching Methods

- Lecture
- Audio tutorial laboratory
- Audio and/or visual tutorial segments available in media center or classroom
- Small group instructor
- Team teaching
- Other (specify): Open broadcast, cable, and closed-circuit television, or media center viewing of video programs; study guide; textbook; home video viewing

## IX. Evaluation Methods

A bank of multiple-choice questions is available in the faculty manual. The test questions are suitable for quizzes or for midterms and finals. They cover both the video and the print portions of the course. The “Using What You’ve Learned” sections of the Telecourse Student Guide provide suggestions for additional activities to enhance students’ understanding and knowledge of biology.

## X. Required Course Materials

Study Guide: *Telecourse Student Guide for **Cycles of Life: EXPLORING BIOLOGY***, Brooks/Cole Publishing Company.

Textbook: *Biology: Concepts and Applications*, Cecie Starr, Brooks/Cole Publishing Company.

*Biology: The Unity and Diversity of Life*, Cecie Starr and Ralph Taggart, Brooks/Cole Publishing Company.

## XI. Supplementary Course Materials

*Biology Laboratory Manual for the Telecourse **Cycles of Life: EXPLORING BIOLOGY*** is available. There is also a laboratory kit, containing basic equipment and chemicals. Another optional item is the *Photo Atlas for Biology*, by James W. Perry and David Morton, Brooks/Cole Publishing Company. It contains more than 600 full-color photographs.

## Request for Preview Videocassette and Review Copies of Print Materials

Please complete this form and mail it to: **Coast Learning Systems**  
Coastline Community College  
11460 Warner Avenue  
Fountain Valley, California 92708-2597



For faster service,  
phone (800) 547-4748 or fax (714) 241-6286.

We are considering offering the telecourse *Cycles of Life: EXPLORING BIOLOGY* and would like to receive the following preview material to aid us in making our decision:

- A sample VHS videocassette
- Review copies of the course's print materials:
  - *Biology: Concepts and Applications*, Cecie Starr, Brooks/Cole Publishing Company.
  - *Biology: The Unity and Diversity of Life*, Cecie Starr and Ralph Taggart, Brooks/Cole Publishing Company.
  - *Telecourse Student Guide for Cycles of Life: EXPLORING BIOLOGY*, Brooks/Cole Publishing Company.
- Information on licensing and costs.

PLEASE PRINT OR TYPE

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- Please send the *Coast Learning Systems Catalog* describing other telecourses available.