UNIT 2 Ecology

Atlantic puffins

Plastic bottles for recycling

UNIT 2

Green turtle with surgeon fish

DISCOVERIES IN SCIENCE

The Changing Environment

AROUND 250

Mayan farmers build terraces to control the flow of water to crops. The irrigated terraces greatly increase crop yields and enable farmers to make use of farmland on steep hillsides.

1791

A canal for Washington D.C. is designed to connect the James and Tiber Creeks. The canal drains wet areas of the city and provides a new commercial transportation route.

Washington, D.C., capital of the United States

1890

John Muir and others successfully persuade Congress to create Yosemite National Park, the first national park in the world.

Half Dome, Yosemite National Park

1936

The captive thylacine, or Tasmanian tiger, dies in a zoo in Hobart, Tazmania. Sightings in the wild continue but are rare. The population dwindles because of predation by humans and dogs. The thylacine is declared extinct in 1986.

1962

Rachel Carson's book, *Silent Spring,* which describes the careless use of pesticides and their damage to the environment, is published.

Rachel Carson

1986

In the Ukraine, an accident at the Chernobyl nuclear power plant releases large amounts of nuclear radiation. The area around the power plant becomes one of the most highly radioactive places on Earth. A cloud of radioactive fallout travels as far as the eastern United States.

1990

Three large tuna companies announce that they will sell only tuna that is caught using nets that do not trap dolphins. This change is attributed to a successful consumer boycott of tuna caught using conventional nets that can trap and drown dolphins.

1999

Hybrid cars, which run on gas and electricity, hit the mass market in the United States.

Prototype Daihatsu UFE II hybrid

Ant removing butterfly eggs from a leaf

BIOLOGY CAREER

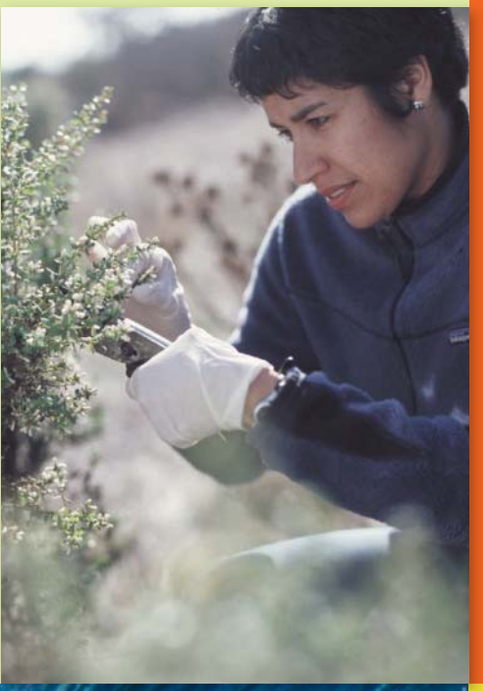
Ecologist

Erika Zavaleta

Erika Zavaleta is an assistant professor in the Environmental Studies department of the University of California, Santa Cruz. Her current research focuses on changes in levels of biodiversity in biological communities and ecosystems that result from environmental challenges and changes.

A high school science teacher, Dr. Roberts, inspired Zavaleta to become a scientist. Roberts used scientific nonfiction and an inquiry-based approach to inspire her students. Zavaleta still loves to read and engage scientific problems with a creative and open mind.

Zavaleta considers her greatest accomplishment in science to be bridging scientific disciplines to explore changes from many angles. These changes include climate change, the invasive species, the ecological and socio-economic implications of losing biodiversity, and woodland restoration.



Apart from science, Zavaleta enjoys traveling, reading, and outdoor activities such as surfing, bodyboarding, bicycling, hiking, and backpacking.

Hamster and grasshopper predator-prey relationship

Chapter Planner 4

Ecosystems

		Standards	Teach Key Ideas
CHAPTER OPENER, pp. 76–77	15 min.	*National Science Education Standards*	
SECTION 1 What Is an Ecosystem?, pp. 79–85 › Ecosystems › Succession › Major Biological Communities › Terrestrial Biomes › Aquatic Ecosystems	45 min.	LSInter 3, LSInter 5, LSMat 5, ESS3	**Bellringer Transparency** **Transparencies** E25 Ecological Succession at Glacier Bay **Visual Concepts** Levels of Ecology • Habitat • Community • Ecosystem • Comparing Biotic and Abiotic Factors • Pioneer Species • Ecological Succession
SECTION 2 Energy Flow in Ecosystems, pp. 86–89 › Trophic Levels › Loss of Energy	45 min.	LSInter 2, LSMat 2, LSMat 3, LSMat 6, PS6, ESS1	**Bellringer Transparency** **Transparencies** E4 Trophic Levels • E5 Food Chain in an Antarctic Ecosystem • E6 Food Web in an Antarctic System • E8 Energy Transfer Through Trophic Levels • E11 Energy Efficiency in Food Consumption **Visual Concepts** Comparing Consumers and Producers • Food Chains and Food Webs • Types of Consumers • Food Chains and Energy Transfer • Energy Pyramid • Biomass
SECTION 3 Cycling of Matter, pp. 90–93 › Water Cycle › Carbon and Oxygen Cycles › Phosphorus Cycle › Nitrogen Cycle	45 min.	LSInter 1, ESS2	**Bellringer Transparency** **Transparencies** E12 Water Cycle • E13 Carbon Cycle • E14 Nitrogen Cycle **Visual Concepts** Biogeochemical Cycle • Water Cycle • Groundwater • Water Table • Carbon Cycle • The Nitrogen Cycle • Nitrogen Fixation

See also PowerPoint® Resources

Chapter Review and Assessment Resources

- SE Super Summary, p. 96
- SE Chapter Review, p. 97
- SE Standardized Test Prep, p. 99
- Review Resources
- Chapter Tests A and B
- Holt Online Assessment

CHAPTER FastTrack

Instructional time for this chapter can be reduced by eliminating the activities.

Basic Learners

- TE Succession Timeline, p. 81
- TE Biome Postcards, p. 82
- TE Increases in Atmospheric CO_2, p. 91
- Directed Reading Worksheets*
- Active Reading Worksheets*
- Lab Manuals, Level A*
- Study Guide* ■
- Note-taking Workbook*
- Special Needs Activities and Modified Tests*

Advanced Learners

- TE Factors Affecting Rainfall, p. 83
- TE Sustainable Agriculture, p. 92
- Critical Thinking Worksheets*
- Concept Mapping Worksheets*
- Science Skills Worksheets*
- Lab Datasheets, Level C*

Key

SE Student Edition
TE Teacher's Edition
Chapter Resource File
Workbook
Transparency
CD or CD-ROM
* Datasheet or blackline master available
■ Also available in Spanish

All resources listed below are also available on the Teacher's One-Stop Planner.

Why It Matters	Hands-On	Skills Development	Assessment
Build student motivation with resources about high-interest applications.	SE **Inquiry Lab** Water Cycle, p. 77*■	TE **Reading Toolbox** Assessing Prior Knowledge, p. 76 SE **Reading Toolbox** p. 78	
TE **Pioneer Species,** p. 81 TE **Latitude and Longitude,** p. 83 SE **Maintained by Fire,** p. 85	SE **Quick Lab** Evaluation Biodiversity, p. 80*■	TE **Reading Toolbox** Visual Literacy, p. 82 SE **Reading Toolbox** Word Families, p. 84 TE **Reading Toolbox** Word Families, p. 84 TE **Reading Toolbox** Visual Literacy, p. 85	SE **Section Review** TE **Formative Assessment** **Spanish Assessment***■ **Section Quiz**■
TE **Demonstration** Field Food Web, p. 86	SE **Inquiry Lab** Ecosystem Change, p. 94*■ **Skills Practice Lab** Mapping Biotic Factors in the Environment*	SE **Math Skills** Energy Pyramid, p. 88 TE **Math Skills** Energy in Trophic Levels, p. 88 SE **Reading Toolbox** Word Problem, p. 89 TE **Reading Toolbox** Word Problem, p. 89	SE **Section Review** TE **Formative Assessment** **Spanish Assessment***■ **Section Quiz**■
TE **Crop Rotation,** p. 92 TE **Demonstration** Nitrogen–Fixing Plants, p. 92	SE **Quick Lab** The Carbon Cycle, p. 93*■ **Skills Practice Lab** Assessing Abiotic Factors in the Environment*	SE **Reading Toolbox** Word Families, p. 91 TE **Reading Toolbox** Word Families, p. 91	SE **Section Review** TE **Formative Assessment** **Spanish Assessment***■ **Section Quiz**■
	See also Lab Generator		**See also Holt Online Assessment Resources**

Resources for Differentiated Instruction

English Learners

TE Biotic and Abiotic Factors, p. 80
Directed Reading Worksheets*
Active Reading Worksheets*
Lab Manuals, Level A*
Study Guide*■
Note-taking Workbook*
Multilingual Glossary

Struggling Readers

TE Summarize the Water Cycle, p. 91
Directed Reading Worksheets*
Active Reading Worksheets*
Lab Manuals, Level A*
Study Guide*
Note-taking Workbook*
Special Needs Activities and Modified Tests*

Special Education Students

Directed Reading Worksheets*
Active Reading Worksheets*
Lab Manuals, Level A*
Study Guide*■
Note-taking Workbook*
Special Needs Activities and Modified Tests*

Alternative Assessment

TE Flow of Energy, p. 88
Science Skills Worksheets*
Section Quizzes*■
Chapter Tests A, B, and C*■

Chapter 4

Overview

The purpose of this chapter is to explain the interactions between organisms and their environment in an ecosystem. The biodiversity of an ecosystem depends on the biotic and abiotic factors of the ecosystem. In all ecosystems, energy flows through food chains. Materials, such as water, carbon, phosphorus and nitrogen, cycle through an ecosystem.

READING TOOLBOX

Assessing Prior Knowledge Students should understand the following concepts:

- atoms and molecules
- cellular nature of life

Visual Literacy Ask students why water quality is important for the survival of both species in this illustration. (The spider gets its food from the water, and the water is where the fish lives and gets the things it needs to survive.) What materials would these and other organisms that live in this water need? (Possible answers: oxygen, sunlight, food) Ask students why water quality is important to humans, even though we don't live in the water. (Humans cannot live without a sufficient supply of clean water.)

Chapter 4

Ecosystems

Organisms in ecosystems interact with each other. This small fish has an unusual predator—a spider. This fishing spider from French Guiana waits at the surface of the water for its prey.

Some species of fishing spiders can walk on the water's surface, aided by fine hairs on the legs which trap air and act as buoys.

Preview

Why It Matters

An ecosystem is a community of organisms that interact with one another and their physical environment. Humans are part of ecosystems and are dependent on healthy ecosystems. However, humans can disrupt ecosystems, and the disruption may harm the organisms of the ecosystems and humans themselves.

InquiryLab

15 min

Water Cycle

The cycling of water in an ecosystem is necessary for the organisms that are part of the ecosystem. In this activity, you will model the water cycle.

Procedure

1. Place a **small, dark-colored bowl** inside a **large, sealable, plastic freezer bag.** Position the bag so that the opening is at the top.
2. Fill the bowl halfway with **water.** Place three drops of **red food coloring** in the water. Seal the bag.
3. Place the bowl and bag under a strong and warm light source, such as a **lamp** or direct sunlight.
4. Leave the bag in the light for one hour. Observe the bag at regular intervals.

Analysis

1. **Describe** how your model mimics the behavior of water in the environment
2. **Predict** how organisms such as plants would be affected if water did not cycle through the environment.

InquiryLab

Teacher's Notes Times for condensation to occur will vary according to the intensity of light.

Materials

- dark colored bowl, small
- freezer bag, plastic
- red food coloring
- water
- light source

Answers to Analysis

1. In my model, water evaporates, condenses, and precipitates just as in the water cycle.
2. Organisms need water to survive. If water did not cycle through the environment, organisms would not have access to water, and they would die.

Key Resources

Interactive Tutor

READING TOOLBOX

Using Words

1. In the carbon cycle, carbon moves in a circular process through living things and the environment. In the water cycle, water moves in a circular process through living things and the environment. In the phosphorus cycle, phosphorus moves through living things and the environment.
2. The three cycles differ in the kinds of matter that are cycled and the paths they take. Phosphorus does not have a gaseous form.

Using Language

1. $10\% \times 2000 \text{ kcal} = 200 \text{ kcal}$

Using FoldNotes

Create a sample FoldNote and display it for students before they make their own. Suggest using FoldNotes for each of the four cycles of matter.

READING TOOLBOX

These reading tools can help you learn the material in this chapter. For more information on how to use these and other tools, see **Appendix: Reading and Study Skills.**

Using Words

Word Families Word families include words that can be combined to create a meaning that differs from the meaning of each word in the combination. The names of natural cycles of Earth are formed from word families that you will find in this chapter.

Your Turn Use the information in the table to answer the following questions.

1. What do you think happens in the carbon, water, and phosphorus cycles?
2. How do the three cycles differ?

Word Parts

Word part	Type	Meaning
carbon	noun	an element common to all living things
water	noun	a liquid necessary for life
phosphorus	noun	a chemically reactive, nonmetallic element
cycle	noun	a circular process

Using Language

Word Problems Read word problems several times before trying to solve them. After you understand what the problems are asking, write down all of the relevant information on a piece of paper. Then, use the mathematical processes that apply to the situation.

Your Turn Solve the following word problem about energy.

1. When a snake a eats a mouse, only about 10% of the energy stored in the mouse's body is stored in the snake. If the body of a mouse contains 2000 kcal of energy, how much energy is stored in the snake?

Using FoldNotes

Layered Book A layered book is a useful tool for taking notes as you read a chapter. The four flaps of the layered book can summarize information into four categories. Write details of each category on the appropriate flap to create a summary of the chapter.

Your Turn Create a layered book FoldNote.

1. Lay one sheet of paper on top of another sheet. Slide the top sheet up so that 2 cm of the bottom sheet is showing.
2. Holding the two sheets together, fold down the top of the two sheets so that you see four 2 cm tabs along the bottom.
3. Using a stapler, staple the top of the FoldNote.
4. On each tab, write the category of the information that will appear on that layer.

Section 1

What Is an Ecosystem?

Key Ideas	Key Terms	Why It Matters
❯ What are the parts of an ecosystem? ❯ How does an ecosystem respond to change? ❯ What two key factors of climate determine a biome? ❯ What are the three major groups of terrestrial biomes? ❯ What are the four kinds of aquatic ecosystems?	**community** **ecosystem** **habitat** **biodiversity** **succession** **climate** **biome**	Ecosystems are important units of the natural world. Humans are part of ecosystems and depend on ecosystems for food and many products. Without healthy ecosystems, humans would be in trouble!

When you walk through a forest, you see many different organisms. There are trees, birds, ants, mushrooms, and much more. You may not see many of these organisms interact. But all organisms, including humans, that live together are interdependent.

Ecosystems

A species never lives alone. A group of various species that live in the same place and interact with one another is called a **community.** The group, along with the living and nonliving environment, make up an **ecosystem.** ❯ An ecosystem includes a community of organisms and their physical environment.

Community of Organisms A community of organisms is a web of relationships. One relationship is that of a predator eating its prey. For example, some fish eat spiders, as **Figure 1** shows. Some species help each other. For example, some bacteria fix nitrogen into a form that plants can use to grow. Relationships between organisms are examples of biotic factors that affect an ecosystem. *Biotic* describes living factors in an ecosystem. Biotic factors also include once-living things, such as dead organisms and the waste of organisms.

community a group of various species that live in the same habitat and interact with each other

ecosystem a community of organisms and their abiotic environment

Figure 1 In this relationship, the fish is the predator, and the spider is the prey. ❯ Give another example of a relationship between two species in a community.

Key Resources

Transparencies
E25 Ecological Succession at Glacier Bay

Visual Concepts
Levels of Ecology
Habitat
Community
Ecosystem
Comparing Biotic and Abiotic Factors
Biodiversity
Pioneer Species
Ecological Succession
Climate
Biomes, Climate, and Species
Biomes on Land
Tropical Rain Forest
Desert
Savanna
Temperate Deciduous Forest
Temperate Grassland
Taiga
Tundra
Freshwater Biomes
Intertidal Zone
Neritic Zone
Oceanic Zone
Benthic Zone

Section 1

Focus

This section identifies some biotic and abiotic factors of an ecosystem and describes how those factors change over time in a process called succession. It also describes the seven major terrestrial biomes and discusses aquatic communities.

Bellringer
Use the Bellringer transparency to prepare students for this section.

Teach

Demonstration

Species Count If possible, take students on a walk-around tour of your school. Point out different species of plants and animals that you observe. Have students count the number of species identified on the campus. When finished, mention that biologists sampling a tropical rain forest in Ecuador obtained samples suggesting that there are as many as 24,000 different insect species per acre. LS Visual

Answers to Caption Questions

Figure 1: trees provide shade to humans and other animals.

Teach, *continued*

QuickLab

Teacher's Notes Have each student use an area of equal dimensions, at least 50 m × 50 m to make the task more manageable and to allow comparisons between different ecosystems. Encourage students to take their time; they will observe much more if they do. Emphasize that students should observe without touching. Students should wash their hands when they return to the classroom.

Answers to Analysis

1. Answers will vary.
2. Answers will vary. Example: 6 species/30 total organisms = 0.2 = 20%
3. Answers will vary. Example: Mosquitos are a more important food source for the frog population than flies because there are more mosquitos than flies in the ecosystem.
4. Sample answer: In general, the abiotic factors in an ecosystem provide organisms (biotic factors) with a physical place to live, energy, nutrients, and water. The organisms alter and recycle some of these abiotic factors, changing the landscape in the process.

Hands-On

QuickLab

30 min

Biodiversity Evaluation

By making simple observations, you can draw some conclusions about biodiversity in an ecosystem.

Procedure

CAUTION: Follow your teacher's instructions about sun protection handling organisms. Prepare a list of biotic and abiotic factors to observe around your home or in a nearby park, and record your observations.

Analysis

1. **Identify** the habitat and community that you observed.
2. **Calculate** the number of different species as a percentage of the total number of organisms that you saw.
3. **Rank** the importance of biotic factors within the ecosystem that you observed.
4. **Infer** what the relationships are between biotic factors and abiotic factors in the observed ecosystem.

habitat a place where an organism usually lives

biodiversity the variety of organisms in a given area, the genetic variation within a population, the variety of species in a community, or the variety of communities in an ecosystem

succession the replacement of one type of community by another at a single location over a period of time

Physical Factors The physical or nonliving factors of an environment are called *abiotic factors*. Examples of abiotic factors are oxygen, water, rocks, sand, sunlight, temperature, and climate. These physical factors shape organisms. For example, plants and animals in deserts are small because deserts do not have enough water to support large organisms. Water supply also affects the number of individuals and variety of species that an ecosystem can support. A crop of corn will have a higher yield in a wetter habitat than in a drier habitat. A **habitat** is the place where an organism lives.

Biodiversity Suppose you counted the various species in a pine forest. Then, you counted the number of species in a tropical rain forest. Do you think the number of species in each ecosystem would be the same? No, a tropical rain forest has many more species than a pine forest does. The variety of organisms in a given area is called **biodiversity.**

Physical factors can have a big influence on biodiversity. In places that have very high or very low temperatures, biodiversity is often lower. Limited water and food also cause lower biodiversity. The biodiversity of habitats and ecosystems varies greatly. The vast expanse of the open ocean has very low biodiversity. In contrast, rain forests and coral reefs have very high biodiversity. When ecosystems have high biodiversity, they are often more able to resist damage. Damage to ecosystems can be caused by severe weather events or human activities. Systems with low biodiversity can be severely damaged easily. When biodiversity decreases in any ecosystem, that ecosystem is not as healthy as it could be.

Reading Check *List three examples of physical parts of an ecosystem. (See the Appendix for answers to Reading Checks.)*

MISCONCEPTION ALERT

Ecosystems Students may think that an ecosystem must be an area that is delineated by specific boundaries, like the walls of an aquarium or the edge of a pond. Point out that the limits of an ecosystem are defined by the observer. Thus, an ecosystem could be in a jar of pond water, or it could be the entire pond itself.

Differentiated Instruction

English Learners

Biotic and Abiotic Factors Point to a classroom aquarium or show a picture of an aquarium with a variety of organisms. Ask student to list all the organisms they see. When they finish, have them list all the factors that affect the survival of the organisms in the aquarium. (Sample answer: water, food, temperature range, light, pH, and oxygen) LS Visual

Succession

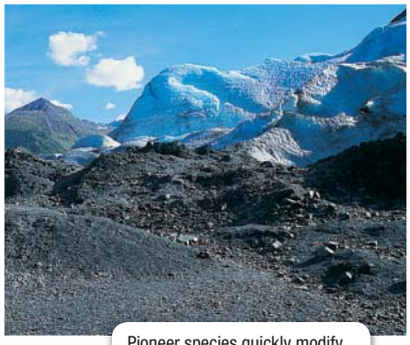
When we observe an ecosystem, it may look like an unchanging feature of the landscape. However, all ecosystems change. As an ecosystem changes, the kinds of species that the ecosystem supports change. The replacement of one community by another at a single place over a period of time is called **succession.**

Change in an Ecosystem When a volcano forms a new island or a fire burns the vegetation of an area, new opportunities are made for organisms. The first organisms to appear in a newly made habitat are called *pioneer species*. Pioneer species are often small, fast-growing plants that reproduce quickly. They change the habitat in such a way that other species can live in the ecosystem. For example, pioneer species such as lichens and mosses will break down volcanic rock on a new island to help form soil. Other species can then grow on the soil. For example, after lichens and mosses have formed soil, grasses and weeds may then cover a volcanic island. Even later, shrubs and trees often outcompete and replace the grass. Then, the grassland turns into a forest. **Figure 2** shows an example of succession in response to the receding of a glacier.

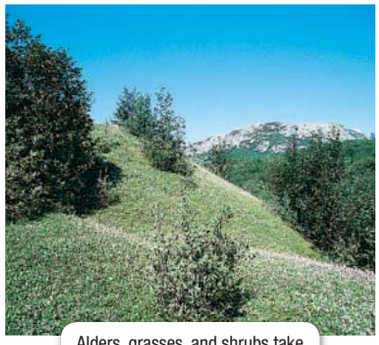
Equilibrium If a major disruption strikes a community, many of the organisms may be wiped out. But the ecosystem reacts to the change. **An ecosystem responds to change in such a way that the ecosystem is restored to equilibrium.** When a tree falls down in a rain forest, for example, the newly vacant patch proceeds through succession until the patch returns to its original state. Sometimes, the ecosystem will find an equilibrium in which different species dominate after a change. In the grasslands of Africa, for example, weather conditions can lead to succession. When there is a lot of rain in the grasslands, one species of grass dominates the savanna. But when conditions are drier, a drought-resistant species of grass will dominate.

Reading Check *Why are pioneer species helpful to other species?*

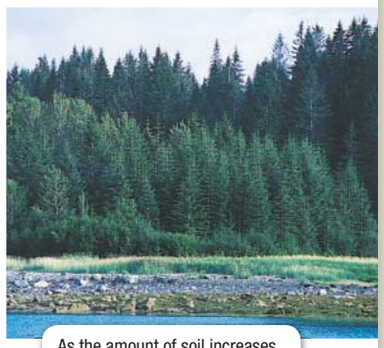
SCILINKS
www.scilinks.org
Topic: Biodiversity
Code: HX80151



Pioneer species quickly modify the land recently exposed after a glacier has receded.



Alders, grasses, and shrubs take over from the pioneer plants and help form more soil.



As the amount of soil increases, spruce and hemlock trees become plentiful.

Figure 2 At Glacier Bay in Alaska, a receding glacier makes succession possible.

Differentiated Instruction

Basic Learners

Succession Timeline Have each student draw an illustrated timeline representing the succession that occurs after a forest fire has burned all of the vegetation in an area. (Starting at time zero, the land should be barren, followed by the appearance of grasses and weeds, then small bushes, and finally trees.) LS Visual

Teaching Key Ideas

Primary Succession Primary succession occurs where life has not existed before. Secondary succession occurs where there has been previous growth. Have students examine the photos in **Figure 2.** Ask them what other events might lead to primary succession. (Sample answers: landslides and volcanic eruptions.) Tell students that primary succession can be a very slow process. Scientists estimate that the primary succession from sand dunes to the beech-maple forest along the shores of Lake Michigan took about 1,000 years. In contrast, secondary succession may take less than 100 years. Ask students why hemlock and spruce trees don't grow in an area before grasses and shrubs. (Grasses and shrubs often help form soil that makes it possible for the seeds of trees to survive.) LS Logical

Why It Matters

Pioneer Species Bring to class a rock covered with lichens or mosses. Ask students why these organisms are known as "pioneer species." (Like pioneer settlers, they are the first to inhabit a new area.) Point out that lichens can extract nutrients from the bare rock. LS Visual

Teach, *continued*

Teaching Key Ideas

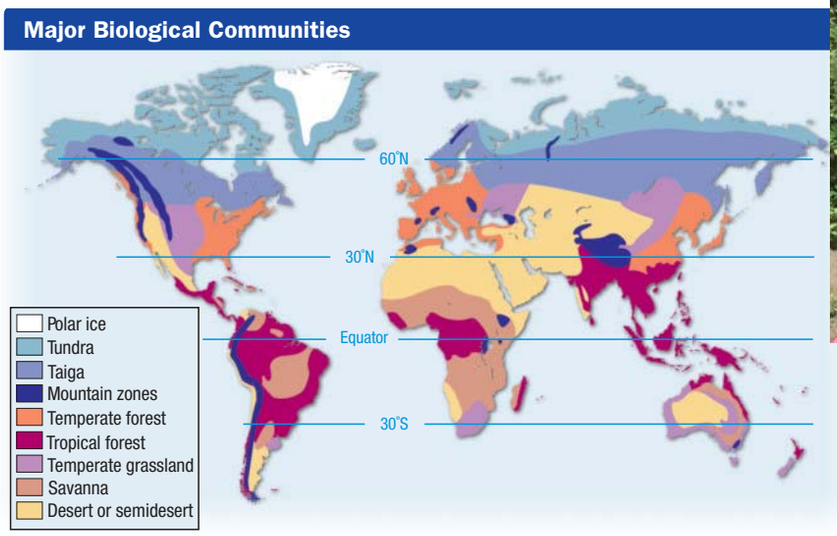
Characteristics of Biomes Show students photographs of the five major biomes found in the lower 48 states and Alaska: desert, temperate grassland, temperate forest (both deciduous and evergreen), tundra, and taiga. Ask students what they can deduce about the physical and biological characteristics of these biomes from examining the photos. LS Visual

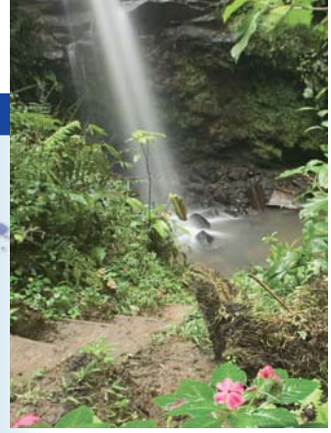
READING TOOLBOX

Visual Literacy Have students refer to **Figure 3.** Emphasize that a biome is a category and not a place and that the boundaries of biomes are not as well defined as they are shown in this figure. LS Visual

Answers to Caption Questions

Figure 3: Sample answer: I live in the temperate forest biome.





Tropical biome: rain forest

Figure 3 Biomes cover most of Earth's land surface. Because mountainous areas do not belong to any one biome, they are given their own designation. Polar ice covers Greenland and Antarctica, which is not shown in the map. **Identify the biome that you live in.**

Major Biological Communities

If you drive across the United States, you notice a change in the kinds of plants and animals. The kinds of species that live in a particular place are determined partly by climate. **Climate** is the average weather conditions in an area over a long period of time. At places near the North Pole, you may see polar bears. Polar bears have thick, white fur and insulating fat that keep them warm on the frozen tundra. The same adaptations that help polar bears in the tundra would hurt polar bears in a tropical forest. Polar bears must live in a biome to which they are adapted. A **biome** is a large region characterized by a specific kind of climate and certain kinds of plant and animal communities.

Two key factors of climate that determine biomes are temperature and precipitation. Most organisms are adapted to live within a particular range of temperatures and cannot survive at temperatures too far above or below that range. Precipitation also determines the kinds of species that are found in a biome. In biomes where precipitation is low, for example, the vegetation is made up mostly of plants that need little water, such as cactuses.

ACADEMIC VOCABULARY

range a scale or series between limits

climate the average weather conditions in an area over a long period of time

biome a large region characterized by a specific type of climate and certain types of plant and animal communities

Terrestrial Biomes

There are many different biomes on land. **Earth's major terrestrial biomes can be grouped by latitude into tropical, temperate, and high-latitude biomes.** As **Figure 3** shows, tropical biomes are generally near the equator. For the most part, temperate biomes are between 30° and 60° latitude. High-latitude biomes are at latitudes 60° and higher. Latitude affects the amount of solar energy that a biome receives and thus affects a biome's temperature range.

Differentiated Instruction

English Learners

Peer Group Research Pair English learners with English-proficient students. Have each pair create a table and graph showing their monthly estimates for average temperature and rainfall in their locale. Then have students research the same information on the Internet. Have them graph the researched data and compare their two graphs. Students should provide explanations for differences that they notice. This activity can be used to help reinforce the importance of accurate measurements. LS Verbal, Interpersonal

Basic Learners/Struggling Readers

Biome Postcards Have students use index cards to create postcards to send to the class from a biome they have visited. Students should include a description of the biome, its climate, the kinds of animals and plants that live there, and the location of the biome exists. On the postcard, students can draw a picture that represents the characteristics of the biome or cut pictures from discarded magazines. LS Verbal

Temperate biome: temperate grasslands

Polar biome: taiga

Tropical Biomes Because they are located at low latitudes near the equator, all tropical biomes are warm. However, each tropical biome receives a different amount of rain. *Tropical rain forests* receive large amounts of rain and are warm all year. They have the greatest biodiversity of any land biome. At least half of Earth's species of land organisms live in tropical rain forests. *Savannas* are tropical grasslands. They get less rain than tropical rain forests do. Savannas also have long dry seasons and shorter wet seasons. The most well-known savannas are in eastern Africa, where zebras, giraffes, lions, and elephants roam the grasslands. *Tropical deserts* get very little rain. Because the deserts have less water, they have fewer plants and animals than other biomes do.

Temperate Biomes Biomes at mid-latitudes have a wide range of temperatures throughout the year. *Temperate grasslands* have moderate precipitation and cooler temperatures than savannas do. Temperate grasslands are often highly productive when used for agriculture. Herds of grazing animals, like bison, used to live on the temperate grasslands of North America. *Temperate forests* grow in mild climates that receive plenty of rain. Trees of the temperate deciduous forests shed their leaves in the fall because of the cold winters. Trees of temperate evergreen forests do not lose their leaves or needles during the winter. Temperate forests are home to deer, bears, beavers, and raccoons. Like tropical deserts, *temperate deserts* receive little precipitation. However, unlike tropical deserts, temperate deserts have a wide temperature range throughout the year.

High-Latitude Biomes Biomes at high latitudes have cold temperatures. Coniferous forests in cold, wet climates are called *taiga*. Winters are long and cold. Most of the precipitation falls in the summer. Moose, wolves, and bears live in the taiga. The *tundra* gets very little rain, so plants are short. Much of the water in the soil is not available because the water is frozen for most of the year. Foxes, lemmings, owls, and caribous live in the tundra.

› **Reading Check** ***In what latitudes are savannas found?***

SCILINKS
www.scilinks.org
Topic: Biomes
Code: HX80158

Teaching Key Ideas

Biome Collages Place students in groups of three. As students study each biome, have them collect images of plants and animals that are characteristic of that biome. After studying the biomes and collecting the images, have students develop a collage of each biome. Have each group present their collages to the class, explaining why their images are appropriate to each biome. Hang all the collages of each type of biome together on the wall and label. LS Visual

Why It Matters

Latitude and Longitude Using a globe, remind students that longitude indicates east-west position and latitude indicates north-south position. Lead students to conclude that latitude profoundly affects climate, but longitude is essentially irrelevant to climate. Also, use the globe to discuss the tilt of the Earth and the angle of the sun's rays and the relationship between these factors and the seasons. LS Logical, Visual

Differentiated Instruction

Advanced Learners

Factors Affecting Rainfall Have students check library or Internet resources to identify areas in the world that receive the highest amounts of rainfall. Have them write a report that explains the physical factors responsible for the heavy rainfalls in these areas. LS Interpersonal

Teach, *continued*

READING TOOLBOX

Word Families **aquatic** growing or living in water; **ecosystem** the complex of a community of organisms and its environment functioning as an ecological unit **aquatic ecosystem** a community of organisms living in a water environment

Close

Formative Assessment

Which biome is a transitional area between tropical rain forest and desert?

A. taiga (Incorrect. A taiga is a high latitude biome having a cold, wet climate.)

B. savanna (Correct! The savanna is a tropical grassland, receiving less rainfall than the rain forest, but more than the desert.)

C. temperate forest (Incorrect. A temperate forest is a temperate biome with a wide range of temperatures and is much cooler than tropical biomes.)

D. tundra (Incorrect. A tundra is a high-latitude biome with very little rain and short vegetation.)

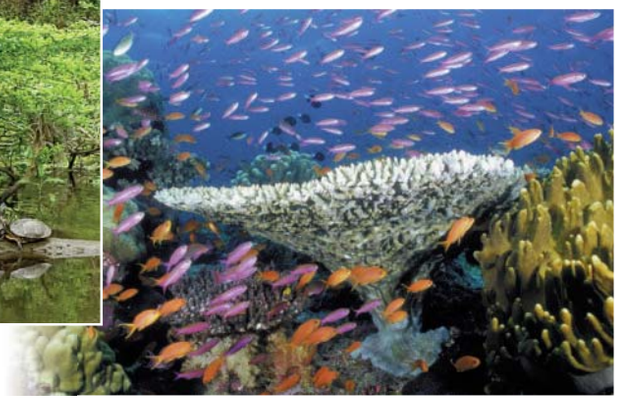


Figure 4 A bayou, such as this one in Louisiana, is an example of a wetland. The coral reef is an example of a marine ecosystem.

READING TOOLBOX

Word Families Use a dictionary to find the meanings of the words *aquatic* and *ecosystem*. Then, use the definitions to write your own definition of *aquatic ecosystem*.

SCILINKS
www.scilinks.org
Topic: Estuaries
Code: HX80536

Aquatic Ecosystems

The diverse regions in the world's bodies of water are not usually called *biomes*. They are often called *aquatic ecosystems*. **Aquatic ecosystems are organized into freshwater ecosystems, wetlands, estuaries, and marine ecosystems.**

Freshwater ecosystems are located in bodies of fresh water, such as lakes, ponds, and rivers. These ecosystems have a variety of plants, fish, arthropods, mollusks, and other invertebrates.

Wetlands provide a link between the land and fully aquatic habitats. Water-loving plants dominate wetlands. This ecosystem supports many species of birds, fishes, and plants, as shown in **Figure 4.** Wetlands are important because they moderate flooding and clean the water that flows through them.

An *estuary* is an area where fresh water from a river mixes with salt water from an ocean. Estuaries are productive ecosystems because they constantly receive fresh nutrients from the river and the ocean.

Marine ecosystems are found in the salty waters of the oceans. Kelp forests, seagrass communities, and coral reefs are found near land. The open ocean, far from land, has plankton and large predators, such as dolphins, whales, and sharks.

Reading Check ***Which aquatic ecosystems have salt water?***

Section 1 Review

KEY IDEAS

1. **Describe** the difference between an ecosystem and a community.
2. **Explain** how an ecosystem responds to change.
3. **Identify** the three major groups of terrestrial biomes.
4. **Describe** the four types of aquatic ecosystems.
5. **Identify** two factors of climate that determine a biome.

CRITICAL THINKING

6. **Relating Concepts** If two areas on separate continents have similar climates, do they have similar communities? Explain your answer.

WRITING FOR SCIENCE

7. **Essay** Identify a biome in which the plants are short and require little water and the animals are small. Then, write a one page description of this biome.

Answers to Section Review

1. A community is a group of different species that live in the same habitat and interact with each other. An ecosystem is the community of organisms and their abiotic environment.
2. An ecosystem responds to change in a way that restores the ecosystem to equilibrium.
3. The three major groups of terrestrial biomes are tropical biomes, temperate biomes, and high-latitude biomes.
4. Freshwater ecosystems have organisms that live in bodies of fresh water. Wetland ecosystems are dominated by water-loving plants. Estuaries have organisms that live where fresh water and salt water mix. Marine ecosystems are in the salty water of the oceans.
5. Two factors of climate that determine a biome are temperature and precipitation.
6. Sample answer: Two areas on separate continents with similar climates would have similar communities because the climate of an area affects the type of organisms that can live in an area.
7. Students should describe a tropical desert, a temperate desert, or a tundra.

Why It Matters

Maintained by Fire

When a fire sweeps through a forest, the fire destroys just about everything in its path. But did you know that fire can actually be a good thing for certain communities? In fact, fire is important for preserving many plant communities and the animals that depend on them.

REAL WORLD

Fire Lovers

Some plants benefit from fire. Fireweed, a plant with purple flowers as shown in this burned forest in Alaska, is one such plant. Fireweed gets its name because it quickly colonizes burned land without competition from other species. Other species of plants need fire in order to reproduce! The jack pine is one such species. The jack pine can release seeds only after it is exposed to the intense heat of a fire.

Ecosystem on Fire
Firefighters often light fires on purpose. This firefighter in South Dakota is setting a controlled fire because burned vegetation helps bring nutrients to the soil.

Research Find out more about controlled fires. Why must controlled fires be set in some ecosystems? What are the advantages and disadvantages of controlled fires?

Answer to Research

Exposure to fire is necessary for some plant species to reproduce. Advantages: low cost, highly effective, and advantageous for many plant and animal communities. Disadvantages: killing desirable trees and vegetation, burning out of control, and threatening or destroying wildlife.

Why It Matters

Teacher's Notes Scientists have found that controlled or prescribed fires are an effective and economical method of managing certain forest ecosystems. Controlled burns can be used to aid in species reproduction and to bring nutrients to the soil. They also can be tools for managing wildfires by burning trees and undergrowth that would fuel a large wildfire. Techniques are well planned and executed, and weather conditions must be optimum at the time of the burn.

READING TOOLBOX

Visual Literacy Have students review the illustration and identify additional objectives land management professionals might have when using a controlled burn. (Sample answers: controlling undesirable plant species and certain plant diseases; preparing sites for regeneration; reducing hazardous forest fuel buildup)

Section 2

Focus

This section discusses how producers and consumers facilitate the flow of energy through ecosystems in food webs and food chains. Depletion in the amount of available energy limits the number of steps that can occur in a food chain.

Bellringer

Use the Bellringer transparency to prepare students for this section.

Teach

Demonstration

Field Food Web List the following organisms that can be found in an open field: meadow grasses, shrub, robin, hawk, snake, frog, grasshopper, mouse, and rabbit. Have students draw arrows to show what eats what in this field ecosystem. Students should see the complexity of even this simple food web in which each predator can take more than one type of prey and each type of prey could be exploited by several different species of predators.

LS Visual

Section 2

Energy Flow in Ecosystems

Key Ideas	Key Terms	Why It Matters
How does energy flow through an ecosystem? What happens to energy as it is transferred between trophic levels in a community?	producer consumer decomposer trophic level energy pyramid	The way in which energy flows through an ecosystem is critical to the ecosystem's productivity and ability to support its species. By understanding this flow of energy, we can learn how to develop food more efficiently.

Everything that organisms do requires energy. Running, breathing, and even sleeping require energy. Every species must somehow get food for energy. A zebra grazes on savanna grass. A lion chases down the zebra and eats it. The lion eventually dies and is eaten by scavengers. The rest of the carcass is decomposed by bacteria and other microbes. At each step in this process, energy flows through the ecosystem.

Trophic Levels

An organism eating another organism is the most obvious interaction in a community. This interaction transfers energy through an ecosystem. The way in which energy flows through an ecosystem determines how many species and individuals live in the ecosystem.

The primary source of energy for an ecosystem is the sun. Photosynthetic organisms, such as plants and algae, change light energy from the sun into energy that they can use to grow. These photosynthetic organisms are **producers,** the basic food source for an ecosystem. **Consumers** are organisms that eat other organisms instead of producing their own food. **Decomposers,** such as bacteria and fungi, are organisms that break down the remains of animals.

In an ecosystem, energy flows from the sun to producers to consumers to decomposers. Each step in the transfer of energy through an ecosystem is called a **trophic level.** **Figure 5** shows the trophic levels through which energy passes to a blue jay.

Reading Check *Where do consumers get their energy?*

SCILINKS
www.scilinks.org
Topic: Food Webs
Code: HX80600

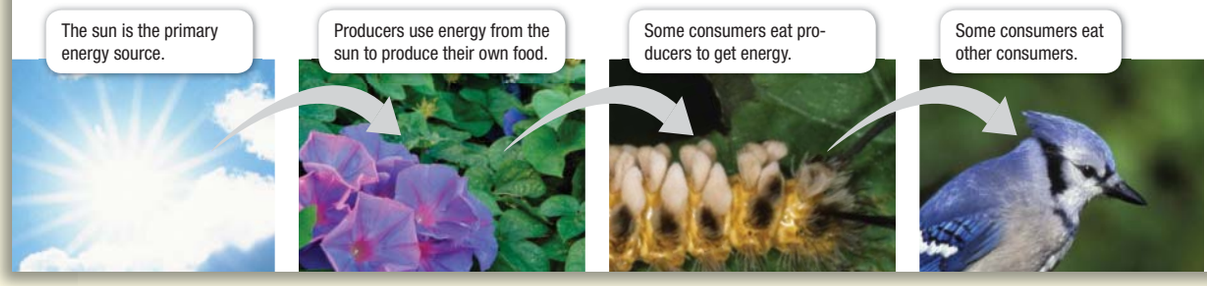


Figure 5 Each step in the transfer of energy through an ecosystem is called a *trophic level.*

Key Resources

Transparencies
- E4 Trophic Levels
- E5 Food Chain in an Antarctic Ecosystem
- E6 Food Web in an Antarctic Ecosystem
- E8 Energy Transfer Through Trophic Levels
- E11 Energy Efficiency in Food Consumption

Visual Concepts
- Comparing Consumers and Producers
- Food Chains and Food Webs
- Types of Consumers
- Food Chains and Energy Transfer
- Energy Pyramid
- Biomass

Food Chains In ecosystems, energy flows from one trophic level to the next, forming a *food chain.* The first trophic level of ecosystems is made up of producers. Plants, algae, and some bacteria use the energy in sunlight to build energy-rich carbohydrates. The second trophic level of a food chain is made up of *herbivores,* which eat producers. Cows are an example of an herbivore. The third trophic level includes animals that eat herbivores. Any animal that eats another animal is a *carnivore.* Some carnivores are on the third trophic level because they eat herbivores. For example, small birds eat caterpillars, which feed on plant leaves. Other carnivores are on the fourth trophic level or an even higher trophic level because they eat other carnivores. For example, hawks eat small birds. *Omnivores,* such as bears, are animals that are both herbivores and carnivores.

Food Web In most ecosystems, energy does not follow a simple food chain. Energy flow is much more complicated. Ecosystems almost always have many more species than a single food chain has. In addition, most organisms eat more than one kind of food. For example, hawks eat fish, small birds, and rabbits. Rabbits are food not only for hawks but also for wolves, mountain lions, and many other carnivores. This complicated, interconnected group of food chains, such as the group in **Figure 6,** is called a *food web.*

producer a photosynthetic or chemosynthetic autotroph that serves as the basic food source in an ecosystem

consumer an organism that eats other organisms or organic matter instead of producing its own nutrients or obtaining nutrients from inorganic sources

decomposer an organism that feeds by breaking down organic matter from dead organisms

trophic level one of the steps in a food chain or food pyramid

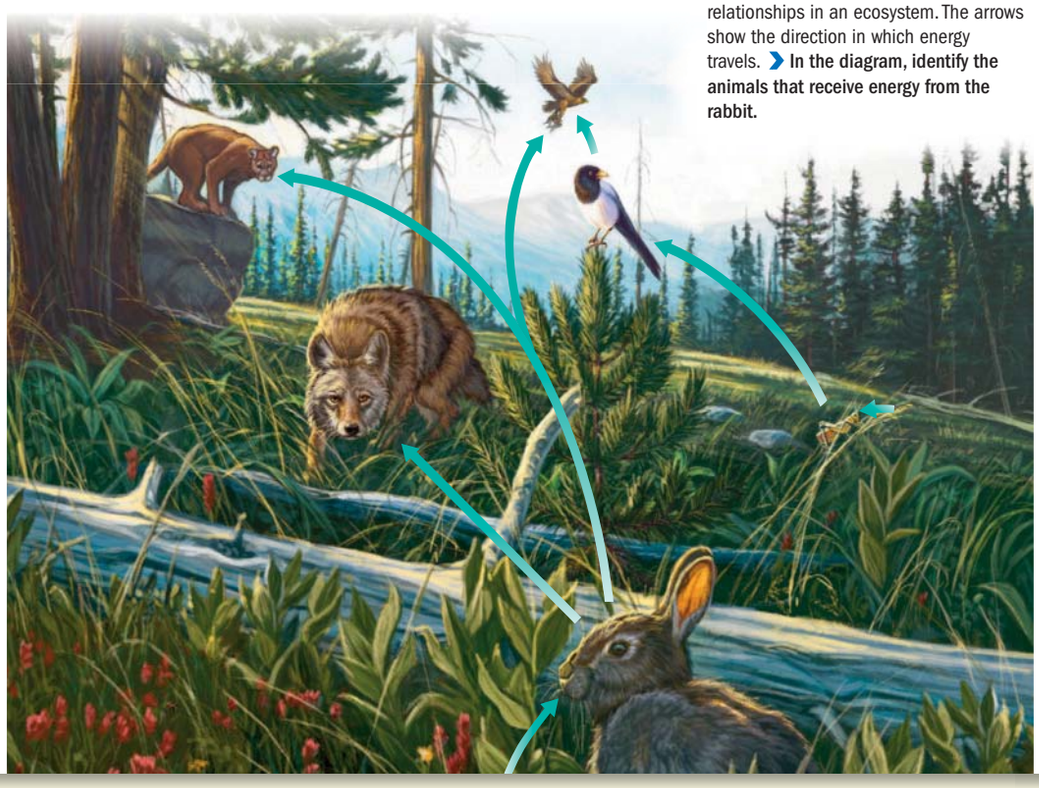


Figure 6 A food web shows a more complete picture of the feeding relationships in an ecosystem. The arrows show the direction in which energy travels. **In the diagram, identify the animals that receive energy from the rabbit.**

MISCONCEPTION ALERT

Food Chains versus Food Webs Emphasize that food chains, while being useful tools for showing the flow of energy through a biotic community, can be misleading because they imply that each organism eats ONLY the organism below it in the food chain. We know, of course, that most organisms eat a wide variety of other organisms, and for this reason the term *food web* gives a more accurate picture of what actually happens in an biotic community.

Teaching Key Ideas

Food Webs and Biodiversity Organize students into groups of four. Obtain large sheets of butcher paper. Have one student in each group write the name of an organism anywhere on the sheet, followed by one of these letters: *P* (producer), *C* (carnivore), *H* (herbivore), *O* (omnivore), and *D* (decomposer). Each student writes the name of another organism randomly on the sheet and draws an arrow from this organism to anything that eats it and an arrow to this organism from organisms it would eat. Continue until the web gets very messy.

Ask each group to hold up their paper, and have the class "vote" on which food web shows the greatest biodiversity. Discuss what would happen to the "winning" food web if just one organism became extinct. (In most cases there would be no effect if there was a lot of biodiversity, but if the extinct organism was the only producer, it could have a profound effect.) LS **Visual**

Answers to Caption Questions

Figure 6: The mountain lion, coyote, and predatory bird receive energy from the rabbit when they eat the rabbit.

Teach, *continued*

Teaching Key Ideas

Energy Changes Remind students that the first law of thermodynamics states that energy cannot be created or destroyed but only changed in form. Have students give examples of energy changes from one form into another. (Sample answers: electricity to heat and light in a light bulb; chemical energy changed to electrical energy in a battery) The second law of thermodynamics states that energy change between forms is never 100 percent efficient. Ask students to think of an example that shows the inefficiency of energy conversions. (Sample answer: In an automobile engine, gasoline and chemical energy is changed to kinetic energy to turn the wheels; however, much of the energy is converted to heat, which is unavailable to power the automobile.) LS Logical

Math Skills

Energy in Trophic Levels Tell students that if an average of 1,500 kcal of light energy per day falls on a square meter of land surface covered by plants, only about 15–30 kcal become incorporated into chemical compounds through photosynthesis. Ask how much of this energy could end up in a person who eats these plants. (1.5–3.0 kcal) How much of this energy could end up in a person who eats a steak from a steer that ate the plants? (0.15–0.30 kcal) LS Logical

Figure 7 This girl is eating producers, which form the base of an energy pyramid.

Loss of Energy

When a zebra eats 20 lb of grass, the zebra does not gain 20 lb. A lot of the energy that was stored in the grass is lost. Where did the energy go? **Energy is stored at each link in a food web. But some energy that is used dissipates as heat into the environment and is not recycled.**

The Ten Percent Rule When a zebra eats grass, some of the energy in the grass is stored in the zebra. The energy may be stored as fat or as tissue. However, most of the energy does not stay in the zebra. As the zebra uses energy from the grass to run and grow, the energy is changed into heat energy. Then, the heat energy is dispersed into the environment. Thus, the zebra does not keep 90% of the energy that it gets from the grass. Only about 10% of the energy in the grass becomes part of the zebra's body. This amount of stored energy is all that is available to organisms at the next trophic level that consume the zebra. For example, a 100 kg lion needs 1,000 kg of zebras. And combined, the zebras need 10,000 kg of plants!

By understanding energy flow between trophic levels, we can learn how to feed more people. If people eat big fish that are in the third trophic level, it takes 1,000 kg of producers to build 1 kg of human. If people eat cows that are in the second trophic level, 100 kg of producers are needed for 1 kg of human. If people, such as the girl in **Figure 7,** eat producers—such as vegetables, fruits, and grains—only 10 kg of producers are needed to produce 1 kg of human.

Reading Check ***When energy is transferred from one trophic level to another, where does 90% of the energy go?***

Math Skills Energy Pyramid

This energy pyramid shows the trophic levels in a marine ecosystem. You can use the pyramid to help you understand how energy is transferred from one trophic level to another.

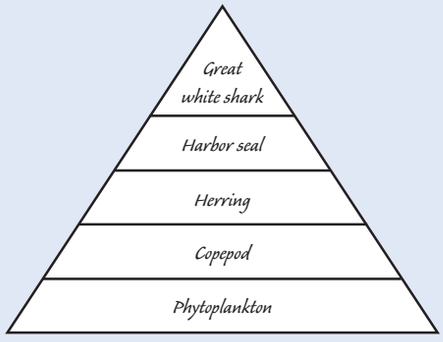
The base of a pyramid is the producer, which contains the most energy. Phytoplankton is the base of this pyramid. As energy is transferred from one trophic level to the next trophic level, 90% of the energy is lost. Only 10% of the energy is available to the next trophic level.

If the phytoplankton level has 10,000 units of energy, the amount of energy stored in the copepod level can be calculated as follows:

10,000 units of energy × 10% = 1,000 units of energy

The amount of energy stored in the herring level can be calculated as follows:

1,000 units of energy × 10% = 100 units of energy

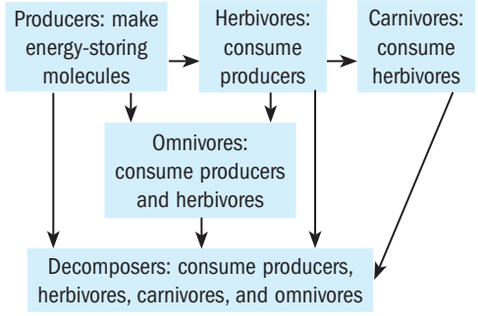


Assume an energy loss of 90% from trophic level to trophic level.

Differentiated Instruction

Alternative Assessment

Flow of Energy Have students draw a graphic organizer that summarizes the flow of energy from producers to herbivores, omnivores, carnivores, and decomposers. A sample graphic organizer is shown. LS Visual



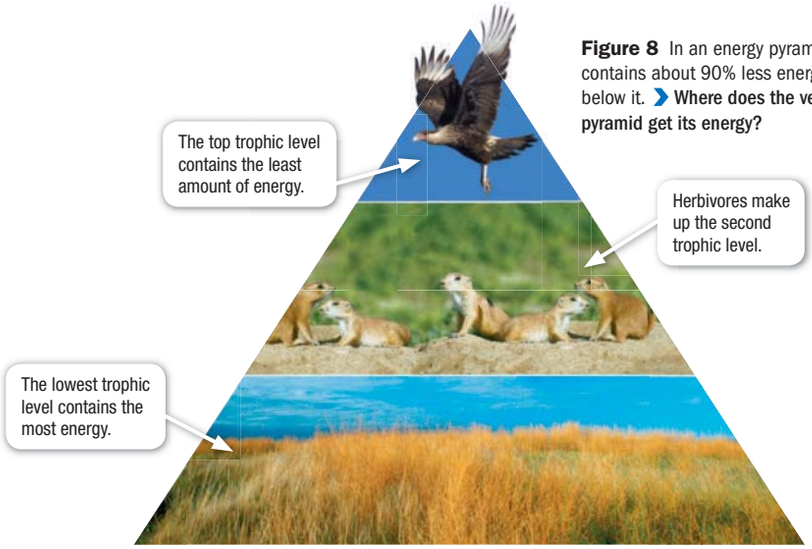


Figure 8 In an energy pyramid, each level contains about 90% less energy than the level below it. **Where does the vegetation in this pyramid get its energy?**

Energy Pyramid A triangular diagram that shows an ecosystem's loss of energy, which results as energy passes through the ecosystem's food chain, is called an **energy pyramid.** An energy pyramid is shown in **Figure 8.** Each layer in the energy pyramid represents one trophic level. Producers form the pyramid's base, which is the lowest trophic level. The lowest level has the most energy in the pyramid. Herbivores have less energy and make up the second level. Carnivores that feed on herbivores make up the higher level. The energy stored by the organisms at each trophic level is about one-tenth the energy stored by the organisms in the level below. So, the diagram takes the shape of a pyramid.

Big predators, such as lions, are rare compared to herbivores. Big predators are rare because a lot more energy is required to support a single predator than a single herbivore. Many ecosystems do not have enough energy to support a large population of predators.

energy pyramid a triangular diagram that shows an ecosystem's loss of energy, which results as energy passes through the ecosystem's food chain

READING TOOLBOX

Word Problem If the prairie dog level in a food pyramid contains 35,000 units of energy, how much of that energy can be stored in the eagle level of the food pyramid?

Section 2 Review

KEY IDEAS

1. **Describe** how energy flows in an ecosystem.
2. **Explain** why only 10% of energy is transferred from one trophic level to the next.
3. **Describe** the difference between a herbivore, a carnivore, and an omnivore.

CRITICAL THINKING

4. **Justifying Conclusions** What limits the length of food chains in an ecosystem?
5. **Evaluating an Argument** Explain why scientists believe that most animals would become extinct if all plants died.
6. **Analyzing Data** Which trophic level contains more energy: a trophic level of herbivores or a trophic level of carnivores? Why?

USING SCIENCE GRAPHICS

7. **Creating Diagrams** Draw a diagram of a food web that has four trophic levels and at least one species that is an omnivore. Be sure to label producers, consumers, omnivores, and top predators. Label each trophic level.

Answers to Caption Questions

Figure 8: The vegetation gets its energy from the sun.

READING TOOLBOX

Word Problem 35,000 units × 10% = 3,500 units

Close

Formative Assessment

Which of the following is an example of consumers outnumbering the producers they are feeding upon?

A. a 10-acre grassy field with grasshoppers (Incorrect. There are more producers than grasshoppers.)

B. carnivores feeding upon several herbivores (Incorrect. Both carnivores and herbivores are consumers.)

C. several omnivores feeding on hundreds of wild berry plants (Incorrect. The omnivores are consumers, but they do not outnumber the plants.)

D. a tree with thousands of insects feeding on it. (Correct! The insect population easily outnumbers the single tree producer.)

Answers to Section Review

1. Energy flows from the sun to producers to consumers to decomposers in an ecosystem.
2. Only 10 percent of energy is transferred from one energy level to the next because energy is converted to heat energy and is lost to the environment.
3. A herbivore is an animal that eats producers. A carnivore is an animal that eats other animals. An omnivore is an animal that eats both producers and other animals.
4. Because energy is used and lost to the environment at each trophic level, an ecosystem needs a large number of producers to provide enough energy for organisms at the top trophic level.
5. Plants are the producers in most ecosystems. Animals obtain energy either by eating plants directly or by eating other animals that eat plants. Without plants, animals would not have food.
6. The trophic level of herbivores contain more energy, because herbivores are lower on the energy pyramid than carnivores.
7. Diagrams may vary. Students should use specific examples of organisms for each level.

Section 3

Focus

This section explains how important materials necessary for survival, such as water, carbon, phosphorus, and nitrogen, circle through natural systems, constantly re-supplying organisms. It also describes the important role that bacteria play in the recycling of many materials.

Bellringer

Use the Bellringer transparency to prepare students for this section.

Teach

Teaching Key Ideas

Energy Have students look at **Figure 9** and notice the two arrows labeled *Evaporation* and the one arrow labeled *Transpiration*. Ask what is needed for evaporation or transpiration to occur. (an input of energy) Next, ask how could this energy be harvested? (Water runoff from precipitation may eventually enter a river and run through turbines, spinning them and converting the energy of the water into electrical energy.) LS **Logical**

go.hrw.com
interact online

Students can interact with a model for the water cycle by going to go.hrw.com and typing in the keyword HX8ECOF9.

Section 3

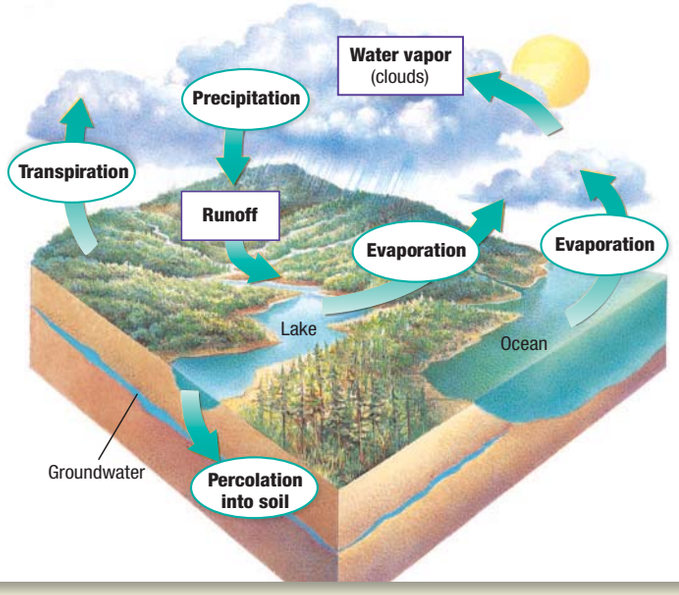
Cycling of Matter

Key Ideas	Key Terms	Why It Matters
❯ What is the water cycle? ❯ Why are plants and animals important for carbon and oxygen in an ecosystem? ❯ Why must nitrogen cycle through an ecosystem? ❯ Why must phosphorus cycle through an ecosystem?	carbon cycle respiration nitrogen cycle phosphorus cycle	Water, carbon, phosphorus, and nitrogen are critical resources for organisms, including humans. Natural cycles of these resources are important to ecosystems, but humans can disrupt these cycles.

Water, carbon, oxygen, nitrogen, and phosphorus are five of the most important substances for life. An ecosystem must be able to cycle these kinds of matter in order to support life.

Water Cycle

Life could not exist without the *water cycle.* ❯ **The water cycle continuously moves water between the atmosphere, the land, and the oceans.** As **Figure 9** shows, water vapor *condenses* and falls to Earth's surface as *precipitation*. Some of this water *percolates* into the soil and becomes groundwater. Other water runs across the surface of Earth into rivers, lakes, and oceans. Then, the water is heated by the sun and reenters the atmosphere by *evaporation*. Water also evaporates from trees and plants in a process called *transpiration*.



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Keyword: HX8ECOF9

Figure 9 Water cycles through ecosystems by the processes of transpiration, evaporation, condensation, precipitation and percolation.

Key Resources

Transparencies
E12 Water Cycle
E13 Carbon Cycle
E14 Nitrogen Cycle

Visual Concepts
Biogeochemical Cycle
Water Cycle
Groundwater
Water Table
Carbon Cycle
The Nitrogen Cycle
Nitrogen Fixation
Ammonification
Nitrification
Denitrification

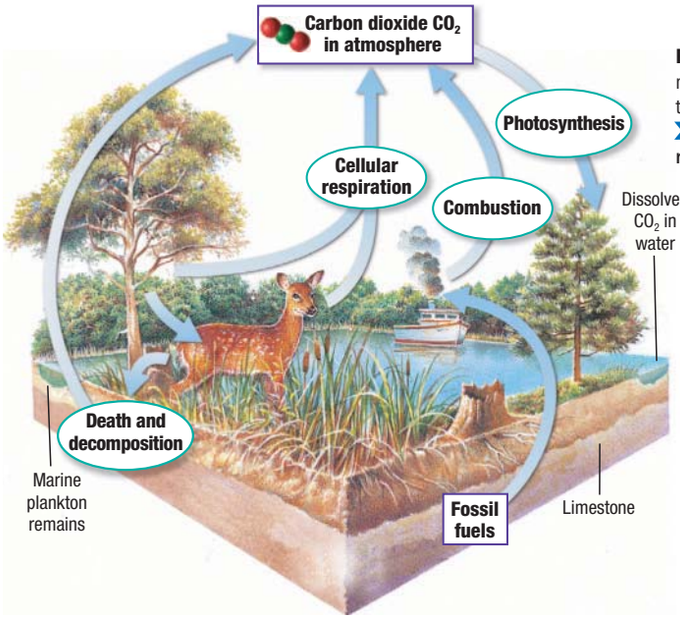


Figure 10 In the carbon cycle, carbon moves from organisms to the atmosphere, to the soil, and to other living things.
How is the carbon in fossil fuels released into the atmosphere?

SCILINKS
www.scilinks.org
Topic: Carbon Cycle
Code: HX80216

Carbon and Oxygen Cycles

Carbon and oxygen are critical for life on Earth, and their cycles are tied closely together. The **carbon cycle** is the continuous movement of carbon from the nonliving environment into living things and back. The carbon cycle is shown in **Figure 10.**

Animals, plants, and other photosynthesizing organisms play an important role in cycling carbon and oxygen through an ecosystem. Plants use the carbon dioxide, CO_2, in air to build organic molecules during the process of photosynthesis. During photosynthesis, oxygen is released into the surroundings. Many organisms, such as animals, use this oxygen to help break down organic molecules, which releases energy and CO_2. Then, plants can use the CO_2 in photosynthesis. The process of exchanging oxygen and CO_2 between organisms and their surroundings is called **respiration.**

Carbon is also released into the atmosphere in the process of combustion. *Combustion* is the burning of a substance. All living things are made of carbon. When living things or once-living things are burned, they release carbon into the atmosphere. For example, the burning of trees releases carbon into the atmosphere as CO_2. Fossil fuels are formed from the remains of dead plants and animals. Thus, the burning of fossil fuels releases CO_2 into the atmosphere. Humans burn fossil fuels to generate electricity and to power vehicles. Examples of fossil fuels that humans burn are oil and coal.

Reading Check ***How does respiration play a role in cycling carbon and oxygen through an ecosystem?***

carbon cycle the movement of carbon from the nonliving environment into living things and back

respiration the exchange of oxygen and carbon dioxide between living cells and their environment

READING TOOLBOX

Word Families Explain how the carbon cycle and the oxygen cycle are similar. Explain how they are different.

Differentiated Instruction

Struggling Readers

Summarize the Water Cycle Have pairs of students silently read about the water cycle. Tell them to make a question mark on a sticky note next to passages that they find confusing. After reading, partners should help each other with any passages they did not understand. Then have one student in each pair summarize the information, asking the second student to add anything omitted. LS Verbal

Basic Learners

Increases in Atmospheric CO_2 Have each student make a list of activities that contribute to rising levels of carbon dioxide. (Combustion of the following: gasoline in a car, propane or natural gas from a stove, charcoal in a barbecue) Have students identify ways to reduce the amount of carbon dioxide they contribute. (Sample answers: walk or ride a bike rather than ride in a car; take public tranportation, turn out lights when not in use) LS Intrapersonal

Teaching Key Ideas

Carbon Cycle Have students observe the processes of the carbon cycle as depicted in **Figure 10.** Point out that an increase in "activity" in one part of the cycle will affect other parts of the cycle. Ask students which part of the carbon cycle they think has changed the most drastically over the last 200 years. (Sample answer: the amount of combustion due to greater demand for energy from burning fossil fuels) LS Logical

READING TOOLBOX

Word Families **similarities:** the cycles intersect for photosynthesis and respiration
differences: plants take in CO_2, animals release it; plants release O_2, animals take it in; plants create larger compounds from CO_2 during photosynthesis; combustion requires O_2 to break down larger compounds and release CO_2

Answers to Caption Questions

Figure 10: Carbon in fossil fuels is released into the atmosphere when the fossil fuels are burned in a process called combustion.

Teach, *continued*

Teaching Key Ideas

Nitrogen Gas Have students study **Figure 11.** Point out the difference between nitrogen fixation (nitrogen combines with hydrogen to form ammonia) and nitrification (ammonia is converted to nitrates). Tell students that lightning also changes nitrogen gas to ammonia, but such atmospheric action amounts to less than 10 percent of that carried out by organisms through nitrogen fixation. Finally, have students recognize that denitrification returns nitrates to the atmosphere as nitrogen gas. LS Logical

Demonstration

Nitrogen-Fixing Plants Tell students that beans are leguminous plants, the roots of which have nodules containing nitrogen-fixing bacteria. Then explain that other nitrogen-fixing plants include clover, peas, alfalfa, lupines, and locust trees. If any of these plants are available nearby, see if you can find examples to show the class any nodules that may be present. LS Visual

nitrogen cycle the cycling of nitrogen between organisms, soil, water, and the atmosphere

phosphorus cycle the cyclic movement of phosphorus in different chemical forms from the environment to organisms and then back to the environment

ACADEMIC VOCABULARY

convert to change from one form to another

Nitrogen Cycle

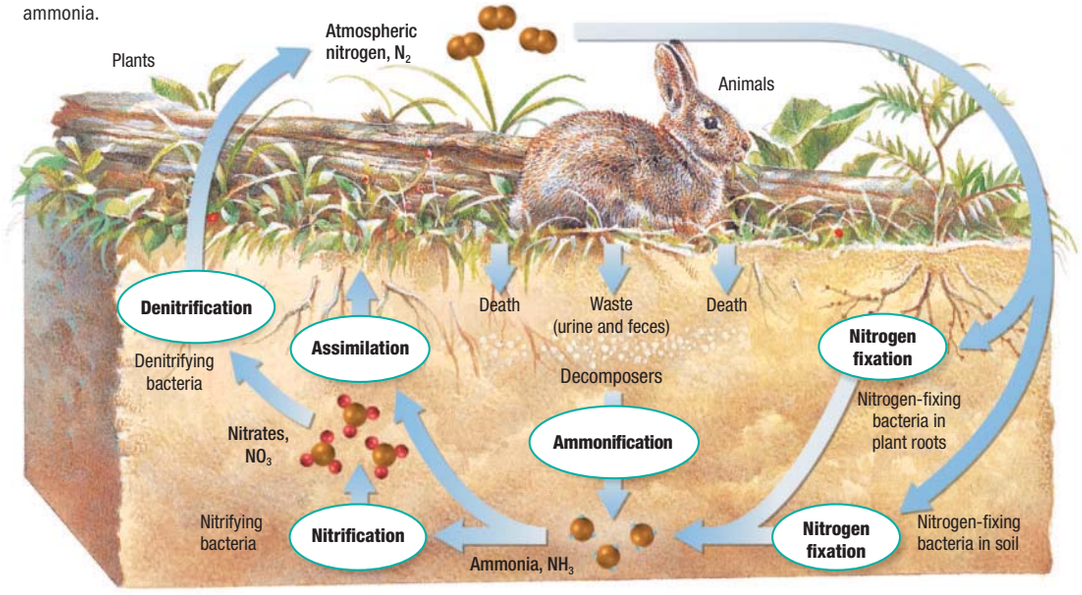
All organisms, including you, need nitrogen. **Nitrogen must be cycled through an ecosystem so that the nitrogen is available for organisms to make proteins.** The **nitrogen cycle** is the process in which nitrogen circulates among the air, soil, water, and organisms in an ecosystem. The nitrogen cycle is shown in **Figure 11.**

The atmosphere is about 78% nitrogen gas, N_2. But most organisms cannot use nitrogen gas. It must be changed into a different form. A few bacteria have enzymes that can break down N_2. These bacteria supply the nitrogen that all other organisms need. The bacteria split N_2 and then bind nitrogen atoms to hydrogen to form ammonia, NH_3. The process of combining nitrogen with hydrogen to form ammonia is called *nitrogen fixation*. Nitrogen may be fixed by lightning. But more nitrogen is fixed by bacteria. Nitrogen-fixing bacteria live in the soil and on the roots of some plants. Nitrogen is also fixed when humans burn fuels in vehicles and industrial plants.

Plants get nitrogen by assimilation. *Assimilation* is the process in which plants absorb nitrogen. When an animal eats a plant, nitrogen compounds become part of the animal's body. During *ammonification,* nitrogen from animal waste or decaying bodies is returned to the soil by bacteria. Ammonia is then converted to nitrite and then nitrate by the process of *nitrification.* Finally, in *denitrification,* nitrate is changed to nitrogen gas, N_2, which returns to the atmosphere.

Reading Check ***Explain the role of bacteria in the nitrogen cycle.***

Figure 11 Bacteria carry out many of the important steps in the nitrogen cycle, including the conversion of atmospheric nitrogen into a usable form, such as ammonia.



Why It Matters

Crop Rotation Tell students that farmers often rotate a nonleguminous crop, such as corn, with a leguminous one, such as alfalfa. The alfalfa will fix nitrogen and release some of it into the soil. If a crop of alfalfa is plowed back into the soil, it may add as much as 350 kg (770 lb) of nitrogen per hectare (2.5 acres) of soil. This mass of nitrogen is enough to grow a crop of nonleguminous plants without the need for additional fertilizer. LS Verbal

Differentiated Instruction

Advanced Learners

Sustainable Agriculture Organic farming is a form of sustainable agriculture that does not use inorganic fertilizers or pesticides. Have students find out how "organic" is used in marketing products. Ask students to find out if organic farming methods lead to bigger profits for farmers. Have them explain their answers in the form of a report, supporting their opinions with information that they have gathered through research. LS Logical

Hands-On

QuickLab

15 min

The Carbon Cycle

You are part of the carbon cycle. Every time that you exhale, you release CO_2 into the atmosphere. But the CO_2 does not stay as CO_2 for very long.

Procedure

1. Pour **100 mL of water** into a **250 mL beaker.** Add **several drops of bromthymol blue** to the water. Add enough drops to make the solution dark blue.
2. **CAUTION: Be sure not to inhale or ingest the solution.** Exhale through a **straw** into the solution until the CO_2 in your breath turns the solution yellow.
3. Pour the yellow solution into a **large test tube** that contains a **sprig of Elodea.**
4. Use a **stopper** to seal the test tube. Then, place the test tube in a sunny location.
5. Observe the solution in the test tube after 15 min.

Analysis

1. CRITICAL THINKING **Inferring Conclusions** What do you think happened to the carbon dioxide that you exhaled into the solution?
2. CRITICAL THINKING **Analyzing Methods** How do plants, such as the *Elodea,* affect the carbon cycle?

Phosphorus Cycle

Phosphorus is an important part of ATP and DNA and must be cycled in order for an ecosystem to support life. The **phosphorus cycle** is the movement of phosphorus in different chemical forms from the surroundings to organisms and then back to the surroundings. Phosphorus is often found in soil and rock as calcium phosphate, which dissolves in water to form phosphate. The roots of plants absorb phosphate. Humans and animals that eat the plants reuse the organic phosphorus. When the humans and animals die, phosphorus is returned to the soil.

Reading Check *How is phosphorus passed from soil to plants?*

Section 3 Review

KEY IDEAS

1. **Explain** how carbon and oxygen are cycled through an ecosystem.
2. **Describe** why nitrogen must cycle through an ecosystem.
3. **Explain** why it is important that phosphorus be cycled through an ecosystem.
4. **Summarize** the steps of the water cycle.

CRITICAL THINKING

5. **Making Connections** Explain why the oxygen and carbon cycles are tied so closely together.
6. **Predicting Outcomes** Describe what would happen if matter could not cycle through ecosystems.
7. **Analyzing Processes** Defend the argument that nutrients can cycle but energy cannot.

METHODS OF SCIENCE

8. **Designing an Experiment** Design an experiment in which you would determine whether nitrogen-fixing bacteria really help plants grow faster.

Answers to Section Review

1. During photosynthesis, plants use carbon dioxide and release oxygen. Organisms use the oxygen during respiration. Carbon is also released during combustion and when bodies of dead organisms decay.
2. Nitrogen must be cycled through an ecosystem so that the nitrogen is available for organisms to make proteins.
3. Phosphorus is an important part of ATP and DNA and must be cycled in order for an ecosystem to support life.
4. Water vapor condenses and falls as precipitation. Some percolates into the soil and becomes groundwater. Other water runs into rivers, lakes, and oceans. The water reenters the atmosphere by evaporation and transpiration.
5. During photosynthesis and respiration, carbon and oxygen cycle between living things and the environment.
6. Nutrients would eventually be used up and living things would die.
7. There is currently no mechanism to efficiently recycle energy lost as heat into the surroundings. This is the reason why energy is lost at each trophic level.
8. Grow the same plants in soil with and without nitrogen-fixing bacteria.

QuickLab

Teacher's Notes *Elodea* can be purchased at aquarium shops.

Materials
- beaker, 250 mL
- bromthymol blue indicator
- *Elodea* sprig
- eyedropper
- rubber stopper (to fit test tube)
- soda straw
- test tube
- water

Safety Cautions
Tell students that bromthymol blue is a skin and eye irritant. It can stain skin and clothing. Remind students to be careful not to accidentally drink the solution while blowing into the straw. Make sure students wear safety goggles to protect their eyes from splashes—especially when blowing into the indicator-stained solution.

Answers to Analysis

1. The elodea used the carbon dioxide during photosynthesis.
2. Plants use atmospheric carbon dioxide during photosynthesis and release carbon dioxide into the atmosphere during cellular respiration.

Close

Formative Assessment

Plants obtain nitrogen in a process called _____.

A. denitrification (Incorrect. In this process, nitrates are converted to a nitrogen gas.)
B. nitrogen fixation (Incorrect. In this process, nitrogen combines with hydrogen to form ammonia.)
C. nitrification (Incorrect. In this process, ammonia is converted to nitrite and then nitrate)
D. assimilation (Correct! In this process, plants absorb and incorporate nitrogen into organic compounds.)

Lab

Time Required

20 minutes on day 1 for setup;
10 minutes each day thereafter over a period of three weeks

Ratings

EASY → HARD

Teacher Prep	1
Concept Level	2
Student Setup	2
Cleanup	1

Safety Cautions

Warn students to take care when handling insects and other small animals, which are easily harmed, Some are capable of biting when disturbed.

Tips and Tricks

Have students bring clear plastic 2- or 3-L bottles from home. Create a separate terrarium that students can use as a control. Soil can be collected from around the school, brought from home, or purchased from a garden center. You may be able to find earthworms and crickets in the local environment or at bait shops. Remind students that the ecosystems are dependent on humans for care. They should not be permitted to overheat or become too cold. Water should be replenished as needed.

Inquiry

Chapter 4 Lab

Objectives

- Construct an ecosystem model.
- Observe interactions of organisms in an ecosystem model.
- Compare an ecosystem model with a natural ecosystem.

Materials

- goggles, gloves, and lab apron
- coarse sand or pea gravel
- terrarium or glass jar, large, with a lid
- soil
- grass seeds, a pinch of
- clover seeds, a pinch of
- water, 150 mL
- rolled oats
- mealworms (beetle larvae)
- mung bean seeds
- earthworms
- isopods (pill bugs)
- crickets

Safety

Ecosystem Change

Organisms in an ecosystem interact with one another and with their environment. Feeding is one interaction that occurs among the organisms in an ecosystem. A food web describes the feeding relationships among the organisms in an ecosystem. In this lab, you will use a terrarium or a jar to model a closed ecosystem. A *closed ecosystem* is a system that allows energy to enter but that is closed to the transfer of matter.

Preparation

1. SCIENTIFIC METHODS **State the Problem** How might the different organisms interact in an ecosystem model?
2. SCIENTIFIC METHODS **Form a Hypothesis** Form a testable hypothesis about how the number of individuals of each species in an ecosystem model will change over time.

Procedure

Build an Ecosystem in a Jar

1. **CAUTION: Glassware is fragile. Notify your teacher promptly of any broken glass or cuts. Do not clean up broken glass or spills that contain broken glass unless your teacher tells you to do so.** Place 5 cm of sand or pea gravel in the bottom of a large, clean, glass jar that has a lid. Cover the gravel with 5 cm of soil.
2. Sprinkle the seeds of two or three kinds of small plants, such as grasses and clovers, onto the surface of the soil. Add about 150 mL of water. Put the lid on the jar loosely, and place the jar in indirect sunlight. Let the jar remain undisturbed for one week.
3. **CAUTION: Handle animals carefully.** Do not allow animals to escape from containers. After one week, place a handful of rolled oats into the jar. Place the mealworms in the oats. Then, place the other animals into the jar, and replace the lid. Place the lid on the jar loosely so that air can enter the jar.

Answer to Form a Hypothesis

Sample answer: The continuous exposure of the ecosystem to bright light will cause an increase in the number of organisms in the ecosystem.

Sample Experiment Design

1. Place the ecosystem near an artificial light that is left on continuously.
2. Continue to add food and moisture to the system as needed. Using a mister, add four squirts of water per square decimeter of soil surface every other day.
3. Record population data every other day for two weeks.

Design an Experiment

4. Work with the members of your lab group to design an experiment that will test the hypothesis that you recorded previously. Design your experiment to use the ecosystem model that you built.
5. Write a procedure for your experiment. Make a list of all of the safety precautions that you will take. Have your teacher approve your procedure and safety precautions before you begin the experiment.
6. Set up your group's experiment. Conduct your experiment for at least 14 days.

Cleanup and Disposal

7. Dispose of solutions, broken glass, and other materials in the designated waste containers. Do not put lab materials in the trash unless your teacher tells you to do so.
8. Clean up your lab materials according to your teacher's instructions. Wash your hands before you leave the lab.

Analyze and Conclude

1. **Summarizing Results** Make graphs showing how the number of individuals of each species in your ecosystem changed over time. Be sure to count both plants and animals. Plot time on the *x*-axis and the number of organisms on the *y*-axis.
2. SCIENTIFIC METHODS **Analyzing Data** Compare your results with your hypothesis. Explain any differences.
3. **Inferring Conclusions** Construct a food web for the ecosystem that you observed.
4. SCIENTIFIC METHODS **Recognizing Relationships** Does your ecosystem model resemble a natural ecosystem? Explain your answer.
5. **Analyzing Methods** How can you build an ecosystem model that better represents a natural ecosystem?
6. **Critiquing Models** Was your ecosystem model truly a closed ecosystem? List your model's strengths and weaknesses as a closed ecosystem.
7. **Analyzing Data** List the biotic and abiotic factors in your ecosystem model.

SCILINKS
www.scilinks.org
Topic: Ecosystems
Code: HK80466

Extensions

8. **Further Inquiry** Write a new question to explore with another investigation using an ecosystem model.
9. **Making Comparisons** Use the library or Internet to learn about Biosphere 2. What problems did the Biosphere 2 crew encounter during the 1991–1993 project?

Answers to Analyze and Conclude

1. Students should make one graph for each species or use different colors to indicate each species.
2. Answers will vary.
3. Answer will vary. All plants are producers; earthworms feed on dead plant material; crickets feed on plants; mealworms (beetle larvae) feed on plants; isopods eat wood.
4. Yes and no. Both contain organisms at several trophic levels, have biotic and abiotic factors, and depend on the sun for energy. The model ecosystem is less diverse, younger, and has more definite boundaries than a natural ecosystem.
5. Answers will vary.
6. No. Strengths: Organisms in the model did not leave the ecosystem; outside organisms could not enter. Weaknesses: Water and air had to be added to maintain a healthy ecosystem.
7. Sample answer: The biotic factors were the animals and plants. The abiotic factors were water, soil, glass jar, air, and sunlight.

Answers to Extensions

8. Answers will vary. Sample answer: What are the effects of temperature on organisms in an ecosystem?
9. Biosphere 2 is a 204,000 m^3 glass-and-steel structure containing seven artificial ecosystems near Tucson, Arizona. The structure has been used for research on the biosphere. Problems included significant drops in oxygen levels. Most vertebrate species and insect pollinators died.

Key Resources

- Holt Lab Generator
- Lab Datasheet (Levels A, B, C)
- Holt Science Biology Video Labs
- Virtual Investigations

Chapter 4

SUPER SUMMARY

Have students connect the major concepts in this chapter through an interactive Super Summary. Visit **go.hrw.com** and type in keyword **HX8ECOS** to access the Super Summary for this chapter.

Reteaching Key Ideas

Succession Show students a picture of a forest ecosystem. Have them describe the events that would take place after a fire there. LS Visual

Food Webs and Energy Pyramids Have students construct a food web and energy pyramid for a particular area. Ask students to identify producers, consumers, decomposers, herbivores, carnivores, and omnivores. LS Visual

A World Without Fungi or Bacteria Ask students to write a short essay describing what the world would be like without fungi or bacteria. LS Verbal

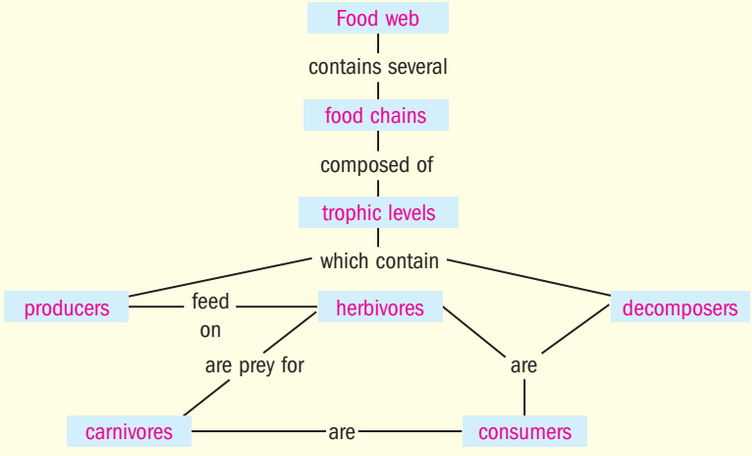
Chapter 4 Summary

go.hrw.com
SUPER SUMMARY
Keyword: HX8ECOS

Key Ideas	Key Terms
1 What Is an Ecosystem? › An ecosystem is a community of organisms and their abiotic environment. › An ecosystem responds to change in such a way that the ecosystem is restored to equilibrium. › Two key factors of climate that determine biomes are temperature and precipitation. › Earth's major terrestrial biomes can be grouped by latitude into tropical, temperate biomes, and high-latitude. › Aquatic ecosystems are organized into freshwater ecosystems, wetlands, estuaries, and marine ecosystems. 	**community** (79) **ecosystem** (79) **habitat** (80) **biodiversity** (80) **succession** (81) **climate** (82) **biome** (82)
2 Energy Flow in Ecosystems › In an ecosystem, energy flows from the sun to producers to consumers to decomposers. › Energy is stored at each link in a food web, but some energy that is used dissipates as heat into the environment and is not recycled. 	**producer** (86) **consumer** (86) **decomposer** (86) **trophic level** (86) **energy pyramid** (89)
3 Cycling of Matter › The water cycle is the continuous movement of water between the atmosphere, the land, and the oceans. › Animals, plants, and other photosynthesizing organisms play an important role in cycling carbon and oxygen through an ecosystem. › Nitrogen must be cycled through an ecosystem so that the nitrogen is available for organisms to make proteins. › Like water, carbon, oxygen, and nitrogen, phosphorus must be cycled in order for an ecosystem to support life.	**carbon cycle** (91) **respiration** (91) **nitrogen cycle** (92) **phosphorus cycle** (93)

Answer to Concept Map

The following is one possible answer to Chapter Review question 2.



Chapter 4 Review

READING TOOLBOX

1. **Layered Book** Create the layered book FoldNote. Use the layered book to summarized the information you learned in this chapter.
2. **Concept Map** Make a concept map that describes the flow of energy through an ecosystem. Try to include the following terms: *trophic level, food web, food chain, producer, consumer, carnivore, decomposer,* and *herbivore.*

Using Key Terms

Use each of the following terms in a separate sentence.

3. *respiration*
4. *biodiversity*
5. *decomposer*

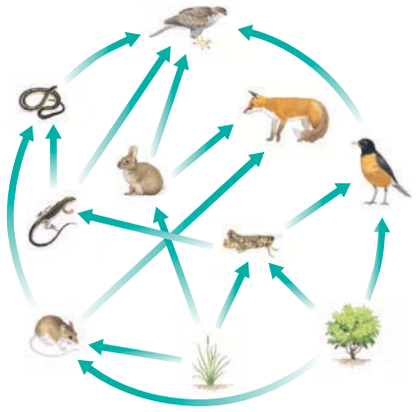
For each pair of terms, explain how the meanings of the terms differ.

6. *climate* and *biome*
7. *ecosystem* and *community*
8. *producer* and *consumer*

Understanding Key Ideas

9. Which of the following is a biotic factor?
   - **a.** rainfall
   - **b.** predators
   - **c.** air temperature
   - **d.** the availability of nitrogen
10. Which kind of organism converts the sun's energy into energy that can be used to grow?
    - **a.** consumers
    - **b.** producers
    - **c.** omnivores
    - **d.** decomposers
11. Which of the following biomes has a wide range of temperatures and is located at mid-latitudes?
    - **a.** taiga
    - **b.** savanna
    - **c.** temperate forest
    - **d.** tropical rain forest
12. Which of the following is not a step in the nitrogen cycle?
    - **a.** nitrification
    - **b.** denitrification
    - **c.** percolation
    - **d.** ammonification
13. Which of the following processes describes the loss of water from leaves to the atmosphere?
    - **a.** transpiration
    - **b.** condensation
    - **c.** precipitation
    - **d.** percolation
14. What percentage of the energy in a rabbit is stored in a coyote that eats the rabbit?
    - **a.** 0%
    - **b.** 10%
    - **c.** 90%
    - **d.** 100%

Use the diagram to answer the following question(s).



15. How would this food web be affected if the plants were eliminated?
    - **a.** Herbivores would become carnivores.
    - **b.** The herbivores would move to another trophic level.
    - **c.** The carnivores would survive, but the herbivores would not survive.
    - **d.** The herbivores would die because of the lack of food. Then, the rest of the animals would die because of the loss of the herbivores.

Explaining Key Ideas

16. **Describe** what eventually happens to the pioneer species in an ecosystem.
17. **Summarize** the steps of energy flow through an ecosystem by creating food chain diagram.
18. **Explain** the process of nitrogen fixation, and describe where it occurs.

Assignment Guide

Section	Questions
1	1, 4, 6, 7, 9, 11, 16, 20, 23, 24, 28, 29, 30
2	1, 2, 5, 8, 10, 14, 15, 17, 19, 21, 25, 27, 32
3	1, 3, 12, 13, 18, 22, 26, 31

Review

Reading Toolbox

1. Answers may vary. Students may summarize one section of the chapter for each page of the layered book.
2. See previous page for answer to concept map.

Using Key Terms

3. *Respiration* is part of the carbon cycle and oxygen cycle.
4. The higher the *biodiversity* of an ecosystem, the more likely the ecosystem will recover from change.
5. *Decomposers* get energy from dead organisms.
6. *Climate* is an area's average weather conditions over a long period. A *biome* is a large region characterized by a specific type of climate and certain types of organisms.
7. An *ecosystem* is a community and its physical environment. A *community* is all the organisms in an area that live together and interact.
8. A *producer* makes its own food with energy from the sun. A *consumer* gets energy by eating producers or other consumers.

Understanding Key Ideas

9. b 10. b 11. c 12. c
13. a 14. b 15. d

Explaining Key Ideas

16. New species will replace pioneer species because the new species outcompete the pioneer species.
17. Producers obtain energy from the sun. The energy in the producer is then passed to a consumer when the consumer eats the producer. The energy is further passed to other consumers in a food chain as one organism eats another.
18. Nitrogen fixation is the reaction of nitrogen with hydrogen to form ammonia. Nitrogen is fixed by bacteria that live in soil.

Interpreting Graphics

19. c
20. about 12°C

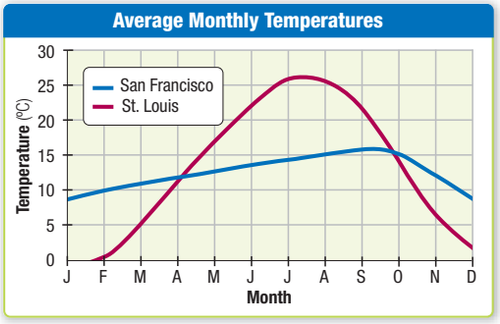
Using Science Graphics

Use the diagram of the food chain to answer the following question(s).

19. Which organisms are consumers?

- **a.** the leaf and bird
- **b.** the tree and leaf
- **c.** the bird and caterpillar
- **d.** the tree and caterpillar

Use this diagram to answer the following question(s).



20. Estimate the difference between the average temperatures of San Francisco and St. Louis in July.

Critical Thinking

21. Predicting Outcomes What would happen to an ecosystem if all of the decomposers disappeared?

22. Analyzing Processes Which component of the carbon cycle removes carbon dioxide from the atmosphere?

23. Drawing Conclusions Why might wetlands be considered economically and environmentally important?

24. Evaluating Information For deciduous trees, compare the benefits and possible disadvantages of shedding leaves in the fall.

25. Forming Reasoned Opinions A friend says that the idea of food chains is silly because almost no ecosystems have simple food chains. Is your friend correct? Explain why or why not.

26. Forming Hypotheses Speculate what might happen to a plant if you sprinkle some nitrogen in a usable form on the soil near the plant.

Writing for Science

27. Advertisement Create an ad explaining how understanding the flow of energy through an ecosystem can help humans feed more people or put less pressure on ecosystems.

Methods of Science

28. Designing an Investigation You are asked to determine the biodiversity inside a local park. How will you measure the park's biodiversity? Explain why you chose this particular method.

Alternative Assessment

29. Research Find information about organisms that live in marine ecosystems. Compare deep-sea organisms with organisms that live near the surface. What are the major abiotic factors that influence the organisms at particular depths? Why don't animals near the surface also live deep below the surface? What is the source of food for animals in the deep sea?

30. Nature Study Spend the afternoon at a park. For every organism that you see, write down what the organism is and how it gets its energy (a butterfly, for example, is a herbivore that gets its energy from flowers). Create two bar graphs. Make one show the number of species in each trophic level and the other show the number of individuals for each trophic level. Explain the patterns that you find.

31. Research Find information on the eutrophication of freshwater ecosystems. Write an essay explaining what happens during this process and how the disruption of the phosphorus cycle affects the ecosystem.

Math Skills

32. Energy Pyramid Assume that 1 energy unit is required to support a great white shark. If an ecosystem has 1,000,000 units of energy at the phytoplankton level, how many great white sharks could this ecosystem support?

Critical Thinking

21. Nutrients would not be cycled through the ecosystem, and dead bodies would pile up. Organisms in the ecosystem would die or move to another ecosystem.

22. photosynthesis

23. Freshwater wetlands act as filters to clean pollutants out of water that flows through them.

24. Trees conserve water by shedding their leaves, but the energy and materials that went into growing and maintaining the leaves is lost.

25. The friend is correct. Most consumers feed on multiple trophic levels, and omnivores can eat both consumers and producers. Most communities are food webs, not food chains.

26. The plant would probably grow more quickly because the growth of many plants is limited by the availability of nitrogen.

Writing Skills

27. Advertisements will vary, but should stress the value of selecting foods that are lower on the food pyramid. Students should support their ideas with facts from the chapter.

Methods of Science

28. Answers will vary. Accept all answers that can be supported with logical reasoning.

Alternative Assessment

29. Abiotic factors that affect organisms at various ocean depths include sunlight, temperature, and water pressure. Organisms are adapted to the conditions of the ocean depth where they live. Some deep-sea organisms get food by eating materials that sink from above. Others are part of a food web that relies on chemosynthetic organisms as producers.

30. Answers will vary depending on organisms in the park. Students should note food chains.

31. Phosphorus can enter fresh water in sewage that contains detergents with phosphates. The phosphates stimulate algal growth, which can lead to oxygen deprivation in the water and result in fish kills.

Math Skills

32. The great white shark is four levels from the base of the pyramid representing phytoplankton. Thus, with 1,000,000 energy units at the base of the pyramid, there would be 100 units at the top of the pyramid. $(1 \times 10^{6})(1 \times 10^{-4}) = 1 \times 10^{2} = 100$ energy units available. If each shark needs one energy unit, the ecosystem can support 100 sharks.

Chapter 4 Standardized Test Prep

TEST TIP For multiple-choice questions, try to eliminate any answer choices that are obviously incorrect. Then, consider the remaining answer choices.

Science Concepts

1. Which of the following is an abiotic factor?
- **A** the presence of ample food
- **B** the presence of trees where birds can nest
- **C** the presence of strong currents around a reef
- **D** the presence of a cleaner shrimp that can help fish get rid of parasites

2. Which of the following biomes is the coldest and driest biome?
- **F** taiga
- **G** tundra
- **H** savanna
- **J** desert

3. In what form is carbon released during respiration?
- **A** calcium carbonate
- **B** carbon dioxide
- **C** carbohydrate
- **D** water vapor

4. Where do animals get their supply of phosphorus?
- **F** plants
- **G** water
- **H** soil
- **J** the atmosphere

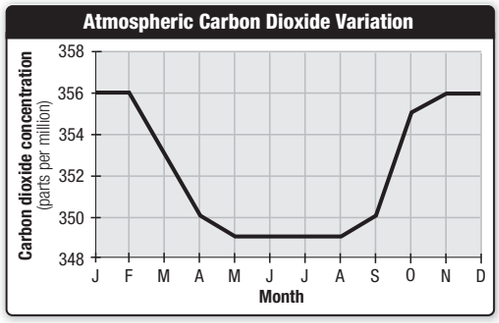
5. Which of the following situations describes a carnivore and a herbivore?
- **A** A horse eats an apple.
- **B** A rabbit eats a dandelion.
- **C** A mountain lion eats a rabbit.
- **D** A fungus breaks down a dead oak tree.

6. Which term applies to most humans?
- **F** herbivore
- **G** carnivore
- **H** omnivore
- **J** decomposer

7. Which of the following does not fix nitrogen?
- **A** trees
- **B** lightning
- **C** bacteria
- **D** burning fuels

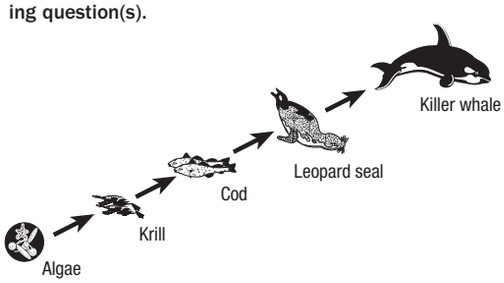
Using Science Graphics

Use the diagram to answer the following question(s).



8. During which of the following months is the rate of photosynthesis greatest?
- **F** January
- **G** March
- **H** May
- **J** September

Use the diagram of a food chain to answer the following question(s).



9. What is the role of the krill in this food chain?
- **A** producers
- **B** consumers
- **C** detritivores
- **D** decomposers

Writing Skills

10. Creative Writing Write a short story about an old abandoned farm that experiences succession over a 70-year period.

Answers

1. C	**2.** G	**3.** B
4. F	**5.** C	**6.** H
7. A	**8.** H	**9.** B

10. Answers will vary, but should describe gradual physical changes in the farmland over a 70-year period.

TEST DOCTOR

Question 2 **F.** Incorrect. A taiga biome is cold and damp. **G.** Correct. The tundra is the coldest and driest biome. **H.** Incorrect. A savanna is a tropical or subtropical grassland. **J.** Incorrect. Desert biomes are dry, but not cold.

Question 5 **A.** Incorrect. A horse is an herbivore, and an apple is the fruit of a producer. **B.** Incorrect. A rabbit is an herbivore, and the dandelion is a producer. **C.** Correct. A mountain lion is a carnivore, and the rabbit is an herbivore. **D.** Incorrect. A fungus is a decomposer, and the dead tree was a producer.

Question 9 **A.** Incorrect. Algae are considered a producer in the food chain. **B.** Correct. Krill feed on and consume algae. **C.** Incorrect. Detritivores are consumers of dead organic material (detritus.) **D.** Incorrect. Decomposers break down dead and decaying organisms.

State Resources

For specific resources for your state, visit go.hrw.com and type in the keyword **HSHSTR**.

Test Practice with Guided Reading Development