Science Ch. 7

Ecosystems

Career

Park Ranger

While visiting a national park, you are likely to see a park ranger. Do you have any questions about wildlife? Do you want to find a nice trail? Do you need first aid for a bad scrape? Park rangers are there to help.

A park ranger helps people safely enjoy the many state and national parks. Rangers work in some urban parks, too, such as Central Park in New York City. Park rangers do many jobs. In the same day, a ranger might teach visitors about wildlife, clear a downed tree from a trail, and rescue a lost hiker. The rangers make sure that people are obeying the park rules and not disturbing the wildlife.

A love of the outdoors is one of the most important qualities of park rangers. They learn about biology, ecology, and other topics in college. Rangers should also have good communication skills so that they can help people understand the importance of a park's ecosystems.

Lab zone

Take-Home Activity

One of a park ranger's jobs is to search for fires and to make sure visitors do not start illegal fires. Make a poster that would show visitors the importance of not being careless with fires in the park.

Chapter 7

Ecosystems

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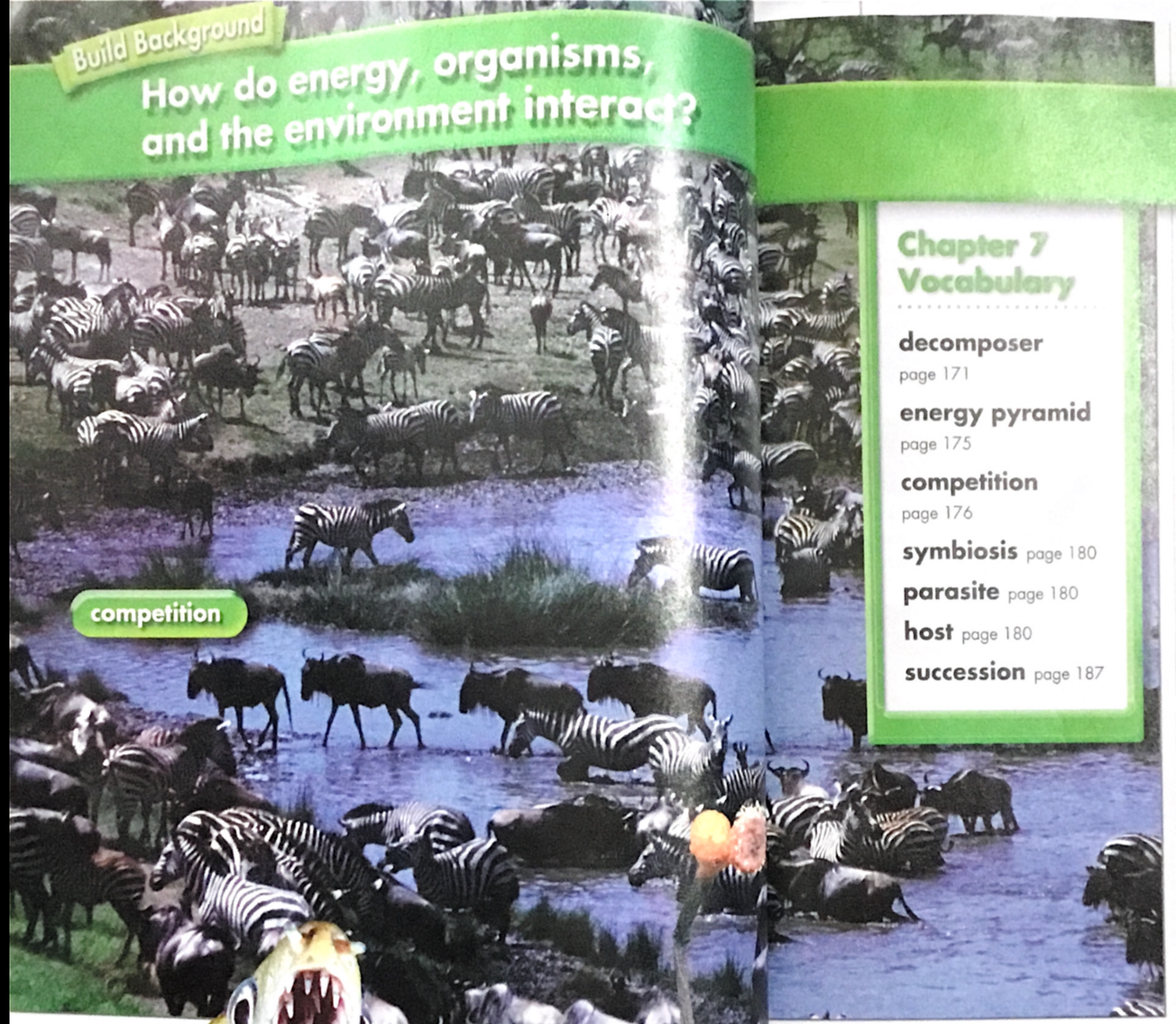
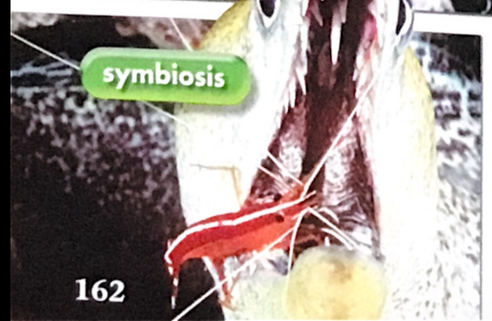
You Will Discover

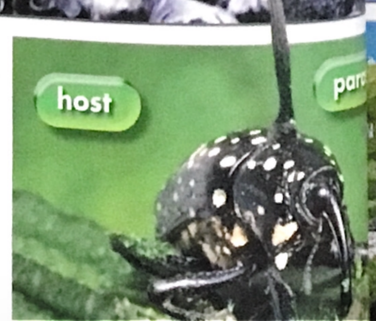
- how adaptations help organisms survive in ecosystems.
- how energy and materials travel through ecosystems.
- the ways ecosystems can change.

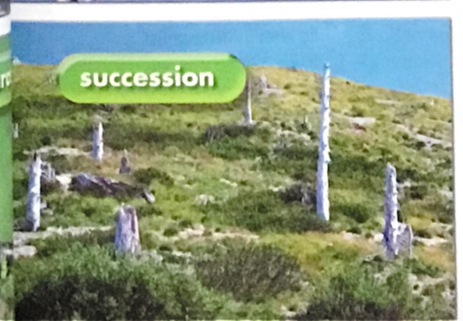
Build Background

How do energy, organisms, and the environment interact?









Chapter 7 Vocabulary

You Are There!

What's that? Over there! Do you see those big ears? It's a fox, but why does such a small animal need such large ears? How does this adaptation help the fox survive in the desert? What other adaptations help desert animals?

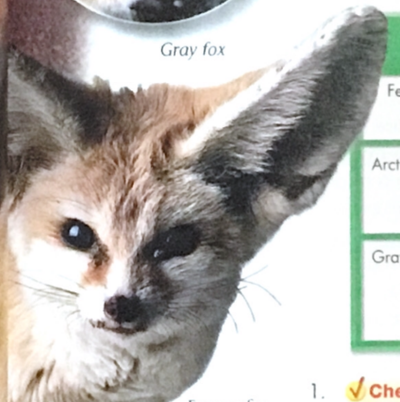
Lesson 1

Why do adaptations vary among species?

Organisms are adapted to the environment in which they live. Each species has its own unique set of adaptations.

Arctic fox

Gray fox



Fennec fox

Surviving in the Environment

Staying cool in a hot desert is not easy. The ears on the fennec fox may look too large for its head, but these ears are a useful adaptation. When the fennec fox becomes too hot, blood rushes to its ears. There body heat moves from the fox's blood into the air. Large ears help keep the fennec fox cool.

Can you guess why small ears are an important adaptation for the arctic fox? The arctic fox must have adaptations that help keep it warm in the extreme cold of its environment. Small ears help an arctic fox by reducing heat loss.

Because Earth's many species live in different environments, each has a unique set of adaptations that helps it meet its needs in different ways. The table shows some other adaptations of the fennec fox and the arctic fox. Compare their adaptations with those of the gray fox, which lives in the deciduous forest.

Adaptations for Different Environments

Fennec fox	• Pale fur reflects the Sun's rays. • Fur on feet protects against burning desert sand.
Arctic fox	• Thick fur changes from white in winter to brown in summer to help the fox blend in with its environment. • Thick fur covers bottom of feet to reduce heat loss.
Gray fox	• Small body and short legs make moving through the forest easy. • Curved claws are good for climbing up trees to avoid predators and find food.

1. **Checkpoint** Why do fennec foxes have adaptations that differ from the adaptations of arctic foxes and gray foxes?
2. **Art in Science** Draw an organism that lives in your environment. Label its adaptations and tell how each enables it to live successfully.

This peacock displays the shimmering colors of his feathers to attract a female.

When rain hits these puffballs, spores spew from them and spread out. In the right conditions, the spores will grow into new organisms.

This dormouse is one of many organisms that hibernate.

Structural Adaptations

The species shown on these pages have different living conditions, and their adaptations make them able to live successfully in their environments. Those adaptations developed over many generations, not during the lifetime of a single individual. A species changes over long periods as individuals are born with new characteristics that make them better suited to survive. These individuals survive and pass their new characteristics to offspring.

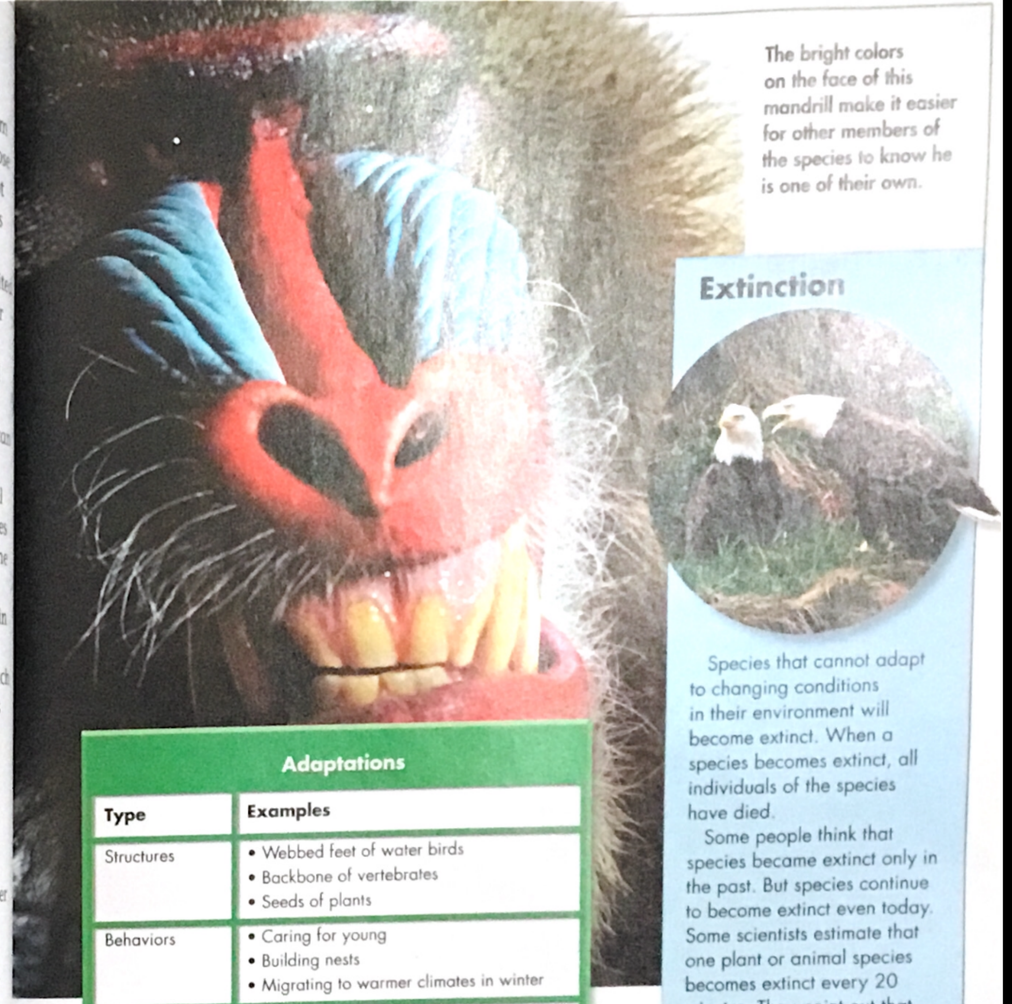
Adaptations enable organisms to get energy and to find mates and reproduce. They also protect organisms from their environments. Adaptations can include behaviors, structures, and body processes.

The mandrill shown on the next page has several important structural adaptations. His long jaw gives his mouth plenty of room for large teeth to grind the seeds and grasses he eats. His powerful hands dig other foods—roots and bulbs. Large pouches open in the cheeks beside the lower teeth and extend down the side of the neck. These pouches can hold as much food as a stomach. This storage frees the mandrill's hands and feet for running and climbing.

Behaviors and Body Processes

The mandrill's teeth have a function other than eating. When the male mandrill shows his large front teeth, the behavior serves as a warning to other males. Animal behaviors are adaptations that are just as important as structural adaptations. Many animal behaviors are inherited traits. You probably are familiar with many behavioral adaptations. Have you ever seen a spider's web or a bird's nest? These structures are a result of inherited behaviors.

The processes that go on in an organism's body also are adaptations that aid survival. When animals hibernate, their body processes slow down. Their temperature may become lower, and their heartbeat and breathing slow down. Hibernation protects animals from the cold months in their environment.



The bright colors on the face of this mandrill make it easier for other members of the species to know he is one of their own.

Adaptations

Type	Examples
Structures	• Webbed feet of water birds • Backbone of vertebrates • Seeds of plants
Behaviors	• Caring for young • Building nests • Migrating to warmer climates in winter
Body processes	• Hibernation • Photosynthesis • Digestion

Lesson Checkpoint

1. Give one example of each type of adaptation: behavior, structure, body process.
2. What adaptations do you have for getting energy and for protection from your environment?
3. **Predict** What might happen to the species of puffball shown on page 168 if the area where it lives received little or no rain for several years? Explain your answer.

Extinction

Species that cannot adapt to changing conditions in their environment will become extinct. When a species becomes extinct, all individuals of the species have died.

Some people think that species became extinct only in the past. But species continue to become extinct even today. Some scientists estimate that one plant or animal species becomes extinct every 20 minutes. They point out that about 40 species of fishes out of 950 species have become extinct in the past century.

Some causes of extinction are natural, such as climate changes. Other species become extinct because of human causes, such as habitat destruction or pollution. The American bald eagle shown above almost became extinct—in part because of the use of DDT, a chemical used to kill insects.

Lesson 2

How do organisms get energy?

All living things need energy to carry out life functions. A food web shows how energy can move through organisms in an ecosystem.

Energy Flow in Ecosystems

As the brown bear prowls the woods in search of food, it needs energy to stay alive and grow. All organisms need energy to carry on life functions, such as growth, movement, repair, and reproduction. Where does this energy come from?

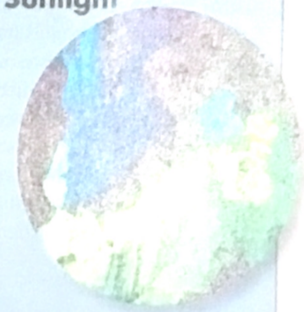
Most living things on Earth depend on the energy of sunlight—either directly or indirectly. The berry bush gets energy directly from sunlight. The leaves of the bush use the energy of sunlight in the process of photosynthesis to produce glucose. Plants can use the chemical energy in glucose as a source of energy for life functions. Plants are producers, organisms that can make their own food.

Not all organisms get their energy directly from the Sun. Bears and other animals do not have adaptations for capturing sunlight to make food. They are consumers, organisms that get energy by eating other organisms. When the bear eats the berries on the bush, it gets energy stored in the berries. The bear is indirectly using energy from sunlight.

The toadstools in the picture can't make their own food, and they don't eat other organisms. How do they get energy? When organisms die and fall to the ground, their bodies decay. Decay is caused by **decomposers,** organisms that get energy by breaking down the remains of dead organisms. Toadstools are decomposers. Decomposers release the materials from the dead organisms' bodies back into the environment, where they can be used by other organisms. Without decomposers, nothing would decay. That might sound good at first. But then remember—dead organisms would just pile up forever!

1. **Checkpoint** Explain how most life on Earth depends on energy from sunlight.
2. **Health** in Science Humans depend indirectly on sunlight for energy. But the UV rays of sunlight can be harmful to the body. Find out how the human body is adapted to protect itself from these harmful rays. Also find out what you can do to get more protection.

Life Without Sunlight



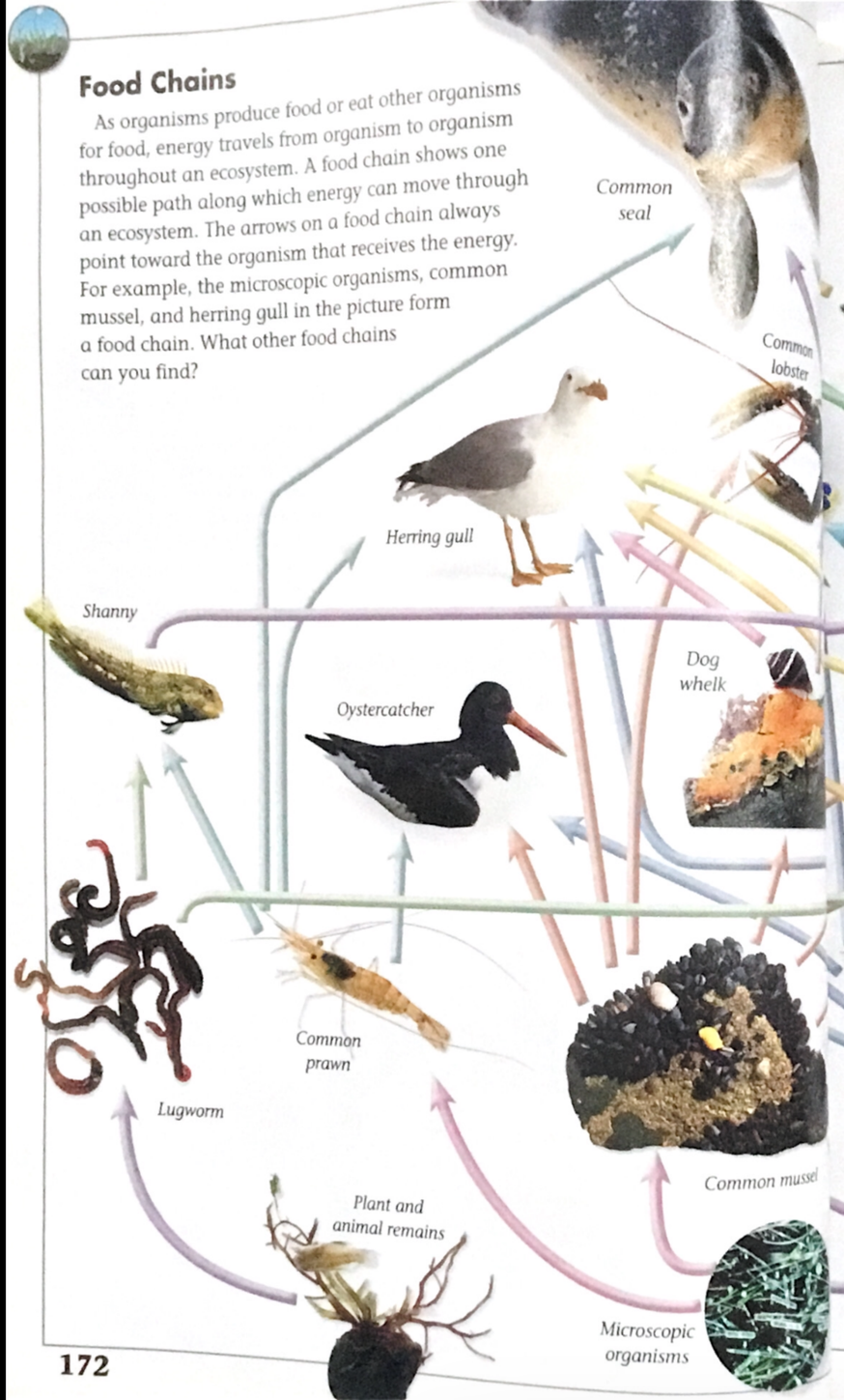
More than a kilometer below the ocean's surface, chimney-like structures, called hydrothermal vents, spew water that can be hotter than boiling. Water pressure is so great that it would crush your lungs immediately. Sunlight never reaches these vents. You might think such conditions make life impossible, but a unique group of organisms thrive there.

Perhaps the most noticeable organisms are giant tubeworms. They have no mouth or digestive system. They get energy from billions of bacteria that live inside them. These bacteria are producers but they don't use sunlight. The bacteria change energy from chemicals in the vent water into food for the tubeworms.

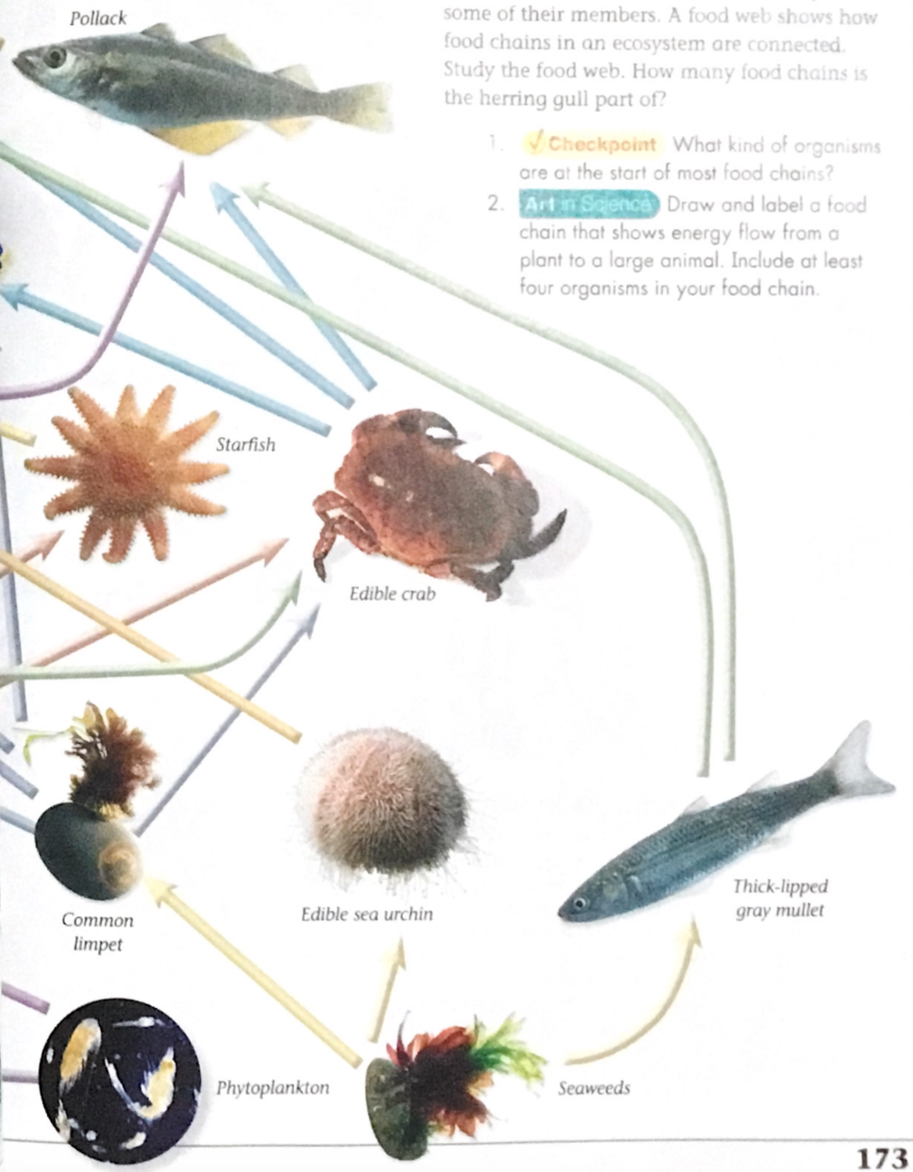
Vent ecosystems are teeming with a variety of species. You can find giant clams, mussels, spiderlike crabs, and soft-bodied spaghetti worms. Blind shrimp, octopuses, and fishes swarm about. In all, you will find more than 500 different species. And scientists are discovering new species every few weeks. That's a lot of life—without any sunlight!

Food Chains

As organisms produce food or eat other organisms for food, energy travels from organism to organism throughout an ecosystem. A food chain shows one possible path along which energy can move through an ecosystem. The arrows on a food chain always point toward the organism that receives the energy. For example, the microscopic organisms, common mussel, and herring gull in the picture form a food chain. What other food chains can you find?



An Ocean Food Web



Food Webs

An ecosystem has many different food chains. Each food chain has producers and consumers. Many consumers are food sources for other consumers, and several food chains may share some of their members. A food web shows how food chains in an ecosystem are connected. Study the food web. How many food chains is the herring gull part of?

1. **Checkpoint** What kind of organisms are at the start of most food chains?
2. **Art in Science** Draw and label a food chain that shows energy flow from a plant to a large animal. Include at least four organisms in your food chain.

Energy Pyramid

When you study a food chain, you can see the path that energy takes from producers to the top consumer. But a food chain doesn't tell you anything about how much energy moves from link to link.

Not all of the energy a green plant captures from sunlight is passed to other organisms. The plant uses some of the energy for life processes, and some energy is lost as heat. This is true for all levels of a food chain. A snake uses energy as it slithers across the ground in search of prey. A wood mouse uses energy as it digs a burrow. Organisms must use energy to grow, move, and reproduce. As a result, only part of the energy is available to the next level of the food chain.

An **energy pyramid** shows how energy moves through an ecosystem. See how the energy pyramid has a larger base that gets smaller as it nears the top? That's because more energy is available at the lower levels. The amount of available energy gets smaller at higher levels because most of the energy has been used by organisms for life processes or is given off as heat. Only energy that is stored in the tissues of organisms can be passed from one level to the next.

Only about ten percent of the energy at one level of a food chain moves to the next higher level. But organisms at higher levels do not need less energy. They must eat many organisms to get the energy they need. For that reason, many organisms are at the base of the pyramid, but only one—the top predator—is at the top.

Most food chains have no more than five links. That's because the amount of energy remaining by the fifth link is only a very small percentage of what was available at the first link.

Chemicals in the Food Chain

Energy isn't the only thing passed along in a food chain. Harmful substances can pass up through the food chain too. You can see in the energy pyramid that many organisms at the base of the pyramid support fewer organisms toward the top. When an organism eats harmful substances, they can be stored in the organism's tissues. As organisms higher up in the food chain eat the many organisms below, they also eat the harmful substances stored in tissues. As a result, the amount of harmful substances becomes more concentrated as you move up the pyramid. As the concentration increases, the effects of the substances can become more harmful—or even deadly.

Lesson Checkpoint

1. How are producers, consumers, and decomposers related to each other?
2. Why isn't all of the energy a green plant gets from sunlight passed to other organisms?
3. **Math in Science** Only about 10 percent of the energy a plant obtains from the Sun is passed to first-level consumers who eat it. What percent of the original energy used by plants reaches a second-level consumer?

Lesson 3

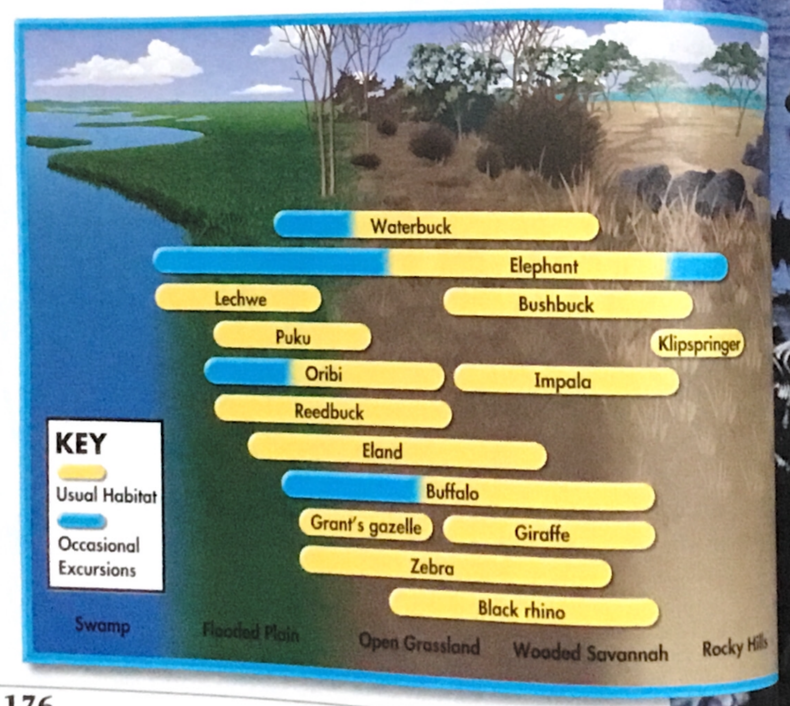
How do organisms compete for resources?

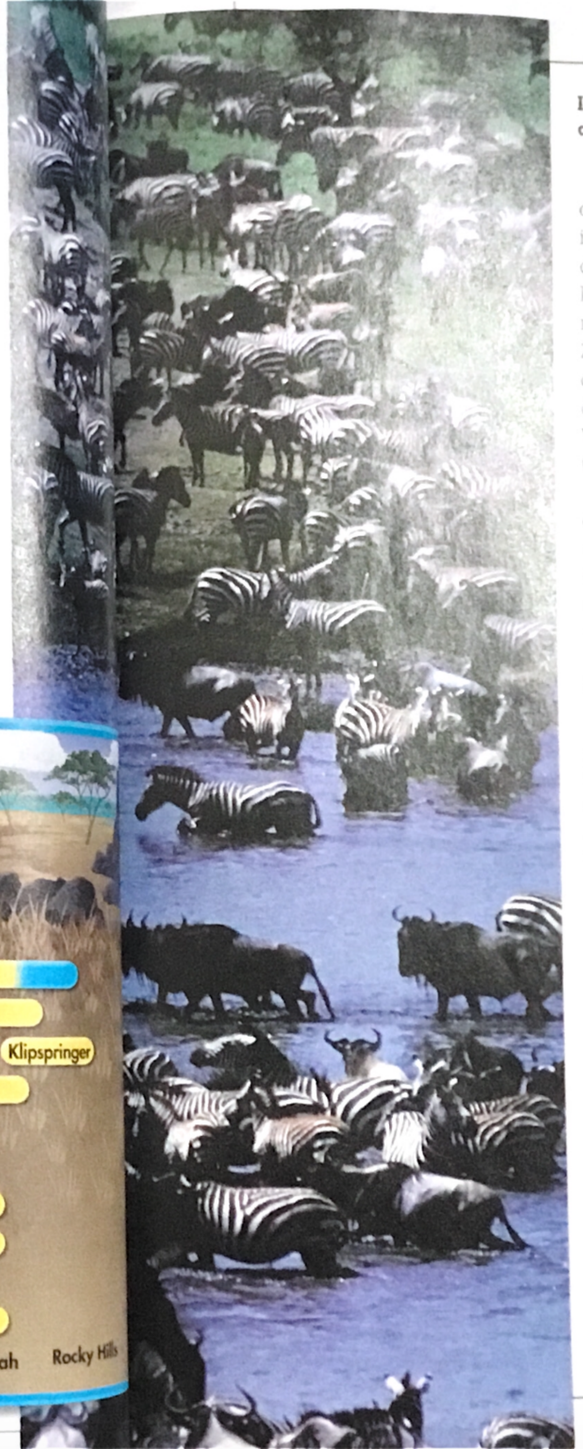
Organisms compete for resources in an ecosystem. Predators survive by eating prey. Some organisms have symbiotic relationships.

Competition

A watering hole is a good place to see the animals on the African savannah. You might see zebras, giraffes, gazelles, wildebeests, and other animals. How can an ecosystem have enough resources for so many organisms?

Competition is the struggle among organisms to survive in a habitat with limited resources. Like all organisms, the animals on the savannah in the picture need food, water, and a place to live. The animals that survive compete successfully for these resources.





In what ways do these animals compete?

As you can see in the diagram on page 176, all the animals on the savannah do not live in the same area. Different species live in different places. Those that do live together have different needs. Organisms with different needs can live together with little competition. Zebras and wildebeests can graze together on the savannah because they have different diets. Zebras prefer the tall, coarse grasses. When zebras eat those grasses, they expose the shorter grasses, which wildebeests then eat.

Competition happens when organisms in an ecosystem have similar needs. An ecosystem can't always meet its organism's needs. Resources, including water, food, and shelter, are limited. Organisms with helpful adaptations will survive. Others will die.

When Resources Are Scarce

Sometimes members of the same species compete. This might happen if resources become scarce, for example by drought. If water in the savannah is scarce, zebras that can survive with less water might survive. Those that need more water might not.

Competition also occurs between different species. Like wildebeests, gazelles eat short, tender grass. If drought reduces the number of grass plants, wildebeests and gazelles will compete for the limited resource.

All organisms, not just animals, compete for resources. Plants compete for water, growing space, minerals, and sunlight. Some plants even have strategies for reducing competition. They release into the soil poisonous chemicals that kill other species around them.

1. **Checkpoint** What causes competition?
2. **Predict** Two species of birds live in the same tree. Species A eats ants that live in the tree. Species B eats ants and caterpillars. Which species is more likely to survive if the ant population decreases? Why?

Eye Placement

To survive, many animals need eyes that are located where they can see what is most important to them.

Predators often have eyes that are in front of the head. This placement helps the animals judge how far away something is.

The eyes of prey are often on the side of its head. This allows the prey to avoid predators by seeing a wide area.

Predators and Prey

Animals use different methods to get the food they need. Some animals, like the tapirs in the photo on the next page, eat plants. But these tapirs can be food for other animals, such as panthers. An animal that feeds on other animals is called a predator. The animal that a predator eats is called a prey.

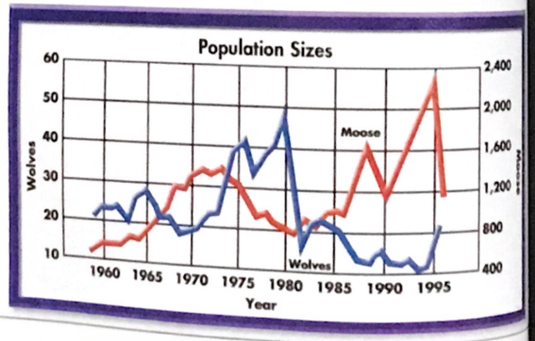
The number of predators that an ecosystem can support depends on the number of prey. And the number of prey depends on how many predators there are. It's a balancing act. As you can see in the graph below, as the number of predators increases, more prey are eaten. The number of prey gets smaller. When that happens, the predators do not have enough food, and some will die. As a result, fewer prey are eaten, and more prey survive to become food for more predators. The number of predators increases again.

Adaptations

Both predators and prey have adaptations that help them survive. Many predators are adapted to hunt and kill. They may be fast or have a keen sense of smell, hearing, or sight to help them locate prey. Some predators have behaviors that help them catch prey. Pack animals, such as wolves, work as a group to attack individuals from a herd. An alligator floats with only its eyes and nostrils out of water. Its strong jaw muscles and sharp teeth help the alligator grab its meal.

Not all predators chase after their prey. A jellyfish has hundreds of stinging cells on its tentacles. Chemicals in these cells can paralyze the prey, which then can be eaten.

Prey are adapted to avoid predators. Some prey animals secrete a poison and are brightly colored to warn away predators. Others mimic, or look like, a dangerous animal. Some prey depend on camouflage to make them look like something else, such as a plant, stick, or rock.



How did the decrease in the number of wolves starting in 1980 affect the moose population?

Prey animals also use behavioral adaptations to avoid being killed by predators. Did you ever hear someone say that they "were playing possum" when they pretended to be sleeping? When threatened, possums curl up and play dead. Predators that are only interested in live prey leave them alone. Sow bugs act in a similar way. When touched, they curl up into a ball. The hard outer covering on their backs acts as armor to protect the animals.

Protective coloration, a structural adaptation, makes a baby tapir hard to spot in the forest. Its spots and stripes look like sunlight shining through the trees.

Would you be able to easily find these insects? What structural adaptation helps them avoid predators?

The spikes of the sea urchin are brittle and sharp. Any predator that attacks the sea urchin will have to deal with the painful jabs it gets from the spikes.

The bright color of this poison dart frog is a warning to predators. Glands in its skin release bad-tasting, poisonous chemicals.

1. √ Checkpoint Give an example of a predator and a prey adaptation for each type: behavior, structure, body process.
2. Writing in Science **Expository** Write a paragraph explaining how the sizes of predator-prey populations depend on each other.

Symbiosis

Can you tell what's happening with the weevil beetle shown on this page? The long thin object growing on its back is a kind of fungus. The fungus and beetle are an example of symbiosis.

Symbiosis is a close, long-term relationship between organisms that benefits at least one of the organisms.

Parasitism is a type of symbiosis in which one organism is helped but the other is harmed. A **parasite** is the organism that benefits in the relationship. A **host** is the organism that is harmed. Parasites do not usually kill their hosts because they depend on the hosts for food. But the parasites often weaken their hosts. The weevil beetle and fungus have a parasite-host relationship. Which organism do you think benefits?

Like the fungus on the beetle, many parasites live on their hosts. Did you ever have a pet with fleas? Fleas are parasites that live on the blood of mammals. As the flea obtains the blood, it can cause itching and possibly disease in the host.

Parasites may also live inside the host. Horses, for example, sometimes take in parasites called tapeworms when they graze in a pasture. The tapeworms live and feed in the horse's intestines. The tapeworms "steal" nutrients from the horse. Tapeworms can cause poor digestion and slow growth for the horse.

Sometimes when two organisms live together, both organisms benefit. This kind of symbiotic relationship is called mutualism. The moray eel and the cleaner shrimp in the photo live together in a mutualistic relationship. The cleaner shrimp eats dead tissue and parasites from the mouth of the eel.

Commensalism is symbiosis that helps one organism, but neither helps nor harms the other. You may have seen photographs of a whale with barnacles on its sides. As the whale moves from place to place, the barnacles can get food from the water. The barnacles do not help or harm the whale.

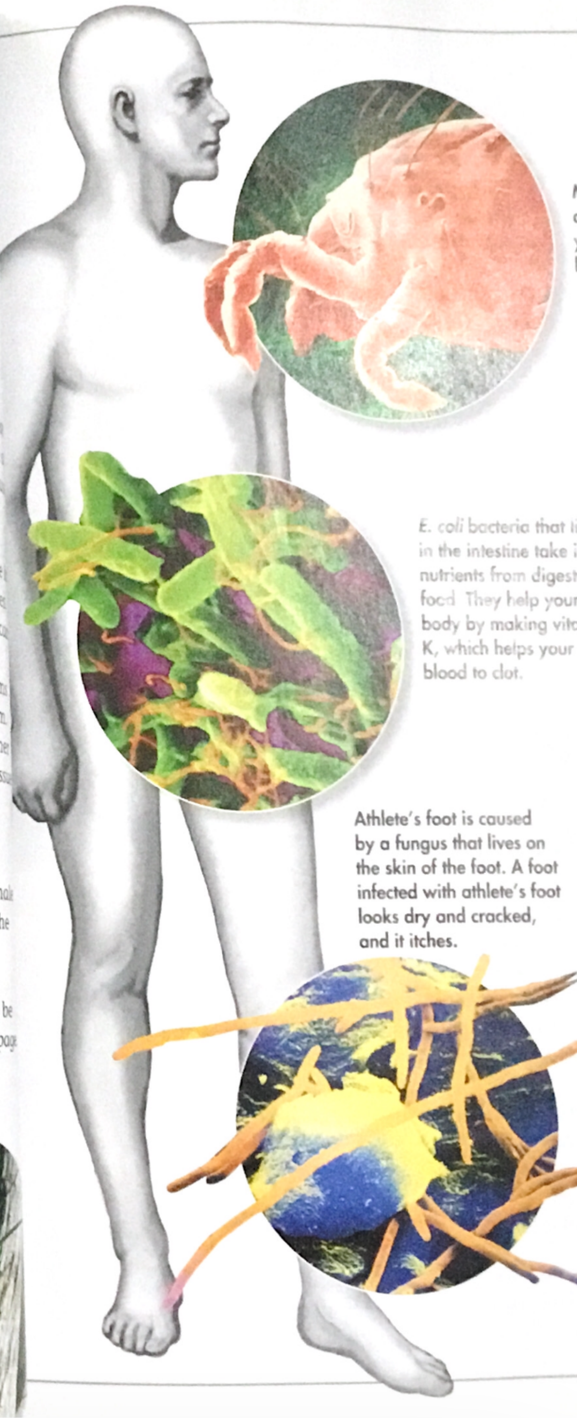
You may not realize that you are part of many symbiotic relationships. Most are harmless, but some relationships can be harmful. Read about some of those relationships on the next page.

Parasitism
This fungus is a parasite on the weevil beetle.

Mutualism
How do the eel and the cleaner shrimp benefit in this symbiotic relationship?

Commensalism
This air plant gets a place to live. The tree is neither helped nor harmed.

Symbiosis in the Human Body



Mites that cover your skin and live at the base of your eyelashes get food by eating dead skin cells.

E. coli bacteria that live in the intestine take in nutrients from digested food. They help your body by making vitamin K, which helps your blood to clot.

Fleas and ticks get food by piercing the skin and sucking out blood.

Athlete's foot is caused by a fungus that lives on the skin of the foot. A foot infected with athlete's foot looks dry and cracked, and it itches.

Lesson Checkpoint

1. Identify each example of symbiosis in the human body on this page as parasitism, mutualism, or commensalism.
2. **Predict** What do you think would happen to the fleas on a dog if they were unable to suck blood from their host?
3. Writing in Science
   Narrative Write a short, humorous story about two organisms living together in a mutualistic relationship.

Lesson 4

How do materials cycle through ecosystems?

Nature depends on cycles so that resources can be used over and over. Earth would quickly run out of resources if they were not recycled. Some important cycles in nature are the nitrogen cycle, the carbon cycle, and the water cycle.

Recycling Matter

Chances are that your home and school recycle some of the materials they use. You might recycle papers, plastic, or glass. Nature too has a recycling system.

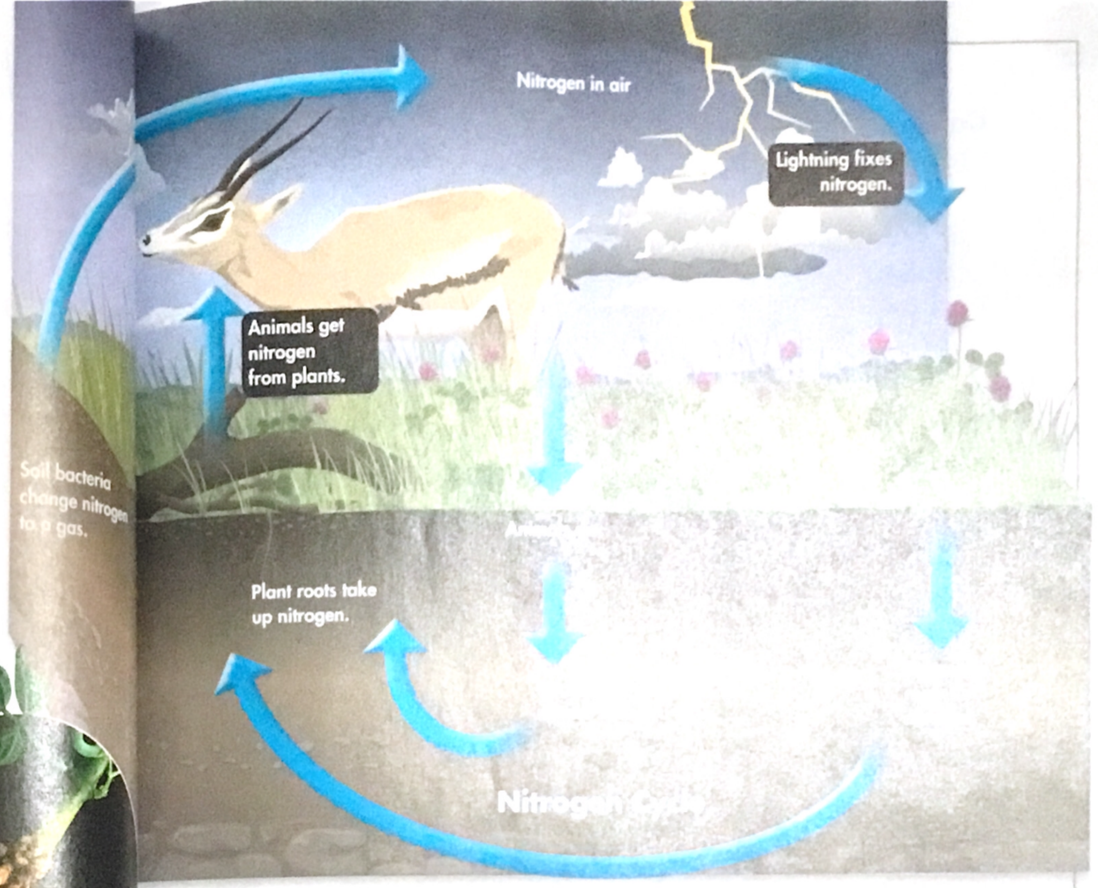
Like energy, the amount of matter on Earth is limited. But unlike energy that flows through ecosystems in only one direction, many of Earth's resources pass through ecosystems in a continuous cycle. If important materials that organisms need, such as nitrogen, water, carbon, and oxygen, were not cycled, they would soon run out. Because of Earth's cycles, organisms can use the same materials over and over. Three important cycles in nature are the nitrogen cycle, the carbon cycle, and the water cycle.

Nitrogen Cycle

One of the most important resources for all living things is nitrogen. It is a main component of protein, a building block of cells. Nitrogen is a common element in Earth's air. In fact, the air is about 78 percent nitrogen, but it is "free nitrogen." That means it is not combined with other elements. Most organisms need nitrogen that is "fixed," or combined with other elements.

Most free nitrogen is fixed by bacteria that live in the soil. Some bacteria live in nodules, or bumps, on certain plant roots. The bacteria get food from the plants, and plants absorb fixed nitrogen from the bacteria. Animals get nitrogen by eating plants or by eating prey that have eaten plants.

Nodules containing bacteria are found on legumes, including clover, peas, beans, and peanuts. The bacteria and plants live together in a mutualistic relationship.



Fixed nitrogen may enter the soil in other ways too. A small amount of free nitrogen in the air is fixed by lightning. It is carried to the ground by rainfall. Fixed nitrogen also enters the soil because of decomposers. Decomposers break down dead organisms, and fixed nitrogen is released into the soil. This fixed nitrogen can be absorbed by plant roots.

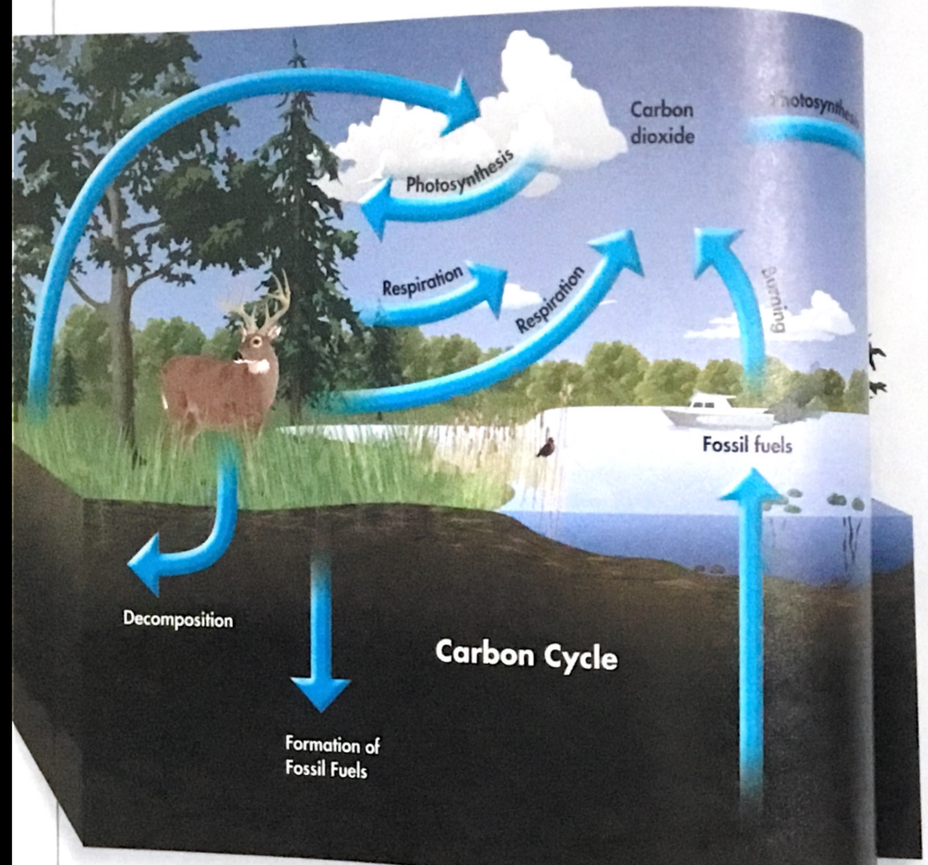
How does nitrogen return to the air? Some bacteria live freely in the soil. These bacteria can break down fixed nitrogen into free nitrogen. This free nitrogen eventually enters the air, and the cycle continues. This movement of nitrogen through ecosystems is called the nitrogen cycle.

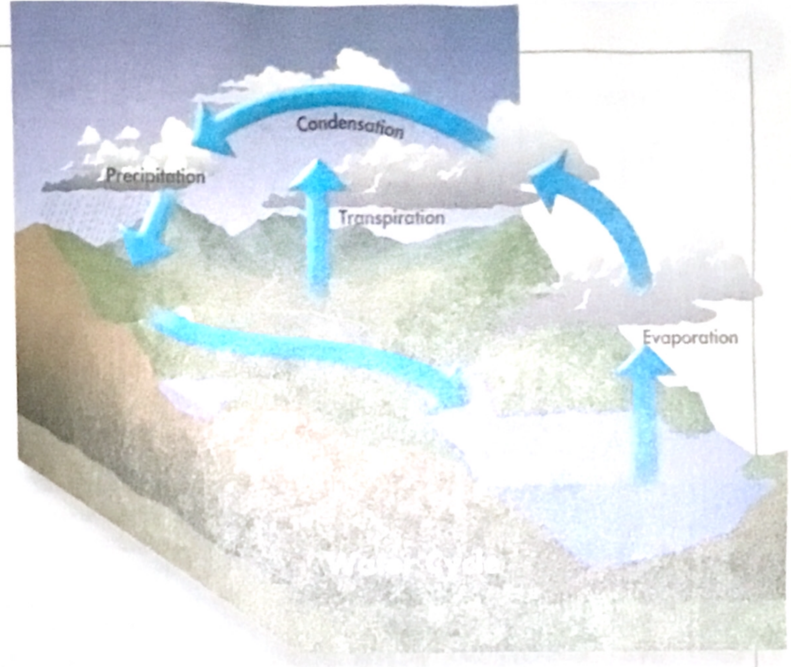
1. **Checkpoint** What is the difference between fixed nitrogen and free nitrogen?
2. **Math in Science** Earth's air is made up of about 78 percent nitrogen, 20 percent oxygen, 1 percent argon, and smaller amounts of other gases. Draw a circle graph that shows the composition of air.

Carbon Cycle

The most common element in all living things is carbon. For example, about 18 percent of your body is carbon. Earth's atmosphere, rocks, and soil also contain carbon. Like nitrogen, carbon is cycled through ecosystems.

Carbon is cycled during photosynthesis and cellular respiration. It is cycled through the environment in other ways too. When decomposers, such as fungi and bacteria, break down wastes and the bodies of dead organisms, carbon is released into the soil to be used again by living organisms. Organisms that do not decompose can be buried and over time form fossil fuels, such as coal, oil, and natural gas. The carbon that was stored in these organisms when they were alive is released into the air when the fuels are burned. Carbon also is released into the air as carbon dioxide gas when volcanos erupt.





Water Cycle

Can you imagine a day without water? Water is necessary for all life. Many chemical reactions that take place in organisms to keep them alive need water. The water cycle helps make water available to all parts of an ecosystem.

As the Sun heats lakes, streams, and other bodies of water, the water evaporates, or changes from a liquid to a gas. As water evaporates, the gas it forms, called water vapor, enters the air. Water also enters the air when the leaves of plants give off water vapor in the process of transpiration. Your breath and that of other animals also contain water.

Once water enters the air, it rises and cools. The cooler temperature causes the water to condense, or change back into tiny drops of water. Clouds form when water vapor condenses on dust or salt particles in the air. Water returns to Earth's surface as precipitation—rain, snow, or hail.

Lesson Checkpoint

1. Explain why each of the following is important to all living things: nitrogen, carbon, water.
2. What is the role of decomposers in the carbon cycle?
3. Writing in Science **Expository** Explain how the cycles of nature help provide Earth's organisms with an unlimited supply of some important resources.

Lesson 5

How do ecosystems change?

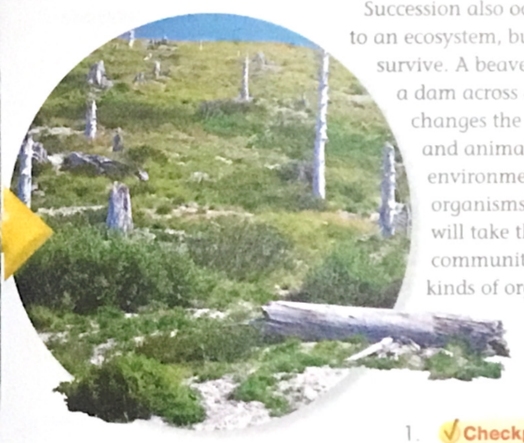
Ecosystems change over time. Some changes are natural, and they may happen slowly or quickly. Humans also cause change to ecosystems.

Natural Changes

The morning of May 18, 1980, was bright and clear on Mount St. Helens in the state of Washington. The beautiful forestland around the mountain was filled with wild animals, towering trees, and wildflowers. But that morning everything changed. This volcanic mountain, which had long been quiet, violently erupted. The explosion spewed fiery rock and ash into the air. The hot blast, combined with mudflows, caused devastation for miles around. The land, which minutes before had been filled with life, was now bare and lifeless.

The eruption of Mount St. Helens sent clouds of smoke and ash more than 24 kilometers into the air. Within minutes of the eruption, the land, which had been heavily forested, was bare.

The land shown here is 11 kilometers from the volcano. Even at this distance, only burrowing animals survived. Some buried seeds also survived, allowing plants to slowly grow back.



Slowly, succession allows the ecosystem to recover. Plants make the soil more fertile. Animals gradually move into the area.

A natural disaster like the explosion of Mount St. Helens changes ecosystems quickly. Ecosystems can also change quickly due to earthquakes, fires, landslides, or floods. Human activities, such as cutting down forests for lumber, can change ecosystems quickly too.

Slow Changes

Changes in the climate of an ecosystem can cause a slower change. As the climate becomes warmer or cooler, the kinds of organisms that can successfully live in the area change. Some species will die, but new species may begin to live there.

Ecosystems also change slowly through **succession**, a series of predictable changes that occur over time. These changes happen because organisms affect their environment. For example, land with no plants or animals, such as the land around Mount St. Helens after the eruption, will not remain bare. The first organisms to appear are called pioneer species. They can live in harsh conditions, such as poor soil or little water. Pioneer species may break down rocks. When these organisms die, their decayed bodies help make soil.

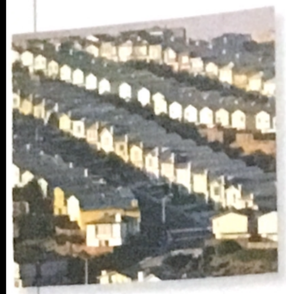
After soil forms, other organisms can live in the ecosystem. Seeds may blow in from another area. The seeds can take root and grow into new plants in the soil produced by the pioneer species. These plants, in turn, may change the environment so that other plants can live there. Over time, animals move into the area.

Succession also occurs when something happens to an ecosystem, but some plants and animals survive. A beaver may cut down trees to form a dam across a river. The flooded river changes the land ecosystem. Some plants and animals can live in the changed environment, while others die. Some organisms will move away, and others will take their place. Gradually, a new community develops with different kinds of organisms.

Fireweed was one of the first plants to grow after the volcano erupted.

1. **Checkpoint** Describe what might happen in an ecosystem after a volcano erupts.
2. **Technology** in Science Scientists have used GIS, geographical information systems, to study succession in the areas around Mount St. Helens after the eruption. Use the Internet to learn more about GIS.

Human Impacts



The habitats of many organisms are destroyed when land is cleared for a housing development.

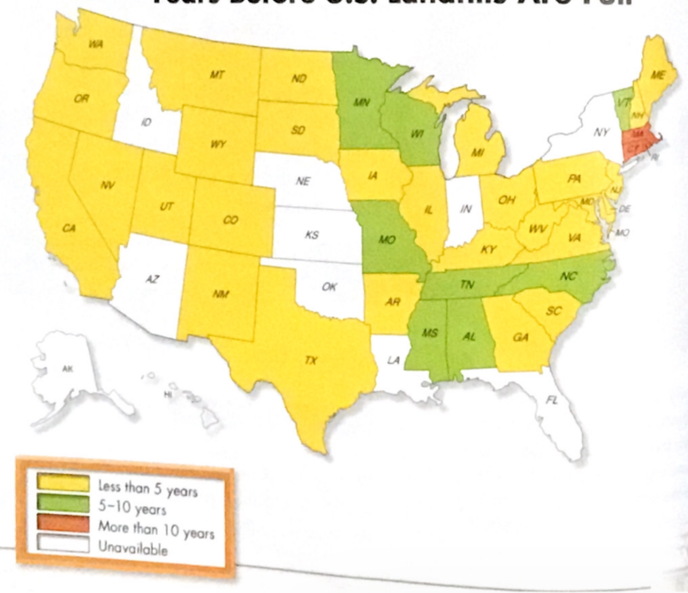
Humans are part of any ecosystem in which they live. Like other organisms living in an ecosystem, their activities can change the environment. Some organisms living in a changing environment cannot survive. The result can be fewer organisms or fewer species.

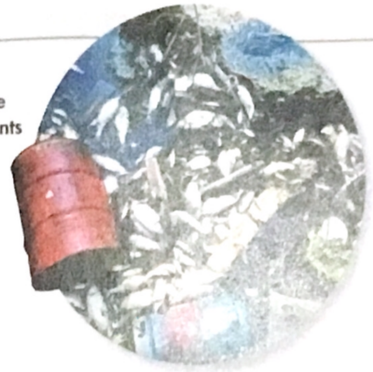
An action as simple as throwing away trash can affect ecosystems. Have you ever stopped to think about how much trash you throw away each day? Do you know where your trash ends up? Much of the household trash—product packaging, furniture, clothing, food scraps, yard trimmings, and other items—ends up in landfills. In 2001, an average of more than four pounds of trash were produced by each person in the United States every day.

Using landfills has advantages. They reduce the odors and health hazards associated with open-air dumps. But they can cause problems too. Hazardous wastes can leak out of landfills and harm ecosystems. Paint, batteries, and other chemicals are a few examples of harmful wastes.

Even "safe" trash harms the environment. When landfills are built, the land changes, and some organisms will die. Another problem with landfills is that they become full. Then other areas must be used to dispose of wastes. As you can see in the map, many of the landfills in the United States are almost full.

Years Before U.S. Landfills Are Full



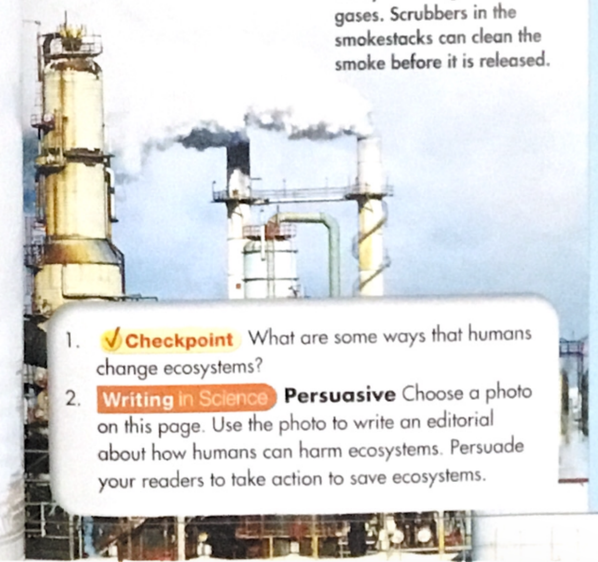


Dead fish show the effects that pollutants can have on an ocean ecosystem.

You might say that most people don't try to harm the environment. But people can harm the environment without realizing it. Every time someone burns fossil fuels, such as when driving a car, pollutants enter the air. Fossil fuels are burned to produce electricity too. The pollution that is produced when fossil fuels burn includes carbon dioxide. Carbon dioxide can cause changes in the environment.

Even ranching and farming can harm the environment. When livestock is allowed to overgraze, plants die and the soil can be easily eroded. The use of fertilizers on farms or on home gardens and lawns can enter the water cycle and pollute lakes, streams, and rivers.

Factories, such as this oil refinery, can pollute the air by releasing harmful gases. Scrubbers in the smokestacks can clean the smoke before it is released.



1. **Checkpoint** What are some ways that humans change ecosystems?
2. **Writing in Science** **Persuasive** Choose a photo on this page. Use the photo to write an editorial about how humans can harm ecosystems. Persuade your readers to take action to save ecosystems.

Introduced Species

Zebra mussels, starling birds, and kudzu are aliens—they are living in parts of the world where they were not originally found. How did they get there? These and other organisms, called introduced species, were brought from their natural home to new places by people. Sometimes people moved the organisms on purpose, but other times the process wasn't planned. Introducing new species to an area causes changes in ecosystems. Often the process can create problems—some of them severe. How can that happen?

Introduced species can . . .

- use up nutrients, block sunlight, and cause other changes to the abiotic factors in an ecosystem.
- outcompete the native species that live in an ecosystem. If the number of plant species is reduced, the number of animal species that depend on them also will get smaller. About half of the endangered species in the United States are threatened by introduced species.
- cost the United States about $138 billion a year.
- cause disease, such as Dutch elm disease, which has killed many native elm trees.

Saving Ecosystems

The people in the picture are cleaning up oil along the coast of Prince William Sound in Alaska. In 1989 large areas of the coast were covered with millions of gallons of oil that leaked from an ocean oil tanker. Thousands of workers worked to help clean up the oil. For example, many of them scrubbed oil-covered animals, such as otters, with soap and water. Oil was cleaned from the water and rocks.

You might think that the effort of these people is a great way to help save the environment. But even with the help of all the scientists and volunteers who worked to clean up after the disaster, much of the damage could not be undone. As a result of the leak, 22 orca whales, 3,000 sea otters, 250,000 seabirds, 300 harbor seals, and 250 bald eagles were among the billions of animals that died. More than two billion dollars were spent to clean up the area. Today oil from that spill still seeps up through the beaches. Many populations of plants and animals have not recovered.

The top picture shows oil that leaked from a damaged oil tanker and covered the shoreline in Prince William Sound, Alaska. You can see in the image below it how clean-up efforts slowly made the ecosystem again habitable for plants and animals.

Cleaning up oil spills must be done quickly to prevent ecological disaster. A better plan is to avoid the disaster before it happens.

Preventing Problems

A better solution to problems such as this oil spill is to prevent them from happening in the first place. One way you can help save ecosystems is by understanding the effect that you have on the environment. Know that you can find ways to reduce the harm that you do.

One step in preserving Earth's ecosystems is to use resources wisely. Conserve, or save, resources by reusing, recycling, or reducing your use of them. You can see some examples of ways to do this in the photos on this page. Conserving resources also reduces the need for landfills.

Another way to help prevent harmful changes to ecosystems is to be informed. Remember that all organisms have needs that must be met in order to survive and reproduce. Know how ecosystems work. Understand how all parts of an ecosystem, including humans, affect other parts. Be aware that if you change ecosystems, some organisms may not survive. Some species might become extinct.

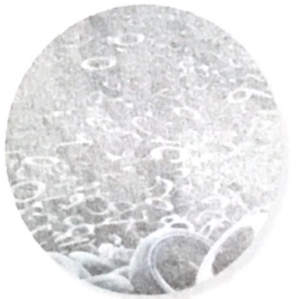
Explore ways that you as a citizen can become involved with keeping your environment healthy for all its organisms. For example, become a member of a local environmental group or start an environmental newsletter for your school or community. Know where to find accurate information about environmental issues.

As an adult, you will need to make decisions that affect your community and other environments in your state, country, or even the world. If you learn to be an informed citizen now, being a responsible adult will be easier later.

Lesson Checkpoint

1. List three things you can do to help save ecosystems.
2. How can being informed help you protect ecosystems?
3. Writing in Science **Expository** Suppose a friend tells you that there is little she can do to protect ecosystems. How would you respond? Write a letter explaining your reasoning.

In 2001, more than 3 million tons of aluminum was thrown away in the United States. Recycling aluminum saves 95 percent of the energy needed to produce aluminum from natural resources.



Tires are made from fossil fuels, a natural resource. Ground rubber from old tires can be used in asphalt and in highway noise barriers.

About 4 percent of the energy used in the United States is for making plastics. Recycling plastic products, such as these milk containers, decreases the use of natural resources.

Math in Science

Inactive Times for Animals

Some species have adapted to living through a cold season in their environment by hibernating. Hibernation is a period of inactivity when an organism needs much less energy. The organism's heart rate, temperature, and other body processes drop significantly.

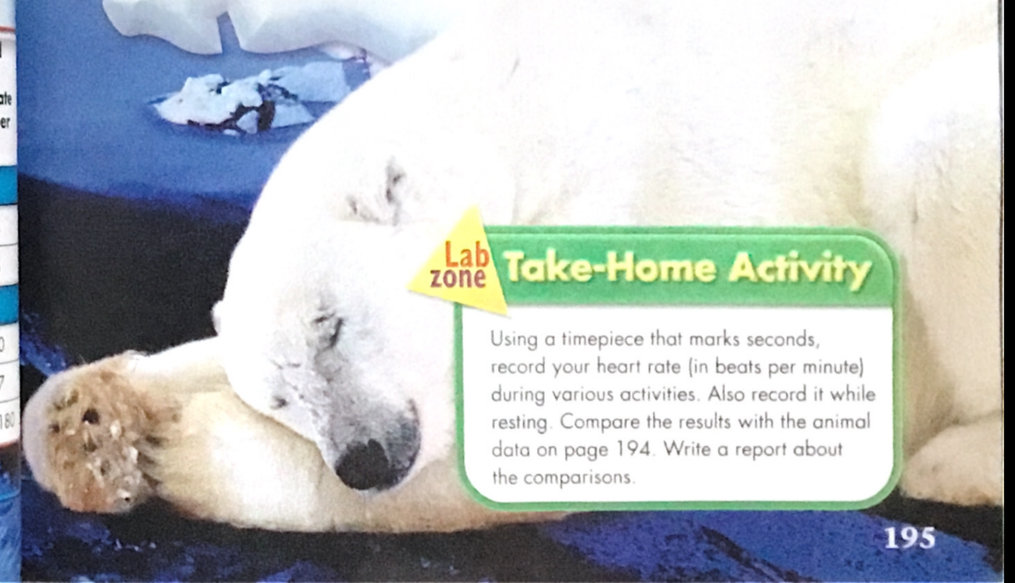
Some people believe bears hibernate, but that is not accurate. Bears have periods of inactivity, called torpor, during which their bodies slow down—but not as much as a hibernating animal's body. Another difference between hibernation and torpor is that a bear can be quickly roused from its "sleep," while a hibernating animal cannot. A hummingbird's normal activity uses a lot of energy. In order to conserve energy while not gathering food, a hummingbird can become torpid overnight.

The chart below shows a comparison of heart rate and body temperature for some animals that hibernate and some that go into a state of torpor.

Organism	Normal Body Temperature (°F)	Reduced Activity Temperature (°F)	Normal Heart Rate (beats per min)	Reduced Activity Heart Rate (beats per min)
Hibernation				
Woodchuck	98	38	80	4
Ground squirrel	100	35	150	5
Torpor				
Black bear	96	88	55	10
Polar bear	98.6	95	46	27
Blue-throated hummingbird	105	66.2	250	50–180

Use the chart on page 194 to answer each question.

1. What is the difference between the normal and reduced activity temperatures for the blue-throated hummingbird? This difference is about what percent of the bird's normal body temperature?
2. The poorwill is the only bird known to truly hibernate. Would you expect its body temperature to drop by more than or less than 40 degrees? Explain.
3. If a human's body temperature drops by only 5%, medical care is needed. By what percent can a ground squirrel's temperature drop?
4. A heart rate of 6 beats per minute is equivalent to 1 beat every 10 seconds. What percent of the organisms on the chart can have a heart rate of less than 1 beat every 10 seconds?
5. Compare the bears with the other mammals on the chart. What can you infer about body temperature and heart rate for organisms that are truly hibernating and those that are in a state of torpor?



Lab zone Take-Home Activity

Using a timepiece that marks seconds, record your heart rate (in beats per minute) during various activities. Also record it while resting. Compare the results with the animal data on page 194. Write a report about the comparisons.

Chapter 7 Review and Test Pre

Use Vocabulary

competition (p. 176)	**host** (p. 180)
decomposer (p. 171)	**parasite** (p. 180)
energy pyramid (p. 175)	**succession** (p. 187)
	symbiosis (p. 180)

Write the vocabulary term from the list above that best completes each sentence.

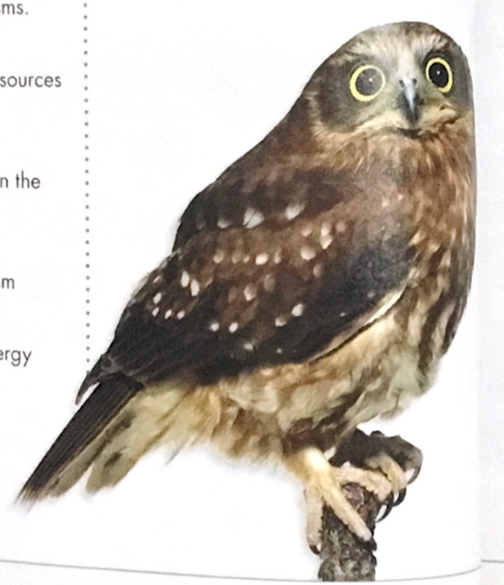
1. A(n) _____ is the organism that benefits in a relationship when another organism is harmed.
2. _____ is a series of predictable changes that occur in an ecosystem over time.
3. _____ is a close, long-term relationship between organisms that benefits at least one of the organisms.
4. The struggle among organisms to survive in a habitat with limited resources is _____ .
5. A(n) _____ is an organism that gets energy by breaking down the remains of dead organisms.
6. The organism that is harmed in a relationship when another organism benefits is the _____ .
7. A(n) _____ shows how energy moves through an ecosystem.

Explain Concepts

8. Why is sunlight such an important factor in an ecosystem?
9. Explain the mutualistic relationship tha can provide plants with nitrogen.
10. Explain why the energy flow in an ecosystem can be shown as a pyramid
11. The climate in a desert area is changing Over several years, the area has recei more rainfall. What effect will this cha likely have on plants and animals in the ecosystem?

Process Skills

12. **Infer** What adaptations help this owl capture prey?



13. **Forming Hypotheses** A scientist studying an ecosystem notices that the numbers of red foxes and hares change in a cycle. A period with few foxes and many hares is followed by a period with many foxes and few hares. This is followed by a period with few foxes and many hares, and the cycle continues. Form a hypothesis about why the sizes of fox and hare populations show this pattern of change.
14. **Making and Using Models** Some chemicals that are used to kill insects can harm the birds that eat the insects and the consumers that eat the birds. Draw a diagram to model how harmful chemicals can move through a food chain.

Predict

15. The last few individuals of a species of mouse living in a field eat only a particular kind of grass. The town plans to convert the field into a baseball stadium. They will move the remaining mice to a new field about 30 kilometers away. The field does not have the kind of grass the mice eat. What might happen to this species if they are moved?

Test Prep

Choose the letter that best completes the statement or answers the question.

16. How do decomposers obtain energy?
    - Ⓐ eating animals
    - Ⓑ eating plants
    - Ⓒ breaking down plant remains
    - Ⓓ directly from the Sun
17. About what percent of the energy at one level of a food chain is transferred to the next higher level?
    - Ⓕ 10%
    - Ⓗ 30%
    - Ⓖ 70%
    - Ⓘ 90%
18. Which best describes why competition occurs among animals in an ecosystem if resources are scarce?
    - Ⓐ Different species of animals live in the same area.
    - Ⓑ Animals of similar species live in the same area.
    - Ⓒ Animals in an area have different needs.
    - Ⓓ Animals in an area have similar needs.
19. Explain why the answer you chose for Question 18 is best. For each of the answers you did not choose, give a reason why it is not the best choice.
20. **Writing in Science** **Description** Active volcanoes on the ocean floor can produce new islands. At first, the new islands will not have any living organisms. Describe the likely process of succession on a new island.