chapter 25

The Nonliving Environment

section 1 Abiotic Factors

Before You Read

How would you describe the climate where you live? How does it affect the plant and animal life around you?

_____

_____

_____

What You'll Learn

- the common abiotic factors in most ecosystems
- the components of air that are needed for life
- how climate influences life in an ecosystem

Read to Learn

Mark the Text

Summarize Write a phrase beside each main heading that summarizes the main point of the section.

Environmental Factors

Living things depend on one another for food and shelter. The features of the environment that are alive, or were once alive, are called **biotic** (bi AH tihk) factors.

Biotic factors are not the only things needed for life. Plants and animals cannot survive without the nonliving environment. The nonliving, physical features of the environment are called **abiotic** (ay bi AH tihk) factors. Abiotic factors include air, water, sunlight, soil, temperature, and climate. These factors often determine the kinds of organisms that live there.

Air

The air that surrounds Earth is called the **atmosphere**. Air is made up of 78 percent nitrogen, 21 percent oxygen, 0.94 percent argon, 0.03 percent carbon dioxide, and trace amounts of other gases. Some of these gases are important in supporting life.

Carbon dioxide (CO_2) is necessary for photosynthesis. Photosynthesis uses CO_2, water, and energy from sunlight to make sugar molecules. Organisms such as plants use photosynthesis to produce their own food.

Reading Check

1. **List** What three things are needed for photosynthesis?

_____

_____

_____

Respiration Oxygen is released into the atmosphere during photosynthesis. Cells use oxygen to release the chemical energy stored in sugar molecules. This process, called respiration, provides cells with the energy needed for all life processes.

Water

Water is necessary to life on Earth. It is a major part of the fluid inside the cells of all organisms. Most organisms are 50 percent to 95 percent water. Processes such as respiration, digestion, and photosynthesis occur only if water is present. Environments that have plenty of water usually have a greater variety of and a larger number of organisms than environments that have little water.

Soil

Think it Over

2. **Recognizing Cause and Effect** How does soil affect plant life in an area?

Soil is a mixture of mineral and rock particles, the remains of dead organisms, water, and air. Soil is the top layer of Earth's crust where plants grow. It is formed partly of rock that has been broken down into tiny particles.

Soil is considered an abiotic factor because most of it is made up of nonliving rock and mineral particles. But soil also contains living organisms and the remains of dead organisms. The decaying matter in soil is called humus. Soils contain different combinations of sand, clay, and humus. The kind of soil in a region affects the kinds of plant life that grow there.

Sunlight

Sunlight is the energy source for almost all life on Earth. Plants and other organisms that use photosynthesis are called producers. They use light energy from the Sun to produce their own food. Organisms that cannot make their own food are called consumers. Energy is passed to consumers when they eat producers or other consumers.

Temperature

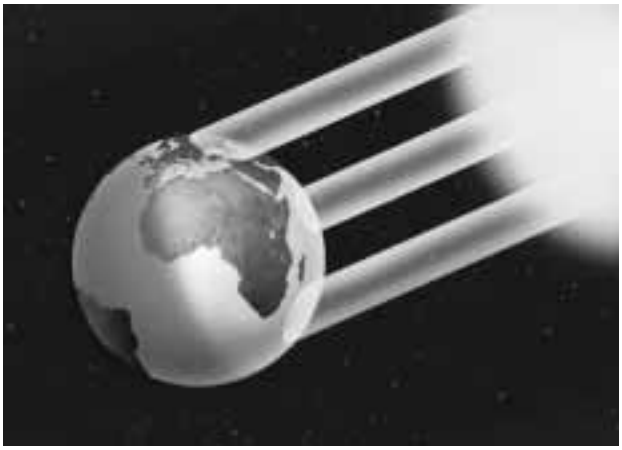
Reading Check

3. **Identify** What are two types of energy the Sun provides?

Sunlight provides the light energy for photosynthesis and the heat energy for warmth. Most organisms can live only if their body temperatures are between the freezing point of water, 0°C, and 50°C. The temperature of a region depends partly on the amount of sunlight it gets. The amount of sunlight depends on the area's latitude and elevation.

How does latitude affect temperature?

The temperature of a region is affected by its latitude. Places farther from the equator generally have colder temperatures than places at latitudes nearer to the equator. Look at the figure below. Near the equator, sunlight directly hits Earth. Sunlight hits Earth at an angle near the poles. This spreads the energy over a larger area.



Picture This

4. Identify Use one color to highlight the sunlight directly hitting Earth at the equator. Use another color to highlight the sunlight hitting Earth at the poles.

How does elevation affect temperature?

A region's elevation, or distance above sea level, affects its temperature. Earth's atmosphere traps the Sun's heat. At higher elevations, the atmosphere is thinner than at lower elevations. Air becomes warmer when sunlight heats the air molecules. Because there are fewer air molecules at higher elevations, the air temperature at higher elevations tends to be cooler.

Trees at higher elevations are usually shorter. The timberline is the elevation above which trees do not grow. Only low-growing plants exist above the timberline. The tops of some mountains are so cold that no plants grow there.

Reading Check

5. Explain Why is the air temperature at higher elevations usually cooler than the air temperature at lower elevations?

_____

_____

Climate

In Fairbanks, Alaska, winter temperatures may be as low as −52°C. More than one meter of snow might fall in one month. In Key West, Florida, winter temperatures rarely go below 5°C. Snow never falls. These two cities have different climates. The **climate** of an area is its average weather conditions over time. Climate includes temperature, rainfall or other precipitation, and wind.

Reading Check

6. **Determine** What are the most important parts of climate for most living things?

How does climate affect life in an area?

Temperature and precipitation are the two most important parts of climate for most living things. They affect the kinds of organisms that live in an area. For example, an area that has an average temperature of 25°C and gets less than 25 cm of rain per year probably has cactus plants growing there. An area with the same average temperature and more than 300 cm of rain every year is probably a tropical rain forest.

How are winds created?

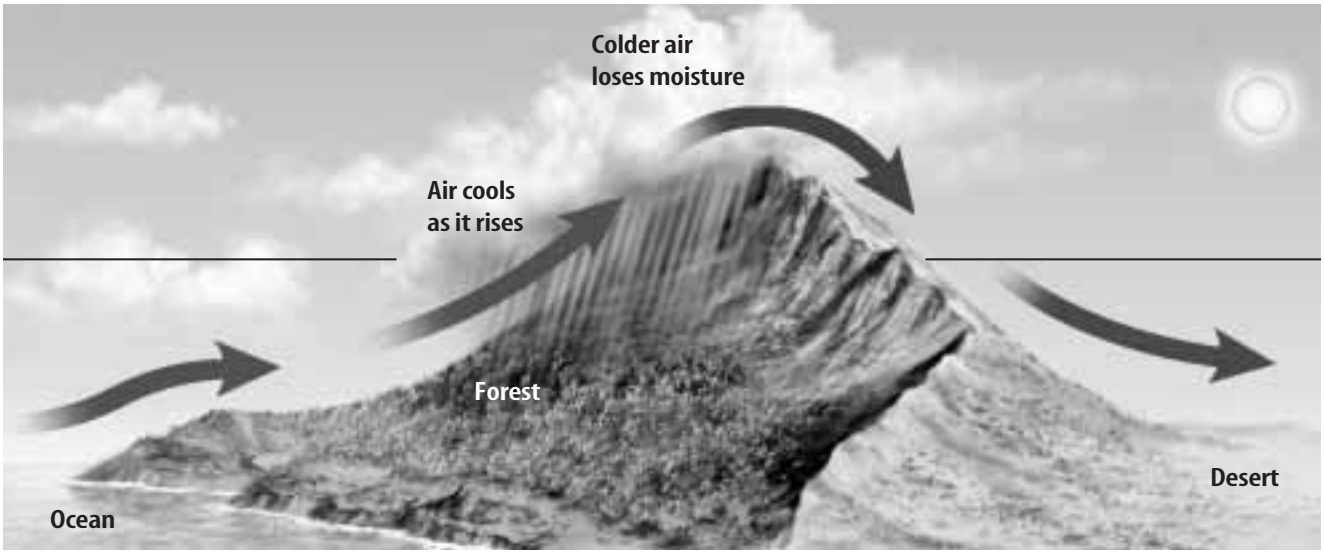
In addition to affecting the temperature of an area, the heat energy from the Sun causes wind. Air is made up of gas molecules. As the temperature increases, the molecules spread farther apart. So, warm air is lighter than cold air. Colder air sinks below warmer air and pushes it upward. This movement creates air currents that are called wind.

What is the rain shadow effect?

Mountains can affect rainfall patterns. As the figure below shows, moist air is carried toward land by the wind. The wind is forced upward by the slope of the mountain. As the air moves to the top, it cools. When air cools, the moisture in it falls as rain or snow. By the time the air crosses over the top of the mountain, it has lost most of its moisture. The drier air warms as it flows down the mountain. The other side of the mountain is in a rain shadow and receives much less precipitation. As a result, one side of the mountain could be covered with forests, while the other side is a desert.

Picture This

7. **Explain** On the figure below, label the first and fourth arrows to complete the explanation of the rain shadow effect.



After You Read

Mini Glossary

abiotic (ay bi AH tihk): nonliving, physical features of the environment, including air, water, sunlight, soil, temperature, and climate

atmosphere: the air that surrounds Earth

biotic (bi AH tihk): features of the environment that are alive or were once alive

climate: an area's average weather conditions over time, including temperature, rainfall or other precipitation, and wind

soil: a mixture of mineral and rock particles, the remains of dead organisms, water, and air

1. Review the terms and their definitions in the Mini Glossary. Write a sentence that explains the difference between abiotic and biotic factors.

2. Complete the chart below to identify a way that each abiotic factor is important to life.

Abiotic Factor	Importance to Life
Air	
Water	
Soil	
Sunlight	
Temperature	
Climate	

ScienceOnline Visit **life.msscience.com** to access your textbook, interactive games, and projects to help you learn more about abiotic factors.

End of Section

chapter 25

The Nonliving Environment

section 2 Cycles in Nature

What You'll Learn

- why Earth's water cycle is important
- about the carbon cycle
- how nitrogen affects life on Earth

Before You Read

What happens when you boil water in a covered pot? What do you see on the lid of the pot when you remove it?

Study Coach

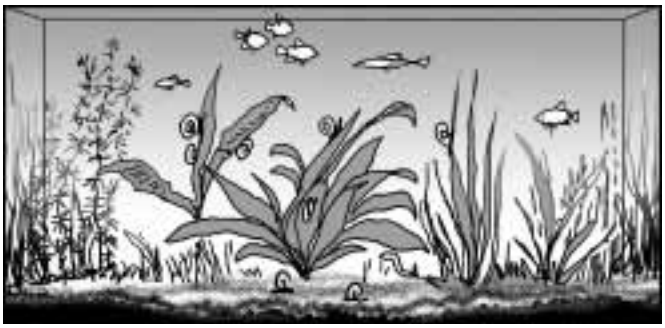
Outline As you read, make an outline to summarize the information in the section. Use the main headings in the section as the main headings in the outline. Complete the outline with the information under each heading in the section.

Read to Learn

The Cycles of Matter

Imagine an aquarium with water, fish, snails, plants, algae, and bacteria. The tank is sealed so that only light can enter. How can the organisms survive without adding food, water, and air? The plants and algae produce their own food through photosynthesis. They also supply oxygen to the tank. The fish and snails eat the plants and algae and take in the oxygen. The wastes from the fish and snails fertilize the plants and algae. Bacteria decompose those organisms that die. The organisms in this closed environment can survive because the materials are recycled.

The environment in the aquarium is similar to Earth's biosphere. Earth only has a certain amount of water, carbon, nitrogen, oxygen, and other materials needed for life. These materials are constantly being recycled.



Picture This

1. **Explain** to a partner how the fish in the tank survive without anyone adding food, water, and air.

The Water Cycle

When you leave a glass of water on a sunny windowsill, the water evaporates. **Evaporation** takes place when liquid water changes into a gas, called water vapor, and enters the atmosphere. Water evaporates from the surfaces of lakes, streams, and oceans. It enters the atmosphere from plants in a process known as transpiration (trans puh RAY shun). Animals release water vapor as they exhale. Water is returned to the environment from animal wastes.

What is condensation?

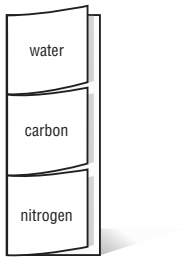
After water vapor enters the atmosphere, eventually it will come into contact with colder air. The temperature of the water vapor drops. Over time, the water vapor becomes cool enough to change back into liquid water. The process of changing from a gas to a liquid is called **condensation**.

The water vapor condenses on particles of dust in the air and forms tiny droplets. The droplets join together to form clouds. When the droplets become large and heavy enough, they fall to the ground as rain or other precipitation.

As the figure below shows, the **water cycle** is a model that describes how water moves from the surface of Earth to the atmosphere and back to the surface again.

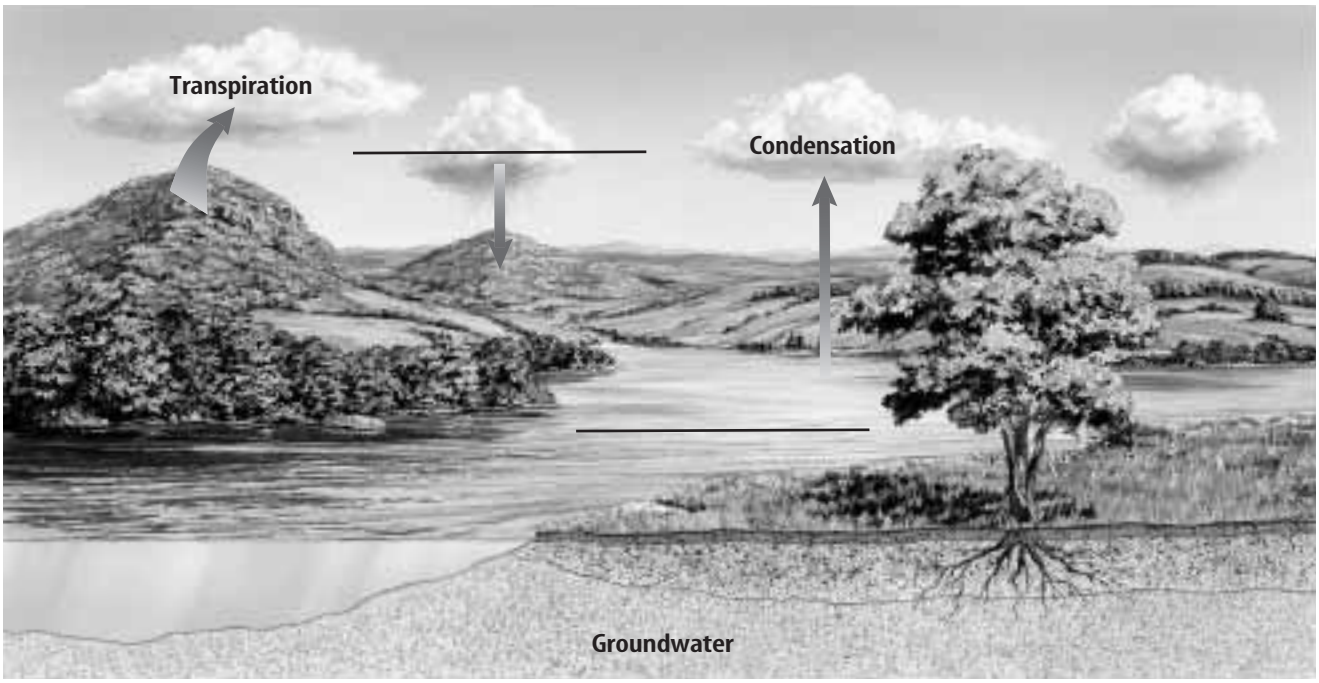
FOLDABLES™

A Describe Make a three-tab book Foldable, as shown below. Use the Foldable to describe the water, carbon, and nitrogen cycles.



Picture This

2. Identify Complete the figure by labeling the missing steps in the water cycle.



Think it Over

3. **Analyze** List some of the ways you use water.

How do humans affect the water cycle?

Humans take water from reservoirs, rivers, and lakes to use in their homes, businesses, and farms. Using this water can reduce the amount of water that evaporates into the atmosphere. Humans also influence how much water returns to the atmosphere by limiting the amount of water available to plants and animals.

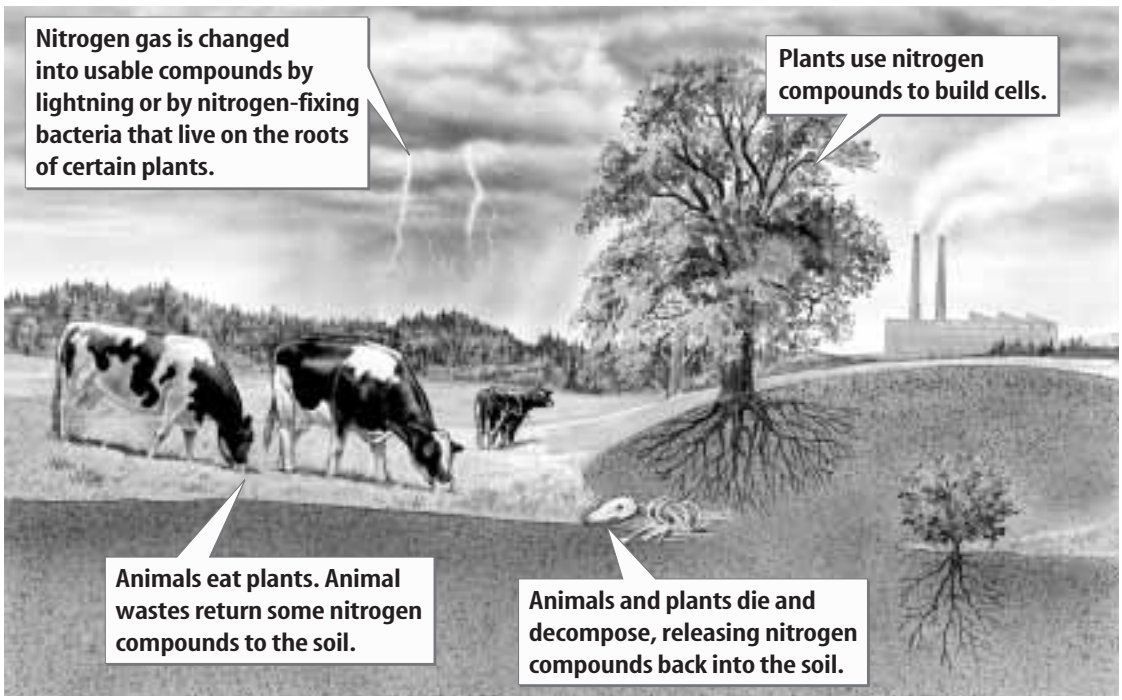
The Nitrogen Cycle

Nitrogen is important to all living things. It is a necessary part of proteins. Proteins are needed for the life processes that take place in the cells of all organisms. Nitrogen is the most plentiful gas in the atmosphere. However, most organisms cannot use nitrogen directly from the air.

Plants need nitrogen that has been combined with other elements to form nitrogen compounds. Through a process called **nitrogen fixation**, some types of soil bacteria form the nitrogen compounds that plants need. Plants take in these nitrogen compounds through their roots. Animals get the nitrogen they need by eating plants or other animals. When dead organisms decay, the nitrogen in their bodies returns to the soil or the atmosphere. This transfer of nitrogen from the atmosphere to the soil, to living organisms, and back to the atmosphere is called the **nitrogen cycle**. The nitrogen cycle is shown in the figure below.

Picture This

4. **Discuss** What is one role animals play in the nitrogen cycle?



How do human activities affect soil nitrogen?

Humans can affect the part of the nitrogen cycle that takes place in the soil. After crops are harvested, farmers often remove the rest of the plant material. The plants are not left in the field to decay and return their nitrogen compounds to the soil. If the nitrogen compounds are not replaced, the soil could become infertile. Fertilizers can be used to replace soil nitrogen. Compost and animal manure also contain nitrogen compounds that plants can use. They can be added to soil to make it more fertile.

Another way to replace soil nitrogen is by growing nitrogen-fixing crops. Most nitrogen-fixing bacteria live on or in the roots of certain plants. Some plants, such as peas, have roots with nodules that contain nitrogen-fixing bacteria. These bacteria supply nitrogen compounds to the plants and add nitrogen compounds to the soil.

Reading Check

5. **Identify** two ways to add nitrogen to soil.

_____

_____

_____

The Carbon Cycle

Carbon atoms are found in the molecules of living organisms. Carbon is part of soil humus and is found in the atmosphere as carbon dioxide gas (CO_2). The **carbon cycle** describes how carbon molecules move between the living and nonliving world.

The cycle begins when producers take CO_2 from the air during photosynthesis. They use CO_2, water, and sunlight to make energy-rich sugar molecules. Energy is released from these molecules during respiration—the chemical process that provides energy for cells. Respiration uses oxygen and releases CO_2. Photosynthesis uses CO_2 and releases oxygen. The two processes help recycle carbon on Earth.

Reading Check

6. **Explain** What two processes recycle carbon on Earth?

_____

_____

_____

Human activities also release CO_2 into the atmosphere. For example, when fossil fuels are burned, CO_2 is released into the atmosphere as a waste product. People also use wood for building and for fuel. Trees that are cut down for these purposes cannot remove CO_2 from the atmosphere during photosynthesis. The amount of CO_2 in the atmosphere is increasing. The extra CO_2 could trap more heat from the Sun and cause average temperatures on Earth to rise.

After You Read

Mini Glossary

carbon cycle: a model that describes how carbon molecules move between the living and nonliving world

condensation: process that occurs when a gas changes to a liquid

evaporation: process that occurs when liquid water changes into water vapor and enters the atmosphere

nitrogen cycle: the transfer of nitrogen from the atmosphere to the soil, to living organisms, and back to the atmosphere

nitrogen fixation: process in which some types of soil bacteria form the nitrogen compounds that plants need

water cycle: a model that describes how water moves from the surface of Earth to the atmosphere and back to the surface again

1. Review the terms and their definitions in the Mini Glossary. Write a sentence that explains the difference between condensation and evaporation.

2. In the chart, list the steps in the nitrogen cycle.

Steps in the Nitrogen Cycle
1.
2.
3.
4.

End of Section

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chapter 25

The Nonliving Environment

section 3 Energy Flow

What You'll Learn

- how organisms make energy-rich compounds
- how energy flows through ecosystems
- how much energy is available at different levels in a food chain

Before You Read

Why do you need energy? What is your source of energy?

Read to Learn

Converting Energy

All living things are made up of matter, and all living things need energy. Matter can be recycled over and over. Energy is not recycled, but it is converted from one form to another. This conversion is important to all life on Earth.

How is energy converted during photosynthesis?

During photosynthesis, producers convert light energy into the chemical energy in sugar molecules. Some of these sugar molecules are broken down as energy. Some are used to build complex carbohydrate molecules that become part of the producer's body. Fats and proteins also contain stored energy.

What are hydrothermal vents?

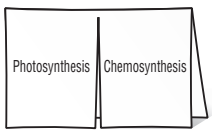
Some producers do not rely on light for energy. These producers live deep underwater in total darkness. They live near powerful hydrothermal vents. Hydrothermal vents are deep cracks in the ocean floor. The water from these vents is very hot from contact with molten rock deep in the Earth's crust.

Mark the Text

Locate Information Read all the headings for this section and circle any word you cannot define. At the end of each section, review the circled words and underline the part of the text that helps you define the words.

FOLDABLES™

B Compare Make a two-tab Foldable, as shown below, to compare how producers use photosynthesis and chemosynthesis to convert energy.



What is chemosynthesis?

Because sunlight does not reach deep ocean regions, the organisms that live there cannot get energy from sunlight. Scientists have learned that the hot water has nutrients that bacteria use to make their own food. The production of energy-rich nutrient molecules from chemicals is called **chemosynthesis** (kee moh SIN thuh sus). Consumers that live in hydrothermal vent communities rely on chemosynthetic bacteria for nutrients and energy.

Reading Check

1. **Explain** What type of organisms use chemosynthesis?

_____

_____

_____

Energy Transfer

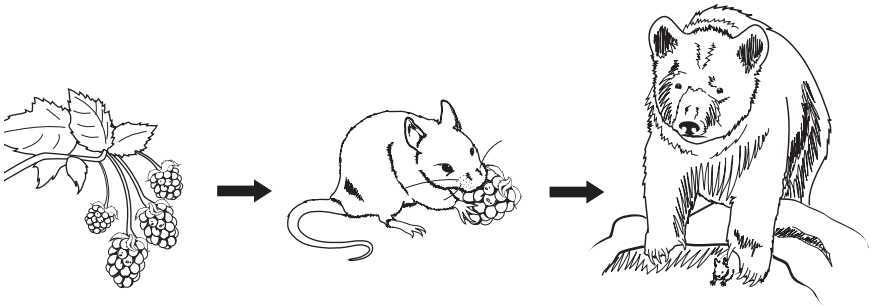
Energy can be converted from one form to another. It also can be transferred from one organism to another. Consumers cannot make their own food. Instead, they obtain energy by eating producers or other consumers. The energy that is stored in the molecules of one organism is transferred to another organism. That organism can release the energy stored in the food. It can use the energy for growth, or it can transform the energy into heat. At the same time, the matter that makes up those molecules is transferred from one organism to another. Throughout nature, energy and matter are transferred from organism to organism.

How does energy flow in food chains?

The food chain in the figure below shows how matter and energy pass from one organism to another. Producers, such as plants, are the first step in a food chain. All producers make their own food using either photosynthesis or chemosynthesis. Animals, such as herbivores, that eat producers are the second step. Animals that eat other consumers are the third and higher steps of food chains.

Picture This

2. **Identify** Write Producer or Consumer below each organism on the food chain.



Berries Mouse Black Bear

_____ _____ _____

What are food webs?

There are many feeding relationships in a forest community. For example, bears eat berries, insects, and fish. Berries are eaten by many different organisms. A **food web** is a model that shows all the possible feeding relationships among the organisms in a community. A food web is made up of many different food chains.

Energy Pyramids

Most food chains have three to five links. The number of links is limited because the amount of available energy is reduced as you move from one level to the next.

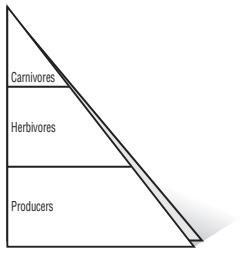
How does available energy decline?

When a mouse eats seeds, energy stored in the seeds transfers to the mouse. But most of the energy the plant took in from the Sun was used to help the plant grow. The mouse uses energy from the seed for its own processes, such as digestion and growth. Some of the energy is given off as heat. A hawk that eats the mouse gets even less energy. The amount of available energy is reduced from one level of a food chain to another.

An **energy pyramid** shows the amount of energy available at each feeding level in an ecosystem. The bottom of the pyramid below includes all producers. It is the first and largest level because it contains the most energy and the largest number of organisms. As the energy is reduced from one level to another, each level becomes smaller. In fact, only about 10 percent of the energy available at each feeding level is transferred to the next higher level.

FOLDABLES™

C Identify Make a pyramid Foldable, as shown below, to identify the flow of energy from producers, to herbivores, to carnivores.



Think it Over

3. **Synthesize** Why are there more producers than consumers?

After You Read

Mini Glossary

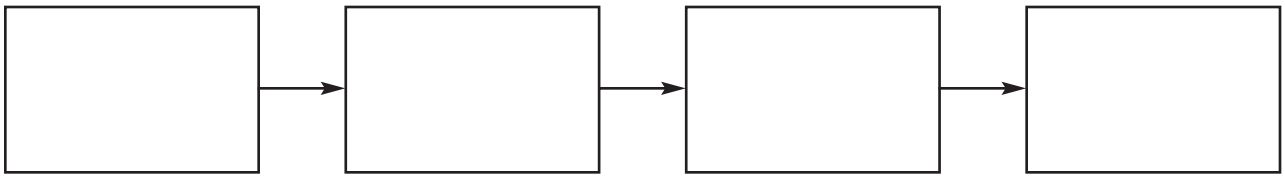
chemosynthesis (kee moh SIN thuh sus): the production of energy-rich nutrient molecules from chemicals

energy pyramid: a model that shows the amount of energy available at each feeding level in an ecosystem

food web: a model that shows all the possible feeding relationships among the organisms in a community

1. Review the terms and their definitions in the Mini Glossary. Choose the term that explains how energy-rich molecules are produced and write a sentence explaining how the process works.

2. Place the following organisms in the order of steps in which they would appear in a food chain: mountain lion, plant, bird, insect.



3. How did finding definitions of words you did not know help you understand energy flow?

End of Section

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