CHAPTER

14 Ecosystems and Biomes

the BIG idea

Matter and energy together support life within an environment.

Key Concepts

SECTION 1 **Ecosystems support life.**
Learn about different factors that make up an ecosystem.

SECTION 2 **Matter cycles through ecosystems.**
Learn about the water, carbon, and nitrogen cycles.

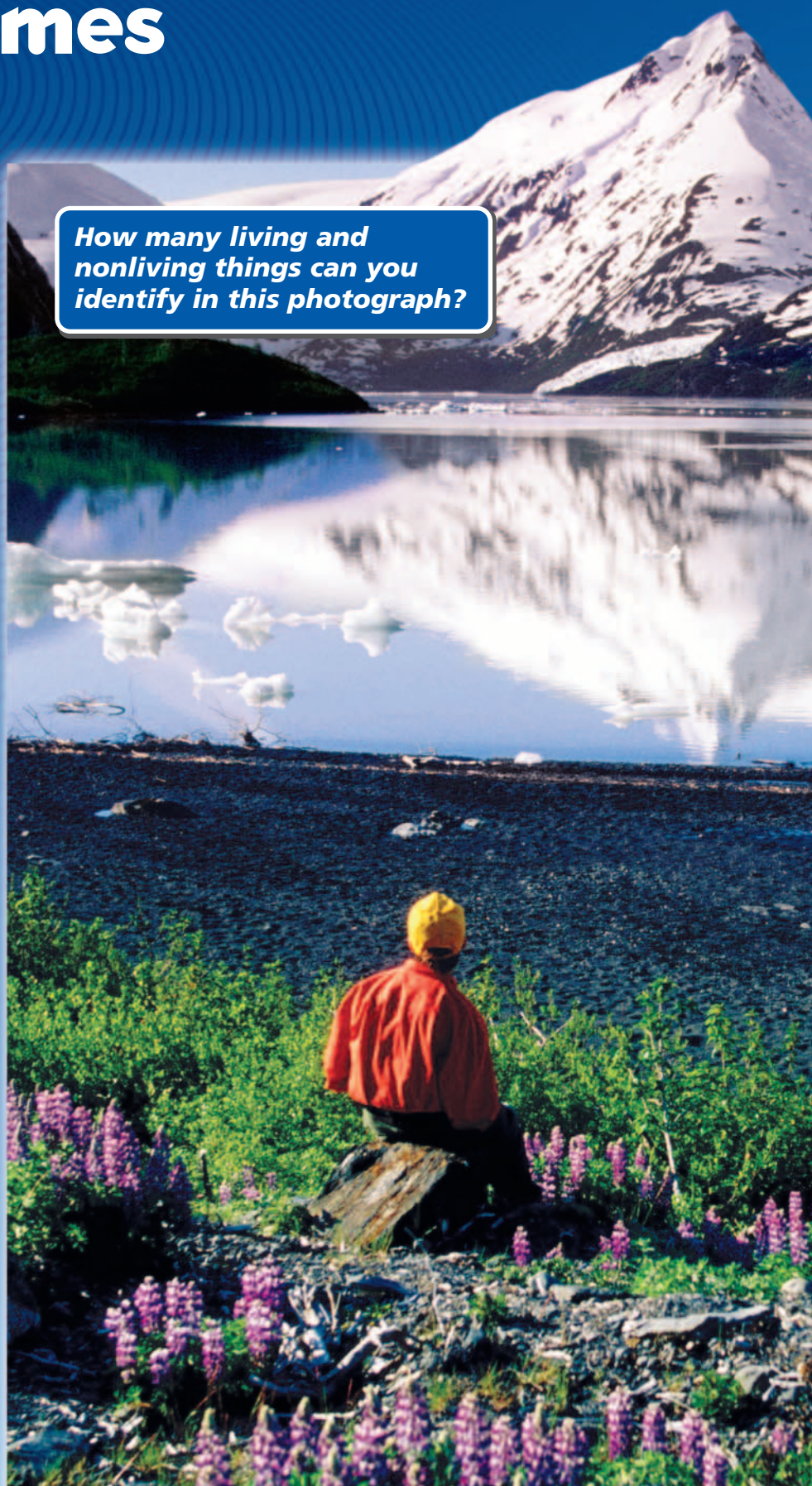
SECTION 3 **Energy flows through ecosystems.**
Learn how energy moves through living things.

SECTION 4 **Biomes contain many ecosystems.**
Learn about different land and water biomes.

FCAT Practice

Prepare and practice for the FCAT
- Section Reviews, pp. 499, 506, 514, 523
- Chapter Review, pp. 524–526
- FCAT Practice, p. 527

CLASSZONE.COM
- Florida Review: Content Review and FCAT Practice



How many living and nonliving things can you identify in this photograph?

EXPLORE the BIG idea

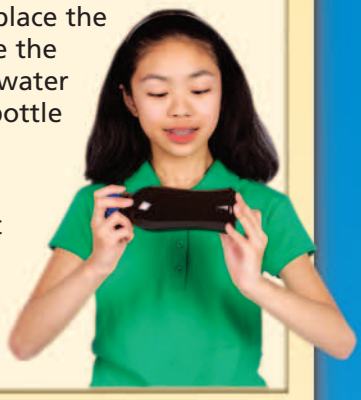
How Do Plants React to Sunlight?

Move a potted plant so that the Sun shines on it from a different direction. Observe the plant each day for a week.

Observe and Think What change do you observe in the plant? What is it that plants get from the Sun?

What Is Soil?

Get a cupful of soil from outside and funnel it into a clear plastic bottle. Fill the bottle two-thirds full with water and place the bottle cap on tightly. Shake the bottle so that the soil and water mix completely. Place the bottle on a windowsill overnight. Wash your hands.



Observe and Think What has happened to the soil and water mixture? How many different types of material do you observe?

Internet Activity: A Prairie Ecosystem

Go to **ClassZone.com** to discover the types of plants and animals best adapted for tall-grass and short-grass prairies. Learn more about how to keep a prairie thriving.

Observe and Think What do all prairie plants have in common? How do prairie plants differ?

NSTA SCILINKS scilinks.org

Food Chains and Food Webs **Code: MDL001**

CHAPTER 14

Getting Ready to Learn

CONCEPT REVIEW

- The natural world that surrounds all living things is called the environment.
- Most living things need water, air, food, and living space.
- All living things need a source of energy to stay alive and grow.

VOCABULARY REVIEW

matter p. 49

photosynthesis p. 230

energy p. 112

See Glossary for definitions.

biology, environment, nutrient, respiration, system

FLORIDA REVIEW
CLASSZONE.COM

Content Review and FCAT Practice

TAKING NOTES

COMBINATION NOTES

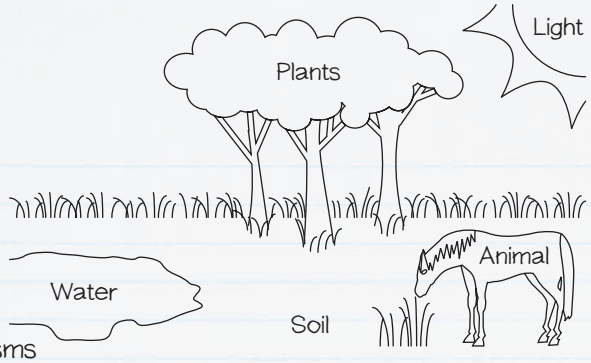
To take notes about a new concept, first make an informal outline of the information. Then make a sketch of the concept and label it so you can study it later.

SCIENCE NOTEBOOK

NOTES

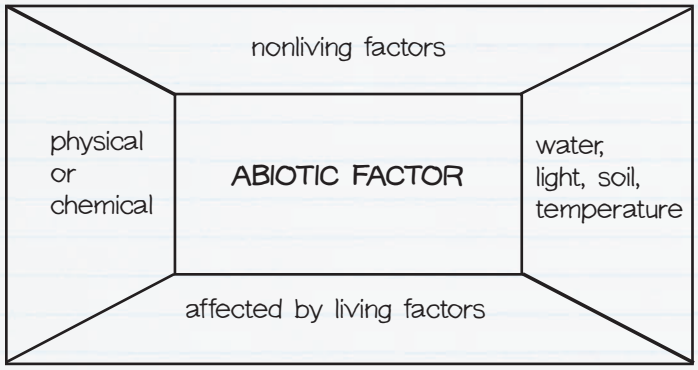
Parts of an ecosystem:

- Animals
- Plants
- Soil
- Water
- Light
- Microorganisms



VOCABULARY STRATEGY

Write each new vocabulary term in the center of a **frame game** diagram. Decide what information to frame the term with. Use examples, descriptions, parts, sentences that use the term in context, or pictures. You can change the frame to fit each item.



See the Note-Taking Handbook on pages R45–R51.

KEY CONCEPT

14.1 Ecosystems support life.

Sunshine State STANDARDS

SC.G.1.3.4: The student knows that the interactions of organisms with each other and with the non-living parts of their environments result in the flow of energy and the cycling of matter throughout the system.

SC.G.2.3.2: The student knows that all biotic and abiotic factors are interrelated and that if one factor is changed or removed, it impacts the availability of other resources within the system.

BEFORE, you learned

- Living things need to obtain matter and energy from the environment
- The Sun provides Earth with light and heat

NOW, you will learn

- What factors define an ecosystem
- About living factors in an ecosystem
- About nonliving factors in an ecosystem

FCAT VOCABULARY

ecosystem p. 495
biotic factor p. 496
abiotic factor p. 496

VOCABULARY

ecology p. 495

EXPLORE Your Environment

How much can temperature vary in one place?

PROCEDURE

1. Choose three different locations inside your classroom where you can measure temperature.
2. Place a thermometer at each location. Wait for at least two minutes. Record the temperatures in your notebook.
3. Compare the data you and your classmates have collected.

MATERIALS

- thermometer
- stopwatch

WHAT DO YOU THINK?

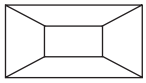
- Which location was the warmest, and which was the coldest?
- Describe what factors may have affected the temperature at each location.

Living things depend on the environment.

You wouldn't find a kangaroo in the Arctic and you won't see a polar bear in Australia. Each of these organisms is suited to a certain environment. The kangaroo and the polar bear are able to survive despite the harsh conditions of their surroundings. **Ecology** is the scientific study of how organisms interact with their environment and all the other organisms that live in that environment.

Scientists use the word **ecosystem** to describe a particular environment and all the living things that are supported by it. An ecosystem can be as small as a pond or as large as a desert. What is important in an ecosystem is how the living parts of the ecosystem relate to the nonliving parts.

VOCABULARY
Add frame game diagrams for *ecology* and *ecosystem* to your notebook.



RESOURCE CENTER
CLASSZONE.COM
Learn more about ecosystems.

Let's take a look at a pond. A pond ecosystem is more than just water and fish. Plants grow in and around the water, and animals feed on these plants. A variety of tiny microorganisms in the water are food for fish and for each other. These are just a few of the living parts, or **biotic factors** (by-AHT-ihk), of a pond ecosystem. The nonliving parts, or **abiotic factors** (AY-by-AHT-ihk), include the air that supplies oxygen and carbon dioxide, the soil that provides nutrients, the water in the pond, and the sunlight that plants need to grow.

CLASSIFY Name three living and three nonliving factors that are part of this pond ecosystem.

Biotic factors interact with an ecosystem.

Living things depend upon an ecosystem for food, air, and water, as well as other things they need for survival. In turn, living things have an impact on the ecosystem in which they live. Plants, as a biotic factor in land ecosystems, affect other biotic and abiotic parts of ecosystems. Plants are an important source of food. The types of plants found in a particular ecosystem will determine the types of animals that can live there. Plants can affect temperature by blocking sunlight. Plant roots hold soil in place. Even the atmosphere is affected by plants taking in carbon dioxide and releasing oxygen.

Animals, as biotic factors, also affect an ecosystem. A beaver that builds a dam changes the flow of a river and so affects the surrounding landscape. Large herds of cattle can overgraze a grassland ecosystem and cause the soil to erode. In an ocean biome, corals form giant reefs that provide food and shelter for marine organisms.

Many abiotic factors affect ecosystems.

Abiotic factors include both the physical and chemical parts of an ecosystem. Physical factors are factors that you can see or feel, such as the temperature or the amount of water or sunlight. Important chemical factors include the minerals and compounds found in the soil and whether the ecosystem's water is fresh or salty. It is the combination of different abiotic factors that determines the types of organisms that an ecosystem will support.

READING TiP
The word *biotic* means "living." The prefix *a-* in *abiotic* means "not," so *abiotic* means "not living."

CHECK YOUR READING List four different abiotic factors that can affect an ecosystem.

Temperature

Temperature is an important abiotic factor in any ecosystem. In a land ecosystem, temperature affects the types of plants that will do well there. The types of plants available for food and shelter, in turn, determine the types of animals that can live there. For example, a tropical rain forest has not only a lot of rain but it has consistently warm temperatures. The wide variety of plants that grow in a tropical rain forest supports a wide variety of monkeys, birds, and other organisms.

Animals are as sensitive to temperature as plants are. Musk oxen with their thick coat of fur can survive in very cold environments, where temperatures of –40°C (–40°F) are normal. The water buffalo, with its light coat, is better suited to warm temperatures. The wild water buffalo lives where temperatures can reach 48°C (118°F).

This musk ox's thick fur keeps it warm in the cold temperatures of northern Canada.

A water buffalo cools itself in a shallow stream during a hot day in India.

READING VISUALS **COMPARE AND CONTRAST** How are these animals alike? How are they different?

COMBINATION NOTES
Remember to make notes and diagrams to show how abiotic factors affect biotic factors in an ecosystem.

Light

You can easily understand how abiotic factors work together when you think about sunlight and temperature. Sunlight warms Earth's surface and atmosphere. In addition, energy from sunlight supports all life on Earth. The Sun provides the energy that plants capture and use to produce food in a process called photosynthesis. The food produced by plants, and other photosynthetic organisms, feeds almost all the other living things found on Earth.

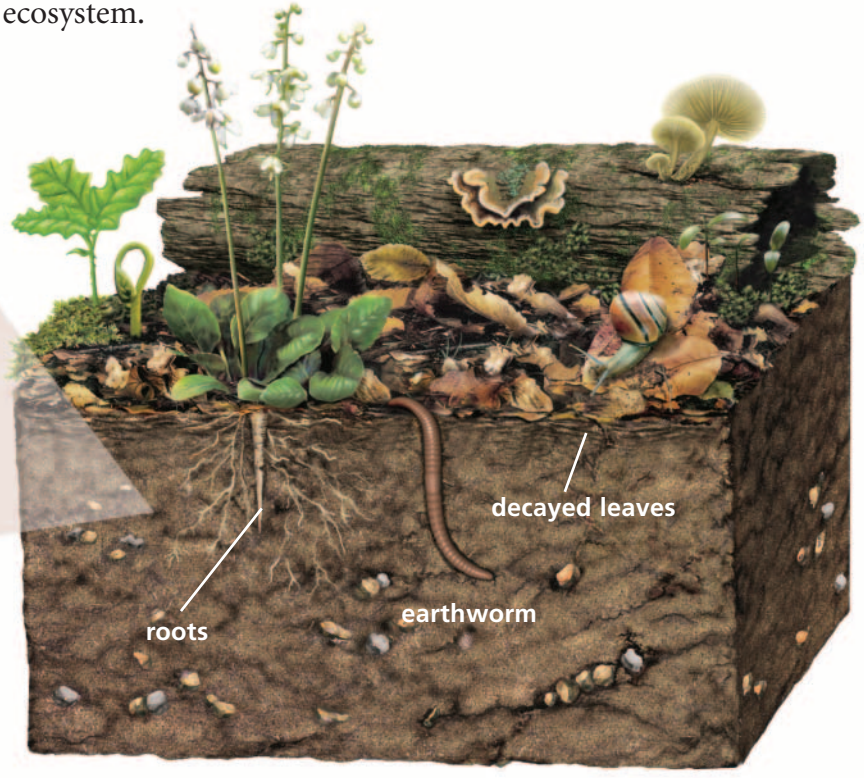
The strength of sunlight and the amount of sunlight available in a land ecosystem determine the types of plants in that ecosystem. A desert ecosystem will have plants like cacti, which can survive where sunlight is very strong. Meanwhile, mosses and ferns grow well on the forest floor, where much of the light is blocked by the trees above.

Light is a factor in ocean ecosystems as well. The deeper the water is, the less light there is available. In the shallow water near the shore, photosynthetic organisms can survive at the surface and on the ocean floor. In the open ocean, light is available for photosynthetic organisms only in the first hundred meters below the surface.

Soil

Soil, which is a mixture of small rock and mineral particles, is an important abiotic factor in land ecosystems. Organisms within the soil break down the remains of dead plants and animals. This process of decay provides important raw materials to the living plants and animals of an ecosystem.

The size of soil particles affects how much air and water the soil can hold.



Different ecosystems have different types of soil. The characteristics of the soil in an ecosystem affect plant growth. Soils that have a lot of decaying, or organic, matter can hold water well and allow air to reach the plant roots. Sandy soils usually do not hold water well because the water flows through too easily. Clay soil, which has small, tightly packed particles, will not allow water to move through easily at all. Minerals in the soil also affect plant growth.

CHECK YOUR READING Explain how soil can affect plant life in an ecosystem.

Water

Another important abiotic factor in land ecosystems is the amount of water available to support life. All living things need water to carry out life processes. Plants need water as well as sunlight for photosynthesis. Animals need water to digest food and release the energy stored in the food. Look at the photograph to see the effect that an underground water source has on an otherwise dry, desert ecosystem. Trees could not survive there without a plentiful supply of water.

Ecosystems that have a lot of water can support a large number of different types of plants. These different types of plants can then support a large number of different types of animals. Tropical rain forests, the wettest of all ecosystems on land, are also the most diverse. Desert ecosystems, which are the driest land ecosystems, have far fewer types of plants and animals. The types and number of living things in a land ecosystem will always be related to the amount of fresh water available for its inhabitants.

INFER An oasis forms in the desert when underground water comes to the surface. How can you identify the boundary of this oasis?

14.1 Review

KEY CONCEPTS

1. Draw a diagram of an ecosystem near where you live. Label the factors "biotic" or "abiotic."
2. Give two examples of how plants and animals affect their environment.
3. Describe how temperature, light, and soil affect an ecosystem.

CRITICAL THINKING

4. **Predict** Think of a forest ecosystem. Now imagine that a large volcanic eruption throws large amounts of dust and ash into the air, blocking out sunlight. How might the forest ecosystem be affected if the sunlight is blocked for a day? For a year?

CHALLENGE

5. **Apply** Think of how you fit into your local environment. List ways in which you interact with biotic and abiotic factors within your ecosystem.

CHAPTER INVESTIGATION

Soil Samples

OVERVIEW AND PURPOSE Nonliving, or abiotic, factors all have an effect on soil. The quality of the soil affects how well plants grow in a particular environment. In this investigation, you will

- observe and record how water travels through three soil samples
- predict how different types of soil would affect plant growth

Problem

Write It Up

How does soil type affect how water moves through soil?

Hypothesize

Write It Up

You should complete steps 1–5 in the procedure before writing your hypothesis. Write a hypothesis to explain how water moves through certain types of soil. Your hypothesis should take the form of an "If . . . , then . . . , because . . ." statement.

Procedure

MATERIALS
- 3 pieces of paper
- spoon
- 50 mL each of clay, coarse sand, loam
- hand lens
- toothpick
- eyedropper
- water
- 3 pieces of filter paper
- 3 plastic funnels
- 3 large beakers
- small beaker
- stopwatch

1. Make a data table in your **Science Notebook** like the one shown on page 501.

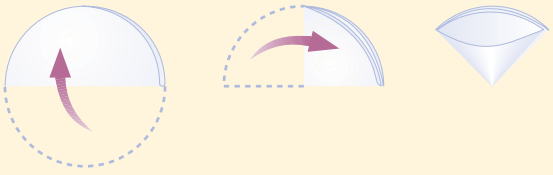
2. Label three sheets of paper "Clay," "Sand," and "Loam." Carefully place a spoonful of each sample on the appropriately labeled paper.

3. Carefully examine each of the soils, with and without the hand lens. Describe the color of each, and record the information in your data table.

4 Use a toothpick to separate the particles of each sample of soil. Record the size of the particles in the data table.

5 Put a small amount of each soil sample in the palm of your hand. Add a drop of water and mix the soil around with your finger. Write a description of the texture of each sample in your data table. Be sure to wash your hands after you finish. After you have recorded your observations, write your hypothesis.

6 Fold each piece of filter paper to form cones as shown in the diagram. Place one filter inside each funnel. Place one funnel in each large beaker. Measure 50 mL of each soil sample and place the sample in one of the funnels.



7 Measure 150 mL of water and pour it into the funnel containing the clay. Start the stopwatch when the water begins to drip out of the funnel. Stop the watch when the water stops dripping. Record the time in seconds in the data table.

8 Repeat step 7 for the sand and the loam. When you have finished with the activity, dispose of the materials according to your teacher's directions, and wash your hands.

Observe and Analyze

Write It Up

1. **INTERPRET DATA** Through which soil sample did the water move the fastest? The slowest?
2. **OBSERVE** What type of changes occurred in the soil as the water was added?

Conclude

Write It Up

1. **INTERPRET** Compare your results with your hypothesis. Does your data support your hypothesis?
2. **IDENTIFY LIMITS** What sources of error could have affected this investigation?
3. **EVALUATE** Based on your observations, what can account for the differences in the times recorded for the three soil samples?
4. **PREDICT** Based on your results, which of the soil samples would you expect to be the best type of soil in which to grow plants? Explain.

INVESTIGATE Further

CHALLENGE Design an experiment in which you test which of the three soil samples is best for growing plants. Include a materials list, hypothesis, and procedure for your experiment.

Soil Samples

Table 1. Soil Characteristics

Characteristics	Clay	Sand	Loam
Color			
Particle size			
Texture			
Time for water to stop dripping (sec)			

KEY CONCEPT

14.2 Matter cycles through ecosystems.

Sunshine State STANDARDS

SC.G.1.3.4: The student knows that the interactions of organisms with each other and with the non-living parts of their environments result in the flow of energy and the cycling of matter throughout the system.

BEFORE, you learned

- Ecosystems support life
- Living and nonliving factors interact in an ecosystem
- Temperature, light, soil, and water are important nonliving factors in ecosystems

NOW, you will learn

- How matter is exchanged between organisms and their environment
- About the water, carbon, and nitrogen cycles

FCAT VOCABULARY

water cycle p. 503

VOCABULARY

cycle p. 502
carbon cycle p. 504
nitrogen cycle p. 505

EXPLORE The Water Cycle

Do plants release water?

PROCEDURE

1. Cover a branch of the plant with a plastic bag. Tape the bag firmly around the stem.
2. Water the plant and place it in a sunny window or under a lamp. Wash your hands.
3. Check the plant after ten minutes, at the end of class, and again the next day.

MATERIALS

- 1 small potted plant
- 1 clear plastic bag
- tape
- water

WHAT DO YOU THINK?

- What do you see inside the plastic bag?
- What purpose does the plastic bag serve?

All ecosystems need certain materials.

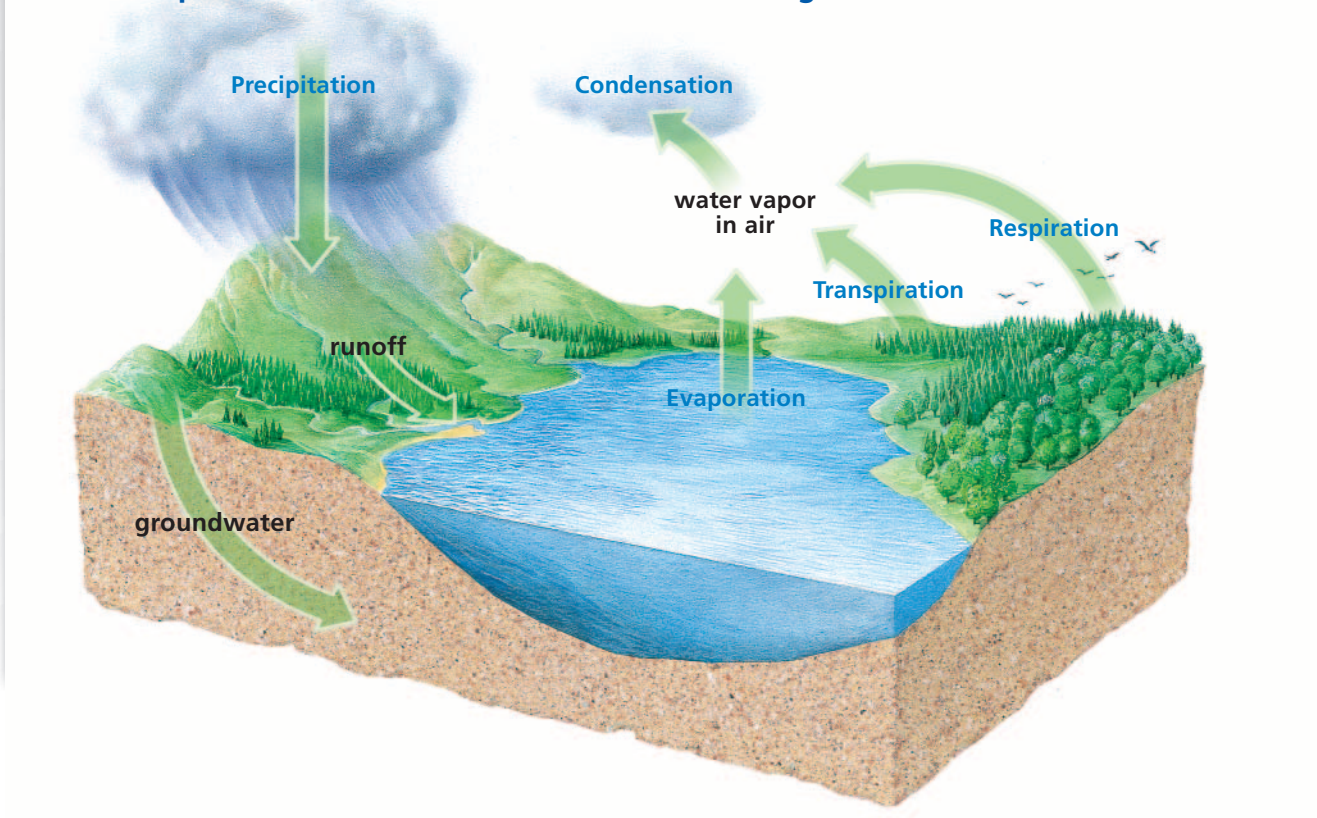
RESOURCE CENTER
CLASSZONE.COM
Explore cycles in nature.

Living things depend on their environment to meet their needs. You can think of those needs in terms of the material, or matter, required by all living things. For example, all organisms take in water and food in order to survive. All of the materials an organism takes in are returned to the ecosystem, while the organism lives or after it dies.

The movement of matter through the living and nonliving parts of an ecosystem is a continuous process, a cycle. A **cycle** is a series of events that happens over and over again. Matter in an ecosystem may change form, but it never leaves the ecosystem, so the matter is said to cycle through the ecosystem. Three of the most important cycles in ecosystems involve water, carbon, and nitrogen.

Water Cycle

Different processes combine to move water through the environment.



Water cycles through ecosystems.

COMBINATION NOTES
Make notes and draw a diagram to show how water cycles through ecosystems.

Water is stored on Earth's surface in lakes, rivers, and oceans. Water is found underground, filling the spaces between soil particles and cracks in rocks. Large amounts of water are stored in glaciers and polar ice sheets. Water is also part of the bodies of living things. But water is not just stored, it is constantly moving. The movement of water through the environment is called the **water cycle.**

Water is made up of just two elements: oxygen and hydrogen. As water moves through an ecosystem, it changes in physical form, moving back and forth between gas, liquid, and solid. Water in the atmosphere is usually in gaseous form—water vapor. Water that falls to Earth's surface is referred to as precipitation. For precipitation to occur, water vapor must condense—it must change into a liquid or solid. This water can fall as rain, snow, sleet, mist, or hail.

CHECK YOUR READING What are the three physical forms of water in the water cycle?

Water returns to the atmosphere when heated, changing back into vapor, a process called evaporation. Living things also release water vapor. Animals release water vapor when they breathe, or respire. Plants release water vapor through a process called transpiration.

Carbon cycles through ecosystems.

Carbon is an element found in all living things. Carbon moves through Earth's ecosystems in a cycle referred to as the **carbon cycle.** It is through carbon dioxide gas found in Earth's atmosphere that carbon enters the living parts of an ecosystem.

READING TiP
Notice that photosynthesis is a process that brings carbon into living matter and respiration is a process that releases carbon.

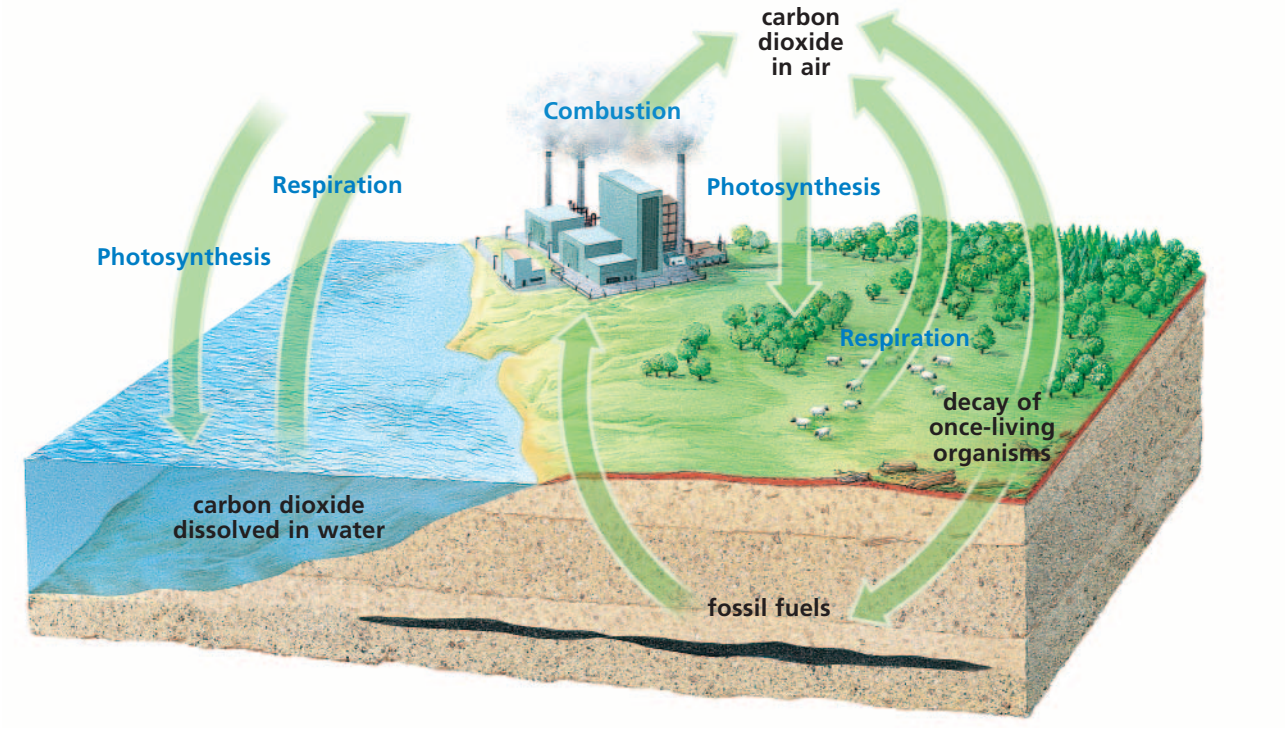
Plants use carbon dioxide to produce sugar—a process called photosynthesis. Sugars are carbon compounds that are important building blocks in food and all living matter. Food supplies the energy and materials living things need to live and grow. To release the energy in food, organisms break down the carbon compounds—a process called respiration. Carbon is released and cycled back into the atmosphere as carbon dioxide. When living things die and decay, the rest of the carbon that makes up living matter is released.

CHECK YOUR READING Name three ways that living things are part of the carbon cycle.

Earth's oceans contain far more carbon than the air does. In water ecosystems—lakes, rivers, and oceans—carbon dioxide is dissolved in water. Algae and certain types of bacteria are the photosynthetic organisms that produce food in these ecosystems. Marine organisms, too, release carbon dioxide during respiration. Carbon is also deposited on the ocean floor when organisms die.

Carbon Cycle

Different processes combine to move carbon through the environment.



INVESTIGATE Carbon

What is one form in which carbon is stored on the ocean floor?

SKILL FOCUS
Observing

MATERIALS
- mortar and pestle
- whole seashell or fragments
- small beaker
- white vinegar

TIME
15 minutes

PROCEDURE

1. Use the mortar and pestle to crush the seashell into a powder.
2. Pour the powder into a small beaker.
3. Add enough white vinegar to cover the powder.

WHAT DO YOU THINK?

- What happens when white vinegar is added to the crushed shell?
- What is the material produced in the reaction and where did it come from originally?

CHALLENGE What type of reaction have you observed?

Large amounts of carbon are stored underground. The remains of plants and animals buried for millions of years decay slowly and change into fossil fuels, such as coal and oil. The carbon in fossil fuels returns to ecosystems in a process called combustion. As humans burn fossil fuels to release energy, dust particles and gases containing carbon are also released into the environment.

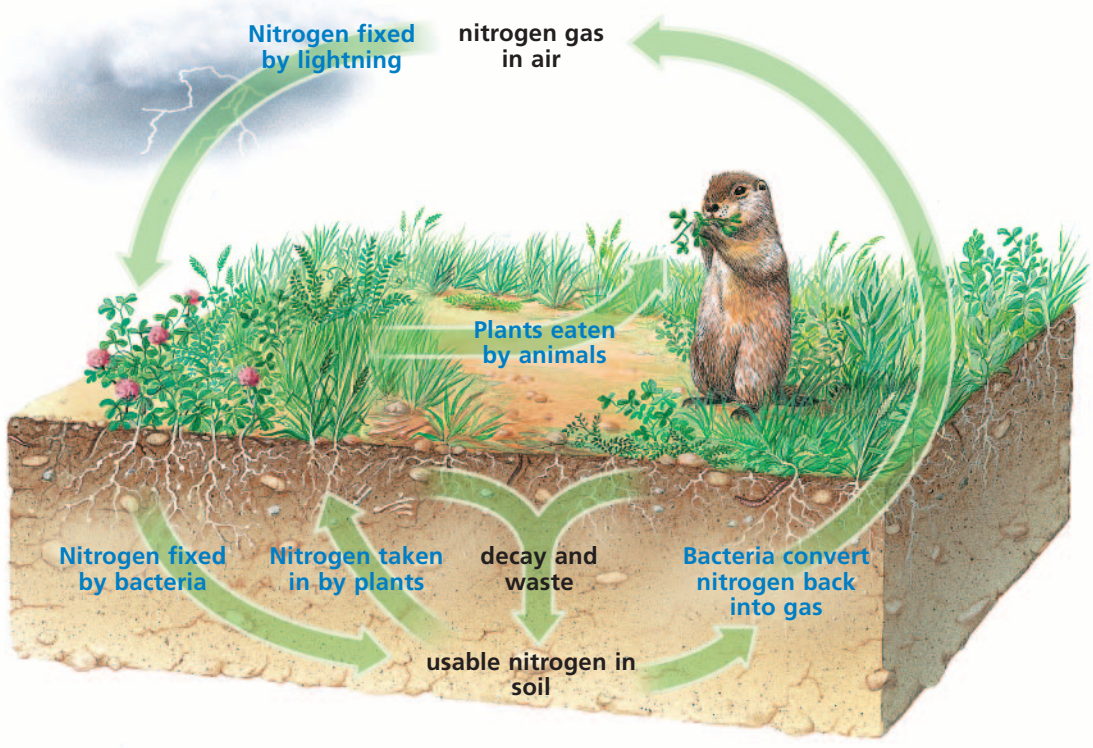
Nitrogen cycles through ecosystems.

Nitrogen is another element important to life that cycles through Earth in the **nitrogen cycle.** Almost four-fifths of the air you breathe is clear, colorless nitrogen gas. Yet, you cannot get the nitrogen you need to live from the air. All animals must get nitrogen from plants.

Plants cannot use pure nitrogen gas either. However, plants can absorb certain compounds of nitrogen. Plants take in these nitrogen compounds through their roots, along with water and other nutrients. So how does the nitrogen from the atmosphere get into the soil? One source is lightning. Every lightning strike breaks apart, or fixes, pure nitrogen, changing it into a form that plants can use. This form of nitrogen falls to the ground when it rains.

Nitrogen Cycle

Different processes combine to move nitrogen through the environment.



VISUALIZATION
CLASSZONE.COM
Watch the nitrogen cycle in action.

A far greater source of nitrogen is nitrogen-fixing bacteria. These bacteria live in the oceans as well as the soil. Some even attach themselves to the roots of certain plants, like alfalfa or soybeans. When organisms die, decomposers in the ocean or soil break them down. Nitrogen in the soil or water is used again by living things. A small amount is returned to the atmosphere by certain bacteria that can break down nitrogen compounds into nitrogen gas.

14.2 Review

KEY CONCEPTS

1. Draw a diagram of the water cycle. Show three ways in which water moves through the cycle.
2. Summarize the main parts of the carbon cycle.
3. Explain two ways that nitrogen gas in the atmosphere is changed into nitrogen compounds that plants can use.

CRITICAL THINKING

4. **Predict** When people burn fossil fuels, carbon dioxide gas is added to the atmosphere. How might increased carbon dioxide affect plant growth?
5. **Compare and Contrast** Review the nitrogen and carbon cycles. How are these two cycles similar and different?

CHALLENGE

6. **Apply** Draw a cycle diagram that shows how water is used in your household. Include activities that use water, sources of water, and ways that water leaves your house.

MATH in SCIENCE

SKILL: ADDING INTEGERS

Temperature and the Water Cycle

MATH TUTORIAL
CLASSZONE.COM
Click on Math Tutorial for more help with adding integers.

Changes in temperature help water move through the environment. At freezing temperatures—below 32°F or 0°C for sea-level environments—water can begin to become solid ice. Ice starts to melt when the temperature rises above freezing, causing the water to become liquid again. Temperature change also causes water to become vapor, or gas, within the air.

This iceberg is made up of fresh water, which freezes at 0°C. The surrounding ocean is salt water, which doesn't freeze at 0°C.

Example

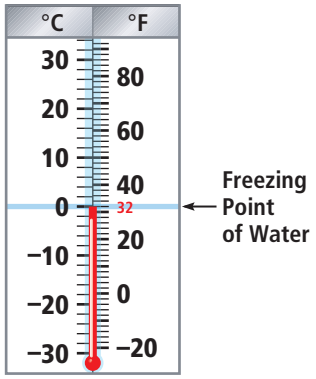
Suppose you are waiting for winter to come so you can skate on a small pond near your house. The weather turns cold. One day the temperature is 25°C, then the next day the air temperature drops by 35°C. What temperature is the air? If the air stays below 0°C, some of the water will begin to freeze.

(1) Write a verbal model:
25 degrees + a 35-degree drop = what temperature?

(2) Write an equation. Use negative and positive integers:
25 + (−35) = ?

(3) Solve the equation:
25 − 35 = −10

ANSWER −10°C.



Answer the following questions.

1. A container of water is left out over night, when the temperature is −18°C. In the morning, the air temperature rises by 8°C. What temperature is the air? What will happen to the water?

2. An ice block sits in a field where the air is 0°C. The air temperature rises by 16°C, then it drops by 8°C. What temperature is the air in the field now? What will happen to the ice?

3. What happens to a block of ice after the temperature in the air follows this pattern: −6 + 17 + 10 + 18 + (−5)? What temperature has the air reached?

CHALLENGE Use a thermometer to measure the temperature of the air outside and indoors in degrees Celsius. Write two addition equations that show the temperature change between the two locations. One equation should show a rise, and one should show a drop.

KEY CONCEPT

14.3 Energy flows through ecosystems.

Sunshine State STANDARDS

SC.G.1.3.4: The student knows that the interactions of organisms with each other and with the non-living parts of their environments result in the flow of energy and the cycling of matter throughout the system.

BEFORE, you learned

- Matter cycles continuously through an ecosystem
- Living things are part of the water, carbon, and nitrogen cycles

NOW, you will learn

- How living things move energy through an ecosystem
- How feeding relationships are important in ecosystems
- How the amount of energy changes as it flows through an ecosystem

FCAT VOCABULARY

producer p. 509
consumer p. 510
decomposer p. 511
food chain p. 512
food web p. 512
energy pyramid p. 514

EXPLORE Energy

How can you observe energy changing form?

PROCEDURE

1. Mark and cut a spiral pattern in a square piece of paper.
2. Cut a 15-cm piece of thread and tape one end to the center of the spiral.
3. Adjust the lamp to shine straight at the ceiling. Turn the lamp on.
4. Hold the spiral by the thread and let it hang 10 cm above the light bulb. CAUTION: Don't let the paper touch the bulb!

MATERIALS

- paper
- marker
- scissors
- thread
- tape
- desk lamp

WHAT DO YOU THINK?

- What do you see happen to the spiral?
- In what sense has the energy changed form?

Living things capture and release energy.

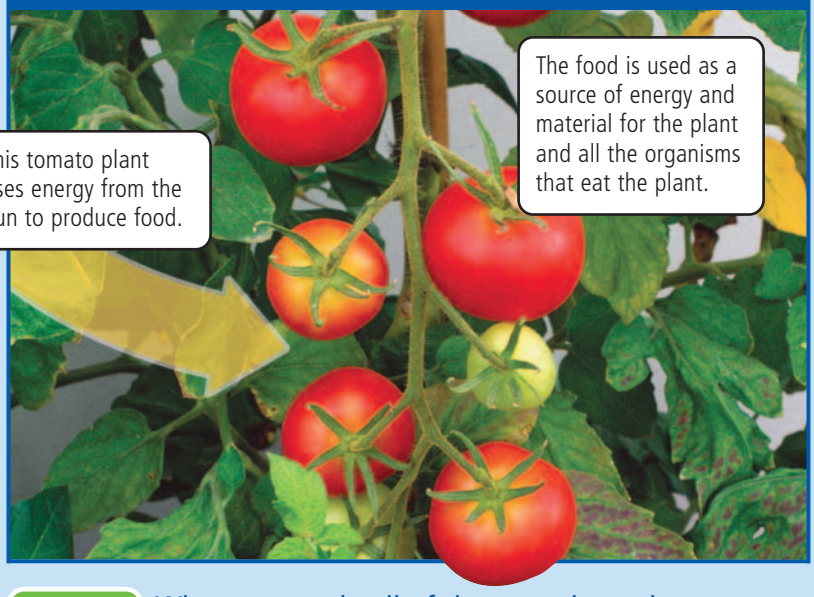
Everything you do—running, reading, and working—requires energy. The energy you use is chemical energy, which comes from the food you eat. When you go for a run, you use up energy. Some of that energy is released to the environment as heat, as you sweat. Eventually, you will need to replace the energy you've used.

Energy is vital to all living things. Most of that energy comes either directly or indirectly from the Sun. To use the Sun's energy, living things must first capture that energy and store it in some usable form. Because energy is continuously used by the activities of living things, it must be continuously replaced in the ecosystem.

Producers

All of these producers capture energy from sunlight.

Plants

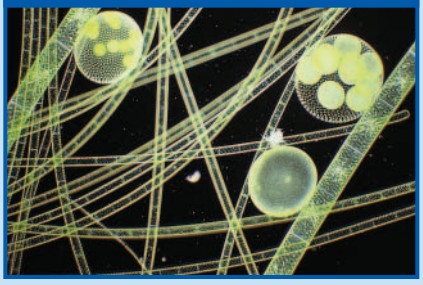


READING VISUALS What process do all of these producers have in common?

Seaweed

Seaweed is a producer found in Earth's oceans and coastal zones.

Phytoplankton



The most numerous producers are tiny organisms that live in water called phytoplankton.

Producers

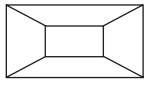
A **producer** is an organism that captures energy and stores it in food as chemical energy. The producers of an ecosystem make energy available to all the other living parts of an ecosystem. Most energy enters ecosystems through photosynthesis. Plants, and other photosynthetic organisms, take water and carbon dioxide from their environment and use energy from the Sun to produce sugars. The chemical energy stored in sugars can be released when sugars are broken down.

CHECK YOUR READING How does energy enter into the living parts of an ecosystem?

Plants are the most common producers found in land ecosystems. In water ecosystems, most food is produced by photosynthetic bacteria and algae. A few examples of producers that use photosynthesis are shown in the photographs above.

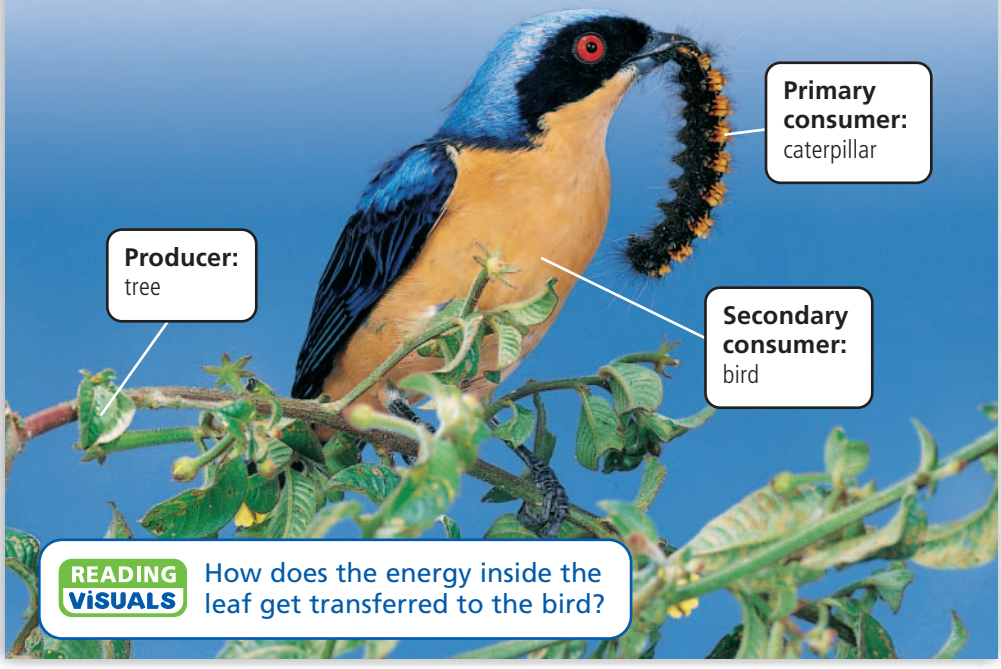
The Sun provides most of the energy that is stored in food. One exception is the unusual case of a type of bacteria that lives in the deep ocean, where there is no sunlight. These bacteria produce food using heated chemicals released from underwater vents. This process is called chemosynthesis. Whether producers use photosynthesis or chemosynthesis, they do just as their name suggests—they produce food for themselves and for the rest of the ecosystem.

VOCABULARY
Remember to add a frame game for *producers* to your notebook.



Consumers

A consumer is an organism that gets energy by eating producers or other consumers.



Consumers

Organisms that cannot produce their own food must get their food from other sources. **Consumers** are organisms that get their energy by eating, or consuming, other organisms. To understand how energy flows through an ecosystem, you have to study feeding relationships. A feeding relationship starts with a producer, followed by one and often many more consumers.

CHECK YOUR READING Describe the producer-consumer relationship in terms of energy.

Consumers are classified by their position in a feeding relationship. In a meadow ecosystem, animals such as antelopes and grasshoppers feed on grasses. They are primary consumers because they are the first link between the producers and the rest of the consumers in an ecosystem. The wolves that eat the antelopes and the meadowlarks that eat the grasshoppers are secondary consumers. There are also tertiary consumers, like the prairie falcon that eats the meadowlark. Ecosystems also have special consumers called scavengers, like the vulture, which is a consumer that feeds on dead animals.

In the photograph above, energy enters the ecosystem through the tree, which is the producer. The caterpillar that gets its energy by feeding on the leaves is the first, or primary, consumer. The bird that gets its energy by feeding on the caterpillar is a secondary consumer.

READING TiP

Primary is a word that means "first in order," *secondary* means "second in order," and *tertiary* means "third in order."

Decomposers

Fungi, such as these mushrooms, are decomposers.

If you've been for a hike through a forest, or a walk through a park, you have seen the interaction of producers and consumers. Tall trees and leafy shrubs are home to many insects and the birds that feed upon the insects. Also important to the maintenance of an ecosystem are decomposers, a group of organisms that often go unseen. **Decomposers** are organisms that break down dead plant and animal matter into simpler compounds.

You can think of decomposers as the clean-up crew of an ecosystem. In a forest, consumers such as deer and insects eat a tiny fraction of the leaves on trees and shrubs. The leaves that are left on the forest floor, as well as dead roots and branches, are eventually digested by fungi and bacteria living in the soil. Decomposers also break down animal remains, including waste materials. A pinch of soil may contain almost half a million fungi and billions of bacteria.

The energy within an ecosystem gets used up as it flows from organism to organism. Decomposers are the organisms that release the last bit of energy from once-living matter. Decomposers also return matter to soil or water where it may be used again and again.

INVESTIGATE Decomposers

Where do decomposers come from?

SKILL FOCUS
Observing

MATERIALS
- clear soda bottle with cap
- scissors
- stones
- garden soil
- leaves
- slices of fruit
- masking tape
- marker
- water

TIME
30 minutes

PROCEDURE

1. Carefully use scissors to cut an opening across the middle of the bottle.
2. Place a handful of stones in the bottom of the bottle for drainage, and add enough soil to make a layer 10 cm deep.
3. Place some leaves and fruit slices on top of the soil.
4. Seal the cut you made with tape. Mark the date on the tape.
5. Add water through the top of the bottle to moisten the soil, and put the cap on the bottle. Wash your hands.
6. Observe the fruit slices each day for two weeks. Record your observations. Keep the soil moist.

WHAT DO YOU THINK?

- What do you observe happening to the fruit slices?
- Where do the decomposers in your bottle come from?

CHALLENGE Predict what would happen if you used potting soil instead of soil from outside.

COMBINATION NOTES
Remember to take notes and draw a diagram for *food chain* and *food web*.

Models help explain feeding relationships.

You have learned how energy is captured by producers and moved through ecosystems by consumers and decomposers. Scientists use two different models to show the feeding relationships that transfer energy from organism to organism. These models are food chains and food webs.

Food Chain

A chain is made of links that are connected one by one. Scientists use the idea of links in a chain as a model for simple feeding relationships. A **food chain** describes the feeding relationship between a producer and a single chain of consumers in an ecosystem.

The diagram on page 513 shows a wetland food chain. The first link in the chain is a cattail, a primary producer that captures the Sun's energy and stores it in food. The second link is a caterpillar, a primary consumer of the cattail. The frog is the next link, a secondary consumer that eats the caterpillar. The final link is a heron, a tertiary consumer that eats the frog. Energy is captured and released at each link in the chain. The arrows represent the flow of energy from organism to organism. You can see that some of the energy captured by the cattail makes its way through a whole chain of other organisms in the ecosystem.

Food Web

A **food web** is a model of the feeding relationships between many different consumers and producers in an ecosystem. A food web is more like a spider web, with many overlapping and interconnected food chains. It is a better model for the complex feeding relationships in an ecosystem, which usually has many different producers, with many primary and secondary consumers.

READING TiP
Notice that the food chain described above is also a part of the food web described here. Follow the blue arrows in the diagram on page 513.

The diagram on page 513 also shows a wetland food web. You can see that the feeding relationships can go in several directions. For example, the food web shows that ruddy ducks eat bulrushes, which are producers. That makes ruddy ducks primary consumers. Ruddy ducks are also secondary consumers because they eat snails. A food web shows how one consumer can play several roles in an ecosystem.

CHECK YOUR READING What is the difference between a food chain and a food web?

Both food chains and food webs show how different organisms receive their energy. They also show how different organisms depend on one another. If one organism is removed from the food web or food chain, it may affect many other organisms in the ecosystem.

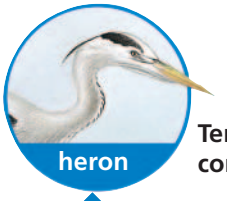
Energy Flows Through Ecosystems

Energy is transferred from one organism to the next as organisms eat or are eaten.

A Wetland Food Chain

Flow of Energy

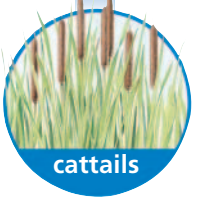
Energy flow starts at the bottom. Arrows represent energy moving from an organism that is eaten to the organism that eats it.



Tertiary consumer

Secondary consumer

Primary consumer



Producer

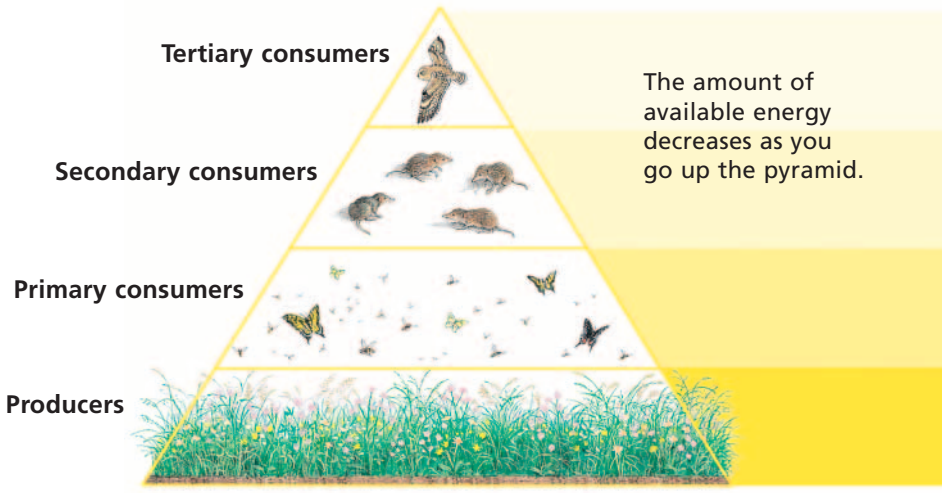
Decomposers

These tiny organisms recycle dead and decayed material.

A Wetland Food Web

Available energy decreases as it moves through an ecosystem.

Another way to picture the flow of energy in an ecosystem is to use an energy pyramid. An **energy pyramid** is a model that shows the amount of energy available at each feeding level of an ecosystem. The first level includes the producers, the second level the primary consumers, and so on. Because usable energy decreases as it moves from producers to consumers, the bottom level is the largest. The available energy gets smaller and smaller the farther up the pyramid you go.



READING TiP

Refer to the diagram above as you read the text. It is because available energy decreases at each level that the diagram takes the shape of a pyramid.

In the pyramid shown here, plants are the producers. They capture energy from sunlight, use some of it, then store the rest as food. The plants are eaten by insects, which also use some of the energy before being eaten by shrews. The shrews use energy before being eaten by the owl. You can see that it takes a lot of sunlight to support the producers and consumers in a food web that feeds an owl.

14.3 Review

KEY CONCEPTS

1. Describe the role of producers, consumers, and decomposers in an ecosystem.
2. Explain why a food web provides a better model of an ecosystem than a food chain does.
3. Explain how the amount of available energy changes as energy moves up a food chain.

CRITICAL THINKING

4. **Apply** Draw a food chain and a food web for an ecosystem near your home.
5. **Predict** Imagine that muskrats are removed from a wetland ecosystem. Predict what would happen both to producers and to secondary consumers.

CHALLENGE

6. **Synthesize** Explain how the carbon cycle is related to a food web. Describe how energy and matter move through the food web and the carbon cycle.

CONNECTING SCIENCES

LIFE SCIENCE AND PHYSICAL SCIENCE

Biomagnification

Matter moves through living things in an ecosystem. Some of it is used up, some of it is stored. Sometimes, a toxic, or poisonous, material can get into a food chain and be stored. Biomagnification is the process by which matter becomes concentrated in living things.

Moving up the Food Chain

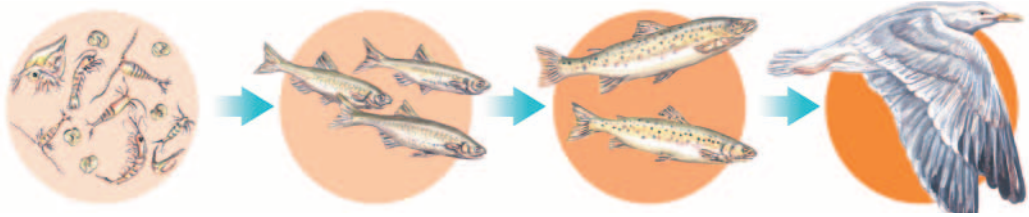
DDT provides one example of the effects of biomagnification in an ecosystem. DDT is a chemical that was widely used to kill plant-eating insects. Some chemicals break down over time, but DDT does not. DDT collected in water and soil, was absorbed by living things, and moved up the food chain. The diagram shows how DDT became magnified in a wetland ecosystem. It entered through tiny organisms called zooplankton, which absorbed DDT from the water.

1. The concentration of DDT in zooplankton was about 800 times greater than in the environment.
2. Minnows fed on zooplankton. DDT was magnified 31 times, so the concentration of DDT in minnows was 24,800 times greater than in the environment: 800 x 31 = 24,800.
3. Trout ate minnows. DDT was magnified 1.7 times, so the concentration of DDT in trout was 42,160 times greater than in the environment.
4. Gulls ate trout. DDT was magnified 4.8 times, so the concentration of DDT in gulls was over 200,000 times greater than in the environment.

DDT is especially harmful to large birds such as osprey and eagles. The chemical made the shells of the eggs of these large birds so thin that the eggs did not survive long enough to hatch.

Moving up the Food Chain

This diagram shows how DDT moved up a food chain in Long Island Sound. The color in each circle below represents a certain level of DDT.



1 Zooplankton 2 Minnows 3 Trout 4 Gull

CHALLENGE Even though DDT was effective, some insects were not harmed by DDT. Predict what might happen to the numbers of those insects as a result of DDT use.

KEY CONCEPT

14.4 Biomes contain many ecosystems.

Sunshine State STANDARDS

SC.G.1.3.4: The student knows that the interactions of organisms with each other and with the non-living parts of their environments result in the flow of energy and the cycling of matter throughout the system.

SC.G.2.3.2: The student knows that all biotic and abiotic factors are interrelated and that if one factor is changed or removed, it impacts the availability of other resources within the system.

BEFORE, you learned

- Feeding relationships describe how energy flows through ecosystems
- The amount of available energy decreases as it flows through ecosystems

NOW, you will learn

- How biomes vary by region and by the plant life they support
- How different ecosystems make up a biome
- About the different land and water biomes on Earth

VOCABULARY

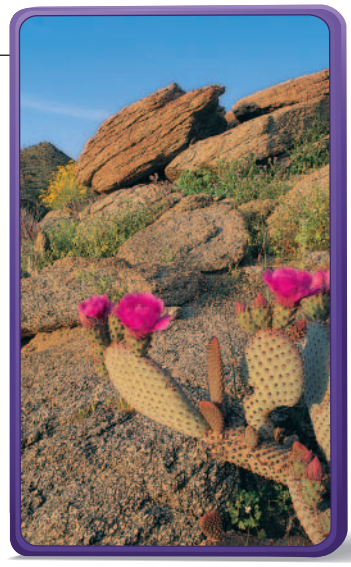
biome p. 516
coniferous p. 518
deciduous p. 519
estuary p. 522

COMBINATION NOTES
Remember to take notes and draw a diagram for each of the six land biomes described in the text.

THINK ABOUT

What do this plant's characteristics suggest about its environment?

A plant's overall shape and form help it to survive in its environment. Look closely at this plant in the photograph. Describe its shape. Does it have leaves? a stem? flowers? Look at the surrounding area. What do your observations suggest about the environment in general?



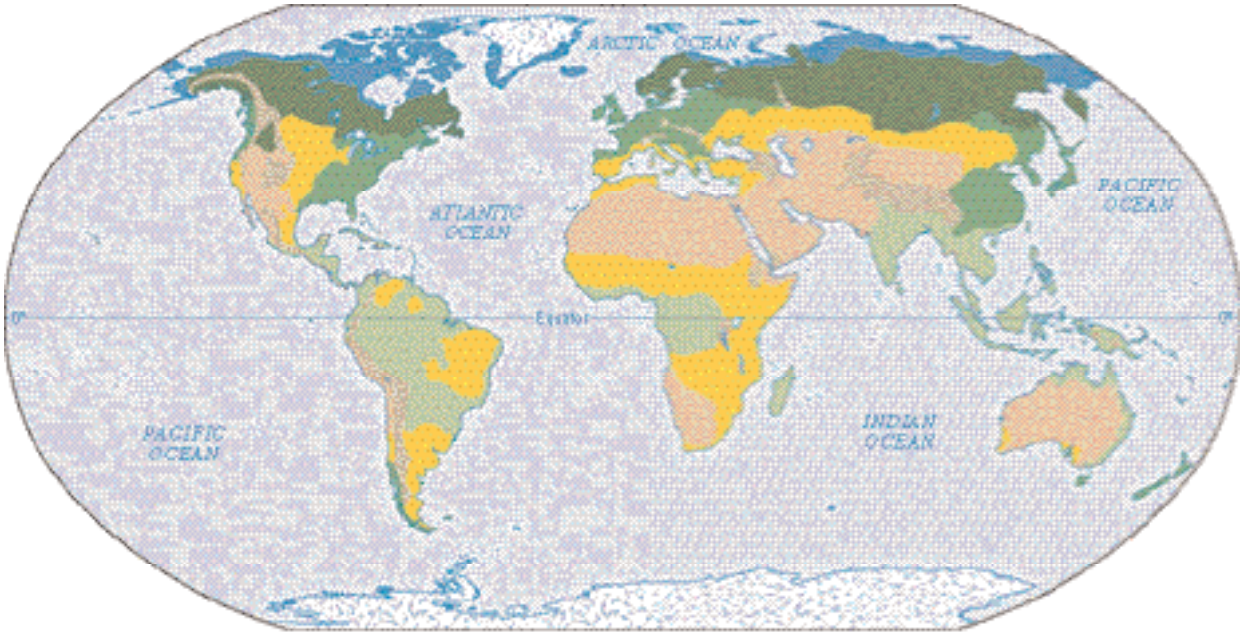
Regions of Earth are classified into biomes.

If you could travel along the 30° latitude line, either north or south of the equator, you'd notice an interesting pattern. You would see deserts give way to grasslands and grasslands give way to forests. Across Earth, there are large geographic areas that are similar in climate and that have similar types of plants and animals. Each of these regions is classified as a **biome** (BY-OHM). There are six major land biomes on Earth, as shown on the map on page 517.

Climate is an important factor in land biomes. Climate describes the long-term weather patterns of a region, such as average yearly rainfall and temperature ranges. Climate also affects soil type. Available water, temperature, and soil are abiotic factors important in ecosystems. The fact that the abiotic factors of a particular biome are similar helps to explain why the ecosystems found in these biomes are similar. Biomes represent very large areas, which means that there will be many ecosystems within a biome.

Land Biomes

Each land biome is characterized by a particular climate, the quality of the soil, and the plant life found there.



Biomes

- Tundra
- Taiga
- Desert
- Grassland
- Temperate Forest
- Tropical Forest

Other zones

- Mountain Zones
- Polar Ice

Taiga and Tundra

If you go to the northernmost regions of Earth, you will find two biomes—tundra and taiga—that are characterized by long cold winters and short cool summers. In the Arctic tundra, temperatures can go as low as –50°C, with a high of about 18°C. Temperature ranges in the taiga (TY-guh) are similar, –40°C to 20°C.

The tundra doesn't get much precipitation, less than 25 centimeters each year. Yet the area is wet because cold temperatures keep the water from evaporating. One of the important characteristics of tundra is permafrost, a deep layer of permanently frozen soil that lies just below the surface soil. Permafrost prevents trees from taking root in the tundra. Plants of the tundra are small and include mosses, grasses, and woody shrubs. Organisms called lichens also do well in the tundra.

The producers of tundra ecosystems support rodents, caribou, and musk oxen. Grizzly bears, white fox, and snowy owls are predators found there. Migrating birds come to nest in the tundra, feeding on insects that mature in summer.

snowy owl

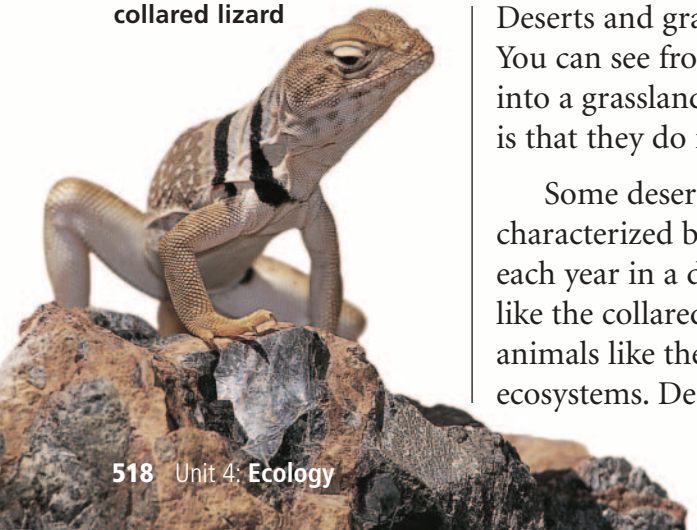
Tundra Only small plants and lichens grow in the tundra because the soil below the surface is frozen.

Taiga Evergreen trees grow in the taiga, where the ground is cold but not frozen.

Even though the temperatures of the taiga are similar to those of the tundra, the taiga has more precipitation, 30 to 60 centimeters a year. The effect of this is that there is more snow on the ground, which insulates the soil below, keeping it from permanently freezing.

Taiga ecosystems are characterized by evergreen trees called **coniferous** (koh-NIHF-uhr-uhs) trees. These trees have needlelike leaves that produce food all year long. This is an advantage in taiga ecosystems because decomposers work slowly in the cold, so the soil is low in nutrients. The wood and leaves of these trees feed insects and their seeds feed birds and squirrels. Taiga ecosystems support deer, elk, snowshoe hares, and beavers. Predators include lynx, owls, bears, and wolves.

Desert and Grassland



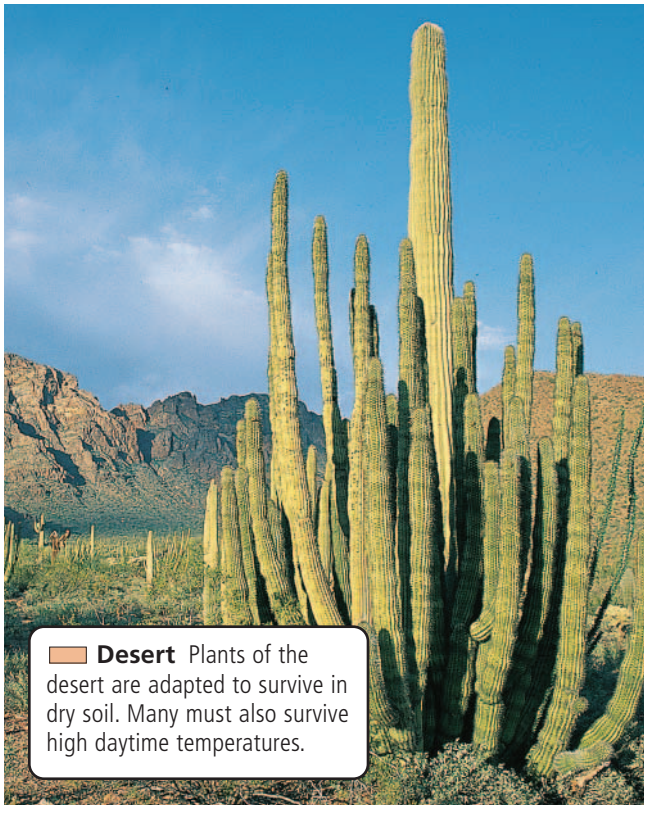
collared lizard

Deserts and grasslands are biomes found toward the middle latitudes. You can see from the map on page 517 that a desert biome often leads into a grassland biome. What deserts and grasslands have in common is that they do not get enough precipitation to support trees.

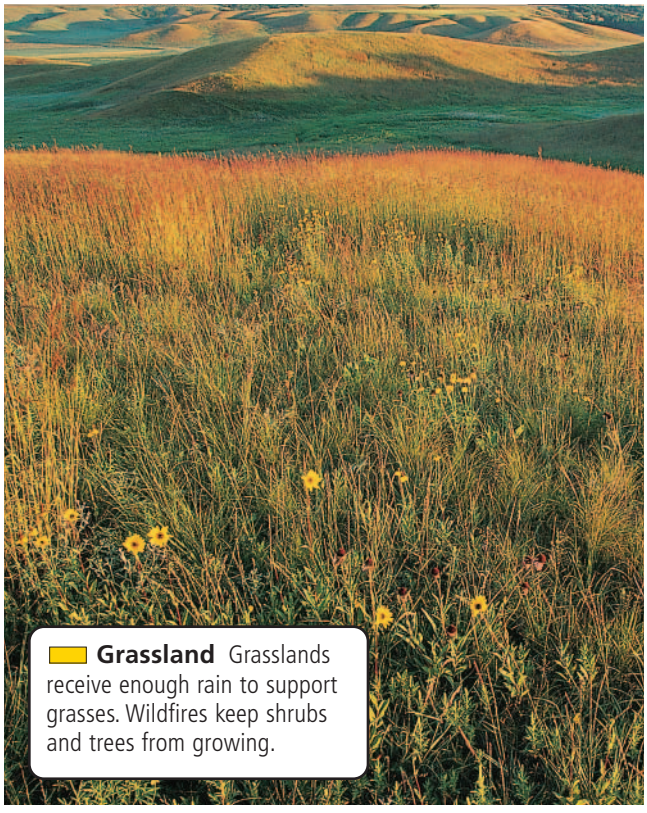
Some deserts are cold and some deserts are hot, but all deserts are characterized by their dry soil. Less than 25 centimeters of rain falls each year in a desert. Desert plants, like the cactus, and desert animals, like the collared lizard, can get by on very little water. Small burrowing animals like the kangaroo rat and ground squirrel are part of desert ecosystems. Desert predators include snakes, owls, and foxes.

Grassland ecosystems develop in areas of moderate rainfall, generally from 50 to 90 centimeters each year. There is enough rain to support grasses, but too little rain to support forests. Periodic wildfires and droughts keep smaller shrubs and tree seedlings from growing. Summers in grassland ecosystems are warm, up to 30°C, but winters are cold.

Grasses do well in large open areas. The more rain a grassland ecosystem gets, the higher the grasses grow. These ecosystems support seed-eating rodents that make their burrows in the grassland soil. There are also large grazing animals, like bison, wild horses, gazelle, and zebra. Predators include wolves, tigers, and lions.



Desert Plants of the desert are adapted to survive in dry soil. Many must also survive high daytime temperatures.

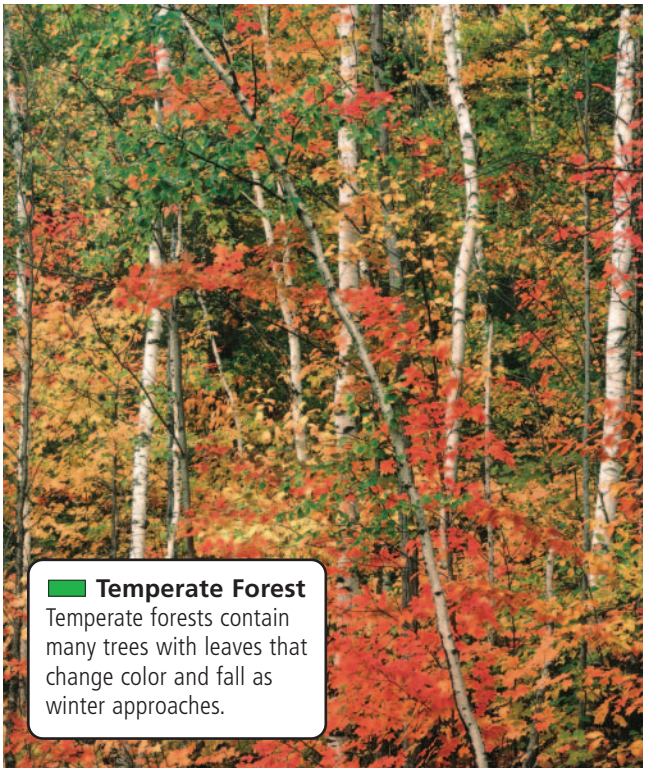


Grassland Grasslands receive enough rain to support grasses. Wildfires keep shrubs and trees from growing.

Temperate Forest and Tropical Forest

Trees need more water than smaller plants, shrubs, and grasses. So forest biomes are usually located in regions where more water is available. The taiga is a forest biome. There the coniferous trees survive on smaller amounts of precipitation because the cold weather limits evaporation. Across the middle latitudes, temperate forests grow where winters are short and 75 to 150 centimeters of precipitation fall each year. Near the equator, there are no winters. There, tropical forests grow where 200 to 450 centimeters of rain fall each year.

Most temperate forests are made up of deciduous trees, sometimes referred to as broadleaf trees. **Deciduous** (dih-SIHJ-oo-uhs) trees drop their leaves as winter approaches and then grow new leaves in spring.



Temperate Forest
Temperate forests contain many trees with leaves that change color and fall as winter approaches.

Tropical Forest
Tropical forests are warm enough that trees stay green during the entire year.

The most common broadleaf trees in North American deciduous forests are oak, birch, beech, and maple. Temperate forests support a wide variety of animals. Animals like mice, chipmunks, squirrels, raccoons, and deer live off seeds, fruit, and insects. Predators include wolves, bobcats, foxes, and mountain lions.

Most temperate forests in North America are deciduous. However, the wet winters and dry summers in the Pacific Northwest support forests made up mostly of coniferous trees—redwoods, spruce, and fir. These forests are referred to as temperate rain forests. The largest trees in the United States are found in these temperate rain forests.

Tropical forests are located near the equator, where the weather is warm all year, around 25°C. The tropical rain forest is the wettest land biome, with a rainfall of 250 to 400 centimeters each year. The trees tend to have leaves year round. This provides an advantage because the soil is poor in nutrients. High temperatures cause materials to break down quickly, but there are so many plants the nutrients get used up just as quickly.

More types of animals, plants, and other organisms live in the tropical rain forest than anywhere else on Earth. The trees grow close together and support many tree-dwelling animals like monkeys, birds, insects, and snakes. There are even plants, like orchids and vines, that grow on top of the trees.

CHECK YOUR READING How does the variety of plants in a biome affect the variety of animals in a biome?

INVESTIGATE Climate

How can you graph climate data for your area?

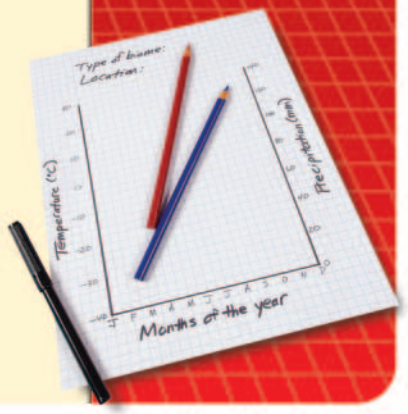
SKILL FOCUS
Graphing data

MATERIALS
- graph data
- 2 colored pencils

TIME
20 minutes

PROCEDURE

1. Gather local data on the average monthly precipitation and the average monthly temperature for a 12-month period.
2. On graph paper, mark off 12 months along the *x*-axis. Make a *y*-axis for each side of the graph, marking one "Temperature (°C)" and the other "Precipitation (mm)."
3. Plot the average precipitation for each month as a bar graph.
4. Plot the average temperature for each month as a line graph.



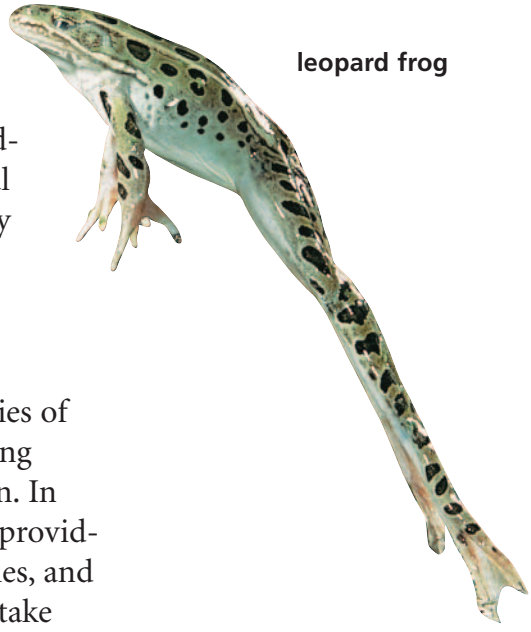
WHAT DO YOU THINK?

- How much precipitation did the area receive overall?
- What is the temperature range for the area?

CHALLENGE Collect data for the same location, going back 10, 20, and 30 years ago. Graph the data for each of these and compare these graphs to your original graph. Has the climate in your area changed? How might severe changes in climate affect the plant and animal life in your area?

Water covers most of Earth's surface.

Close to three-quarters of Earth's surface is covered by water. Water, or aquatic, biomes can be divided into two broad categories: freshwater biomes and saltwater biomes. Plants have a role as producers in the water biomes that are closely surrounded by land—in ponds and streams and wetlands, and in coastal areas. The food chains of deepwater ecosystems depend on tiny photosynthetic microorganisms called phytoplankton.



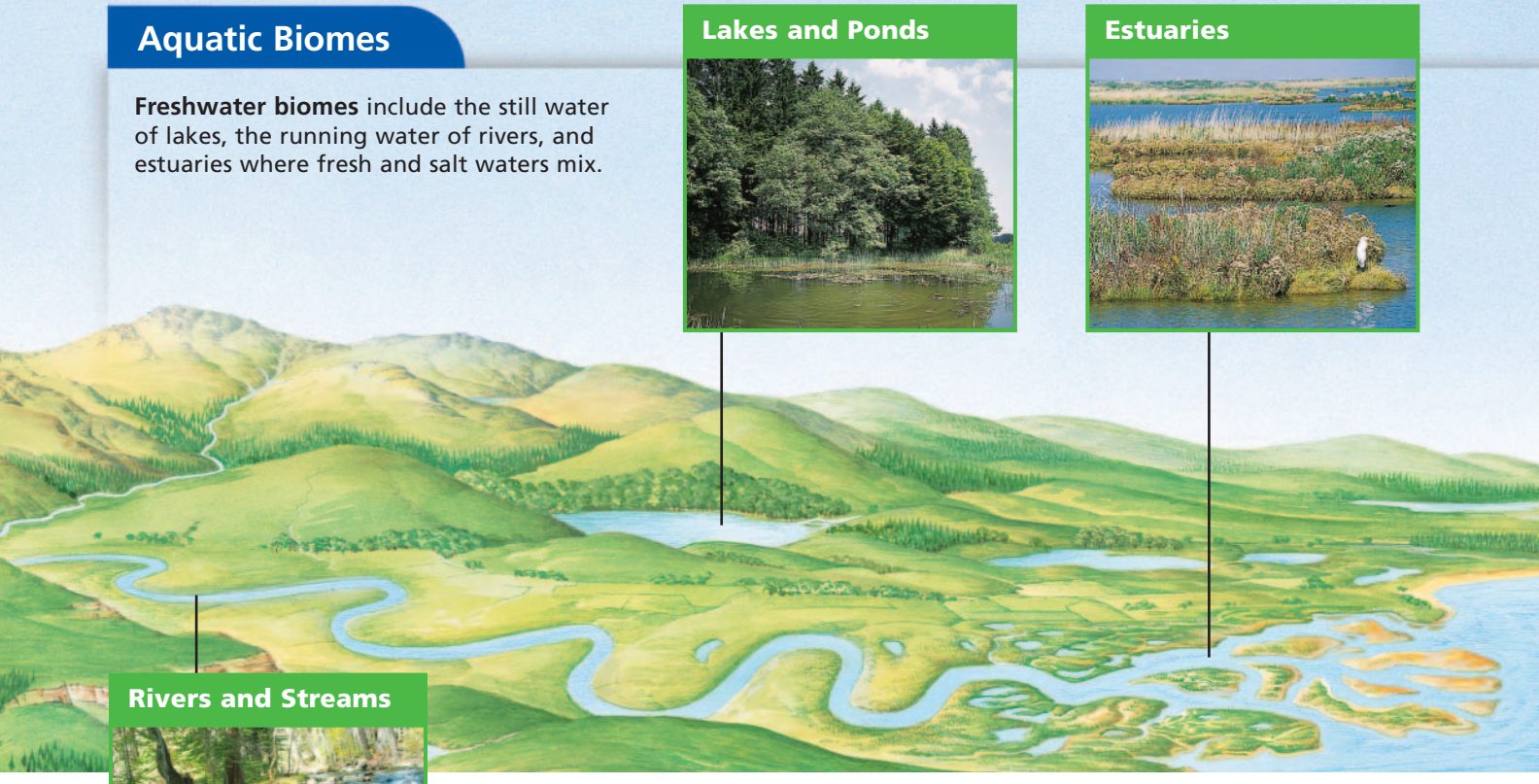
leopard frog

Freshwater Biomes

The ecosystems of freshwater biomes are affected by the qualities of the landscape in which they are found. For example, the running water of streams and rivers results from differences in elevation. In shallow rivers, green algae and plants grow in from the banks, providing food for insects and snails that feed fish, salamanders, turtles, and frogs. Plants in a freshwater biome, like a stream or river, may take root in the soil under the water if the water is not too deep or moving too fast. Phytoplankton are not part of river ecosystems because of the moving water.

Aquatic Biomes

Freshwater biomes include the still water of lakes, the running water of rivers, and estuaries where fresh and salt waters mix.



Ponds and lakes have still water. Ponds are shallow and support many plants as producers. The deeper lakes depend much more on phytoplankton. Ponds and lakes support many different insects, shellfish, snakes, fish, and the land animals that feed off them.

CHECK YOUR READING Name two types of freshwater biomes.

FLORIDA Content Preview

The ocean contains different ecosystems just as land does. You will read more about ocean ecosystems in grade 7.

Estuaries are water ecosystems that mark a transition between freshwater and saltwater biomes. An **estuary** is the lower end of a river that feeds into the ocean, where fresh water and salt water mix. Marshes and wetlands are two types of estuaries. Estuaries are sometimes referred to as the nurseries of the sea because so many marine animals travel into the calm waters of an estuary to reproduce. Seaweed, marsh grasses, shellfish, and birds all thrive in estuaries.

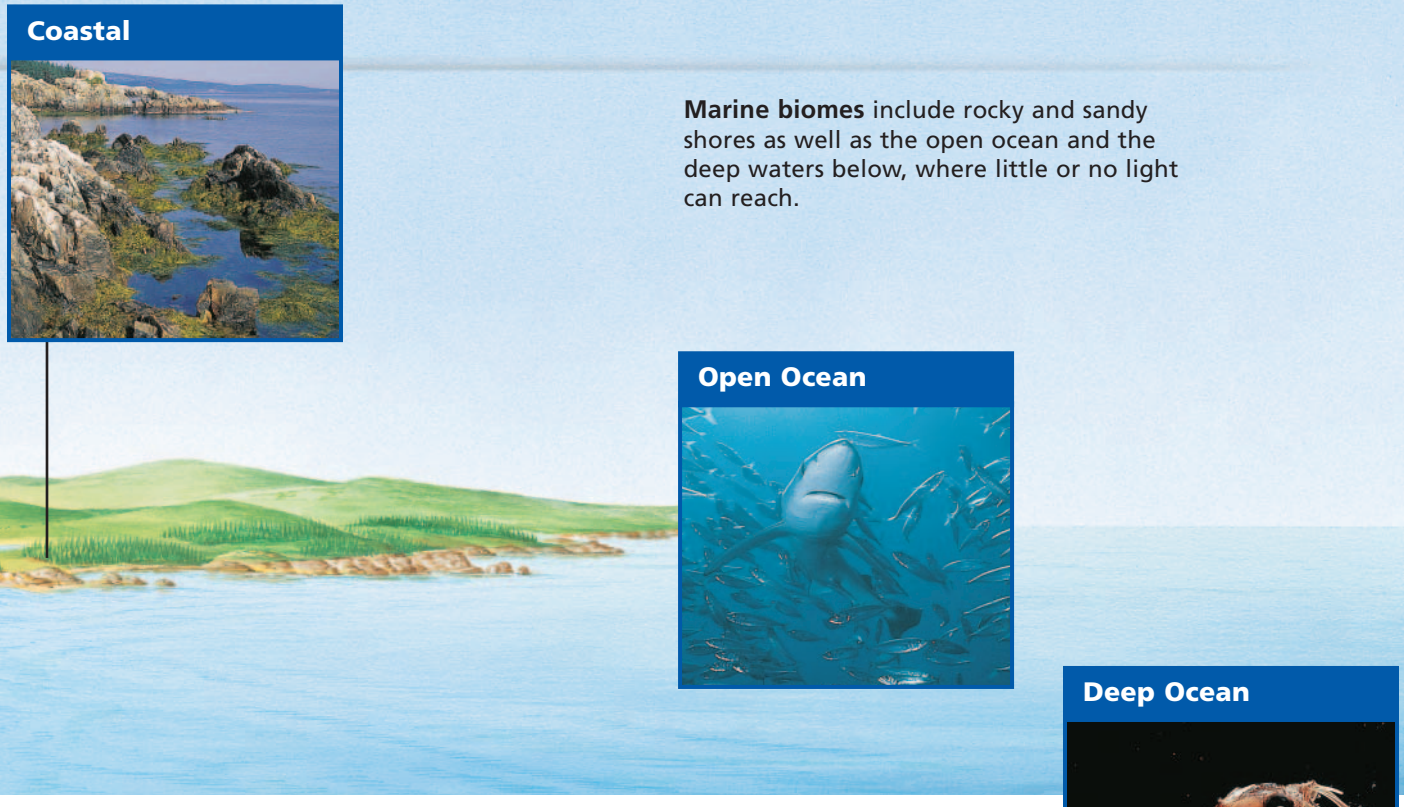
Marine Biomes

Marine biomes are saltwater biomes. The three general marine biomes are coastal ocean, open ocean, and deep ocean. Beaches are part of the coastal ocean biome. Tidal pools also form along the coast as the tide comes in and goes out and the conditions constantly change. Organisms like crabs and clams are able to survive the ever-changing conditions to thrive in coastal areas.

RESOURCE CENTER CLASSZONE.COM

Find out more about land and aquatic biomes.

Organisms in the open ocean receive less sunlight than in the coastal ocean, and the temperatures are colder. Many types of fish and



Marine biomes include rocky and sandy shores as well as the open ocean and the deep waters below, where little or no light can reach.

other marine animals and floating seaweed live in the upper ocean. There are no plants in the open ocean. The producers at the bottom of the food chain are different types of phytoplankton.

The deep-ocean regions are much colder and darker than the upper ocean. In the deep ocean there is no sunlight available for photosynthesis. The animals in the deep ocean either feed on each other or on material that falls down from upper levels of the ocean. Many organisms in deep ocean biomes can only be seen with a microscope.

14.4 Review

KEY CONCEPTS

1. In biomes located on land, abiotic factors are used to classify the different biome types. What are these abiotic factors?
2. Name a characteristic type of plant for each of the six land biomes.
3. Name six different aquatic biomes.

CRITICAL THINKING

4. **Predict** If an ecosystem in the grassland biome started to receive less and less rainfall every year, what new biome would be established?
5. **Infer** Name some abiotic factors that affect aquatic biomes and ecosystems.

CHALLENGE

6. **Apply** Use the map on page 517 to list the following four biomes in the order you would find them, moving from the equator to the poles.
   - desert
   - taiga
   - tropical forest
   - tundra

14 Chapter Review

the BIG idea

Matter and energy together support life within an environment.

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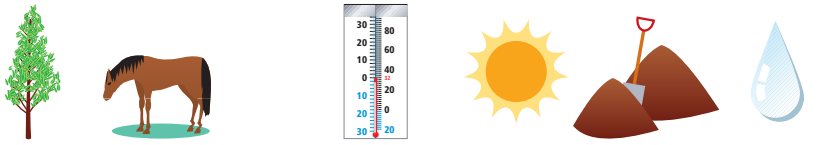
Content Review and FCAT Practice

KEY CONCEPTS SUMMARY

1 Ecosystems support life.

Ecosystems are made up of living things (biotic) and nonliving things (abiotic).



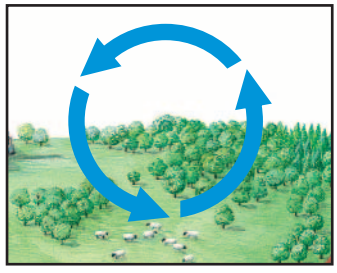
plants, animals — **Biotic Factors**

temperature, Sun, soil, water — **Abiotic Factors**

VOCABULARY
ecology p. 495
ecosystem p. 495
biotic factor p. 496
abiotic factor p. 496

2 Matter cycles through ecosystems.

Water, carbon, and nitrogen are materials that are necessary for life. They move through ecosystems in continuous cycles.



VOCABULARY
cycle p. 502
water cycle p. 503
carbon cycle p. 504
nitrogen cycle p. 505

3 Energy flows through ecosystems.

Producers are the basis of feeding relationships in ecosystems.

Producer — **Primary consumer** — **Secondary consumer**

Food chains and food webs help show how energy moves through living things.

VOCABULARY
producer p. 509
consumer p. 510
decomposer p. 511
food chain p. 512
food web p. 512
energy pyramid p. 514

4 Biomes contain many ecosystems.

Ecosystems of land biomes

- are affected by climate
- are affected by conditions of the soil
- are characterized by types of plants

Ecosystems of water biomes

- can be freshwater or saltwater
- are affected by landscape if freshwater
- are affected by depth if marine

VOCABULARY
biome p. 516
coniferous p. 518
deciduous p. 519
estuary p. 522

Reviewing Vocabulary

Write a statement describing how the terms in each pair are similar and different.

1. biotic, abiotic

2. producer, consumer

3. food chain, food web

The table shows the meanings of word roots that are used in many science terms.

Root	Meaning
bio-	life
ecos-	house
-ogy	study of

Use the information in the table to write definitions for the following terms.

4. ecology

5. biome

6. ecosystem

Reviewing Key Concepts

Multiple Choice *Choose the letter of the best answer.*

7. Which best describes the components of an ecosystem?

a. light, water, soil, and temperature
b. autotrophs and heterotrophs
c. biotic and abiotic factors
d. producers, consumers, and decomposers

8. What is the primary source of energy for most ecosystems?

a. water **c.** soil
b. nitrogen **d.** sunlight

9. What is the process by which the water in rivers, lakes, and oceans is converted to a gas and moves into the atmosphere?

a. precipitation **c.** condensation
b. evaporation **d.** transpiration

10. The process called nitrogen fixation is essential for life on Earth. Which of the following is an example of nitrogen fixation?

a. Plants take in nitrogen gas from the atmosphere.
b. Animals take in nitrogen gas from the atmosphere.
c. Water absorbs nitrogen.
d. Bacteria convert nitrogen gas into a form that plants can use.

11. Which organism is a decomposer?

a. vulture **c.** musk ox
b. sunflower **d.** fungus

12. How are decomposers important in an ecosystem?

a. They make atmospheric nitrogen available to plants in a usable form.
b. They convert organic matter into more complex compounds.
c. They are an important source of food for scavengers.
d. They break down organic matter into simpler compounds.

13. What factor is least important in determining the plant life in a biome?

a. average annual rainfall
b. average annual temperature
c. the type of soil
d. the type of animals living there

Short Response *Write a short response to each question.*

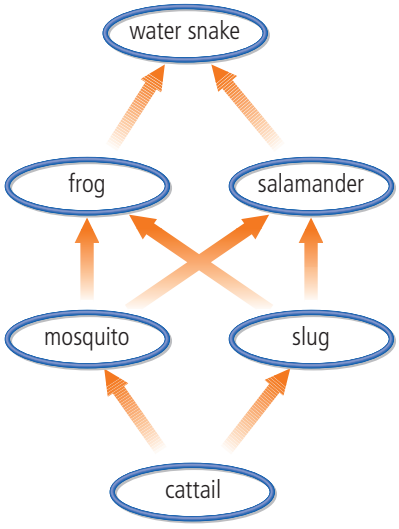
14. Write a paragraph to describe how carbon dioxide gas in the atmosphere can become part of the carbon compounds found inside animals.

15. Write a paragraph to explain how the amount of available energy changes as you move from producers to consumers in a food web.

16. Write a paragraph to describe one important way in which the flow of energy through ecosystems is different from the cycling of matter.

Thinking Critically

Use the diagram to answer the next four questions.



17. **CONNECT** What does the diagram above represent and how does it relate to energy in an ecosystem?

18. **CLASSIFY** Identify each of the animals in the diagram above as a producer, primary consumer, or secondary consumer or tertiary consumer.

19. **APPLY** Another animal that is found in many wetlands ecosystems is the shrew. The shrew eats salamanders and slugs and is eaten by water snakes. Copy the diagram above and show how you would add the shrew to the diagram.

20. **CONNECT** Use the diagram above to make an energy pyramid. If only one-tenth of the energy available at each level is passed on to the next higher level, how much of the energy in a cattail is transferred to a salamander?

21. **SYNTHESIZE** Why would it be difficult to show a decomposer as part of an energy pyramid?

22. **RANK** Arrange the following list of biomes according to the relative amounts of precipitation in each, going from the least amount to the most: grassland, desert, deciduous forest, taiga, tropical rain forest.

23. **SYNTHESIZE** Why are plants but not animals considered an important factor in classifying a land biome?

24. **SUMMARIZE** Draw a diagram that illustrates aquatic biomes. On your diagram label the following: freshwater river, freshwater lake, estuary, coastal zone, open ocean zone. How do abiotic factors differ among these biomes?

25. **COMPARE AND CONTRAST** In what ways is your home like an ecosystem? In what ways is it different?

26. **APPLY** Describe a change in an abiotic factor that affected living factors in an ecosystem near you.

the BIG idea

27. **CLASSIFY** Look again at the photograph on pages 492–493. Now that you have finished the chapter, how would you change or add details to your answer to the question on the photograph?

28. **SYNTHESIZE** Write one or more paragraphs describing how matter and energy together support life in an ecosystem. You may use examples from one specific ecosystem if you wish. In your description, use each of the following terms. Underline each term in your answer.

ecosystem	decomposer
food web	nitrogen cycle
producer	carbon cycle
primary consumer	secondary consumer

UNIT PROJECTS

If you are doing a unit project, make a folder for your project. Include in your folder a list of the resources you will need, the date on which the project is due, and a schedule to track your progress. Begin gathering data.

FCAT Practice

For FCAT practice, go to . . .
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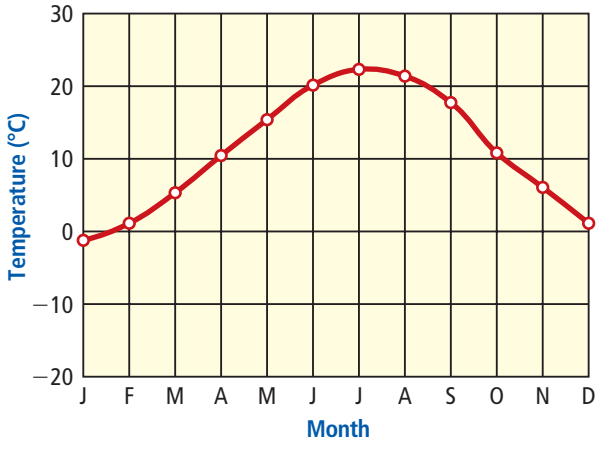
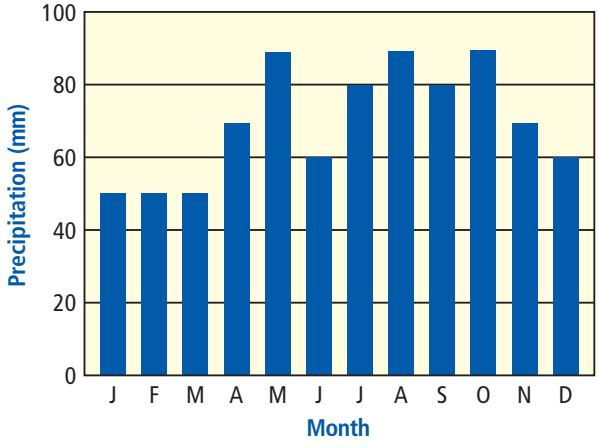
Interpreting Graphs

The graphs below show average monthly temperature and precipitation for one year in Staunton, Virginia, an area located in a temperate deciduous forest biome.

FCAT TiP

When using a graph to answer questions that ask for estimations, be sure to study the measurements on the graph carefully.





Study the graphs and answer the following questions.

GRIDDED RESPONSE

1. What was the average temperature, in degrees Celsius, during July?

2. How much precipitation, in millimeters, fell during the month of September?

MULTIPLE CHOICE

3. Which months had the most precipitation?

A. January, February, March
B. May, August, October
C. July, August, September
D. December, January, February

4. What were conditions during May?

F. warm and moist
G. warm and dry
H. cool and moist
I. cool and dry

5. How much precipitation would you estimate fell as snow in the year shown?

A. less than 50 mm
B. between 50 and 100 mm
C. between 100 and 200 mm
D. over 200 mm

EXTENDED RESPONSE

6. Most of the United States is part of a temperate deciduous forest biome. The deciduous forest biome has four seasons. Trees in this biome lose their leaves yearly. Use this information, as well as the information in the graphs, to describe the seasons in the temperate deciduous forest biome.

7. Write a paragraph in which you describe a typical ecosystem in your city or town. In your answer include biotic factors such as plants, animals, and other organisms. Also include abiotic factors such as light, temperature, soil, and water. Finish your description by saying how you and other humans affect the ecosystem.