Ecology

Unit Overview

This unit focuses on the relationships and interactions that exist among organisms and their environments. In Chapter 2, students are introduced to ecology and the biotic and abiotic factors that exist in an ecosystem. Chapter 3 centers on the development of communities and describes major world biomes. In Chapter 4, environmental factors that limit population growth are presented, and students study the effects of demographics. Chapter 5 brings the unit to a close with a discussion of people's impact on the environment and threats to biodiversity. Strategies of conservation biology are described.

Introducing the Unit

Ask students to look at the scarlet macaws in the photograph and describe how these birds are dependent on both living and nonliving things in their environments. Explain that ecology focuses on the interactions that take place in an environment.

Unit 2

Ecology

A tropical rain forest ecosystem consists of interactions among organisms, and between organisms and their environment. For example, rain forest plants are adapted to use the ample water and sunlight in the production of nutrients. The plants use these nutrients for their own growth and development, and, in turn, the nutrients that make up the plants may then be passed to animals that feed on them. Scarlet macaws eat seeds and fruits from rain forest trees, but they also eat clay soil that helps to detoxify many of the poisonous plants that they eat.

Unit Contents

Unit Project

interNET CONNECTION Use the Glencoe Science Web Site for more project activities that are connected to this unit. www.glencoe.com/sec/science

Unit 2

Advance Planning

Chapter 2

- Purchase seeds and gather materials for MiniLab 2-1.
- Order bromothymol blue and antacid for MiniLab 2-2.
- Set up or borrow a fish tank for a Quick Demo.
- Gather or purchase lichens for a Quick Demo.
- Order cultures of *Paramecium* and *Didinium* for the BioLab.
- Gather materials for the Alternative Lab.

Chapter 3

- Gather lichen and other materials for MiniLab 3-1.
- Purchase or borrow plants for a Quick Demo.
- Purchase plankton and gather materials for Mini Lab 3-2.
- Gather pond water and other materials for the BioLab.
- Gather sod for a Quick Demo.
- Gather materials for the Alternative Lab.

Chapter 4

- Purchase bananas and gather materials for MiniLab 4-1.
- Purchase radish seeds. Gather petri dishes and napkins for the Alternative Lab.
- Purchase materials for the BioLab.

Chapter 5

- Purchase or gather seeds and other materials for the Alternative Lab.
- Gather gingko leaves for a Quick Demo.
- Gather soil, water, and containers for MinLab 5-2.

Unit Projects

Develop a Model of an Ecosystem

Have students do one of the projects for this unit as described on the Glencoe Science Web Site. As an alternative, students can do one of the projects listed on these two pages.

Interview

Linguistic Students can interview a pet shop owner to find out how to keep fish in an aquarium. Students can describe how to maintain a healthy environment for the fish. L1

Display

Visual-Spatial Ask students to make a bulletin board that describes the experimental Biosphere II in Arizona and explains why it did not work. L1 ELL

Make a Model

Kinesthetic Students can create a working aquatic ecosystem that contains both biotic and abiotic elements in a healthy balance. L1 ELL

Use the Library

Intrapersonal Have students use the library to find out why space exploration may be dependent on the quest for artificial closed ecosystems. L2

Final Report

Have students present their group's findings in an oral report that could be understood by students at your local middle school. L3

Unit Projects

Refer to pages 4T-5T of the Teacher Guide for an explanation of the National Science Education Standards correlations.

Section	Objectives	Activities/Features
Section 2.1 **Organisms and Their Environment** National Science Education Standards UCP.1-3; A.2; C.4, C.5, C.6; F.3; G.1-3 (2 sessions, 1 block)	1. **Distinguish** between the biotic and abiotic factors in the environment. 2. **Compare** the different levels of biological organization and living relationships important in ecology. 3. **Explain** the difference between a niche and a habitat.	**MiniLab 2-1:** Salt Tolerance of Seeds, p. 38 **Problem-Solving Lab 2-1:** p. 39 **Careers in Biology:** Science Reporter, p. 40
Section 2.2 **Nutrition and Energy Flow** National Science Education Standards UCP.1-3; A.1, A.2; B.6; C.4, C.5, C.6; D.2; F.3-5; G.1, G.2 (3 sessions, 2½ blocks)	4. **Compare** how organisms satisfy their nutritional needs. 5. **Trace** the path of energy and matter in an ecosystem. 6. **Analyze** how nutrients are cycled in the abiotic and biotic parts of the biosphere.	**Problem-Solving Lab 2-2.** p. 52 **MiniLab 2-2:** Detecting Carbon Dioxide, p. 56 **Inside Story:** The Carbon Cycle, p. 57 **Design Your Own BioLab:** How can one population affect another? p. 60 **Biology & Society:** The Florida Everglades—An Ecosystem at Risk, p. 62

Need Materials? Contact Carolina Biological Supply Company at 1-800-334-5551 or at **http://www.carolina.com**

MATERIALS LIST

BioLab

p. 60 microscope, microscope slides, coverslips, droppers, beakers or jars, sterile pond water, culture of *Didinium,* culture of *Paramecium*

MiniLabs

p. 38 seeds (40), small beaker (2), paper towels, zipper-lock plastic bags (2), labels, water, 10% salt water solution

p. 56 test tubes (2), bromthymol blue solution, antacid tablet, drinking straw

Alternative Lab

p. 40 corn seeds (60), pinto bean seeds (60), paper cups (6), plastic sandwich bags (6), water, paper towels, graduated cylinder, labels, pencil

Quick Demos

p. 40 aquarium setup

p. 45 lichens

p. 55 glass bowl, soil, plants, water, plastic wrap

Key to Teaching Strategies

- L1 Level 1 activities should be appropriate for students with learning difficulties.
- L2 Level 2 activities should be within the ability range of all students.
- L3 Level 3 activities are designed for above-average students.
- ELL ELL activities should be within the ability range of English Language Learners.
- COOP LEARN Cooperative Learning activities are designed for small group work.
- P These strategies represent student products that can be placed into a best-work portfolio.
- These strategies are useful in a block scheduling format.

Teacher Classroom Resources

Section	Reproducible Masters	Transparencies
Section 2.1 **Organisms and Their Environment**	**Reinforcement and Study Guide,** pp. 7-8 L2 **Critical Thinking/Problem Solving,** p. 2 L3 **BioLab and MiniLab Worksheets,** p. 9 L2 **Laboratory Manual,** pp. 9-10 L2 **Tech Prep Applications,** pp. 3-4 L2 **Content Mastery,** pp. 9-10, 12 L1	**Section Focus Transparency 4** L1 ELL
Section 2.2 **Nutrition and Energy Flow**	**Reinforcement and Study Guide,** pp. 9-10 L2 **BioLab and MiniLab Worksheets,** pp. 10-12 L2 **Concept Mapping,** p. 2 L3 ELL **Content Mastery,** pp. 9, 11-12 L1 **Laboratory Manual,** pp. 11-14 L2 **Inside Story Poster** ELL	**Section Focus Transparency 5** L1 ELL **Basic Concepts Transparency 1** L2 ELL **Basic Concepts Transparency 2** L2 ELL **Reteaching Skills Transparencies 1, 2, 3** L1 ELL

Assessment Resources

Chapter Assessment, pp. 7-12
MindJogger Videoquizzes
Performance Assessment in the Biology Classroom
Alternate Assessment in the Science Classroom
Computer Test Bank
BDOL Interactive CD-ROM, Chapter 2 quiz

Additional Resources

Spanish Resources ELL
English/Spanish Audiocassettes ELL
Cooperative Learning in the Science Classroom COOP LEARN
Lesson Plans/Block Scheduling

NATIONAL GEOGRAPHIC Teacher's Corner

Index to National Geographic Magazine

The following articles may be used for research relating to this chapter.

"Rain Forest Canopy: The High Frontier," by Edward O. Wilson, December 1991.

GLENCOE TECHNOLOGY

The following multimedia resources are available from Glencoe.

Biology: The Dynamics of Life

CD-ROM ELL

Video: *How Organisms Interact*
Video: *Symbiosis*
BioQuest: *Antarctic Food Web*
Exploration: *Pyramid of Energy*

Videodisc Program

How Organisms Interact
Symbiosis
The Everglades

The Infinite Voyage

Secrets From a Fozen World

The Secret of Life Series

Niche
Predator–Prey
Mutualism

Getting Started Demo

Have students examine the chapter opener photographs. Discuss the feeding relationships shown. *The trout eats the mosquito. Human blood nourishes the mosquito.* Help students realize that humans, like the mosquito and trout, depend on other living things for food. Have students choose an animal product they eat and then show this feeding relationship in a food chain—for example, sun to grass to cow to human. L1

Theme Development

Systems and interactions is a theme of this chapter. Organisms have niches because of interactions among biotic and abiotic factors. A critical aspect of niche is how organisms obtain nutrients and energy. **Energy** flow, a major theme of Section 2, is traced through the trophic levels of a food chain.

0:00 Out of Time?

If time does not permit teaching the entire chapter, use the BioDigest at the end of the unit as an overview.

Resource Manager

Section Focus Transparency 4 and Master L1 ELL

Chapter 2 Principles of Ecology

What You'll Learn

- You will describe ecology and the work of ecologists.
- You will identify important aspects of an organism's environment.
- You will trace the flow of energy and nutrients in the living and nonliving worlds.

Why It's Important

To understand life, you need to know how organisms meet their needs in their natural environments. To reduce the impact of an expanding human population on the natural world, it is important to understand how living things depend on their environments.

Getting Started

Make a Chain

Think of the things you eat. Now consider how these food items obtained their food when they were alive. *Can you make a food chain, starting with the sun and ending with one of your food items?*

interNET CONNECTION To find out more about ecology, visit the Glencoe Science Web Site. **www.glencoe.com/sec/science**

You might think mosquitoes are pests, but for trout and other animals, mosquitoes and their larvae are a major food source.

Section 2.1 Organisms and Their Environment

As shown in the photographs, people can impact plant and animal communities in both positive and negative ways. Learning how ecological principles explain interaction between organisms and their environment can help you understand environmental issues and form your own opinions about them. In this section, you will learn some of the history and the focus of ecology.

Animals wander into cities in search of food (above). A wildlife rehabilitator releases an owl (inset).

Section Preview

Objectives

Distinguish between the biotic and abiotic factors in the environment.

Compare the different levels of biological organization and living relationships important in ecology.

Explain the difference between a niche and a habitat.

Vocabulary

ecology
biosphere
abiotic factor
biotic factor
population
community
ecosystem
habitat
niche
symbiosis
commensalism
mutualism
parasitism

What Is Ecology?

Do you know anyone who likes to observe nature? Perhaps it is a person who knows the names of many animals, plants, or rocks. People have enjoyed studying nature for thousands of years. Birdwatchers know the names and behaviors of the birds in their area. Some people carefully record observations of rainfall and temperature. Others make it a hobby to study plants; they keep log books with records of when plants produced leaves, flowers, and fruit, as shown in ***Figure 2.1.*** Some people who are interested in nature record observations, discuss their results, and note how patterns change from year to year.

Figure 2.1 An amateur nature study log book from the 17th century.

Prepare

Key Concepts

Students are provided with an overview of the history of ecology, living and nonliving factors in an environment, and close relationships among organisms that enhance survival.

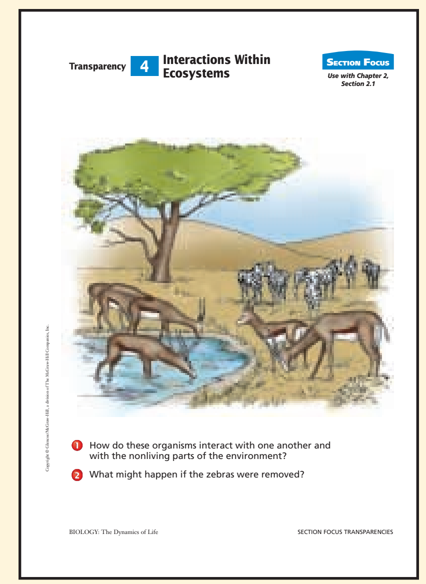
Planning

- Gather seeds, salt, and other materials for MiniLab 2-1. Mustard seeds work very well. You can find them in the spice section of any supermarket.
- Set up or borrow a fish tank for the Quick Demo.
- Gather or purchase lichens for the Quick Demo.
- Gather cups, bags, and seeds (pinto beans or corn) for the Alternative Lab.

1 Focus

Bellringer

Before presenting the lesson, display **Section Focus Transparency 4** on the overhead projector and have students answer the accompanying questions. L1 ELL



Multiple Learning Styles

Look for the following logos for strategies that emphasize different learning modalities.

Visual-Spatial Portfolio, pp. 39, 53; Quick Demo, p. 40; Enrichment, p. 41; Reinforcement, p. 55

Interpersonal Project, p. 43; Reteach, p. 47; Meeting Individual Needs, pp. 51, 54

Intrapersonal Portfolio, p. 42; Meeting Individual Needs, p. 42

Linguistic Biology Journal, pp. 44, 50, 56; Project, p. 46; Extension, p. 47; Portfolio, p. 58

Logical-Mathematical Discussion Question, p. 54

Naturalist Reinforcement, pp. 46, 49; Activity, p. 47; Biology Journal, p. 52; Going Further, p. 62

Assessment Planner

Portfolio Assessment
Portfolio, TWE, pp. 39, 42, 53

Performance Assessment
MiniLab, TWE, p. 38
Alternative Lab, TWE, pp. 40-41
Assessment, TWE, pp. 42, 58, 59
MiniLab, SE, pp. 38, 56
BioLab, SE, pp. 60-61

Knowledge Assessment
Assessment, TWE, pp. 47, 55
Section Assessment, SE, pp. 47, 59
Chapter Assessment, SE, pp. 63-65

Skill Assessment
Problem-Solving Lab, TWE, pp. 39, 52
MiniLab, TWE, p. 56
BioLab, TWE, pp. 60-61

2 Teach

MiniLab 2-1

Purpose

Students will experiment with the abiotic factor of salinity to determine if seed germination is affected.

Process Skills

collect data, experiment, interpret data

Teaching Strategies

- Prepare the 10% sodium chloride (table salt) solution by dissolving 100 g of table salt in 900 mL of tap water.
- Allow students to form a hypothesis prior to the experiment. At the conclusion of the activity, ask if their hypothesis was supported.
- Ask students to identify the control and the independent and dependent variables in the experiment.
- Have students work in small groups.

Expected Results

Seeds soaked in water will show germination. Seeds in salt water will show little or no germination.

Analysis

1. Yes. Seeds soaked in tap water germinate. Seeds soaked in salt water do not.
2. salinity of water; germination
3. No, each seed type may respond differently to salinity. Experimentation is needed.

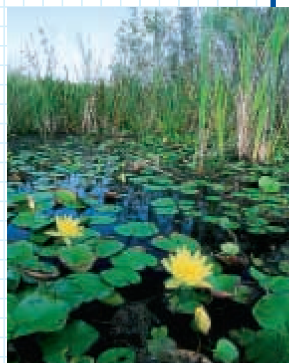
Assessment

Performance Have students design an experiment that would determine the minimum percentage of salinity that can be tolerated by a specific seed type and still allow germination to occur. Use the Performance Task Assessment List for Assessing a Whole Experiment and Planning the Next Experiment in **PASC**, p. 33. L2

MiniLab 2-1 Experimenting

Salt Tolerance of Seeds Salinity, or the amount of salt dissolved in water, is an abiotic factor. Might salt water affect how certain seeds sprout or germinate? Experiment to find out.

Salt marsh



Freshwater pond

Procedure

1. Soak 20 seeds in freshwater and 20 seeds in salt water overnight.
2. The next day, wrap the seeds in two different moist paper towels. Slide the towels into separate self-sealing plastic bags.
3. Label the bags "fresh" and "salt."
4. Examine all seeds two days later. Count the number of seeds in each treatment that show signs of root growth or sprouting, which is called germination. Record your data. **CAUTION:** *Be sure to wash your hands after handling seeds.*

Analysis

1. Did the germination rates differ between treatments? If yes, how?
2. What abiotic factor was tested in this experiment? What biotic factor was influenced?
3. Might all seeds respond to salt in a similar manner? How could you find out?

Ecology defined

The branch of biology that developed from natural history is called ecology. **Ecology** is the scientific study of interactions among organisms and their environments. Ecological study reveals relationships among living and nonliving parts of the world. Ecology combines information and techniques from many scientific fields, including mathematics, chemistry, physics, geology, and other branches of biology.

You have learned that scientific research includes both descriptive and quantitative methods. Most ecologists use both types of research. They obtain descriptive information by observing organisms in the field and laboratory. They obtain quantitative data by making measurements and carrying out carefully controlled experiments. Using these methods, ecologists learn a great deal about relationships, such as what organisms a coyote eats, how day length influences the behavior of migrating birds, how tiny shrimp help rid ocean fishes of parasites, or how acid rain threatens some of Earth's forests.

Aspects of Ecological Study

As far as we know, life exists only on Earth. Living things can be found in the air, on land, and in both freshand salt water. The **biosphere** (BI uh sfihr) is the portion of Earth that supports life. It extends from high in the atmosphere to the bottom of the oceans. This life-supporting layer may seem extensive to us, but if you could shrink Earth to the size of an apple, the biosphere would be thinner than the apple's peel.

Although it is thin, the biosphere is very diverse and supports a wide range of organisms. The climate, soils, plants, and animals in a desert are very different from those in a tropical rain forest. Living things are affected by both the physical environment and by other living things. Ecologists study these interactions among different organisms and their environments.

The nonliving environment: Abiotic factors

Ecology includes the study of features of the environment that are not living because these features are an important part of an organism's life. For example, a complete study of the ecology of moles would include an examination of the types of soil in which these animals dig their tunnels. Similarly, a thorough investigation of the life cycle of trout would need to include whether these fish lay their eggs on rocky or sandy stream bottoms. The nonliving parts of an organism's environment are the **abiotic factors** (ay bi AHT ihk). Examples of abiotic factors include air currents, temperature, moisture, light, and soil.

Abiotic factors have obvious effects on living things and often determine which species survive in a particular environment. For example, lack of rainfall can cause drought in a grassland, as shown in ***Figure 2.2.*** Can you think of changes in a grassland that might result from a drought? Grasses would grow more slowly, wildflowers would produce fewer seeds, and the animals that depend on plants for food would find it harder to survive. Examine other ways that abiotic factors affect living things in the *MiniLab* and *Problem-Solving Lab* shown on these pages.

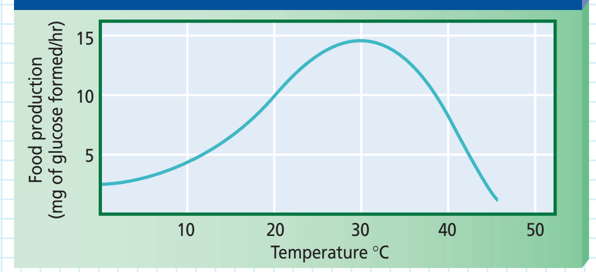
Problem-Solving Lab 2-1 Interpreting Data

How does an abiotic factor affect food production? Green plants carry out the process of photosynthesis. Glucose, a sugar, is one of the products produced during this process. Thus, glucose production can be used as a means for judging the rate at which the process of photosynthesis is occurring.

Analysis

Examine the following graph of a plant called salt bush *(Atriplex)*. It shows how this plant's glucose production is influenced by temperature.

Food Production in Salt Bush



Thinking Critically

1. Name the abiotic factor influencing photosynthesis and describe the influence of this factor on photosynthesis.
2. Name the biotic factor being influenced.
3. Based on the graph, describe the type of ecosystem this plant might live in. Explain your answer.
4. Does the graph tell you how the rate of photosynthesis might vary for plants other than salt bushes? Explain your answer.
5. Hypothesize why the formation of glucose drops quickly after reaching 30°C.

Figure 2.2 Droughts are common in grasslands. As the grasses dry out, they turn yellow and appear to be dead, but new shoots grow in the low-lying areas soon after it rains. Some animal species are adapted to living in grasslands by their ability to burrow underground and sleep through the dry periods.

Problem-Solving Lab 2-1

Purpose

Students will determine how temperature influences the rate at which photosynthesis occurs for a specific plant.

Process Skills

analyze information, draw a conclusion, interpret data

Teaching Strategies

- You may wish to introduce the process of photosynthesis by describing the raw materials needed and the role the process plays in providing food for all life forms.
- You might explain the term *optimum* as it relates to the optimum temperature at which photosynthesis occurs for salt bush.

Thinking Critically

1. Temperature. As temperature increases, the photosynthesis rate also increases until a maximum of 30°C (optimum temperature) is reached. Above 30°, the photosynthesis rate decreases.
2. food production
3. Salt bush appears to benefit from warm temperatures because it produces maximum food amounts at higher temperatures. It may, therefore, be found living in the desert.
4. The graph is specific for salt bush. The responses of other plants to temperature would have to be determined experimentally.
5. High temperatures may damage or kill the cells responsible for photosynthesis.

Assessment

Skill Have students write a lab report summarizing the results of the lab. Use the Performance Task Assessment List for Lab Report in **PASC**, p. 47. L2

TechPrep

People and Habitats

People may alter habitats, which changes the abiotic factors. Have students survey the school grounds and find five examples of specific changes that people made and how each has affected the abiotic environment. For example, a parking lot covered with asphalt reduces the amount of water entering the ground. On sunny days the asphalt gets hotter than unpaved land. L1 ELL

Meeting Individual Needs

Learning Disabled

Visual-Spatial Provide students who may require reinforcement of the concepts of biotic and abiotic factors with photographs from old nature magazines. Ask students to identify all the biotic factors in each photograph. Ask them to explain why they identified these factors as biotic. L1 ELL

Portfolio

Studying the Local Environment

Visual-Spatial Ask students to observe the natural environment of the area in which they live on several different days. Tell them to prepare a table in which they list the biotic and abiotic factors of the environment. Have students summarize the importance of the abiotic factors listed in their tables. L2 ELL P

Quick Demo

Visual-Spatial Show students an aquarium with live fish and plants. Ask what nonliving things influence the life of a fish. *water quality, temperature, light, and presence of oxygen* Ask what living things influence the life of the fish. *other fish, plants, and bacteria* L1

Careers in Biology

Career Path

Courses in high school: journalism, biology, physics, astronomy, geology, and other sciences.

College: degree in journalism or a scientific field

Career Issue

Ask students if they think science reporters should focus primarily on the inventions, discoveries, and issues that most readers will be able to understand. Should science reporters avoid highly technical topics?

For More Information

For more information about becoming a science reporter, students can write to:

The National Association of Science Writers
P.O. Box 294
Greenlawn, NY 11740

Figure 2.3 How might other living things affect this goldfish?

Careers in Biology

Science Reporter

Does science fascinate you? Can you explain complex ideas and issues in a clear and interesting way? If so, you should consider a career as a science reporter.

Skills for the Job

As a science reporter, you are a writer first and a scientist second. A degree in journalism and/or a scientific field is usually necessary, but curiosity and good writing skills are also essential. You might work for newspapers, national magazines, medical or scientific publications, television networks, or Internet news services. You could work as a full-time employee or a freelance writer. You must read constantly to stay up-to-date. Many science reporters attend scientific conventions and events to find news of interest to the public. Then they carefully and accurately translate what's new so nonscientists can understand it.

interNET CONNECTION For more careers in related fields, be sure to check the Glencoe Science Web Site.
www.glencoe.com/sec/science

The living environment: Biotic factors

Look at the goldfish in *Figure 2.3.* Now consider its relationships with other organisms. It may depend on other living things for food, or it may be food for other life. The goldfish needs members of the same species to reproduce. To meet its needs, the goldfish may compete with organisms of the same or different species.

A key consideration of ecology is that living organisms affect other organisms. All the living organisms that inhabit an environment are called **biotic factors** (by AHT ihk). Ecologists investigate how biotic factors affect different species. To help them understand the interactions of the biotic and abiotic parts of the world, ecologists have organized the living world into levels.

Levels of Organization in Ecology

The study of an individual organism, such as a male deer, known as a buck, might reveal what food items it prefers, how often it eats, and how far it roams to search for food or shelter. Although it spends a large part of its time alone, it does interact with other individuals of its species. For example, it periodically goes in search of a mate, which may require battling with other bucks.

All organisms depend on others for food, shelter, reproduction, or protection. So you can see that the study of an individual would provide only part of the story of its life cycle. To get a more complete picture requires studying its relationships with other organisms.

Ecologists study interactions among organisms at several different

Figure 2.4 Ecology deals with several levels of biological organization, including organisms, populations, communities, ecosystems, biomes, and the biosphere.

levels, as shown in *Figure 2.4.* They study individual organisms, interactions among organisms of the same species, and interactions among organisms of different species. Ecologists also study how abiotic factors affect groups of interacting species.

Enrichment

Visual-Spatial Have students observe organisms in their habitats, such as insects in a forest. Ask students to list a few examples of how the organisms interact with other organisms and with their nonliving environment. Then have them choose an illustration in Figure 2.4 and describe its biotic and abiotic interactions. L2

Revealing Misconceptions

Students may think an ecologist is the same as an environmentalist. Ask students how they are different. *Ecologists investigate ecology. Environmentalists are proponents of protecting the environment.*

GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
Video: *How Organisms Interact*
Disc 1

Resource Manager

BioLab and MiniLab Worksheets, p. 9 L2
Laboratory Manual, pp. 9-10 L2

Alternative Lab

Moisture and Seed Germination

Purpose

Students will determine if the amount of time that seeds are soaked in water influences their future germination.

Materials

120 seeds (corn, pinto beans), six paper cups, six plastic sandwich bags, water, paper toweling, graduated cylinder, labels

Procedure

Give students the following directions.

1. Label each of six cups with your name, the date, and one of the following times: 1, 6, 12, 24, or 48 hours.
2. Fill each cup with 10 mL of water. Add 20 seeds to each cup.
3. Remove the seeds from each cup when the time marked is reached. Wrap the seeds in a layer of paper toweling and place each batch of seeds into a separate, labeled plastic bag.
4. Seal the bags. Prepare a control bag with 20 unsoaked seeds. Caution: *Remind students to wash their hands after handling seeds.*
5. Starting the next day and continuing for five days, observe each group of seeds. Look for signs of germination (small roots growing from a seed), and record the number of seeds from each container that are germinating each day.

Analysis

1. What abiotic factor is being investigated? *effect of water on seed germination*
2. Which seems to be the optimum (best) time for seed germination? *The time will depend on the seed type used.*
3. Will the seeds all germinate at the same time? Explain. *No, each seed type will have its own optimum soaking time.*

Assessment

Performance Have students design and then perform an experiment to determine how the abiotic factor of light affects seed germination. Use the Performance Task Assessment List for Designing an Experiment in **PASC,** p. 23. L2

Visual Learning

Ask students to use Figure 2.6 to describe the adaptations of the adult frog that enable it to swim well. *strong hind legs, webbed feet* Which adaptations allow it to hide or escape from its predators? *body coloration, strong hind legs* What adaptations in the tadpole enable it to swim well? *large tail fin* L1

Assessment

Performance Have students write two questions based on what they have read so far. Organize the class into pairs and have them use their questions to quiz each other. L2

GLENCOE TECHNOLOGY

VIDEODISC
Biology: The Dynamics of Life
How Organisms Interact (Ch. 4)
Disc 1, Side 1,
40 sec.

Figure 2.5
These marsh marigolds represent a population of organisms. What characteristics are shared by this group of flowers that make them a population?

Interactions within populations

The marsh marigolds shown in ***Figure 2.5*** form a population. A **population** is a group of organisms of one species that interbreed and live in the same place at the same time.

Members of the same population may compete with each other for food, water, or other resources. Competition occurs only if resources are in short supply. How organisms in a population share the resources of their environment determines how far apart organisms live and how large the populations become.

Some species have adaptations that reduce competition within a population. An example is the life cycle of a frog, shown in ***Figure 2.6***. The juvenile stage of the frog, called the tadpole, not only looks very different from the adult but also has completely different food requirements. Many species of insects, including dragonflies and moths, also produce juveniles that differ from the adult in body form and food requirements.

Individuals interact within communities

No species lives independently of other species. Just as a population is made up of individuals, a community is made up of several populations. A **community** is a collection of interacting populations. An example of a community is shown in ***Figure 2.7***.

A change in one population in a community will cause changes in the other populations. Some of these changes can be minor, such as when a small increase in the number of individuals of one population causes a small decrease in the size of another population.

For example, if the population of mouse-eating hawks increases slightly, the population of mice will, as a result, decrease slightly. Other changes might be more extreme, as when the size of one population grows so large it begins affecting the food supply for another species in the community.

Figure 2.6
Adult frogs and their young have different food requirements. This limits competition for food resources for the species.

A Eggs that adult frogs lay in the water hatch into tadpoles. Tadpoles have gills, live in water, and eat algae and small aquatic creatures.

B Adult frogs live both on land and in the water. They breathe air and eat insects such as dragonflies, grasshoppers, and beetles.

Interactions among living things and abiotic factors form ecosystems

In a healthy forest community, interactions among populations might include birds eating insects, squirrels eating nuts from trees, mushrooms growing from decaying leaves or bark, and raccoons fishing in a stream. In addition to population interactions, ecologists also study interactions among populations and their physical surroundings in ecosystems. An **ecosystem** is made up of the interactions among the populations in a community and the community's physical surroundings, or abiotic factors.

There are three major kinds of ecosystems. Terrestrial ecosystems are those located on land. Examples include forests, meadows, and desert scrub. Aquatic ecosystems occur in both fresh- and saltwater. Freshwater ecosystems include ponds, lakes, and streams. Saltwater ecosystems, also called marine ecosystems, make up approximately 75 percent of Earth's surface. ***Figure 2.8*** shows a marine and a freshwater ecosystem.

Figure 2.7
Beech and maple trees dominate this forest community; therefore, it is called a beech-maple forest. Beech-maple forests are found in the eastern United States, Europe, and northeast China.

Figure 2.8
There may be hundreds of populations interacting in a pond or tide pool. How do you think the abiotic factors in these environments affect the biotic factors?

A Dragonflies live near moist meadows and ponds. They feed on small insects they catch while flying. Dragonflies lay their eggs in the pond or on pond plants.

B Organisms living in tide pools must survive dramatic changes in abiotic factors. When the tide is high, ocean waves replenish the water in the pool. When the tide is low, water in the pool evaporates.

Visual Learning

Ask students to use Figure 2.8 to describe adaptations that help animals living in tide pools survive when the tide is low for several hours. *Responses may include shells that help the animal retain moisture or the ability to burrow into moist sand.* Then ask students how they think the abiotic factors in these environments affect the biotic factors. *Responses may include that sunlight affects water temperature and whether photosynthesis will occur. Air dissolved in the water affects the respiratory and photosynthetic processes of the pond organisms, which, in turn, affect the flow of energy.*

GLENCOE TECHNOLOGY

VIDEODISC
The Infinite Voyage
Secrets from a Frozen World, The Southern Ocean—A Rich Marine Ecosystem (Ch. 1)
5 min. 30 sec.

Resource Manager

Tech Prep Applications, p. 3 L2

Portfolio

Limits on Life

Intrapersonal Ask students to find the names of five organisms that belong to tide pool or pond communities. Have them research how abiotic factors limit or affect life and write a report for their portfolios. L2 P

Meeting Individual Needs

Hearing Impaired

Intrapersonal Provide students with pictures of an insect larval stage and adult stage, such as a caterpillar and butterfly. Have students research the insect's life cycle and determine how differences in the developmental stages help the insect survive in its community. L2

PROJECT

A Miniature Ecosystem

Interpersonal Have students work in cooperative groups to create aquariums or terrariums in large, wide-mouthed jars, such as a peanut butter jar. For the aquarium, students will need to purchase materials from a pet store. For the terrarium, they can obtain soil, plants, and animals from the environment. Instruct each team to keep a log of the interactions between populations and the abiotic factors of their environment. Caution students to handle live animals with care. Remind them to wash their hands after handling animals, soil, and plants. L2 ELL COOP LEARN

Concept Development

The term *niche* is sometimes described as an activity that a person is good at but that others find difficult. Ask how this is similar to the biological definition. *Organisms in a niche frequently have adaptations that give them an advantage in their environments.*

GLENCOE TECHNOLOGY

VIDEODISC
The Secret of Life
Niche (fundamental)

Niche (realized)

Organisms in Ecosystems

A prairie dog living in a grassland makes its home in burrows it digs underground. Some species of birds make their homes in the trees of a beech-maple forest. In these forests, they find food, avoid enemies, and reproduce. The grassland and beech-maple forests are examples of habitats. A **habitat** (HAB uh tat) is the place where an organism lives out its life. Organisms of different species use a variety of strategies to live and reproduce in their habitats. Habitats can change, and even disappear, from an area. Examples of how habitats change due to both natural and human causes are presented in *Biology and Society* at the end of this chapter.

Niche

Although several species may share a habitat, the food, shelter, and other essential resources of that habitat are often used in different ways. For example, if you turn over a log like the one shown in ***Figure 2.9***, you will find millipedes, centipedes, insects, and worms living there. At first, it looks like this community of animals is competing for food because they all live in the same habitat. But close inspection reveals that each feeds in different ways, on different materials, and at different times. These differences lead to reduced competition.

Each species is unique in satisfying all its needs; each species occupies a niche. A **niche** (nich) is the role and position a species has in its environment—how it meets its needs for food and shelter, how it survives, and how it reproduces. A species' niche includes all its interactions with the biotic and abiotic parts of its habitat. It is an advantage for a species to occupy a niche different from those of other species. Life may be harsh in the polar regions, but the polar bear, with its thick coat, flourishes there. Nectar may be deep in the flower, inaccessible to most species, but the hummingbird, with its long beak, gets it. Unique strategies and structures are important to a species' niche and important for reducing competition with other species.

Living relationships

Some species enhance their chances of survival by forming relationships with other species. Biologists once assumed that all organisms living in the same environment are in a continuous battle for survival. Some interactions are harmful to one species, yet beneficial to another. Predators are animals such as lions and insect-eating birds that

Figure 2.9
This series of photographs shows how a habitat can be seen as a collection of several niches. As you can see, each species uses the available resources in a different way.

A A worm obtains nourishment from the organic material it eats as it burrows through the soil.

B A centipede is a predator that captures and eats beetles and other animals.

C A millipede eats decaying leaves near the log.

D These ants eat dead insects.

Quick Demo

Bring in a stone or tree bark with lichens growing on it. Explain that lichens consist of two organisms—fungi and algae. Have students hypothesize why they coexist. L2

Revealing Misconceptions

Some people incorrectly assume that symbiosis is equivalent to mutualism. Ask students to explain the relationship between the terms. *Symbiosis includes several kinds of relationships, including mutualism, which is a relationship in which both species benefit.*

GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
Video: *Symbiosis*
Disc 1

VIDEODISC
Biology: The Dynamics of Life
Symbiosis (Ch. 5)
Disc 1, Side 1
37 sec.

BIOLOGY JOURNAL

Connecting the Disciplines

Linguistic Have students list in their journals specific areas of chemistry, physics, and geology that might be studied as part of ecology. Also,ask them to describe the types of quantitative data that would be used in the specific areas they have listed. L2

Internet Address Book

interNET CONNECTION Note Internet addresses that you find useful in the space below for quick reference.

Reinforcement

Naturalist Describe the following situations to students: A bird builds its nest in the crook of a tree branch. Algae grow on the shell of a marine turtle. Ask why each situation illustrates commensalism. *Nests at tree height are protected from some predators, and the tree is neither helped nor harmed. Algae benefit by receiving light as the turtle swims near the water's surface. The turtle is not harmed nor helped. Both examples show relationships between different species.* L1

GLENCOE TECHNOLOGY

VIDEODISC
The Secret of Life
Predator-Prey

Mutualism

3 Assess

Check for Understanding

Have students explain the relationship between the words in each of the following pairs. L1 ELL

a. biology—ecology
b. population—ecosystem
c. habitat—niche
d. symbiosis—mutualism

Resource Manager

Critical Thinking/Problem Solving, p. 2 L3

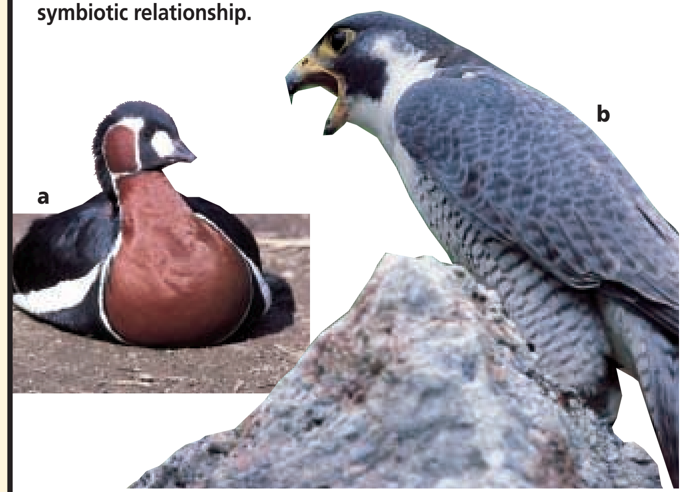


Figure 2.10
Red-breasted geese (a) and peregrine falcons (b) both nest in the Siberian arctic in the spring. They share a symbiotic relationship.

kill and eat other animals. The animals that predators eat are called prey. Predator-prey relationships such as the one between lions and wildebeests involve a fight for survival. Use the *BioLab* at the end of this chapter to more closely examine a predator-prey relationship. But there are other relationships among organisms that help maintain survival in many species. The relationship in

Figure 2.11
Spanish moss grows on and hangs from the limbs of trees but does not obtain any nutrients or cause any harm to the trees.

which there is a close and permanent association among organisms of different species is called **symbiosis** (sihm by OH sus). Symbiosis means living together.

There are several kinds of symbiosis. A symbiotic relationship between the peregrine falcon and red-breasted goose has evolved in the cold arctic region of Siberia in Russia, as shown in ***Figure 2.10.*** Normally, the peregrine falcon preys upon the red-breasted goose, but the falcon hunts away from its nesting area. During the nesting season, the falcon fiercely defends its territory from predators. The geese take advantage of this, choosing nesting areas close to those of the falcons, and are thereby protected from predators. The geese benefit from the relationship, and the falcon is neither benefited nor harmed. This is called a commensal relationship. **Commensalism** (kuh MEN suh lihz um) is a symbiotic relationship in which one species benefits and the other species is neither harmed nor benefited.

Commensal relationships also occur among plant species. Spanish moss, a kind of flowering plant that grows on the branch of a tree, is shown in ***Figure 2.11.*** Orchids, ferns, mosses, and other plants sometimes grow on the branches of larger plants. The larger plants are not harmed, but the smaller plants benefit from the additional habitat.

Sometimes, two species of organisms benefit from living in close association. A symbiotic relationship in which both species benefit is called **mutualism** (MYEW chuh lihz um). Ants and acacia trees living in the subtropical regions of the world illustrate mutualism, as shown in ***Figure 2.12.*** The ants protect the tree by attacking any animal that tries to feed on it. The tree provides nectar and a home for the ants. In an experiment, ecologists removed the ants from some acacia trees. Results showed that the trees with ants grew faster and survived longer than trees without ants.

Sometimes, one organism harms another. Have you ever owned a dog or cat that was attacked by ticks or fleas? Ticks and fleas, shown in ***Figure 2.13,*** are examples of parasites. A symbiotic relationship in which one organism derives benefit at the expense of the other is called **parasitism** (PER uh suh tihz um). Parasites have evolved in such a way that they harm, but usually do not kill, the host. If the host dies, the parasite also will die unless it can quickly find another host. Some parasites, such as tapeworms and roundworms, live inside other organisms.

Figure 2.12
These ants and acacia trees both benefit from living in close association. This mutualistic relationship is so strong that in nature the trees and ants are never found apart.

Figure 2.13
Ticks cause harm to the animals they live on when they obtain nutrients from their host animal. This relationship is called parasitism.

WORD *Origin*

ecology
From the Greek words *oikos,* meaning "homestead," and *logos,* meaning "the study of." Ecology is the study of how organisms interact with their environments.

Section Assessment

Understanding Main Ideas

1. List several different biotic and abiotic factors in an ecosystem.
2. Compare and contrast populations and communities.
3. Give examples that would demonstrate the differences between the terms niche and habitat.
4. A leaf-eating caterpillar turns into a nectar-eating butterfly. How is this feeding behavior an advantage for this species?

Thinking Critically

5. Clownfish are small, tropical marine fish usually found swimming among the stinging tentacles of sea anemones. What type of symbiotic relationship do these animals have if the clownfish are protected by the sea anemone, but the sea anemone does not benefit from the clownfish?

SKILL REVIEW

6. **Designing an Experiment** Design an experiment to test the hypothesis that clownfish and sea anemones have a mutualistic relationship. For more help, refer to *Practicing Scientific Methods* in the **Skill Handbook.**

Reteach

Interpersonal Ask students to work in groups to provide examples of biotic and abiotic factors within the classroom or school. L2 COOP LEARN

Extension

Linguistic Ask students to research how abiotic factors limit life in the Arctic tundra or in a desert environment. Have them include a written summary of the information they gather in their portfolios. L3 P

Assessment

Knowledge Ask students to consider the school grounds an ecosystem. Have them explain and give examples of populations and communities that live in this "ecosystem." L2

4 Close

Activity

Naturalist Have students work in groups to invent four pairs of organisms that display all four symbiotic relationships. Students should name the organisms, describe the interactions, and identify the symbiotic relationships. L1 COOP LEARN

Resource Manager

Reinforcement and Study Guide, pp. 7-8 L2
Content Mastery, p. 10 L1

PROJECT

Living With a Legume

Linguistic A mutualistic symbiotic relationship exists between clover root nodules and bacteria. This relationship is commonly found in leguminous plants. Prepared slides are available of root nodules that show this relationship. Have students observe these slides under a microscope and make diagrams of their observations. Have students use caution when working with prepared slides. Ask them to research the name of the bacterium that lives in the nodules. Students should write a report of their observations and explain how the relationship benefits both plant and bacterium. L2

Section Assessment

1. Responses may include the following: *Biotic—tree, grass, human, dog, ant Abiotic—daylight hours, amount of rainfall, humidity, air, soil.*
2. A population consists of a single species that can interbreed and is present in the same place at the same time. A community consists of several populations that interact with one another.
3. Responses may be similar to the following: *Squirrel—habitat: forest; niche: gathers, eats, and stores nuts. Mushroom—habitat: moist forest soil; niche: digests and absorbs organic matter. Bat—habitat: cave; niche: fertilizes flowers, eats insects.*
4. The caterpillar and the butterfly do not compete with each other for food.
5. Commensalism. The clownfish benefits, but the sea anemone is not helped nor hurt.
6. The experiment would compare the growth and health of a sea anemone and clownfish when they live together and when they live separately.

Section 2.2

Prepare

Key Concepts

Energy is needed for survival. The ways that organisms obtain and pass energy are depicted with food chains and food webs. This section also addresses trophic levels and the nitrogen, carbon, and water cycles.

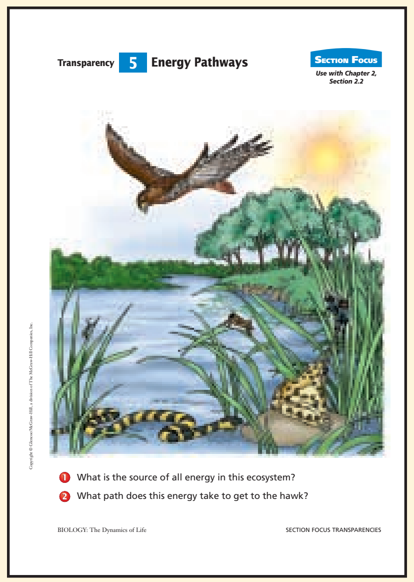
Planning

- Set up a terrarium to help show the water cycle.
- Gather bromothymol blue and antacid for MiniLab 2-2.
- Bring in a fertilizer label for the Enrichment.
- Purchase duckweed for the Project on plant growth.
- Prepare sterile pond water or follow the directions in the BioLab for substitutions.

1 Focus

Bellringer

Before presenting the lesson, display **Section Focus Transparency 5** on the overhead projector and have students answer the accompanying questions. L1 ELL


Transparency 5 Energy Pathways

SECTION FOCUS
Use with Chapter 2, Section 2.2

1. What is the source of all energy in this ecosystem?
2. What path does this energy take to get to the hawk?

BIOLOGY: The Dynamics of Life — SECTION FOCUS TRANSPARENCIES

SECTION PREVIEW

Objectives

Compare how organisms satisfy their nutritional needs.

Trace the path of energy and matter in an ecosystem.

Analyze how nutrients are cycled in the abiotic and biotic parts of the biosphere.

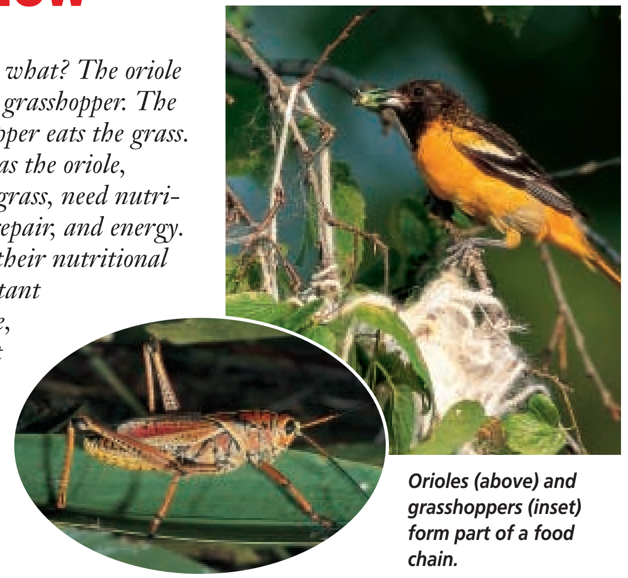
Vocabulary

autotroph
heterotroph
scavenger
decomposer
food chain
trophic level
food web

Section

2.2 Nutrition and Energy Flow

What eats what? The oriole eats the grasshopper. The grasshopper eats the grass. Organisms, such as the oriole, grasshopper, and grass, need nutrition for growth, repair, and energy. How they satisfy their nutritional needs is an important part of their niche, and an important focus of ecology.


Orioles (above) and grasshoppers (inset) form part of a food chain.

Word Origin

autotroph
From the Greek words *auto,* meaning "self," and *trophe,* meaning "nourishment." Autotrophs are self-nourishing; they make their own food.

heterotroph
From the Greek words *hetero,* meaning "other," and *trophe,* meaning "nourishment." Heterotrophs consume other organisms for their nutrition.

How Organisms Obtain Energy

A roadrunner sprints, a cactus flowers, an aphid reproduces. Energy drives all these events. One of the most important characteristics of a species' niche is how the species obtains its energy. Ecologists trace the flow of energy through communities to discover nutritional relationships. The ultimate source of the energy is the sun, which supplies the energy that fuels life.

The producers: Autotrophs

Plants use the sun's energy to manufacture food in a process called photosynthesis. Organisms that use energy from the sun or energy stored in chemical compounds to manufacture their own nutrients are called **autotrophs** (AWT uh trohfs). The grass in ***Figure 2.14*** is an autotroph. Although plants are the most familiar terrestrial autotrophs, some unicellular organisms also make their own nutrients. Most other organisms depend on autotrophs for nutrients and energy.

The consumers: Heterotrophs

A deer nibbles the leaves of a clover plant, a bison munches grass, an owl swallows a mouse. The deer, buffalo, and owl are incapable of producing their own food. They obtain nutrients by eating other organisms. Organisms that cannot make their own food and must feed on other organisms are called **heterotrophs** (HET uh ruh trohfs). Heterotrophs include organisms that feed only on autotrophs, organisms that feed only on other heterotrophs, and organisms that feed on both autotrophs and heterotrophs.

Some heterotrophs, such as grazing, seed-eating, and algae-eating animals, feed directly on autotrophs. The wildebeests in ***Figure 2.14*** depend on plants for their food. A heterotroph that feeds only on plants is called a herbivore. Herbivores include rabbits, grasshoppers, beavers, squirrels, bees, elephants, and fruit-eating bats.

Some heterotrophs eat other heterotrophs. Animals such as lions that kill and eat only other animals are called carnivores. Some animals do not kill for food; instead, they eat animals that have already died. **Scavengers** such as black vultures feed on carrion and refuse, and play a beneficial role in the ecosystem. Imagine for a moment what the environment would be like if there were no vultures to devour animals killed on the African plains, no buzzards to clean up dead animals along roads, and no ants and beetles to remove dead insects and small animals from sidewalks and basements.

Humans are an example of a third type of heterotroph. The teenagers in ***Figure 2.15*** are eating a variety of foods that include both animal and plant materials. They are omnivores. Raccoons, opossums, and bears are other examples of omnivores.


Figure 2.14
Many kinds of organisms live in the savanna of East Africa. Identify the autotrophs and the heterotrophs.

Word Origin

herbivore
From the Latin words *herba,* meaning "grass," and *vorare,* meaning "to devour." Herbivores feed on grass and other plants.

carnivore
From the Latin words *caro,* meaning "flesh," and *vorare,* meaning "to devour." Carnivores eat animals.

omnivore
From the Latin words *omnis,* meaning "all," and *vorare,* meaning "to devour." Carnivores eat both plants and animals.

Figure 2.15
People are omnivores because they eat both autotrophs and heterotrophs.

2 Teach

Using Scientific Terms

Call students' attention to the derivations of the terms *herbivore, carnivore,* and *omnivore,* presented in the margins of these pages. Ask students to explain the appropriateness of each term to the feeding habits of the organisms it describes. *Herbivores are organisms that feed upon grasses and plants; carnivores feed on the flesh of animals; omnivores feed on both plant and animal products.* L2 ELL

Reinforcement

Naturalist Have students list common pets. Ask them to identify the foods that are typically provided to each pet on their list. Challenge students to classify each pet as an omnivore, carnivore, or herbivore based upon the foods it eats. L1

Resource Manager

Concept Mapping, p. 2 L3 ELL

Meeting Individual Needs

Learning Disabled

Linguistic Have students who understand the concept of producer and consumer work with students who are having difficulty. Group the terms *producer, plant,* and *autotroph* and *consumer, heterotroph,* and *animal.* Have students analyze the meanings of the groups. L1 ELL COOP LEARN

Resource Manager

Section Focus Transparency 5 and Master L1 ELL

Cultural Diversity

Cultural Adaptations to the Environment

Humans occupy all types of habitats, adapting to Earth's varying environments in many ways. For example, people have designed clothing suited to a wide range of climate conditions, from heavy rainfall to sub-zero temperatures. People around the world use available materials to create shelters adapted to their environments. Ask students to describe some examples of using available materials to meet needs created by the environment. *Inuit groups in North America built homes from snow and ice to conserve heat. Groups living in the southwestern United States built homes using a mud and clay mixture called adobe.*

Discussion Questions

Ask students to explain what the arrow in all food chains represents. *The arrow shows in which direction matter and energy are moving through the food chain.* Why must all second-level organisms be consumers? *By definition, these organisms feed on or consume other organisms.* Why must all third-level organisms be carnivores and not herbivores? *By definition, these organisms feed on other animals and are therefore meat or flesh eaters.* L2

Some organisms, such as fungi, break down and absorb nutrients from dead organisms. These organisms are called **decomposers.** Decomposers break down the complex compounds of dead and decaying plants and animals into simpler molecules that can be more easily absorbed by the decomposers, and by other organisms. Some protozoans, many bacteria, and most fungi carry out this essential process of decomposition.

Matter and Energy Flow in Ecosystems

When you pick an apple from a tree and eat it, you are consuming carbon, nitrogen, and other elements the tree has used to produce the fruit. That apple also contains energy from the sunlight trapped by the tree's leaves while the apple was growing and ripening.

Matter and energy flow through organisms in ecosystems. You have already learned that feeding relationships and symbiotic relationships describe ways in which organisms interact. Ecologists study these interactions to make models that trace the flow of matter and energy through ecosystems.

Food chains: Pathways for matter and energy

The wetlands community pictured in ***Figure 2.16*** illustrates examples of food chains. A **food chain** is a simple model that scientists use to show how matter and energy move through an ecosystem. Nutrients and energy proceed from autotrophs to heterotrophs and, eventually, to decomposers.

A food chain is typically drawn using arrows to indicate the direction in which energy is transferred from one organism to the next. One food chain in ***Figure 2.16*** could be shown as

algae → fish → heron

Food chains can consist of three links, or steps, but most have no more than five links. This is because the amount of energy remaining in the fifth link is only a small portion of what was available at the first link. A portion of the energy is lost as heat at each link. It makes sense, then, that typical food chains are three or four links long.

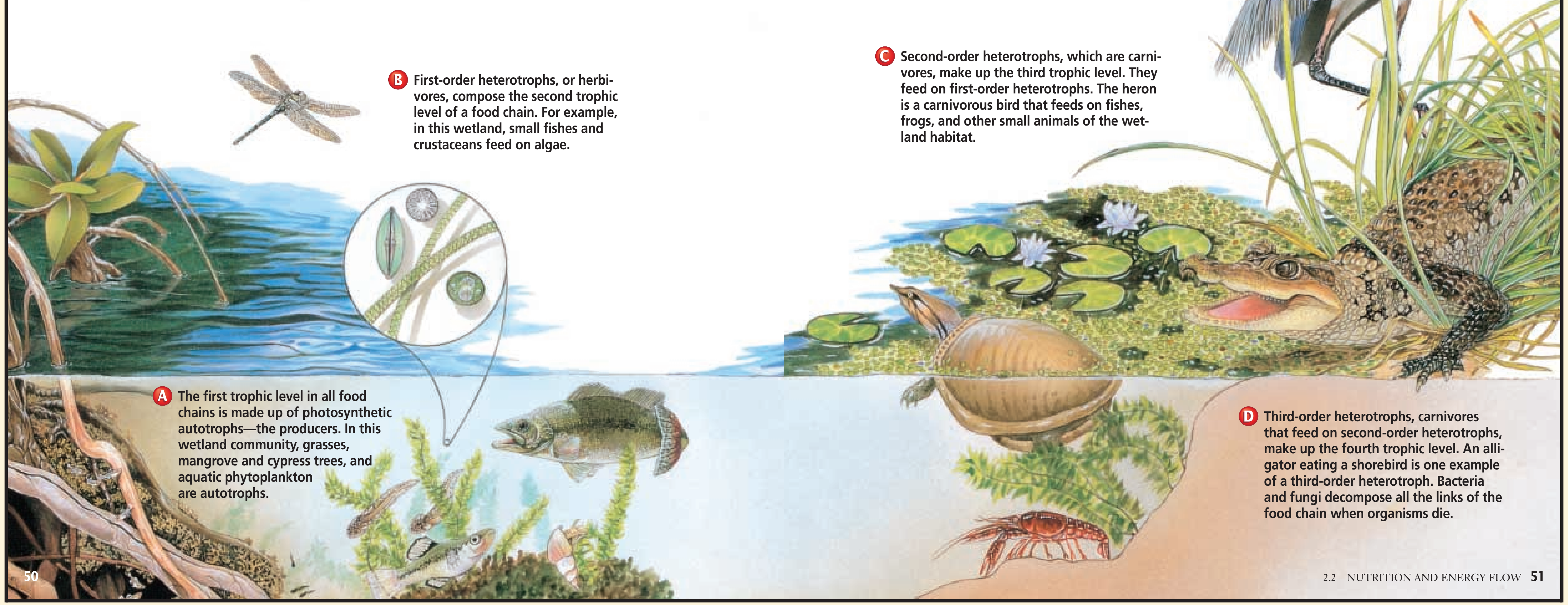


Figure 2.16
In order for a wetland ecosystem to function, its organisms must depend on each other for a supply of energy. Follow the steps in the wetland food chain shown here.

A The first trophic level in all food chains is made up of photosynthetic autotrophs—the producers. In this wetland community, grasses, mangrove and cypress trees, and aquatic phytoplankton are autotrophs.

B First-order heterotrophs, or herbivores, compose the second trophic level of a food chain. For example, in this wetland, small fishes and crustaceans feed on algae.

C Second-order heterotrophs, which are carnivores, make up the third trophic level. They feed on first-order heterotrophs. The heron is a carnivorous bird that feeds on fishes, frogs, and other small animals of the wetland habitat.

D Third-order heterotrophs, carnivores that feed on second-order heterotrophs, make up the fourth trophic level. An alligator eating a shorebird is one example of a third-order heterotroph. Bacteria and fungi decompose all the links of the food chain when organisms die.

Reinforcement

Ask students to describe possible food chains, other than the one shown in Figure 2.16. *They are likely to substitute different organisms in place of those shown or mentioned in the text. Accept all logical responses.*

Visual Learning

Ask students to use Figure 2.16 to identify other animals that might occupy the third trophic level. *Responses may include other birds of prey such as owls or eagles or land animals such as lions, bears, or cats. Accept all logical responses.*

GLENCOE TECHNOLOGY

VIDEODISC
The Infinite Voyage: *Secrets from a Frozen World*
Krill: The Vital Link of a Food Chain (Ch. 2)
5 min. 30 sec.

Resource Manager

Basic Concepts Transparency 1 and Master L2 ELL

BIOLOGY JOURNAL

Living as a Decomposer

Linguistic Have students assume they are decomposers. Ask them to write a short paragraph that describes: a) what they look like, b) where they live, c) what they are going to eat. L2

MEETING INDIVIDUAL NEEDS

English Language Learners

Interpersonal Have students work in pairs to list some of the foods they have consumed in the past 24 hours. Then have each pair determine if they were a first-order, second-order, or third-order consumer of each food. L2

BIOLOGY JOURNAL

Human Diets

Have students write out a restaurant menu that incorporates several food items that would illustrate humans acting as first-order, second-order, and third-order consumers. L1

Problem-Solving Lab 2-2

Purpose

Students use their knowledge of trophic levels to organize and summarize information.

Process Skills

think critically, classify, sequence

Teaching Strategies

- You may wish to provide the outline diagrams to students.
- Allow students to work in small groups to complete the lab.
- Remind students that there is only one correct placement for each label.
- Review and/or define any term that is still not clear to students.

Thinking Critically

1. Starting at the lowest level: autotroph; 1st-order heterotroph; 2nd-order heterotroph; 3rd-order heterotroph.
2. Starting at the lowest level on the left: producer, herbivore, carnivore (top two levels). On the right, the lowest level is autotroph and the top three levels are heterotrophs.
3. Small arrows show direction of energy from one trophic level to next.

Assessment

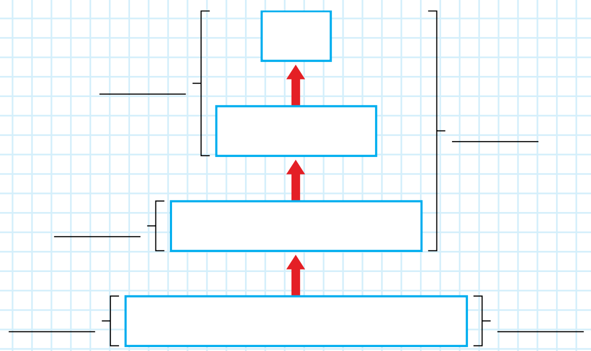
Skill Ask students to prepare a concept map of the ideas covered in this lab. Their maps must include all terms used on the diagram. Use the Performance Task Assessment List for Concept Map in **PASC**, p. 89. L3 ELL

GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
BioQuest: *Antarctic Food Web*
Disc 1

Problem-Solving Lab 2-2 — Applying Concepts

How can you organize trophic level information?
Diagrams or charts may help to summarize information or concepts in a more logical and simpler manner. This is the case with information that shows relationships among trophic levels.



Analysis

Copy the diagram above. It will show, when completed correctly, the various relationships in a food chain.

Thinking Critically

1. Each box represents a trophic level. Write the name for each trophic level in the proper box. Use these choices: 1st order heterotroph, autotroph; 3rd order heterotroph; 2nd order heterotroph.
2. Each bracket identifies one or more traits of the trophic levels. Use the following labels to identify them in their proper order: herbivore, autotroph, carnivore, heterotroph, producer.
3. What is being represented by the small arrows connecting trophic levels?

Trophic levels represent links in the chain

Each organism in a food chain represents a feeding step, or **trophic level** (TROHF ihk), in the passage of energy and materials. Examine how energy flows through trophic levels in the *Problem-Solving Lab* shown here. A food chain represents only one possible route for the transfer of matter and energy in an ecosystem. Many other routes may exist. As *Figure 2.16* indicates, many different species occupy each trophic level in a wetlands ecosystem. In addition, many different kinds of organisms eat a variety of foods, so a single species may feed at several trophic levels. For example, the great blue heron eats largemouth black bass, but it also eats minnows, bluegills, and frogs. The alligator may feed on the heron, fish, or even a deer that comes too close. Can you think of other possible food chains in this ecosystem?

Food webs

Simple food chains are easy to study, but they cannot indicate the complex relationships that exist among organisms that feed on more than one species. Ecologists who are particularly interested in energy flow in an ecosystem set up experiments with as many organisms in the community as they can. The model they create, a **food web,** expresses all the possible feeding relationships at each trophic level in a community. A food web is a more realistic model than a food chain because most organisms depend on more than one other species for food. Notice how the food web of the forest ecosystem shown in *Figure 2.17* represents a network of interconnected food chains. In an actual ecosystem, many more plants and animals would be involved in the food web.

Energy and trophic levels: Ecological pyramids

How can you show how energy is used in an ecosystem? Ecologists use food chains and food webs to model the distribution of matter and energy within an ecosystem. They also use another kind of model, called an ecological pyramid. An ecological pyramid shows how energy flows through an ecosystem. The base of the ecological pyramid represents the autotrophs, or first trophic level. Higher trophic levels are layered on top of one another. Examine each type of ecological pyramid in *Figures 2.18, 2.19* and *2.20.* Each pyramid gives different information about an ecosystem. Observe that each pyramid summarizes interactions of matter and energy at each trophic level. Notice that the initial source of energy for all three of these ecological pyramids is energy from the sun.

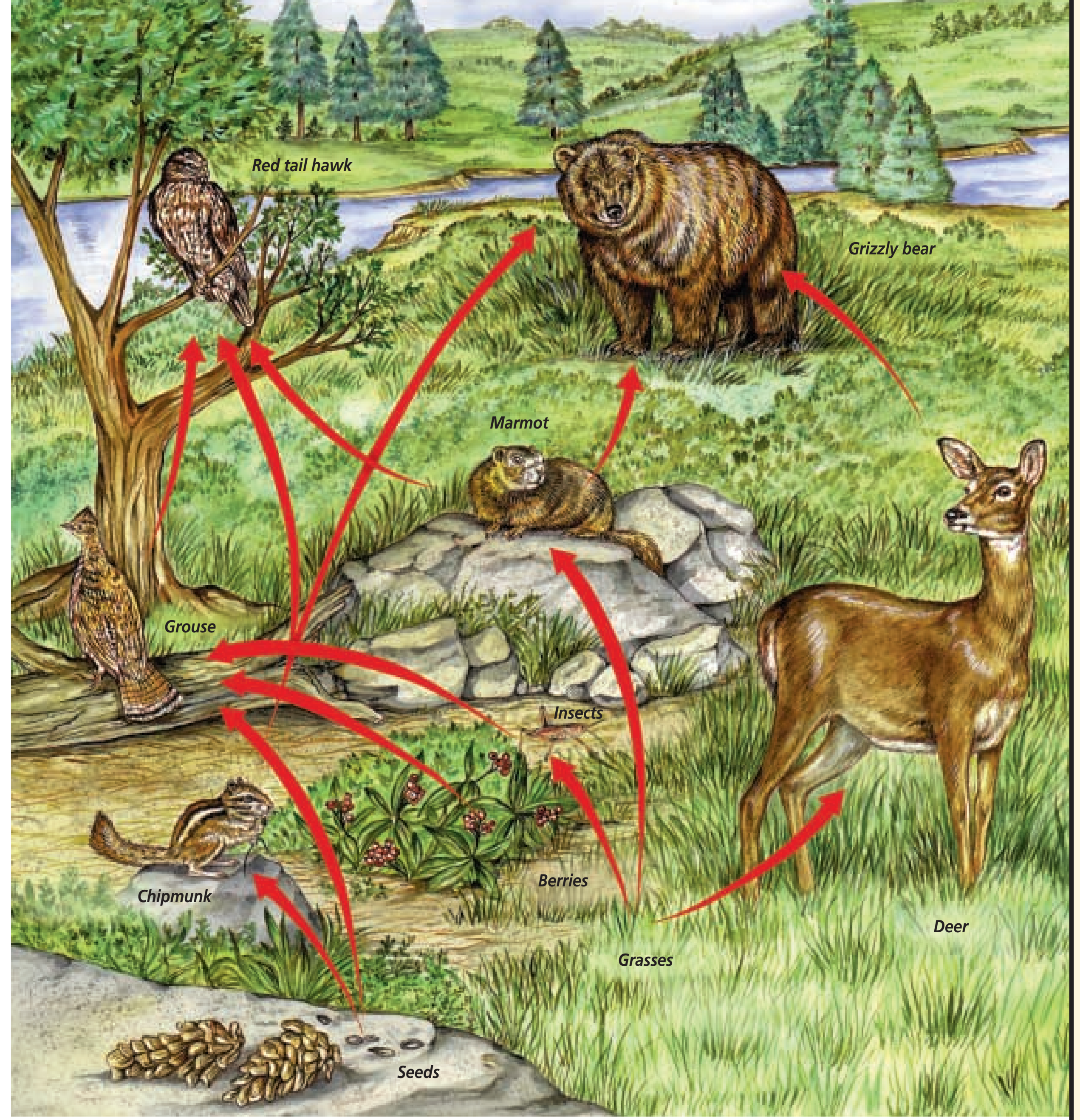


Figure 2.17
A forest community food web includes many organisms at each trophic level. Arrows indicate the flow of materials and energy.

Chalkboard Example

Write the word *human* at the top of the chalkboard. Ask students to complete a food web that includes the two trophic levels below humans, using as many different organisms for each level as possible. *Examples of first-order consumers may include chickens, cows, sheep, and pigs; examples of producers may include grass, shrubs, lettuce, pears, and corn.* Ask students to explain why this represents a food web rather than a food chain. *A food chain involves only one organism for each trophic level.*

Tying to Previous Knowledge

Have students review the meanings of the terms *scavenger* and *decomposer*. Ask them to describe the role of each type of organism in a food chain or food web. L1 ELL

GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
Exploration: *Pyramid of Energy*
Disc 1

Resource Manager

Basic Concepts Transparency 2 and Master L2 ELL

Biology Journal

It's a Jungle

Naturalist Have students compare trophic levels to the organization of a business. Ask them to diagram a specific business to show how each level of employee supports the next level. L2

Portfolio

Making a Food Web

Visual-Spatial Ask students to design a food web using the following organisms: wheat, rat, fox, human, cow, corn, rabbit, hawk, grass. Have them use a colored pencil or marker to outline one food chain in this web. Ask them to indicate tropic levels as well as omnivores, herbivores, and carnivores. L1

Concept Development

Have students imagine a roped-off patch of forest. All the producers, herbivores, and consumers are put into piles. Ask which pile would be largest. *the producer pile* Explain that a biomass pyramid is made after weighing the piles. Burning the piles and measuring the energy leads to a pyramid of energy. Counting organisms leads to a pyramid of numbers.

Discussion Question

Logical-Mathematical Have students analyze the error in logic for the following scenario. Humans are not at the mercy of producers for their food because they eat animals as a food source. Thus, people would not suffer if all autotrophs were suddenly to die out. *Students should recognize that the animals humans eat are themselves dependent on producers for their food.* L3

GLENCOE TECHNOLOGY

VIDEODISC
The Secret of Life
Pyramid of Biomass

Resource Manager

Reteaching Skills Transparency 3 and Master L1 ELL

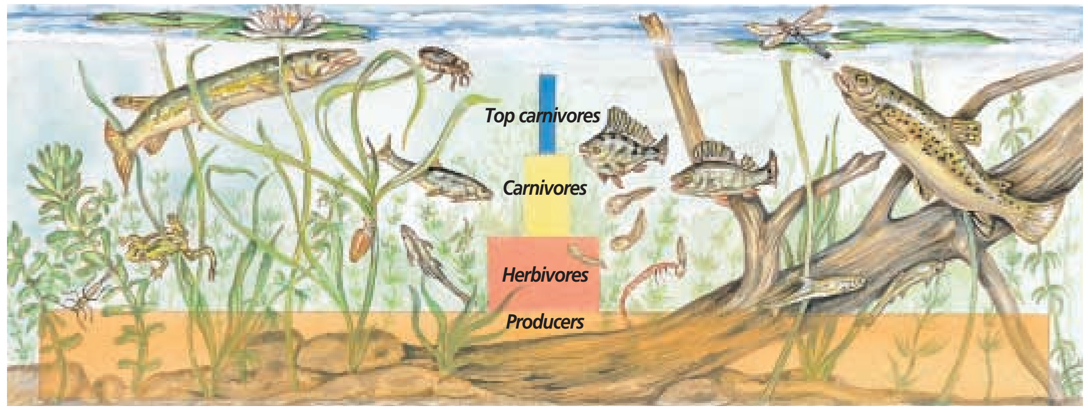


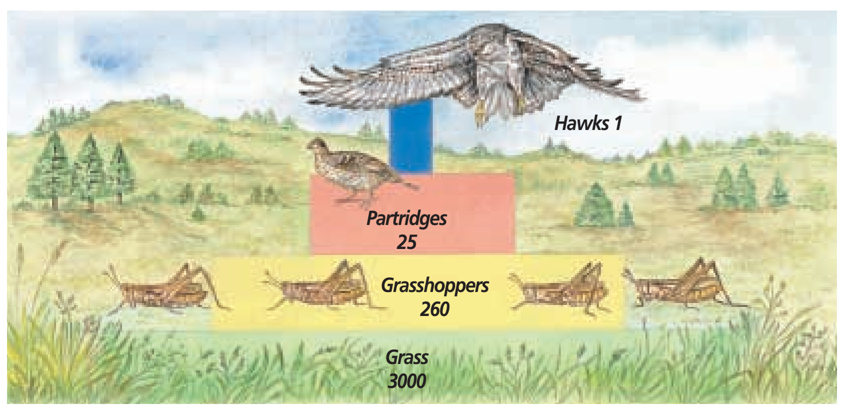
Figure 2.18
Pyramid of energy Each bar in the pyramid represents energy available within a trophic level. Notice that energy decreases as the trophic level increases.

The pyramid of energy shown in *Figure 2.18* illustrates that energy decreases at each succeeding trophic level. The total energy transfer from one trophic level to the next is only about ten percent because organisms fail to capture and eat all the food available at the trophic level below them. When an organism consumes food, it uses some of the energy in the food for metabolism, some for building body tissues, and some is given off as waste. When the organism is eaten, the energy that was used to build body tissue is available as energy to be used by the organism that consumed it. The energy lost at each successive trophic level enters the environment as heat.

Ecologists construct a pyramid of numbers based on the population sizes of organisms in each trophic level. The pyramid of numbers in *Figure 2.19* shows that population sizes decrease at each higher trophic level. This is not always true. For example, one tree can be food for 50 000 insects. In this case, the pyramid would be inverted.

A pyramid of biomass, such as the one shown in *Figure 2.20*, expresses the weight of living material at each trophic level. Ecologists calculate the biomass at each trophic level by finding the average weight of each species at that trophic level and multiplying by the estimated number of organisms in each population.

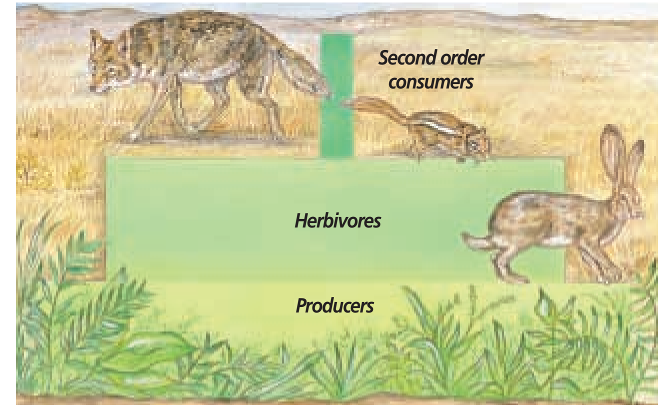
Figure 2.19
Pyramid of numbers Each bar in the pyramid represents population size within a trophic level. Notice that population size decreases as the trophic level increases.



Cycles in Nature

Food chains, food webs, and ecological pyramids all show how energy moves in only one direction through the trophic levels of an ecosystem. Ecological pyramids also show how energy is lost from one trophic level to the next. This energy is lost to the environment as heat generated by the body processes of organisms. Sunlight is the primary source of all this energy, so energy is always being replenished.

Matter, in the form of nutrients, also moves through the organisms at each trophic level. But matter cannot be replenished like the energy from sunlight. The atoms of carbon, nitrogen, and other elements that make up the bodies of organisms alive today are the same atoms that have been on Earth since life began. Matter is constantly recycled.

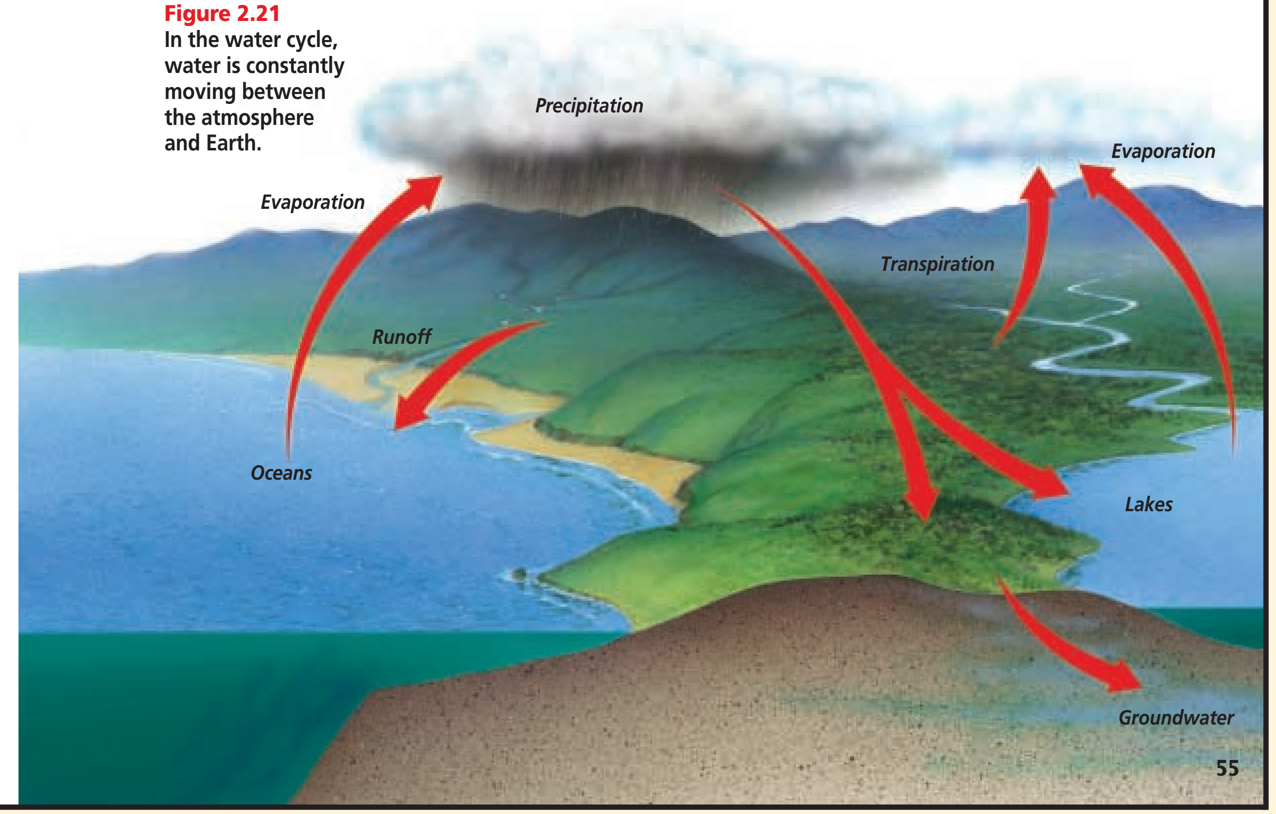


The water cycle

Life on Earth depends on water. Even before there was life on Earth, water cycled through stages, as shown in *Figure 2.21*. Have you ever left a glass of water out and a few days later observed there was less water in the glass? This is the result of evaporation. Just as the water

Figure 2.20
Pyramid of biomass Each bar in the pyramid represents the amount of biomass within a trophic level. Notice that biomass decreases as the trophic level increases.

Figure 2.21
In the water cycle, water is constantly moving between the atmosphere and Earth.



Quick Demo

A terrarium, such as a large glass bowl containing soil and plants and capped with plastic wrap, can be used to show the water cycle. Through evaporation and transpiration, water leaves the soil. The water vapor condenses on the plastic wrap and drops accumulate, simulating cloud formation. When the drops are large enough, they fall back to the soil, simulating precipitation.

Reinforcement

Visual-Spatial Have students diagram the water cycle for inclusion in their portfolios. Encourage them to label the major processes involved in the water cycle, such as evaporation, condensation, precipitation, respiration, transpiration, excretion, and decomposition. Students may use library reference materials if necessary. L2 ELL P

Assessment

Knowledge Have students explain how the movement of water through its cycle differs from the movement of energy through the trophic levels. L2

NATIONAL GEOGRAPHIC

VIDEODISC
STV: Water
Water Quality
Unit 1, Side 1, 1 min. 37 sec.
Hydrologic Cycle

Meeting Individual Needs

English Language Learners/ Learning Disabled

Interpersonal Have students work in pairs to count the number of grass plants, ants, earthworms, or beetles in a ten-centimeter-square area on the school grounds. Students should then use this small sample to estimate the biomass for a ten-square meter area. L1 ELL

Biology Journal

Follow the Light Energy

Visual-Spatial Have students assume they are a "packet" of light energy from the sun with a value of 100 energy units. Have them trace their path through a simple food chain and indicate their value at each level. Have them assume that only ten percent of the energy is passed from one level to the next. L2

MiniLab 2-2

Purpose

Students will use bromothymol blue to test for the presence of carbon dioxide gas.

Process Skills

acquire information, draw a conclusion, observe and infer, recognize cause and effect

Safety Precautions

Caution students not to inhale or drink the bromothymol solution. Have them wear goggles and a lab apron.

Teaching Strategies

- Prepare bromothymol blue solution as follows: Stock solution—add 0.5 g bromothymol blue powder to 500 mL distilled water. Dilute 10 mL stock solution with 500 mL of distilled water. (If solution is green, add one or more drops of NH_4OH until a blue color appears. If solution is deep blue, add one or more drops of HCl until a light blue color appears.)
- An effervescent antacid must be used. Check the label to be sure the ingredients include a carbonate or bicarbonate and a weak acid such as citric acid.
- Bromothymol blue does not actually indicate the presence of carbon dioxide. It changes color in the presence of any acid solution, such as the carbonic acid formed by carbon dioxide and water.

Expected Results

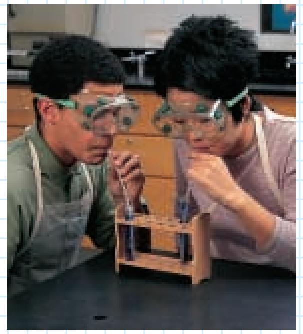
Bromothymol blue will change to green or yellow when an antacid tablet is added or exhaled air is bubbled through the indicator. The color change shows that carbon dioxide is present.

Analysis

1. Bromothymol blue changes to green or yellow when carbon dioxide gas is added.
2. carbon dioxide
3. Yes, the color change in the bromothymol blue indicated the presence of carbon dioxide.

MiniLab 2-2 Observing and Inferring

Detecting Carbon Dioxide



Carbon dioxide is given off during respiration. When carbon dioxide is dissolved in water, an acid is formed. Certain chemicals called indicators can be used to detect acids. One indicator, called bromothymol blue, will change from its normal blue color to green or yellow if an acid is present.

Procedure

1. Half fill a test tube with bromothymol blue solution.
2. Add a quarter of an effervescent antacid tablet to the tube and note any color change.
3. Half fill a test tube with bromothymol blue solution. Using a straw, exhale into the bromothymol blue at least 30 times. **CAUTION:** ***Do not inhale the bromothymol blue.*** Record any color change in the test tube.

Analysis

1. Describe the color change that occurs when carbon dioxide is added to bromothymol blue.
2. What was the chemical composition of the bubbles seen in the tube with the antacid tablet?
3. Does exhaled air contain carbon dioxide? Explain.

evaporated from the glass, water evaporates from lakes and oceans and becomes water vapor in the air.

Have you ever noticed the drops of water that form on a cold can of soda? The water vapor in the air condenses on the surface of the can because the can is colder than the surrounding air. Just as water vapor condenses on cans, it also condenses on dust in the air and forms clouds. Further condensation makes small drops that build in size until they fall from the clouds as precipitation in the form of rain, ice, or snow. The water falls on Earth and accumulates in oceans and lakes where evaporation continues.

Plants and animals need water to live. Plants pull water from the ground and lose water from their leaves through transpiration. This puts water vapor into the air. Animals breathe out water vapor in every breath; when they urinate, water is returned to the environment. Natural processes constantly recycle water throughout the environment.

The carbon cycle

All life on Earth is based on carbon molecules. Atoms of carbon form the framework for proteins, carbohydrates, fats, and other important molecules. More than any other element, carbon is the molecule of life.

The carbon cycle starts with the autotrophs. During photosynthesis, energy from the sun is used to convert carbon dioxide gas into energy-rich carbon molecules. Autotrophs use these molecules for growth and energy. Heterotrophs, which feed either directly or indirectly on the autotrophs, also use the carbon molecules for growth and energy. When the autotrophs and heterotrophs use the carbon molecules for energy, carbon dioxide is released and returned to the atmosphere. Learn how to detect the presence of carbon dioxide in the *MiniLab* shown here. The carbon cycle is described in the *Inside Story* on the next page.

The nitrogen cycle

If you add nitrogen fertilizer to a lawn, houseplants, or garden, you may see that it makes them greener, bushier, and taller. Even though the air is 78 percent nitrogen, plants seem to do better when they receive nitrogen fertilizer. This is because plants cannot use the nitrogen in the air. They use nitrogen in the soil that has been converted into more usable forms.

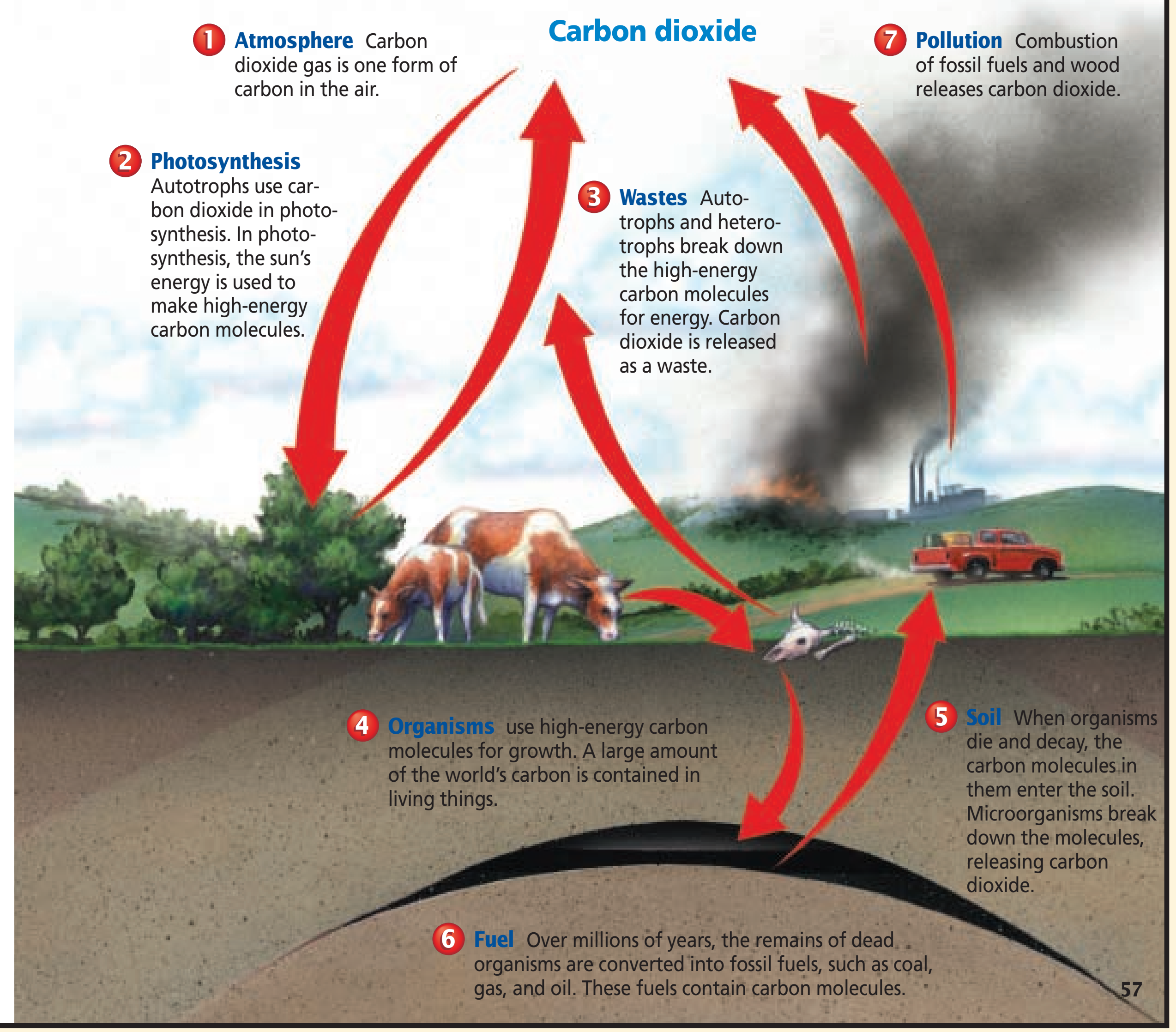
INSIDE STORY

The Carbon Cycle

From proteins to sugars, carbon is the building block of the molecules of life. Linked carbon atoms form the frame for molecules produced by plants and other living things. Organisms use these carbon molecules for growth and energy.

Critical Thinking *How is carbon released from the bodies of organisms?*

Forests use carbon dioxide.



INSIDE STORY

Purpose

Students study the cycling of carbon in the environment.

Teaching Strategies

- Help students understand that plants remove carbon dioxide from the atmosphere and use it to create nutrients. When plants and animals use the nutrients for energy, carbon dioxide is returned to the atmosphere.
- Help students understand other ways carbon dioxide enters the atmosphere.

Visual Learning

- Have students trace a carbon molecule from the atmosphere, through two trophic levels, and back into the atmosphere. L1

Critical Thinking

The carbon is released in the form of carbon dioxide through respiration, decay, or burning.

GLENCOE TECHNOLOGY

VIDEODISC
The Secret of Life
Carbon Cycle

Assessment

Portfolio Have students summarize the carbon cycle and draw their own diagrams. Ask them to label the parts of the cycle and use arrows to show the direction of movement.

Assessment

Skill Have students make a hypothesis for an experiment using bromothymol blue and a decomposer. Use the Performance Task Assessment List for Formulating a Hypothesis in **PASC**, p. 21. L2

BIOLOGY JOURNAL

A Wet Life Cycle

Linguistic Have students write a description of what it would be like to be a molecule of water that is cycled through an ecosystem. Where would they spend most of their time, what sites would they visit, and how many changes in phase (gas, liquid, solid) might they experience? L2

MEETING INDIVIDUAL NEEDS

English Language Learners

Visual-Spatial Have students work in groups to prepare a concept map describing the carbon cycle. Included in this map should be terms such as *consumers, photosynthesis, respiration, decay,* and *producers.* Group students who are learning English with those who are fluent in the language. L2

Resource Manager

BioLab and MiniLab Worksheets, p. 10 L2
Laboratory Manual, pp. 11-14 L2
Reteaching Skills Transparency 1 and Master L1

Reinforcement

Ask students to trace the roles of producers, consumers, and decomposers in the cycling of nitrogen. *Producers take in nitrogen compounds in soil and pass these compounds to consumers that eat the producers. Decomposers break down the nitrogen compounds and release nitrogen gas to the air.*

Enrichment

Show students plant fertilizer labels. These fertilizers add nitrogen and phosphorous to the soil because these substances are frequently in short supply. Explain the numbers on the label. For example, a plant fertilizer that is labeled 20-20-10 contains 20 percent nitrogen, 20 percent phosphorous, and 10 percent potassium compounds.

Assessment

Performance Assessment in the Biology Classroom, p. 59, *First-Level Biological Magnification.* Have students complete this activity to expand upon their knowledge of environmental problems that can harm organisms. L2 P

3 Assess

Check for Understanding

Have students explain the relationship between the words in each of the following pairs.

a. autotroph—producer
b. heterotroph—consumer
c. recycling—carbon
d. lightning—nitrogen cycle

L1 ELL

GLENCOE TECHNOLOGY

VIDEODISC
The Secret of Life
Nitrogen Cycle

As *Figure 2.22* shows, lightning and certain bacteria convert the nitrogen in the air into these more usable forms. Chemical fertilizers also give plants nitrogen in a form they can use.

Plants use the nitrogen to make important molecules such as proteins. Herbivores eat plants and convert nitrogen-containing plant proteins into nitrogen-containing animal proteins. After you eat your food, you convert the proteins in your food into human proteins. Urine, an animal waste, contains excess nitrogen. When an animal urinates, nitrogen returns to the water or soil. When organisms die, their nitrogen molecules return to the soil. Plants reuse these nitrogen molecules. Bacteria also act on these molecules and put nitrogen back into the air.

The phosphorus cycle

Materials other than water, carbon, and nitrogen cycle through ecosystems. Substances such as sulfur, calcium, and phosphorus, as well as others, must also cycle through an ecosystem. One essential element, phosphorus, cycles in two ways.

All organisms require phosphorus for growth and development. Plants obtain phosphorus from the soil. Animals get phosphorus by eating plants, as shown in *Figure 2.23.* When these animals die, they decompose and the phosphorus is returned to the soil to be used again. This is the short-term phosphorus cycle. Phosphorus also has a long-term cycle, where phosphates washed into the sea are incorporated into rock as insoluble compounds. Millions of years later, as the environment changes, the rock containing phosphorus is exposed. As the rock erodes and disintegrates, the phosphorus again becomes part of the local ecological system.

Figure 2.22
In the nitrogen cycle, nitrogen is converted from a gas to compounds important for life and back to a gas.

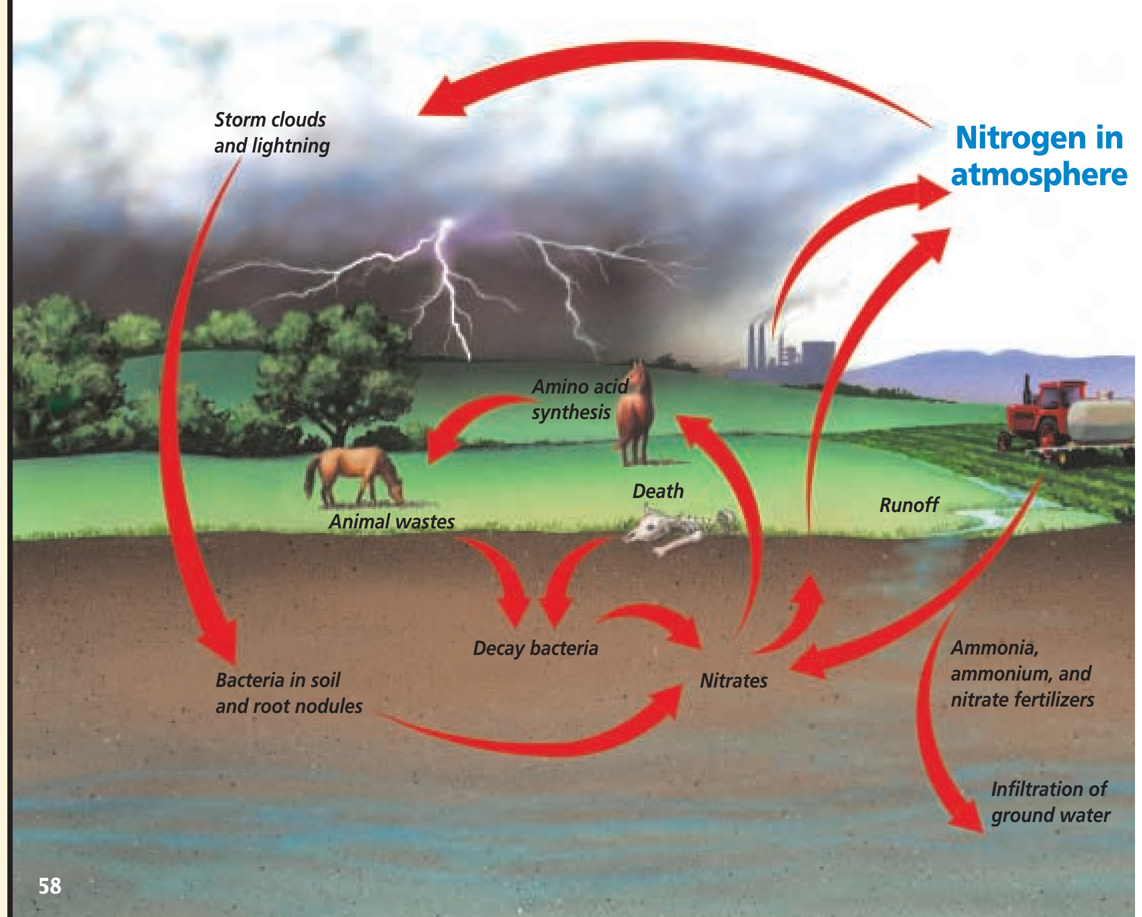
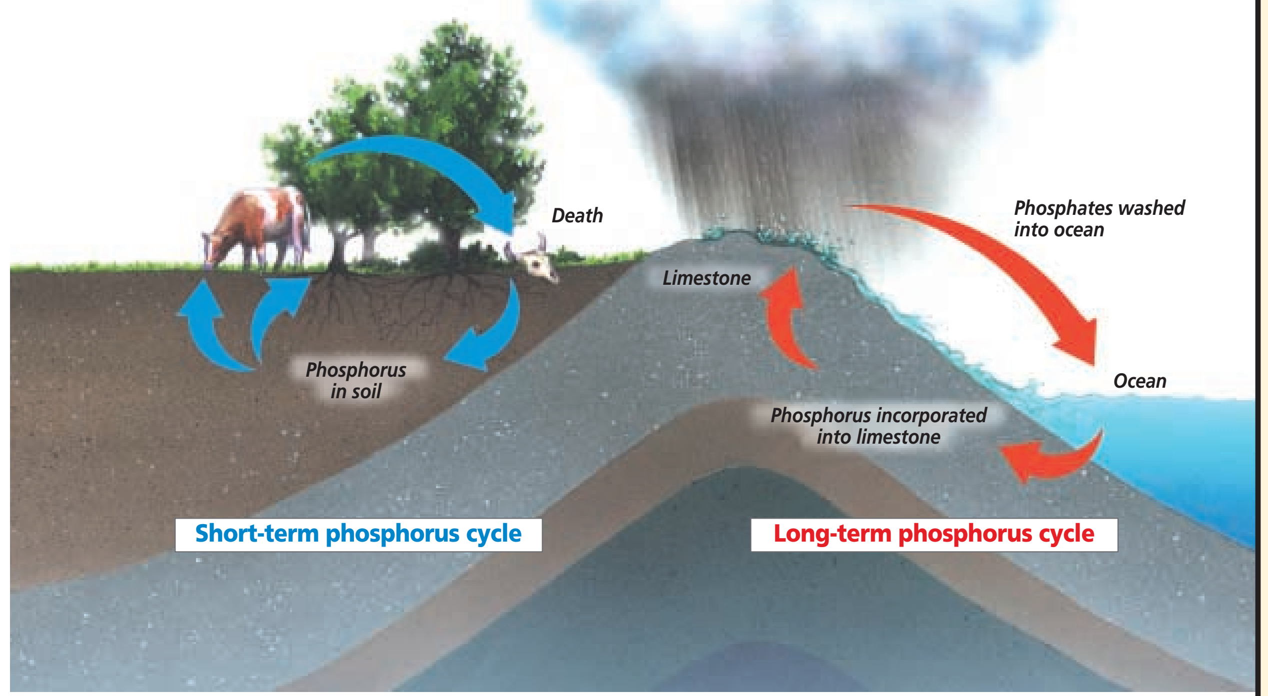


Figure 2.23
In the phosphorus cycle, phosphorus moves between the living and nonliving parts of the environment.



Section Assessment

Understanding Main Ideas

1. What is the difference between an autotroph and a heterotroph?
2. Why do autotrophs always occupy the lowest level of ecological pyramids?
3. Give two examples of how nitrogen cycles from the abiotic portion of the environment into living things and back.
4. Describe a food chain that was not presented in this section.

Thinking Critically

5. The country of Avorare has many starving people. Should you encourage the people to grow crops such as vegetables, wheat, and corn, or is it better to encourage them to use the land to raise cattle for beef?

SKILL REVIEW

6. **Designing an Experiment** Suppose there is a fertilizer called GrowFast. It contains extra nitrogen and phosphorus. Design an experiment to see if GrowFast increases the growth rate of plants. For more help, refer to the *Practicing Scientific Methods* in the **Skill Handbook.**

Reteach

Have students identify the trophic level of each organism in a food chain and indicate the direction of energy flow. L1

Extension

Naturalist Have students speculate about the consequences to a food web if an organism at the second trophic level were to be eliminated. *This would eliminate a food source for some organisms at the third trophic level.* L2

Assessment

Performance Have students diagram, label, and explain one of the following: a food web, water cycle, energy or biomass pyramid, or carbon cycle. L2

4 Close

Activity

Visual-Spatial List on the chalkboard 20 different organisms. Have students use these organisms to create a food web. L1 ELL

Portfolio

Cycles and Gardening

Linguistic Ask students to write a report for local gardeners, explaining how the water and nitrogen cycles affect their success in growing flowers and vegetables. Have students include diagrams showing both cycles. L2 ELL P

Resource Manager

Reteaching Skills Transparency 2 and Master L1
Reinforcement and Study Guide, pp. 9-10 L2
Content Mastery, pp. 9, 11-12 L1

Section Assessment

1. An autotroph makes its own nutrients. A heterotroph must consume another organism to meet its nutritional needs.
2. Autotrophs capture light energy and create nutrients. When eaten, they provide nutrients for other organisms.
3. (1) Nitrogen in the air passes to bacteria, which form compounds used by plants. Decay of dead plants returns nitrogen to air. (2) Nitrogen in air passes to bacteria and again moves to plants. Plants are eaten by consumers, passing along nitrogen. Decay of dead consumers returns nitrogen to air.
4. Any realistic food chain is acceptable. Arrows should show the correct flow of energy.
5. Crops are better because growing them takes less land than raising cattle. Crops provide more energy for people than cattle, at a higher trophic level.
6. Designs should include control and experimental groups. Sample size should be greater than one plant. Students should define *growth,* as the increase in plant height.

Design Your Own BioLab

Time Allotment
Initial preparation: one class session; ten-minute sessions for one to two weeks every other day.

Process Skills
observe, record and analyze data, design an experiment, separate and control variables

Safety Precautions
Use oven mitts when handling hot, sterile pond water. Have students wash their hands after the lab.

Preparation

Alternative Materials
- Artificial pond water, called Chalkey's solution, may be prepared as follows. Dissolve 1 g sodium chloride, with 0.04 g potassium chloride, and 0.06 g calcium chloride in 1 L of distilled water. Dilute the prepared solution by adding 100 mL of solution to 900 mL of distilled water.
- To prepare sterile pond water, filter the water and place it in flat pans. Boil for 15 minutes. Allow to cool before using.

Possible Hypotheses
In general, if a predator population is added to a prey population, the size of the predator population will increase while the prey population decreases.

However, if a small predator population is added to a large prey population, no observable difference will occur in the sizes of the populations.

Design Your Own BioLab

How can one population affect another?

Why don't prey populations disappear when predators are present? Prey organisms have evolved a variety of defenses to avoid being eaten. For example, some caterpillars are distasteful to birds, and some fishes confuse predators by appearing to have eyes at both ends of their bodies. Just as prey have evolved defenses to avoid predators, predators have evolved mechanisms to overcome those defenses.

Even single-celled protists such as Paramecium *have predators.* Didinium *is another unicellular protist that attacks and devours* Paramecium *larger than itself. Do populations of* Paramecium *change when a population of* Didinium *is present? In this investigation, you will use various methods to determine how both of these species interact.*

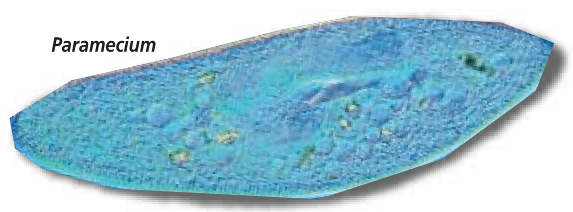
Didinium

Preparation

Problem
How does a population of *Paramecium* react to a population of *Didinium?*

Hypotheses
Have your group agree on an hypothesis to be tested. Record your hypothesis.

Objectives
In this BioLab, you will:
- **Design** an experiment to establish the relationships between *Paramecium* and *Didinium*.
- **Use** appropriate variables, constants, and controls in experimental design.



Paramecium

Possible Materials
microscope
microscope slides
coverslips
culture of *Didinium*
culture of *Paramecium*
beakers or jars
eyedroppers
sterile pond water

Safety Precautions
Take care when using electrical equipment. Always use goggles in the lab. Handle slides and coverslips carefully. Dispose of broken glass in a container provided by your teacher.

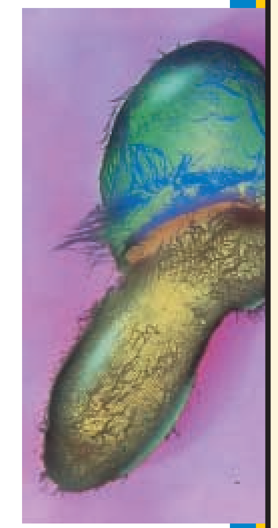
Skill Handbook
Use the **Skill Handbook** if you need additional help with this lab.

Plan the Experiment

1. Review the discussion of feeding relationships in this chapter.
2. Decide which materials you will use in your investigation. Record your list.
3. Be sure that your experimental plan contains a control, tests a single variable such as population size, and allows for the collection of quantitative data.
4. Prepare a list of numbered directions. Explain how you will use each of your materials.

Check the Plan
Discuss the following points with other group members to decide final procedures. Make any needed changes to your plan.

1. What will you measure to determine the effect of the *Didinium* on *Paramecium?* If you count *Paramecia*, will you count all you can see in the field of vision of the microscope at a certain power? Will you have multiple trials? If so, how many?
2. What single factor will you vary? For example, will you put no *Didinium* in one culture of *Paramecium* and 5 mL of *Didinium* culture in another culture of *Paramecium?*
3. How long will you observe the populations?
4. How will you estimate the changes in the populations of *Paramecium* and *Didinium* during the experiment?
5. ***Your teacher must approve your plan before you proceed.***
6. Carry out your experiment.
7. Make a data table that has Date, Number of *Paramecium*, and Number of *Didinium* across the top. Place the data obtained for each culture in rows. Design and complete a graph of your data.



A *Didinium* captures a *Paramecium.*

Analyze and Conclude

1. **Analyzing Data** What differences did you observe among the experimental groups? Were these differences due to the presence of *Didinium?* Explain.
2. **Drawing Conclusions** Did the *Paramecium* die out in any culture? Why or why not?
3. **Checking Your Hypothesis** Was your hypothesis supported by your data? If not, suggest a new hypothesis.
4. **Thinking Critically** List several ways that your methods may have affected the outcome of the experiment.

Going Further
Project Based on this lab experience, design another experiment that would help you answer any questions that arose from your work. What factors might you allow to vary if you kept the number of *Didinium* constant?

interNET CONNECTION To find out more about population biology, visit the Glencoe Science Web Site.
www.glencoe.com/sec/science

Design Your Own BioLab

Analyze and Conclude

1. Only cultures containing both *Didinium* and *Paramecium* showed a decline in numbers after a period of time. This difference was due to the presence of *Didinium* because they preyed upon the *Paramecium*.
2. *Paramecium* died out in the mixed culture. They were preyed upon by *Didinium*.
3. In most cases, hypotheses will be supported.
4. The list may include: counting errors, too few samples, or cultures becoming contaminated or being affected by temperature.

Error Analysis
The amount of initial culture of the two species should be equal and can be quantified by premeasuring the volume in the pipettes.

Assessment
Skill Ask students to prepare a summary of this experiment in their journals. Use the Performance Task Assessment List for Writing in Science in **PASC**, p. 87. L2

Going Further
Have students alter the type of protozoans used or change the initial volume of predator culture. L2

Resource Manager
BioLab and MiniLab Worksheets, p. 11 L2

Plan the Experiment

Teaching Strategies
- A lower magnification provides a wider field of view, making counting easier.
- Methyl cellulose, available from supply houses, may be used to slow the protozoans.

Troubleshooting
- Cover or stack culture dishes to prevent drying out.

- Have students examine unmixed cultures first so they can later distinguish between *Paramecium* and *Didinium*.
- Suggest that several low-power field counts be made and an average of these counts be used in the data tables.

Possible Procedures
Controls will consist of *Paramecium* cultures with no predators added. Food will have to be added to these cultures. Use one alfalfa pill (available from pharmacies) per liter of water. Note: If one culture receives food, all cultures must receive food to maintain control conditions.

Data and Observations
Depending on the experiment, data and observations will vary. Typically, when the populations are mixed together, both will initially increase in number. A decrease in prey will then be detected as the predator population feeds upon them, with a final drop in the population of predators as their food supply runs out.

Purpose

Students gain an understanding of the complexity of ecosystems and learn some ways in which human activities can affect the environment.

Background

Everglades water that flows all the way to the Gulf coast carries with it nutrients that support the growth of mangrove swamps and sea grass beds. These two estuarine communities feed and shelter young fish, shellfish, and other important links in the marine food chain. Changes in the water flow of the area sometimes result in the discharge of large amounts of freshwater into Florida Bay, changing the salinity of the water and endangering the health of mangroves and sea grass. Pollutants and excessive amounts of fresh water may also be endangering the coral reefs off the Florida coast.

Teaching Strategies

After students have completed the reading, invite them to discuss issues involved in balancing the needs of both human and wildlife populations. Point out that one of the main reasons why south Florida's human population has increased over the past 100 years is the strong attraction of the Everglades. Also, many Florida residents work in the tourism industry, and the Everglades brings large numbers of tourists to the state. L2

Investigating the Issue

The park was cut off from its water source. Even though land and wildlife inside the park were protected from development, not enough clean water was provided to keep the park healthy.

Biology & SOCIETY

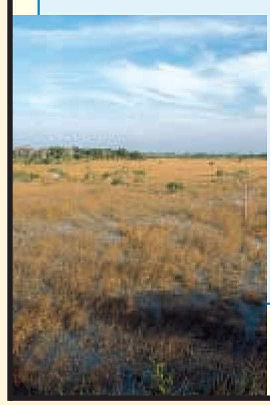
The Florida Everglades—An Ecosystem at Risk

The Florida Everglades ecosystem covers the southern portion of the Florida peninsula. As with any wetlands, water is the critical factor that defines the ecology of the area.

This subtropical region receives between 100 and 165 cm (40-65 inches) of rain each year, but only during the rainy season, which lasts from May to October. The heavy rainfall causes shallow Lake Okeechobee to overflow. A wide, thin sheet of water spreads out from the lake, creating an extensive marshy area.

Early in the twentieth century, the slow-moving river that flows out of Lake Okeechobee was 80 km (50 miles) wide in some places, and only 15-90 cm (six inches to three feet) deep. This wetland teemed with fishes, amphibians, and other animals that fed millions of wading birds. Healthy populations of crocodiles, alligators, and other large animals also lived here. During the dry season, from December to April, water levels in the marshes gradually dropped. Fishes and other water dwellers moved into deeper pools that held water all year long.

Changing the Everglades Water from Lake Okeechobee is no longer allowed to flood the countryside. Instead, it is diverted into channels to create dry land for agriculture and homes, and stored behind levees to supply water for cities. As a result, half the acreage of the original Everglades has been drained. Habitats have disappeared.



The map (above) shows the location of the Everglades (inset).

Different Viewpoints

Everglades National Park was established to preserve a portion of the Everglades. But the land that forms the park is an island surrounded by farms and towns and cut off from the waters of Lake Okeechobee. Human needs determine how much water comes into the park. When reserves are low, water is held back for people to use, depriving Everglades habitats of the moisture they need. If floods threaten, large amounts of water are released quickly. These sudden flows destroy the nests of wading birds and other animals.

Restoring the Everglades In 1993, Florida developed a restoration plan for rescuing the Everglades. The goals of the plan are to restore, as much as possible, the natural flow of unpolluted water through the area, recover native habitats and species, and create a sustainable ecosystem that permits both humans and native species to flourish.

INVESTIGATING THE ISSUE

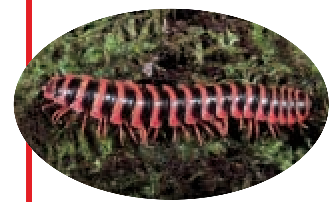
Analyzing the Issue When Everglades National Park was established, scientists and government officials believed a portion of the Everglades ecosystem could be preserved by drawing boundaries around it and declaring it off limits to development. Why did this approach fail to preserve the Everglades?

interNET CONNECTION To find out more about the Everglades, visit the Glencoe Science Web Site.
www.glencoe.com/sec/science

Chapter 2 Assessment

SUMMARY

Section 2.1 Organisms and Their Environment



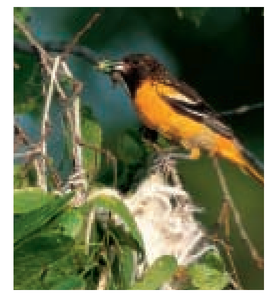
Main Ideas

- Natural history, the observation of how organisms live out their lives in nature, led to the development of the science of ecology—the study of the interactions of organisms with one another and with their environments.
- Ecologists classify and study the biological levels of organization from the individual up to the ecosystem. Ecologists study the abiotic and biotic factors that are a part of an organism's habitat. They investigate the strategies an organism uses to exist in its niche. An aspect of its niche may involve symbiosis with other organisms.

Vocabulary

abiotic factor (p. 39)
biosphere (p. 38)
biotic factor (p. 40)
commensalism (p. 46)
community (p. 42)
ecology (p. 38)
ecosystem (p. 43)
habitat (p. 44)
mutualism (p. 46)
niche (p. 45)
parasitism (p. 47)
population (p. 42)
symbiosis (p. 46)

Section 2.2 Nutrition and Energy Flow



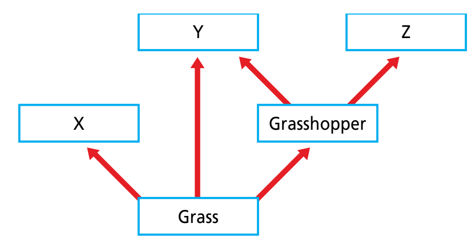
- Autotrophs, such as plants, make nutrients that can be used by the plants and by heterotrophs. Heterotrophs include herbivores, carnivores, omnivores, and decomposers.
- Food chains are simple models that show one way that materials move from autotrophs to heterotrophs and eventually to decomposers.
- Food webs represent many interconnected food chains and illustrate possible ways materials are transferred within an ecosystem. Energy from the sun fuels life in the ecosystems. Although the sun adds new energy, the materials of life, such as carbon and nitrogen, do not increase. These materials are used and reused as they cycle through the ecosystem.

Vocabulary

autotroph (p. 48)
decomposer (p. 50)
food chain (p. 51)
food web (p. 52)
heterotroph (p. 49)
scavenger (p. 49)
trophic level (p. 52)

UNDERSTANDING MAIN IDEAS

1. Which of the following would be abiotic factors for a polar bear?
   a. extreme cold, floating ice
   b. eating only live prey
   c. large body size
   d. paws with thick hair
2. Organisms that use the sun's energy to make food are called ______.
   a. herbivores c. autotrophs
   b. animals d. heterotrophs
3. In the food web below, which of the organisms, X, Y, or Z, is a herbivore?
   a. Z c. both X and Y
   b. Y d. X



Main Ideas

Summary statements can be used by students to review the major concepts of the chapter.

Using the Vocabulary

To reinforce chapter vocabulary, use the Content Mastery Booklet and the activities in the Interactive Tutor for Biology: The Dynamics of Life on the Glencoe Science Web Site.
www.glencoe.com/sec/science

THE PRINCETON REVIEW *All Chapter Assessment questions and answers have been validated for accuracy and suitability by The Princeton Review.*

UNDERSTANDING MAIN IDEAS

1. a
2. c
3. d

GLENCOE TECHNOLOGY

VIDEODISC
Biology: The Dynamics of Life
The Everglades (Ch. 6)
Disc 1, Side 1, 29 sec.

NATIONAL GEOGRAPHIC

VIDEODISC
STV: Water, *Water Management*
Unit 3, Side 1, 3 min. 9 sec.
Everglades

Going Further

Naturalist Everglades habitats include sea grass beds, coastal prairies, mangrove swamps, freshwater sloughs, marl prairies, hammocks, and pinelands. Invite students to find out what kinds of environmental conditions characterize one or more of these habitats and what kinds of organisms live there. L3

GLENCOE TECHNOLOGY

VIDEOTAPE
MindJogger Videoquizzes
Chapter 2: *Principles of Ecology*
Have students work in groups as they play the videoquiz game to review key chapter concepts.

Resource Manager

Chapter Assessment, pp. 7-12
MindJogger Videoquizzes
Computer Test Bank
BDOL Interactive CD-ROM, Chapter 2 quiz

4. c
5. b
6. a
7. d
8. d
9. b
10. c
11. commensalism, parasitic
12. biotic
13. symbiosis, mutualism
14. population, community
15. omnivore, herbivore
16. food, trophic
17. Ecology
18. pyramid of energy, pyramid of numbers
19. carbon dioxide
20. nitrogen

Applying Main Ideas

21. The pesticide may be carried in the water to other bodies of water or may be carried from one organism to another.
22. Algae ⇒ Caterpillar/Moth ⇒ Bird. The symbiotic relationship between the algae and the sloth is commensal because the algae have a place to grow undisturbed, while the sloth is neither helped nor harmed.

4. Which organism is a carnivore?
   a. human   c. lion
   b. rabbit   d. opossum
5. Biotic factors in a wetland community might include _______.
   a. water   c. temperature
   b. crayfishes   d. soil type
6. Which of the following would decrease the amount of carbon dioxide in the air?
   a. a maple tree growing
   b. a dog running
   c. a person driving a car to work
   d. a forest burning
7. As energy flows through an ecosystem, energy _______ at each trophic level.
   a. remains the same
   b. increases
   c. decreases then increases
   d. decreases
8. An elk eats grass. A grizzly bear eats the elk. This is an example of a _______.
   a. pyramid of numbers
   b. commensal relationship
   c. food web
   d. food chain
9. Which of the following is true concerning the flow of energy and matter in an ecosystem?
   a. Both energy and matter are recycled and used again.
   b. Matter is recycled and used again, energy is lost.
   c. Energy is recycled and used again, matter is lost.
   d. Neither energy nor matter are recycled and used again.

THE PRINCETON REVIEW Test-Taking Tip

Quiet Zone
It's best to study in an environment similar to the one in which you'll be tested. Blaring stereos, video game machines, chatty friends, and beepers are NOT allowed in the classroom during test time. So why get used to them?

10. Cowbirds get their name because they follow cows and eat the insects disturbed by the walking cows. Cowbirds have an unusual method for reproducing. The brown-headed cowbird goes to the nest of a different bird species, such as the red-wing blackbird. The cowbird rolls one of the blackbird's eggs out of the nest and lays its own egg in place. The blackbird protects the cowbird egg and feeds the chick when it hatches. This description best describes part of the cowbird's _______.
   a. community   c. niche
   b. habitat   d. tropic level
11. For the cowbird description in question 10, the symbiotic relationship between the cow and the cowbird is _______. The association between the cowbird and the blackbird is a(n) _______ relationship.
12. The presence of predators, prey, and parasites are examples of _______ factors in an organism's habitat.
13. A close and permanent relationship between two organisms is called _______. If both organisms benefit it is _______.
14. A group of organisms of the same species living in the same area is called a(n) _______. When the group includes different species, it is called a _______.
15. A(n) _______ eats both plants and animals. A(n) _______ eats only plants.
16. A(n) _______ chain is a model of how matter and energy pass through organisms. Each organism is at a different _______ level.
17. _______ is a branch of biology that studies the interactions of organisms and their environment.
18. An ecological pyramid that shows the amount of energy for different trophic levels is called a(n) _______. If it shows how many organisms are at each tropic level, it is called a(n) _______.

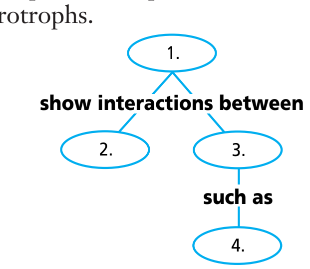
19. Plants absorb _______ from the air, and with the sun's light energy they make high-energy carbon molecules.
20. Lightning and bacteria act to move and convert _______ from the air into compounds in the soil that can be readily used by plants.

Applying Main Ideas

21. Explain how pesticides sprayed on the water in a wetland ecosystem could affect a different ecosystem.
22. Sloths are slow-moving herbivores that have algae growing in their fur. Caterpillars of certain kinds of moths eat the algae. Birds eat the moths. Using this example, draw a food chain and describe one symbiotic relationship.

Thinking Critically

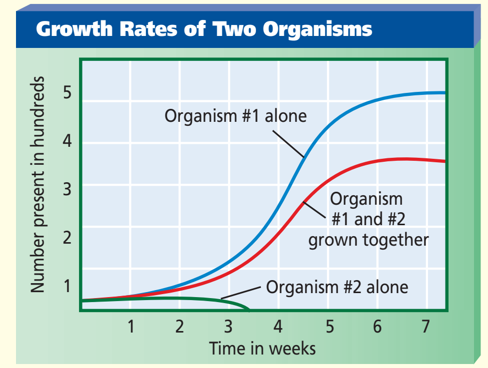
23. **Sequencing** Place the following organisms in correct order in a food chain: mouse, hawk, wheat, snake.
24. **Sequencing** Describe one example of feeding relationships that cycle matter through an ecosystem.
25. **Concept Mapping** Complete the concept map by using the following vocabulary terms: autotrophs, decomposers, food webs, heterotrophs.



CD-ROM
For additional review, use the assessment options for this chapter found on the ***Biology: The Dynamics of Life Interactive CD-ROM*** and on the Glencoe Science Web Site.
www.glencoe.com/sec/science

Assessing Knowledge & Skills

The graph below compares the growth rates of two organisms when grown together and when grown separately.



Interpreting Data Use the graph and information to answer the following questions.

1. When grown separately, approximately how long after the extinction of Organism 2 did it take the population of Organism 1 to reach its highest point?
   a. 3 days   c. 3 weeks
   b. 1 week   d. 5 weeks
2. When the organisms were grown together, what was the approximate rate of growth between weeks 2 and 6?
   a. 75 per week   c. 50 per week
   b. 100 per month   d. 25 per day
3. **Observing and Inferring** From the data, it is clear that the association between the organisms is _______.
   a. commensalism   c. mutualism
   b. parasitism   d. socialism
4. **Hypothesizing** Describe one possible benefit that Organism 2 gets from its association with Organism 1. Explain a possible reason why the association lowers the population of Organism 1.

Thinking Critically

23. wheat ⇒ mouse ⇒ snake ⇒ hawk
24. There are a variety of acceptable answers such as the following. Plants provide nitrogen to animals that eat the plants. Bacteria and other decomposers release nitrogen and carbon dioxide when they feed upon decaying organisms. Animals obtain carbon when eating other organisms.
25. 1. food webs 2. autotrophs 3. heterotrophs 4. decomposers

Assessing Knowledge & Skills

1. c
2. a
3. b
4. Organism #2 most likely benefits by obtaining nutrients from Organism #1. Other possible benefits include anything that helps Organism #2 satisfy its needs. The population size of Organism #1 is probably lowered because Organism #1 is weakened and cannot grow or reproduce as quickly. The interactions of the species may also cause more deaths in the population of Organism #1.