CHAPTER 4 Ecosystems

## What Is an Ecosystem?

#### **KEY IDEAS**

#### As you read this section, keep these questions in mind:

- 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?

### What Makes Up an Ecosystem?

Every living thing is part of a community. A **community** is a group of species that live in the same area and interact with each other. For example, a community in a forest may include trees, birds, and other organisms.

A community and its nonliving environment make up an **ecosystem**. Ecosystems contain both *biotic factors*, or living things, and *abiotic factors*, or nonliving things.  $\checkmark$ 

Biotic factors include both living things and once-living things, such as dead organisms. Abiotic factors include nonliving things, such as air, water, rocks, sunlight, temperature, and climate.



Ecosystems, such as the one shown here, have both living and nonliving factors.

#### BIODIVERSITY

Ecosystems contain different organisms. The variety of organisms in a given area is called **biodiversity**. Some ecosystems have greater biodiversity than others. For example, a tropical rain forest has a greater variety of organisms than a desert.

#### **READING TOOLBOX**

**Organize** As you read this section, create a Concept Map using the following vocabulary terms: ecosystem, community, succession, biome.

### READING CHECK

**1. Identify Relationships** How is a community related to an ecosystem?

### LOOKING CLOSER

**2. List** Name three biotic and three abiotic factors in the ecosystem in this picture.

## Talk About It

**Discuss** What can cause an ecosystem to change? In groups of two or three, discuss different factors or events that can change an ecosystem.

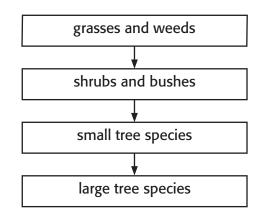
### How Do Ecosystems Respond to Change?

All ecosystems change. As an ecosystem changes, the community of organisms that lives in it changes. **Succession** is the replacement of one kind of community by another at a single place over a period of time.

An ecosystem responds to change by restoring equilibrium. When a major change happens in an ecosystem, many organisms may die. However, this creates an opportunity for new organisms to replace them.

A place where an organism lives is called its **habitat**. Changes in ecosystems create new habitats. The first organisms to appear in a new habitat are called *pioneer species*. Pioneer species are often small, fast-growing plants. Pioneer species may change a habitat and make it possible for other organisms to live there.

For example, after a forest fire, grasses and weeds may appear first. They enrich the soil, which allows shrubs and bushes to grow. Eventually, these shrubs and bushes replace the grasses and weeds. As succession proceeds, other species replace the shrubs and bushes. Eventually, the forest may be restored. The flow chart below shows an example of succession after a forest fire.



### LOOKING CLOSER

**3. Identify** Which types of organisms in the diagram are the pioneer species?



**4. Describe** How are biomes defined?

### What Is a Biome?

Every ecosystem is part of a biome. A **biome** is a large region that has certain weather conditions and certain kinds of organisms. The weather conditions in an area over a long period of time make up its **climate**. Scientists define biomes based on the average temperature and precipitation of their climate.  $\checkmark$ 

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SECTION 1 What Is an Ecosystem? continued

#### TERRESTRIAL BIOMES

The latitude of a *terrestrial*, or land, biome affects how much energy it receives from the sun. Therefore, latitude affects a biome's average temperature.

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Scientists classify Earth's terrestrial biomes into three major groups based on latitude: tropical, highlatitude, and temperate. Tropical biomes are near the equator. *High-latitude* biomes are near the polar regions. *Temperate* biomes are at latitudes between tropical biomes and high-latitude biomes.

Each biome group contains several biomes. The chart below lists the climates that are characteristic of these terrestrial biomes.

Biome Group	Biome	Climate
Tropical	tropical rain forest	warm; rainy
	savanna	warm; dry and wet seasons
	tropical desert	warm; dry
Temperate	temperate grassland	cool; moderate precipitation
	temperate forest	mild; rainy
	temperate desert	wide temperature range; dry
High-latitude	taiga	cold; wet
	tundra	very cold; dry

### Background

Recall that *latitude* describes how far north or south of the equator a place on Earth is.

### Critical Thinking

5. Infer Which major biome group is most of the United States part of?

ome Group	Biome	Climate	
opical	tropical rain forest	warm; rainy	L
	savanna	warm; dry and wet seasons	6
	tropical desert	warm; dry	cl
mperate	temperate grassland	cool; moderate precipitation	ai di
	temperate forest	mild; rainy	
	temperate desert	wide temperature range; dry	
gh-latitude	taiga	cold; wet	
	tundra	very cold; dry	

### OOKING CLOSER

. Compare How do the limates of a tropical desert and a temperate desert liffer?

### What Is an Aquatic Ecosystem?

The communities found in Earth's bodies of water belong to aquatic ecosystems. There are four types of aquatic ecosystems:

- Freshwater ecosystems include lakes, ponds, and rivers. They are habitats for a variety of plants, animals, and other organisms.
- *Wetlands* are the areas that link land and aquatic habitats. They support many species of birds, fish, plants, and other organisms. They also help control flooding.
- *Estuaries* are areas where fresh water from a river mixes with salty water from an ocean. They are productive ecosystems because they contain many nutrients.
- *Marine ecosystems* are made up of the salty water of the oceans. They stretch from the open ocean waters to the shore and support a variety of organisms.  $\mathbf{V}$

**READING CHECK** 

7. Identify What are two aquatic ecosystems that contain salt water?

**Section 1 Review** 

#### SECTION VOCABULARY

<ul> <li><b>biodiversity</b> 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</li> <li><b>biome</b> a large region characterized by a specific type of climate and certain types of plant and animal communities</li> <li><b>climate</b> the average weather conditions in an area over a long period of time</li> </ul>	<ul> <li>community a group of various species that live in the same habitat and interact with each other</li> <li>ecosystem a community of organisms and their abiotic environment</li> <li>habitat the place where an organism usually lives</li> <li>succession the replacement of one type of community by another at a single location over a period of time</li> </ul>
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**1. Identify** What two types of factors make up an ecosystem?

**2. Describe** How does an ecosystem restore equilibrium after a major change?

**3. Compare** Explain how the location and temperature of a high-latitude biome is different from the location and temperature of a tropical biome.

- **4. Identify** What are the two major components of climate?
- **5. Predict** Suppose you relocate a fish from a freshwater ecosystem to a marine ecosystem. What abiotic factor in the marine ecosystem will most likely make it hard for the fish to survive?

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CHAPTER 4 Ecosystems

## **Energy Flow in Ecosystems**

#### **KEY IDEAS**

#### As you read this section, keep these questions in mind:

- How does energy flow through an ecosystem?
- How is energy transferred between trophic levels in a community?

# How Does Energy Flow Through an Ecosystem?

Every living thing needs energy to survive. The primary source of energy in an ecosystem is the sun. Plants and algae use energy from sunlight to carry out photosynthesis. During *photosynthesis*, light energy from the sun is changed into chemical energy. Organisms that carry out photosynthesis are called **producers**. Producers are the basic food source for an ecosystem.

Organisms that eat other organisms instead of making their own food are called **consumers**. A consumer that eats mostly producers is a *herbivore*. Cows are herbivores because they eat grasses. A consumer that eats mostly animals is a *carnivore*. Hawks are carnivores because they eat small animals. A consumer that eats both plants and animals is an *omnivore*. Bears are omnivores because they eat animal meat and plant berries.

Organisms that break down the remains of plants and animals are called **decomposers**. Bacteria and fungi are examples of decomposers. In an ecosystem, energy flows from the sun to producers to consumers to decomposers. Each step in this flow of energy is called a **trophic level**.

#### FOOD CHAINS AND FOOD WEBS

The flow of energy from one trophic level to the next is called a *food chain*. The following diagram is an example of a food chain.

	plants		caterpillars	►	blue jays
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A food chain does not usually show all the feeding relationships in an ecosystem. This is because most organisms eat different types of food. Different organisms may also eat the same type of food. As a result, in most ecosystems, several food chains join to form a *food web*.

#### READING TOOLBOX

**Apply Concepts** After you read this section, construct a food chain with three or four trophic levels. Include yourself at the end of the food chain.

## Talk About It

**Discuss** With a partner, identify as many consumers as you can. Discuss whether the consumers are herbivores, carnivores, or omnivores.

### LOOKING CLOSER

**1. Identify** Which type of organism in this food chain uses energy from the sun to make food?

### READING CHECK

**2. Describe** What happens to the energy not stored in an organism's body?



**3. Calculate** A blue jay obtains 100 energy units from eating caterpillars. About how much of this energy will it store in its body?

### LOOKING CLOSER

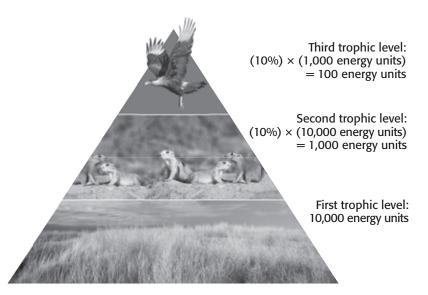
**4. Explain** Why is the base of the energy pyramid wider than the top?

### What Is an Energy Pyramid?

Organisms get energy from the food they eat. However, most of this energy does not stay in the organism. When a zebra eats grass, it uses most of the energy from the grass to grow, run, and even sleep. The energy the zebra uses changes into heat. Heat energy is released into the environment. The zebra's body stores some energy from the grass in compounds such as fat.  $\checkmark$ 

An organism uses up approximately 90% of the energy it gets from a lower trophic level. About 10% of the energy an organism gets from a lower trophic level is stored in its body. That means only 10% of the energy from one trophic level is available to the next.

This loss of usable energy through trophic levels is often shown as an **energy pyramid** like the one below. Each layer in an energy pyramid represents one trophic level. The bottom layer represents the first trophic level, the producers. This level contains the most energy in the pyramid. The top of the pyramid represents the highest trophic level, consumers. The organisms in the highest trophic level contain the least energy in the pyramid.



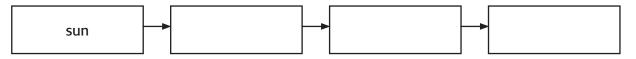
In an ecosystem, there are fewer organisms at the top of an energy pyramid than at the bottom. This is because usable energy is lost at each trophic level. In addition, those at the top usually require more energy to function.

## **Section 2 Review**

#### **SECTION VOCABULARY**

<ul> <li>consumer an organism that eats other organisms or organic matter instead of producing its own nutrients or obtaining nutrients from inorganic sources</li> <li>decomposer an organism that feeds by breaking down organic matter from dead organisms; examples include bacteria and fungi</li> <li>energy pyramid a triangular diagram that shows an ecosystem's loss of energy, which results as energy passes through the ecosystem's food chain; each row in the pyramid represents a trophic (feeding) level in an ecosystem, and the area of a row represents the energy stored in that trophic level</li> </ul>	<ul> <li><b>producer</b> an organism that can make organic molecules from inorganic molecules; a photosynthetic or chemosynthetic autotroph that serves as the basic food source in an ecosystem</li> <li><b>trophic level</b> one of the steps in a food chain or food pyramid; examples include producers and primary, secondary, and tertiary consumers</li> </ul>
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**1. Summarize** Fill in the generalized food chain to show how energy flows through an ecosystem. Use words from the vocabulary list above.



- 2. Compare What is the difference between an omnivore and a herbivore?
- **3. Explain** Why is there more energy in the bottom trophic level of an energy pyramid than in the next highest trophic level?
- **4. Identify** Name two types of organisms that are decomposers.
- **5. Calculate** A lion stores 100 energy units after eating zebra meat from the trophic level below it. How many energy units did the zebra meat have?

### KEY IDEAS

#### As you read this section, keep these questions in mind:

• What is the water cycle?

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• Why are plants and animals important for carbon and oxygen in an ecosystem?

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- Why must nitrogen cycle through an ecosystem?
- Why must phosphorus cycle through an ecosystem?

#### **READING TOOLBOX**

**Diagram** As you read about each cycle, create your own diagram to summarize what happens. Include all the processes of the cycle.

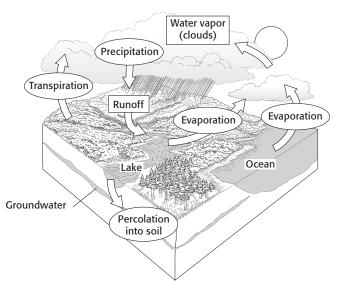


**1. Describe** What happens when water vapor in the atmosphere condenses?

### How Does Water Cycle in Nature?

All living things need water to survive. Water is continuously cycled on Earth between the atmosphere, the land, and the oceans. This is known as the *water cycle*.

Water vapor in the atmosphere *condenses* and falls to Earth as *precipitation*. This water *percolates* into the soil and runs into rivers, lakes, and oceans. Water re-enters the atmosphere by *evaporation* and *transpiration*.  $\mathbf{N}$ 



Water cycles through an ecosystem.

Processes that Are Part of the Water Cycle	
Process	Description
Condensation	Water vapor in the air cools and becomes liquid.
Precipitation	Water falls to Earth as rain, snow, hail, or sleet.
Percolation	Water enters the soil and becomes groundwater.
Evaporation	Liquid water warms and forms water vapor.
Transpiration	Water vapor evaporates from plants.

LOOKING CLOSER

**2. Examine** What happens to water that falls to Earth as precipitation and does not percolate into the soil?

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SECTION 3 Cycling of Matter continued

## How Do Carbon and Oxygen Cycle in Nature?

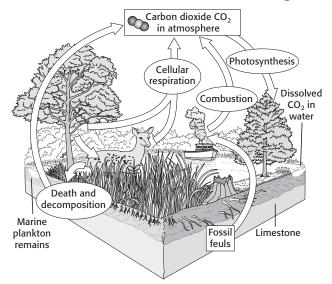
The movement of carbon in nature is called the **carbon cycle**. Carbon can be cycled in the form of carbon dioxide,  $CO_2$ . Oxygen,  $O_2$ , is moved through ecosystems in the *oxygen cycle*. The carbon cycle and the oxygen cycle are closely linked.

Class

Plants and animals play an important role in cycling carbon and oxygen through an ecosystem. Plants use  $CO_2$  to make food during photosynthesis. They also release  $O_2$  into the atmosphere during photosynthesis.

Both plants and animals carry out respiration. **Respiration** is the exchange of  $O_2$  and  $CO_2$  between organisms and their environment. During respiration, plants and animals use  $O_2$  to obtain the energy stored in food. Respiration releases  $CO_2$  into the atmosphere.

Combustion is the burning of a substance, such as a fossil fuel. Burning coal or oil uses  $O_2$  and releases  $CO_2$ . Decomposition also releases  $CO_2$  into the atmosphere. Recall that decomposers break down dead organisms. Decomposition of organic matter releases  $CO_2$ .



Carbon and oxygen cycle through an ecosystem.

Processes that Are Part of the Carbon and Oxygen Cycles		
Process	Description	
Photosynthesis	uses	and releases
Respiration	uses	and releases
Combustion	uses	and releases
Decomposition	releases	

### \_\_\_\_\_

oxygen cycles?

**READING CHECK** 

3. Explain How do plants

contribute to the carbon and

#### **LOOKING CLOSER 4. List** Name three

processes that release carbon dioxide into the atmosphere.

### LOOKING CLOSER

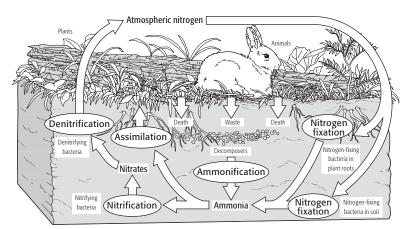
**5. Identify** Fill in the blanks in the table using  $CO_2$  (for carbon dioxide) and  $O_2$  (for oxygen).

#### SECTION 3 Cycling of Matter continued

### How Does Nitrogen Cycle in Nature?

All organisms need nitrogen to live, because they use it to build proteins. The **nitrogen cycle** is the movement of nitrogen between organisms and their environment.

Organisms cannot use the nitrogen gas in the atmosphere directly. They need the help of bacteria. Bacteria convert nitrogen gas into usable forms, such as ammonia and nitrates. The table below describes the processes of the nitrogen cycle.  $\mathbf{V}$ 



Nitrogen cycles through an ecosystem.

Processes that Are Part of the Nitrogen Cycle		
Process	Description	
Nitrogen fixation	Bacteria change nitrogen gas into ammonia.	
Ammonification	Bacteria change nitrogen from animal waste or decaying organic matter into ammonia and return it to the soil.	
Nitrification	Bacteria change ammonia into nitrates.	
Assimilation	Plants get nitrogen by absorbing nitrates or ammonia.	
Denitrification	Bacteria convert nitrates into nitrogen gas.	

### READING CHECK

**6. Identify Relationships** How do bacteria help organisms use nitrogen?

### **Critical ThinKing**

**7. Infer** How do animals get nitrogen?

### LOOKING CLOSER

**8. Identify** What process recycles nitrogen to the atmosphere as nitrogen gas?

### How Does Phosphorus Cycle in Nature?

The **phosphorus cycle** is the movement of phosphorus between organisms and their environment. Plants absorb and use phosphorus from the soil as phosphate. Animals that eat plants reuse phosphorus. When plants and animals die, decomposers return phosphorus to the soil.

## **Section 3 Review**

#### SECTION VOCABULARY

<ul> <li>carbon cycle the movement of carbon from the nonliving environment into living things and back</li> <li>nitrogen cycle the cycling of nitrogen between organisms, soil, water, and the atmosphere</li> </ul>	<ul> <li><b>phosphorus cycle</b> the cyclic movement of phosphorus in different chemical forms from the environment to organisms and then back to the environment</li> <li><b>respiration</b> in biology, the exchange of oxygen and carbon dioxide between living cells and their environment; includes breathing and cellular respiration</li> </ul>
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**1. Describe** What role does precipitation play in the water cycle?

2. Predict How might an increase in the burning of fossil fuels affect the carbon cycle?

**3. Explain** What role do decomposers play in the phosphorus cycle?

- **4. Compare** How are the processes of nitrogen fixation and denitrification different?
- **5. Predict** If nitrogen-fixing bacteria did not exist in an ecosystem, what would organisms be unable to make?

**6.** Compare How are photosynthesis and respiration different?

7. Compare In the water cycle, what do the processes of transpiration and evaporation have in common?