

1

Interactions of Living Things

SECTION 1 Everything Is Connected 4

SECTION 2 Living Things Need Energy 8

SECTION 3 Types of Interactions . . . 14

Chapter Lab 22

Chapter Review 24

Standardized Test Preparation 26

Science in Action 28

About the **PHOTO**

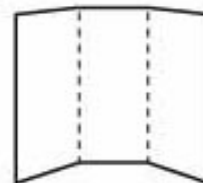
A chameleon is about to grab an insect using its long tongue. A chameleon's body can change color to match its surroundings. Blending in helps the chameleon sneak up on its prey and also keeps the chameleon safe from animals that would like to make a snack out of a chameleon.



PRE-READING **ACTIVITY**

FOLDNOTES

Tri-Fold Before you read the chapter, create the FoldNote entitled "Tri-Fold" described in the **Study Skills** section of the Appendix. Write what you know about the interactions of living things in the column labeled "Know." Then, write what you want to know in the column labeled "Want." As you read the chapter, write what you learn about the interactions of living things in the column labeled "Learn."





START-UP ACTIVITY

Who Eats Whom?

In this activity, you will learn how organisms interact when finding (or becoming) the next meal.

Procedure

1. On each of **five index cards**, print the name of one of the following organisms: killer whale, cod fish, krill shrimp, algae, and leopard seal.
2. On your desk, arrange the cards in a chain to show who eats whom.
3. Record the order of your cards.
4. In nature, would you expect to see more killer whales or cod? Arrange the cards in order of most individuals in an organism group to fewest.

Analysis

1. What might happen to the other organisms if algae were removed from this group? What might happen if the killer whales were removed?
2. Are there any organisms in this group that eat more than one kind of food? (Hint: What else might a seal, a fish, or a killer whale eat?) How could you change the order of your cards to show this information? How could you use pieces of string to show these relationships?

READING WARM-UP

Objectives

- Distinguish between the biotic and abiotic parts of the environment.
- Explain how populations and communities are related.
- Describe how the abiotic parts of the environment affect ecosystems.

Terms to Learn

ecology	community
biotic	ecosystem
abiotic	biosphere
population	

READING STRATEGY

Reading Organizer As you read this section, create an outline of the section. Use the headings from the section in your outline.

Everything Is Connected

An alligator drifts in a weedy Florida river, watching a long, thin fish called a gar. The gar swims too close to the alligator. Then, in a rush of murky water, the alligator swallows the gar whole and slowly swims away.

It is clear that two organisms have interacted when one eats the other. But organisms have many interactions other than simply “who eats whom.” For example, alligators dig underwater holes to escape from the heat. After the alligators abandon these holes, fish and other aquatic organisms live in the holes during the winter dry period.

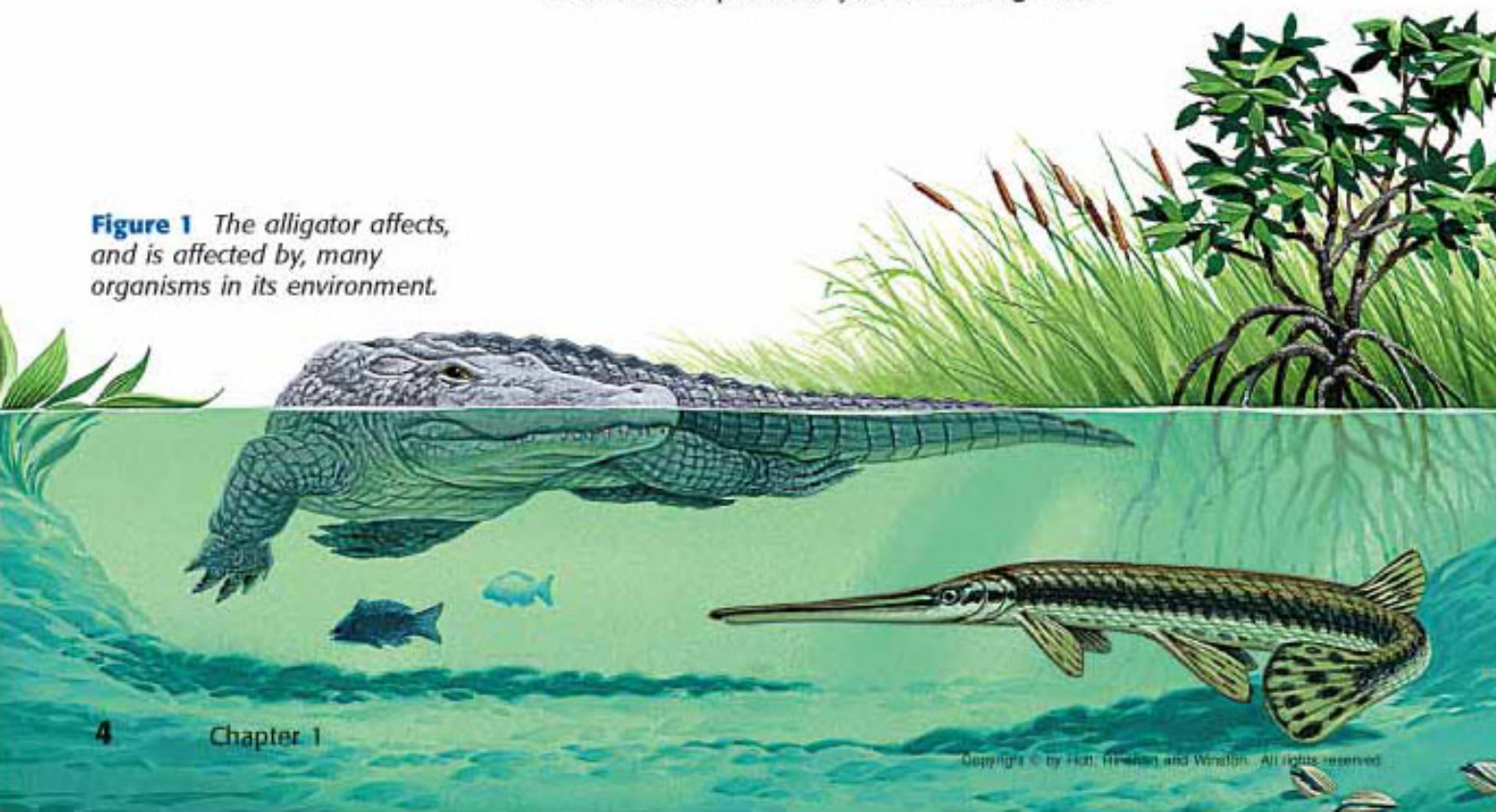
Studying the Web of Life

All living things are connected in a web of life. Scientists who study the web of life specialize in the science of ecology. **Ecology** is the study of the interactions of organisms with one another and with their environment.

The Two Parts of an Environment

An organism’s environment consists of all the things that affect the organism. These things can be divided into two groups. All of the organisms that live together and interact with one another make up the **biotic** part of the environment. The **abiotic** part of the environment consists of the nonliving factors, such as water, soil, light, and temperature. How many biotic parts and abiotic parts do you see in **Figure 1**?

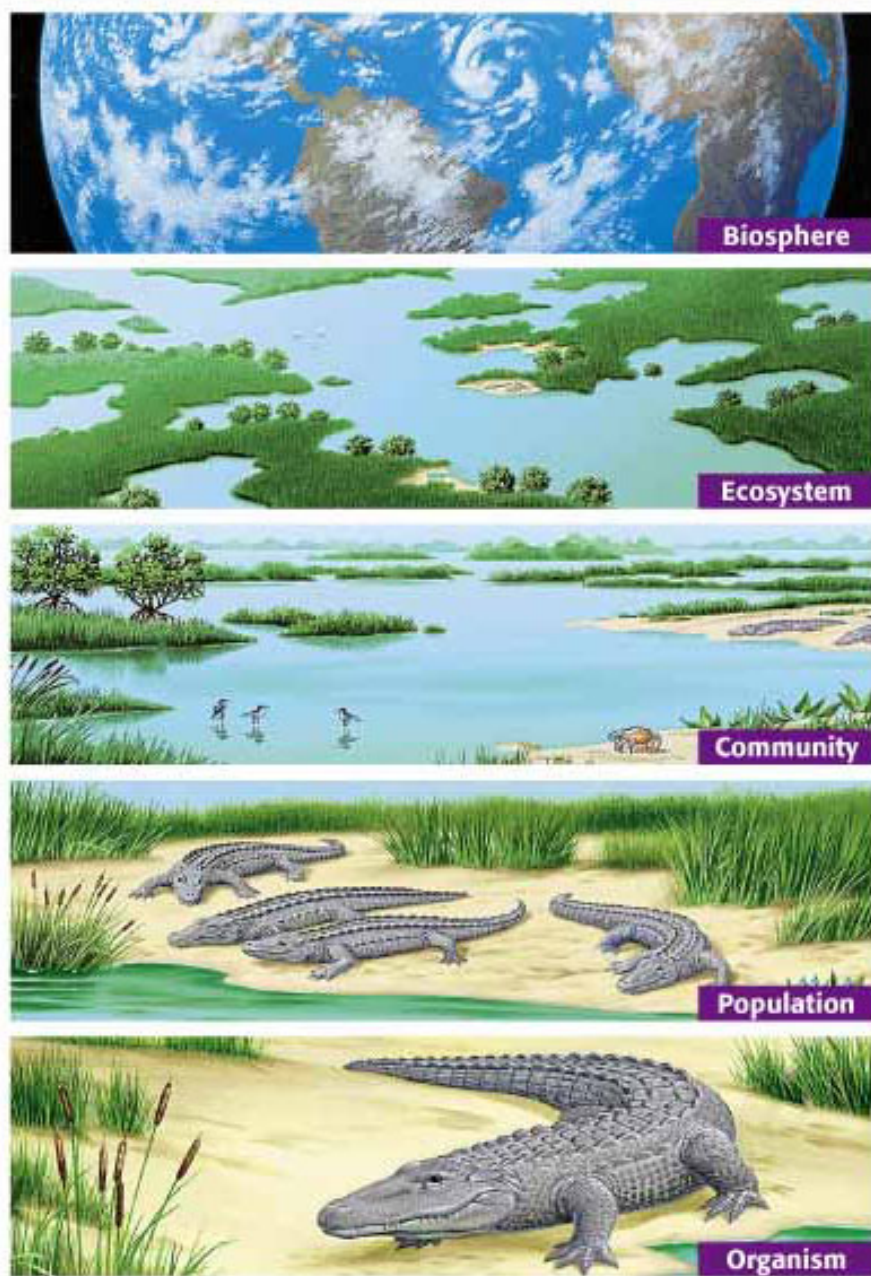
Figure 1 The alligator affects, and is affected by, many organisms in its environment.



Organization in the Environment

At first glance, the environment may seem disorganized. However, the environment can be arranged into different levels, as shown in **Figure 2**. The first level is made of an individual organism. The second level is larger and is made of similar organisms, which form a population. The third level is made of different populations, which form a community. The fourth level is made of a community and its abiotic environment, which form an ecosystem. The fifth and final level contains all ecosystems, which form the biosphere.

Figure 2 The Five Levels of Environmental Organization



QUICK LAB

Meeting the Neighbors

1. Explore two or three blocks of your neighborhood.
2. Draw a map of the area's biotic and abiotic features. For example, map the location of sidewalks, large rocks, trees, water features, and any animals you see. Remember to approach all plants and animals with caution. Use your map to answer the following questions.
3. How are the biotic factors affected by the abiotic factors?
4. How are the abiotic factors affected by the biotic factors?

population a group of organisms of the same species that live in a specific geographical area

community all the populations of species that live in the same habitat and interact with each other

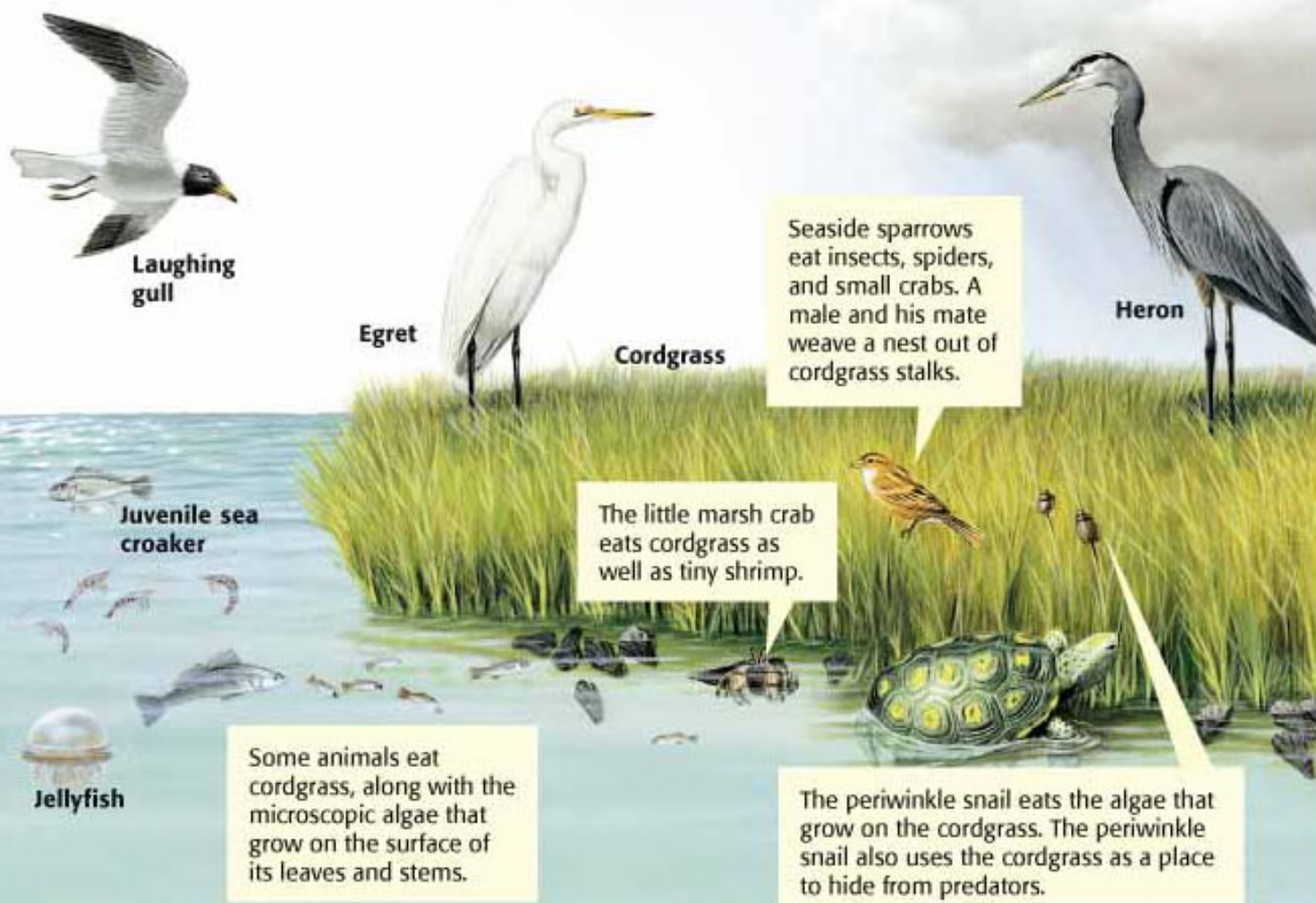
Populations

A salt marsh, such as the one shown in **Figure 3**, is a coastal area where grasslike plants grow. Within the salt marsh are animals. Each animal is a part of a **population**, or a group of individuals of the same species that live together. For example, all of the seaside sparrows that live in the same salt marsh are members of a population. The individuals in the population often compete with one another for food, nesting space, and mates.

Communities

A **community** consists of all of the populations of species that live and interact in an area. The animals and plants you see in **Figure 3** form a salt-marsh community. The populations in a community depend on each other for food, shelter, and many other things.

Figure 3 Examine the picture of a salt marsh. Try to find examples of each level of organization in this environment.




Ecosystems

An **ecosystem** is made up of a community of organisms and the abiotic environment of the community. An ecologist studying the ecosystem could examine how organisms interact as well as how temperature, precipitation, and soil characteristics affect the organisms. For example, the rivers that empty into the salt marsh carry nutrients, such as nitrogen, from the land. These nutrients affect the growth of the cordgrass and algae.

The Biosphere

The **biosphere** is the part of Earth where life exists. It extends from the deepest parts of the ocean to high in the air where plant spores drift. Ecologists study the biosphere to learn how organisms interact with the abiotic environment—Earth's atmosphere, water, soil, and rock. The water in the abiotic environment includes fresh water and salt water as well as water that is frozen in polar icecaps and glaciers.

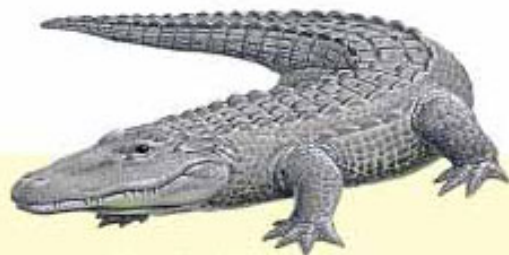
 **Reading Check** What is the biosphere? (See the Appendix for answers to Reading Checks.)

ecosystem a community of organisms and their abiotic environment

biosphere the part of Earth where life exists

INTERNET ACTIVITY

For another activity related to this chapter, go to **go.hrw.com** and type in the keyword **HL5INTW**.



SECTION Review

Summary

- All living things are connected in a web of life.
- The biotic part of an environment is made up of all of the living things found within it.
- The abiotic part of an environment is made up of all of the nonliving things found within it, such as water and light.
- An ecosystem is made up of a community of organisms and its abiotic environment.

Using Key Terms

1. In your own words, write a definition for the term *ecology*.
2. Use the following terms in the same sentence: *biotic* and *abiotic*.

Understanding Key Ideas

3. Which one of the following is the highest level of environmental organization?
a. ecosystem c. population
b. community d. organism
4. What makes up a community?
5. Give two examples of how abiotic factors can affect an ecosystem.

Math Skills

6. From sea level, the biosphere goes up about 9 km and down about 19 km. What is the thickness of the biosphere in meters?

Critical Thinking

7. **Analyzing Relationships** What would happen to the other organisms in the salt-marsh ecosystem if the cordgrass suddenly died?
8. **Identifying Relationships** Explain in your own words what people mean when they say that everything is connected.
9. **Analyzing Ideas** Do ecosystems have borders? Explain your answer.

SCILINKS.

NSTA

Developed and maintained by the
National Science Teachers Association

For a variety of links related to this chapter, go to www.scilinks.org

Topic: Biotic and Abiotic Factors;
Organization in the Environment

SciLinks code: HSM0164; HSM1079

READING WARM-UP

Objectives

- Describe the functions of producers, consumers, and decomposers in an ecosystem.
- Distinguish between a food chain and a food web.
- Explain how energy flows through a food web.
- Describe how the removal of one species affects the entire food web.

Terms to Learn

herbivore	food chain
carnivore	food web
omnivore	energy pyramid

READING STRATEGY

Reading Organizer As you read this section, make a table comparing producers, consumers, and decomposers.

Living Things Need Energy

Do you think you could survive on only water and vitamins? Eating food satisfies your hunger because it provides something you cannot live without—energy.

Living things need energy to survive. For example, black-tailed prairie dogs, which live in the grasslands of North America, eat grass and seeds to get the energy they need. Everything a prairie dog does requires energy. The same is true for the plants that grow in the grasslands where the prairie dogs live.

The Energy Connection

Organisms, in a prairie or any community, can be divided into three groups based on how they get energy. These groups are producers, consumers, and decomposers. Examine **Figure 1** to see how energy passes through an ecosystem.

Producers

Organisms that use sunlight directly to make food are called *producers*. They do this by using a process called *photosynthesis*. Most producers are plants, but algae and some bacteria are also producers. Grasses are the main producers in a prairie ecosystem. Examples of producers in other ecosystems include cordgrass and algae in a salt marsh and trees in a forest. Algae are the main producers in the ocean.

Energy Sunlight is the source of energy for almost all living things.

Figure 1 *Living things get their energy either from the sun or from eating other organisms.*

Producer

Plants use the energy in sunlight to make food.

Consumer The black-tailed prairie dog (herbivore) eats seeds and grass in the grasslands of western North America.

Consumer All of the prairie dogs in a colony watch for enemies, such as coyotes (carnivore), hawks, and badgers. Occasionally, a prairie dog is killed and eaten by a coyote.



Consumers

Organisms that eat other organisms are called *consumers*. They cannot use the sun's energy to make food like producers can. Instead, consumers eat producers or other animals to obtain energy. There are several kinds of consumers. A consumer that eats only plants is called a **herbivore**. Herbivores found in the prairie include grasshoppers, prairie dogs, and bison. A **carnivore** is a consumer that eats animals. Carnivores in the prairie include coyotes, hawks, badgers, and owls. Consumers known as **omnivores** eat both plants and animals. The grasshopper mouse is an example of an omnivore. It eats insects, lizards, and grass seeds.

Scavengers are omnivores that eat dead plants and animals. The turkey vulture is a scavenger in the prairie. A vulture will eat what is left after a coyote has killed and eaten an animal. Scavengers also eat animals and plants that have died from natural causes.

✓ Reading Check What are organisms that eat other organisms called? (See the Appendix for answers to Reading Checks.)

Decomposers

Organisms that get energy by breaking down dead organisms are called *decomposers*. Bacteria and fungi are decomposers. These organisms remove stored energy from dead organisms. They produce simple materials, such as water and carbon dioxide, which can be used by other living things. Decomposers are important because they are nature's recyclers.

herbivore an organism that eats only plants

carnivore an organism that eats animals

omnivore an organism that eats both plants and animals

SCHOOL to HOME

A Chain Game

With the help of your parent, make a list of the foods you ate at your most recent meal. Trace the energy of each food back to the sun. Which foods on your list were consumers? How many were producers?

ACTIVITY

Consumer A turkey vulture (scavenger) may eat some of the coyote's leftovers. A scavenger can pick bones completely clean.

Decomposer Any prairie dog remains not eaten by the coyote or the turkey vulture are broken down by bacteria (decomposer) and fungi that live in the soil.



Food Chains and Food Webs

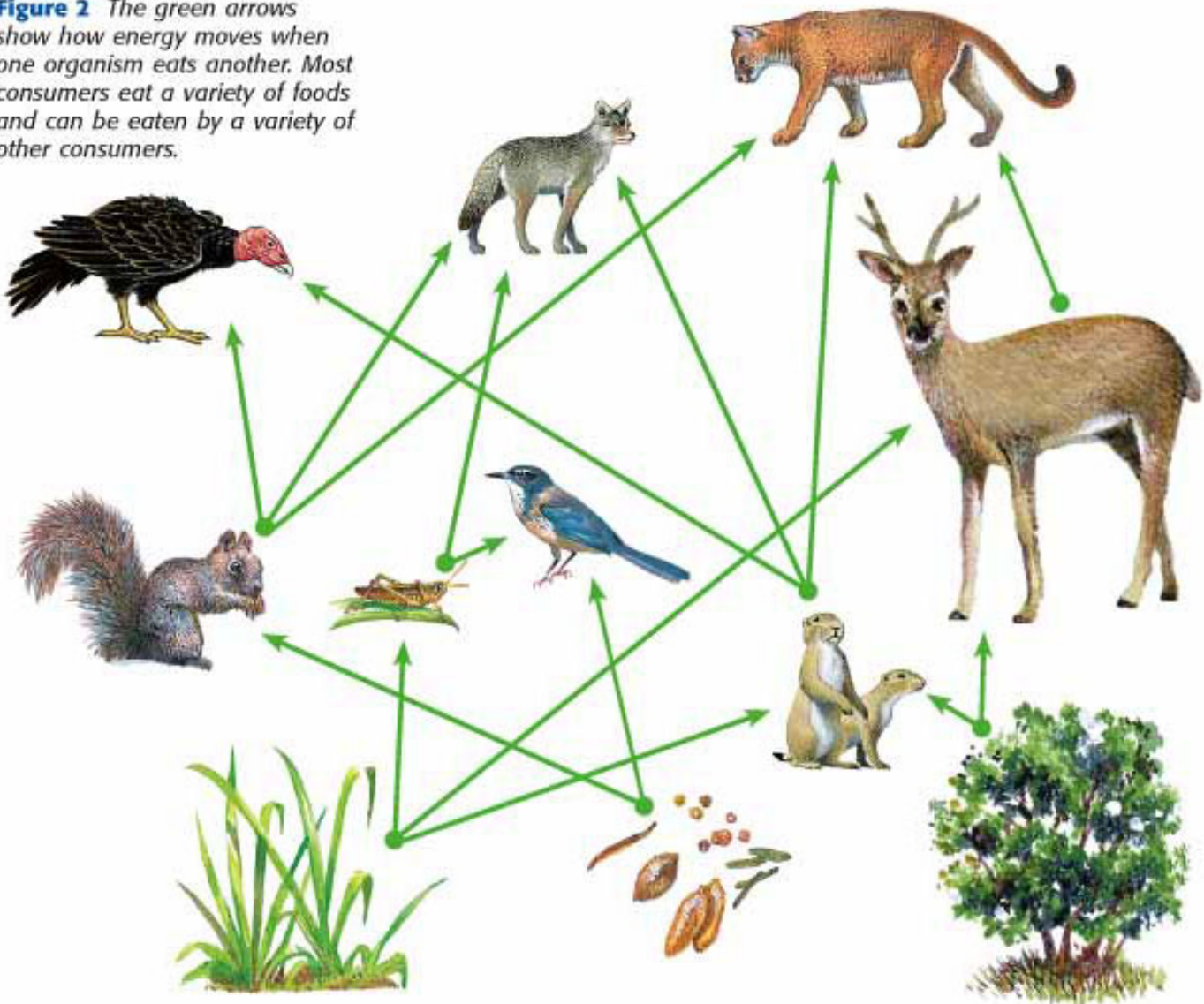
food chain the pathway of energy transfer through various stages as a result of the feeding patterns of a series of organisms

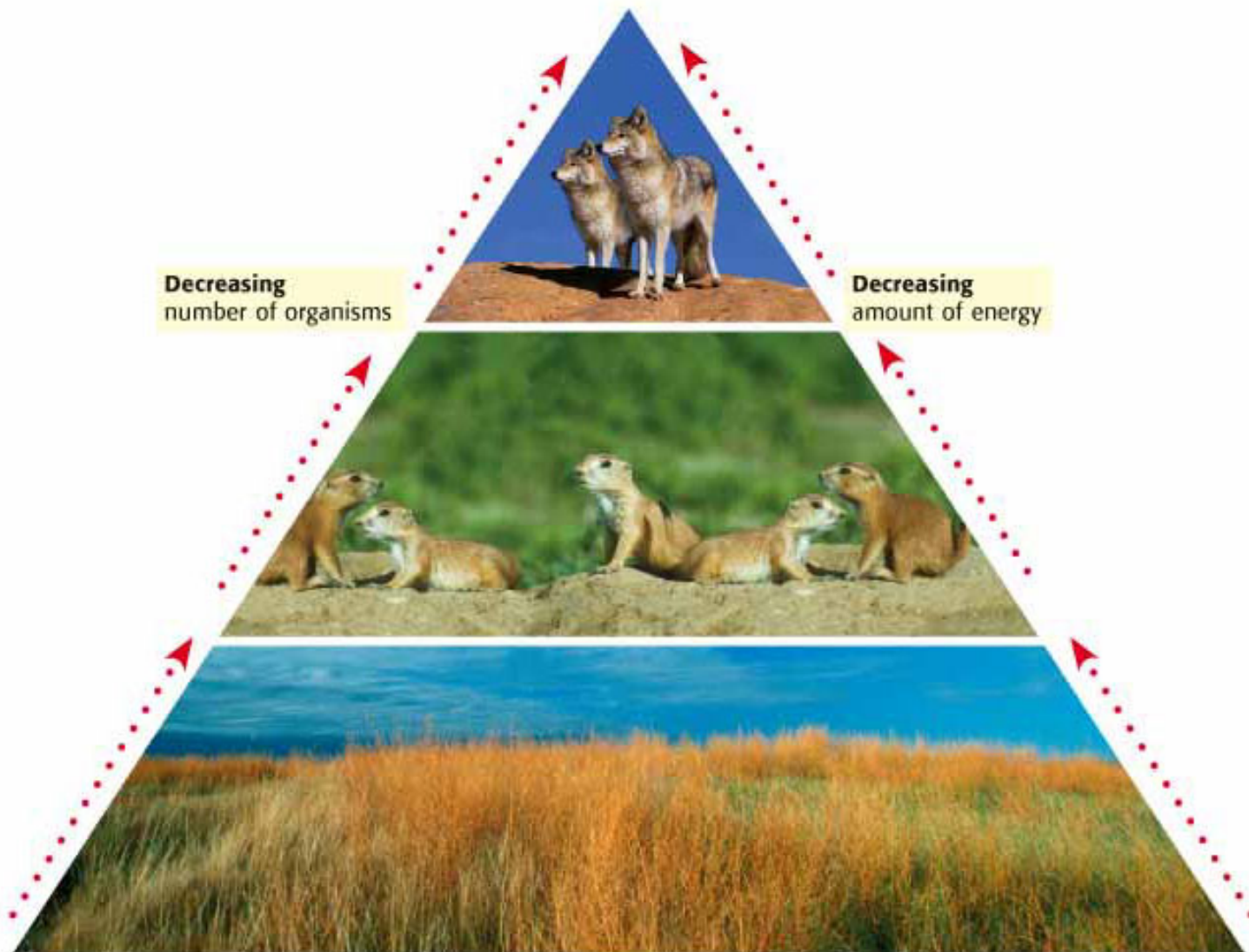
food web a diagram that shows the feeding relationships between organisms in an ecosystem

Figure 1 on the previous page, shows a food chain. A **food chain** is a diagram that shows how energy in food flows from one organism to another. Because few organisms eat just one kind of food, simple food chains are rare.

The energy connections in nature are more accurately shown by a food web than by a food chain. A **food web** is a diagram that shows the feeding relationships between organisms in an ecosystem. **Figure 2** shows a simple food web. Notice that an arrow goes from the prairie dog to the coyote, showing that the prairie dog is food for the coyote. The prairie dog is also food for the mountain lion. Energy moves from one organism to the next in a one-way direction, even in a food web. Any energy not immediately used by an organism is stored in its tissues. Only the energy stored in an organism's tissues can be used by the next consumer. There are two main food webs on Earth: a land food web and an aquatic food web.

Figure 2 The green arrows show how energy moves when one organism eats another. Most consumers eat a variety of foods and can be eaten by a variety of other consumers.





Energy Pyramids

Grass uses most of the energy it gets from sunlight for its own life processes. But some of the energy is stored in the grass' tissues. This energy is used by the prairie dogs and other animals that eat the grass. Prairie dogs use most of the energy they get from eating grass and store only a little in their tissues. Therefore, a population of prairie dogs can support only a few coyotes. In the community, there must be more grass than prairie dogs and more prairie dogs than coyotes.

The energy at each level of the food chain can be seen in an energy pyramid. An **energy pyramid** is a diagram that shows an ecosystem's loss of energy. An example of an energy pyramid is shown in **Figure 3**. You can see that the energy pyramid has a large base and a small top. Less energy is available at higher levels because only energy stored in the tissues of an organism can be transferred to the next level.

Reading Check What is an energy pyramid?

Figure 3 The pyramid represents energy. As you can see, more energy is available at the base of the pyramid than at its top.

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


Figure 4 As the wilderness was settled, the gray wolf population in the United States declined.



Wolves and the Energy Pyramid

One species can be very important to the flow of energy in an environment. Gray wolves, which are shown in **Figure 4**, are consumers that control the populations of many other animals. The diet of gray wolves can include anything from a lizard to an elk. Because gray wolves are predators that prey on large animals, their place is at the top of the food pyramid.

Once common throughout much of the United States, gray wolves were almost wiped out as the wilderness was settled. Without wolves, some species, such as elk, were no longer controlled. The overpopulation of elk in some areas led to overgrazing. The overgrazing left too little grass to support the elk and other populations who depended on the grass for food. Soon, almost all of the populations in the area were affected by the loss of the gray wolves.

 **Reading Check** How were other animals affected by the disappearance of the gray wolf?

Gray Wolves and the Food Web

Gray wolves were brought back to Yellowstone National Park in 1995. The reintroduced wolves soon began to breed. **Figure 5** shows a wolf caring for pups. The U.S. Fish and Wildlife Service thinks the return of the wolves will restore the natural energy flow in the area, bring populations back into balance, and help restore the park's natural integrity.

Not everyone approves, however. Ranchers near Yellowstone are concerned about the safety of their livestock. Cows and sheep are not the natural prey of wolves. However, the wolves will eat cows and sheep if they are given the chance.



Figure 5 In small wolf packs, only one female has pups. They are cared for by all of the males and females in the pack.

Balance in Ecosystems

As wolves become reestablished in Yellowstone National Park, they kill the old, injured, and diseased elk. This process is reducing the number of elk. The smaller elk population is letting more plants grow. So, the numbers of animals that eat the plants, such as snowshoe hares, and the animals that eat the hares, such as foxes, are increasing.

All organisms in a food web are important for the health and balance of all other organisms in the food web. But the debate over the introduction of wolves to Yellowstone National Park will most likely continue for years to come.

MATH PRACTICE

Energy Pyramids

Draw an energy pyramid for a river ecosystem that contains four levels—aquatic plants, insect larvae, bluegill fish, and a largemouth bass. The plants obtain 10,000 units of energy from sunlight. If each level uses 90% of the energy it receives from the previous level, how many units of energy are available to the bass?

SECTION Review

Summary

- Producers use the energy in sunlight to make their own food.
- Consumers eat producers and other organisms to gain energy.
- Food chains represent how energy flows from one organism to another.
- All organisms are important to maintain the balance of energy in the food web.
- Energy pyramids show how energy is lost at each food chain level.

Using Key Terms

1. Use each of the following terms in a separate sentence: *herbivores*, *carnivores*, and *omnivores*.
2. In your own words, write a definition for each of the following terms: *food chain*, *food web*, and *energy pyramid*.

Understanding Key Ideas

3. Herbivores, carnivores, and scavengers are all examples of
 - a. producers.
 - b. decomposers.
 - c. consumers.
 - d. omnivores.
4. Explain the importance of decomposers in an ecosystem.
5. Describe how producers, consumers, and decomposers are linked in a food chain.
6. Describe how energy flows through a food web.

Math Skills

7. The plants in each square meter of an ecosystem obtained 20,810 Calories of energy from sunlight per year. The herbivores in that ecosystem ate all the plants but obtained only 3,370 Calories of energy. How much energy did the plants use?

Critical Thinking

8. **Identifying Relationships** Draw two food chains, and depict how they link together to form a food web.
9. **Applying Concepts** Are consumers found at the top or bottom of an energy pyramid? Explain your answer.
10. **Predicting Consequences** What would happen if a species disappeared from an ecosystem?



SCILINKS.

NSTA

Developed and maintained by the
National Science Teachers Association

For a variety of links related to this chapter, go to www.scilinks.org

Topic: Food Chains and Food Webs
SciLinks code: HSM0594

READING WARM-UP

Objectives

- Explain the relationship between carrying capacity and limiting factors.
- Describe the two types of competition.
- Distinguish between mutualism, commensalism, and parasitism. Give an example of coevolution.

Terms to Learn

carrying capacity mutualism
prey commensalism
predator parasitism
symbiosis coevolution

READING STRATEGY

Reading Organizer As you read this section, make a concept map by using the terms above.

Types of Interactions

Look at the seaweed forest shown in **Figure 1** below. How many fish do you see? How many seaweed plants do you count? Why do you think there are more members of the seaweed population than members of the fish population?

In natural communities, the sizes of populations of different organisms can vary greatly. This variation happens because everything in the environment affects every other thing. Populations also affect every other population.

Interactions with the Environment

Most living things produce more offspring than will survive. A female frog, for example, might lay hundreds of eggs in a small pond. In a few months, the population of frogs in that pond will be about the same as it was the year before. Why won't the pond become overrun with frogs? An organism, such as a frog, interacts with biotic and abiotic factors in its environment that can control the size of its population.

Limiting Factors

Populations cannot grow without stopping, because the environment contains a limited amount of food, water, living space, and other resources. A resource that is so scarce that it limits the size of a population is called a *limiting factor*. For example, food becomes a limiting factor when a population becomes too large for the amount of food available. Any single resource can be a limiting factor to a population's size.

Figure 1 This seaweed forest is home to a large number of interacting species.



Carrying Capacity


The largest population that an environment can support is known as the **carrying capacity**. When a population grows larger than its carrying capacity, limiting factors in the environment cause individuals to die off or leave. As individuals die or leave, the population decreases.

For example, after a rainy season, plants may produce a large crop of leaves and seeds. This large amount of food may cause an herbivore population to grow. If the next year has less rainfall, there won't be enough food to support the large herbivore population. In this way, a population may become larger than the carrying capacity, but only for a little while. A limiting factor will cause the population to die back. The population will return to a size that the environment can support.

carrying capacity the largest population that an environment can support at any given time

Interactions Between Organisms

Populations contain individuals of a single species that interact with one another, such as a group of rabbits feeding in the same area. Communities contain interacting populations, such as a coral reef with many species of corals trying to find living space. Ecologists have described four main ways that species and individuals affect each other: competition, predators and prey, symbiotic relationships, and coevolution.

 **Reading Check** What are four main ways organisms affect one another? (See the Appendix for answers to Reading Checks.)

Competition

When two or more individuals or populations try to use the same resource, such as food, water, shelter, space, or sunlight, it is called *competition*. Because resources are in limited supply in the environment, their use by one individual or population decreases the amount available to other organisms.

Competition happens between individuals *within* a population. The elk in Yellowstone National Park are herbivores that compete with each other for the same food plants in the park. This competition is a big problem in winter when many plants die.

Competition also happens *between* populations. The different species of trees in **Figure 2** are competing with each other for sunlight and space.



Figure 2 Some of the trees in this forest grow tall to reach sunlight, which reduces the amount of sunlight available to shorter trees nearby.

prey an organism that is killed and eaten by another organism

predator an organism that eats all or part of another organism



Figure 3 The goldenrod spider is difficult for its insect prey to see. Can you see it?

Predators and Prey

Many interactions between species consist of one organism eating another. The organism that is eaten is called the **prey**. The organism that eats the prey is called the **predator**. When a bird eats a worm, the worm is prey and the bird is the predator.

Predator Adaptations

To survive, predators must be able to catch their prey. Predators have a wide variety of methods and abilities for doing so. The cheetah, for example, is able to run very quickly to catch its prey. The cheetah's speed gives it an advantage over other predators competing for the same prey.

Other predators, such as the goldenrod spider, shown in **Figure 3**, ambush their prey. The goldenrod spider blends in so well with the goldenrod flower that all it has to do is wait for its next insect meal to arrive.

Prey Adaptations

Prey have their own methods and abilities to keep from being eaten. Prey are able to run away, stay in groups, or camouflage themselves. Some prey are poisonous. They may advertise their poison with bright colors to warn predators to stay away. The fire salamander, shown in **Figure 4**, sprays a poison that burns. Predators quickly learn to recognize its *warning coloration*.


Many animals run away from predators. Prairie dogs run to their underground burrows when a predator approaches. Many small fishes, such as anchovies, swim in groups called *schools*. Antelopes and buffaloes stay in herds. All the eyes, ears, and noses of the individuals in the group are watching, listening, and smelling for predators. This behavior increases the likelihood of spotting a potential predator.

Figure 4 Many predators know better than to eat the fire salamander! This colorful animal will make a predator very sick.



Camouflage

One way animals avoid being eaten is by being hard to see. A rabbit often freezes so that its natural color blends into a background of shrubs or grass. Blending in with the background is called *camouflage*. Many animals mimic twigs, leaves, stones, bark, or other materials in their environment. One insect, called a walking stick, looks just like a twig. Some walking sticks even sway a bit, as though a breeze were blowing.

 **Reading Check** What is camouflage, and how does it prevent an animal from being eaten?

Defensive Chemicals

The spines of a porcupine clearly signal trouble to a potential predator, but other defenses may not be as obvious. Some animals defend themselves with chemicals. The skunk and the bombardier beetle both spray predators with irritating chemicals. Bees, ants, and wasps inject a powerful acid into their attackers. The skin of both the poison arrow frog and a bird called the *hooded pitohui* contains a deadly toxin. Any predator that eats, or tries to eat, one of these animals will likely die.

Warning Coloration

Animals that have a chemical defense need a way to warn predators that they should look elsewhere for a meal. Their chemical weapons are often advertised by warning colors, as shown in **Figure 5**. Predators will avoid any animal that has the colors and patterns they associate with pain, illness, or unpleasant experiences. The most common warning colors are bright shades of red, yellow, orange, black, and white.



Figure 5 The warning coloration of the yellow jacket (left) and the pitohui (above) warns predators that they are dangerous.

CONNECTION TO Environmental Science

Pretenders Some animals are pretenders. They don't have defensive chemicals. But they use warning coloration to their advantage. The Scarlet king snake has colored stripes that make it look like the poisonous coral snake. Even though the Scarlet king snake is harmless, predators see its bright colors and leave it alone. What might happen if there were more pretenders than there were animals with real defensive chemicals?

symbiosis a relationship in which two different organisms live in close association with each other

mutualism a relationship between two species in which both species benefit

commensalism a relationship between two organisms in which one organism benefits and the other is unaffected

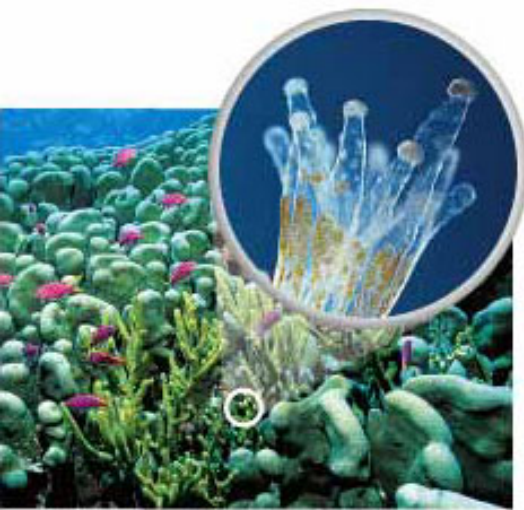


Figure 6 In the smaller photo above, you can see the gold-colored algae inside the coral.

Symbiosis

Some species have very close interactions with other species. **Symbiosis** is a close, long-term association between two or more species. The individuals in a symbiotic relationship can benefit from, be unaffected by, or be harmed by the relationship. Often, one species lives in or on the other species. The thousands of symbiotic relationships in nature are often classified into three groups: mutualism, commensalism, and parasitism.

Mutualism

A symbiotic relationship in which both organisms benefit is called **mutualism** (MYOO choo uhl iz uhm). For example, you and a species of bacteria that lives in your intestines benefit each other! The bacteria get food from you, and you get vitamins that the bacteria produce.

Another example of mutualism happens between corals and algae. Coral near the surface of the water provide a home for algae. The algae produce food for the coral by photosynthesis. When a coral dies, its skeleton is used by other corals. Over a long time, these skeletons build up large formations that lie under the surface of warm seas, as shown in **Figure 6**.

✓ Reading Check Which organism benefits in mutualism?

Commensalism

A symbiotic relationship in which one organism benefits and the other is unaffected is called **commensalism**. One example of commensalism is the relationship between sharks and smaller fish called *remoras*. **Figure 7** shows a shark with a remora attached to its body. Remoras “hitch a ride” and feed on scraps of food left by sharks. The remoras benefit from this relationship, while sharks are unaffected.

Figure 7 The remora attached to the shark benefits from the relationship. The shark neither benefits from nor is harmed by the relationship.





Figure 8 The tomato hornworm is being parasitized by young wasps. Do you see their cocoons?

Parasitism

A symbiotic association in which one organism benefits while the other is harmed is called **parasitism** (PAR uh SIT iz uhm). The organism that benefits is called the *parasite*. The organism that is harmed is called the *host*. The parasite gets nourishment from its host while the host is weakened. Sometimes, a host dies. Parasites, such as ticks, live outside the host's body. Other parasites, such as tapeworms, live inside the host's body.

Figure 8 shows a bright green caterpillar called a *tomato hornworm*. A female wasp laid tiny eggs on the caterpillar. When the eggs hatch, each young wasp will burrow into the caterpillar's body. The young wasps will actually eat the caterpillar alive! In a short time, the caterpillar will be almost completely eaten and will die. When that happens, the adult wasps will fly away.

In this example of parasitism, the host dies. Most parasites, however, do not kill their hosts. Most parasites don't kill their hosts because parasites depend on their hosts. If a parasite were to kill its host, the parasite would have to find a new host.

parasitism a relationship between two species in which one species, the parasite, benefits from the other species, the host, which is harmed

coevolution the evolution of two species that is due to mutual influence, often in a way that makes the relationship more beneficial to both species

Coevolution

Relationships between organisms change over time. Interactions can also change the organisms themselves. When a long-term change takes place in two species because of their close interactions with one another, the change is called **coevolution**.

The ant and the acacia tree shown in **Figure 9** have a mutualistic relationship. The ants protect the tree by attacking other organisms that come near the tree. The tree has special structures that make food for the ants. The ants and the acacia tree may have coevolved through interactions between the two species. Coevolution can take place between any organisms that live close together. But changes happen over a very long period of time.



Figure 9 Ants collect food made by the acacia tree and store the food in their shelter, which is also made by the tree.

CONNECTION TO Social Studies



Rabbits in Australia In 1859, settlers released 12 rabbits in Australia. There was plenty of food and no natural predators for the rabbits. The rabbit population increased so fast that the country was soon overrun by rabbits. Then, the Australian government introduced a rabbit virus to control the population. The first time the virus was used, more than 99% of the rabbits died. The survivors reproduced, and the rabbit population grew large again. The second time the virus was used, about 90% of the rabbits died. Once again, the rabbit population increased. The third time the virus was used, only about 50% of the rabbits died. Suggest what changes might have occurred in the rabbits and the virus.

Coevolution and Flowers

A *pollinator* is an organism that carries pollen from one flower to another. Pollination is necessary for reproduction in most plants.

Flowers have changed over millions of years to attract pollinators. Pollinators such as bees, bats, and hummingbirds can be attracted to a flower because of its color, odor, or nectar. Flowers pollinated by hummingbirds make nectar with the right amount of sugar for the bird. Hummingbirds have long beaks, which help them drink the nectar.

Some bats, such as the one shown in **Figure 10**, changed over time to have long, thin tongues and noses to help them reach the nectar in flowers. As the bat feeds on the nectar, its nose becomes covered with pollen. The next flower it eats from will be pollinated with the pollen it is gathering from this flower. The long nose helps it to feed and also makes it a better pollinator.

Because flowers and their pollinators have interacted so closely over millions of years, there are many examples of coevolution between them.

✓ Reading Check Why do flowers need to attract pollinators?



Figure 10 This bat is drinking nectar with its long, skinny tongue. The bat has coevolved with the flower over millions of years.

SECTION Review



Summary

- Limiting factors in the environment keep a population from growing without limit.
- Two or more individuals or populations trying to use the same resource is called *competition*.
- A predator is an organism that eats all or part of another organism. The organism that is eaten is called *prey*.
- Prey have developed features such as camouflage, chemical defenses, and warning coloration, to protect them from predators.
- Symbiosis occurs when two organisms form a very close relationship with one another over time.
- Close relationships over a very long time can result in coevolution. For example, flowers and their pollinators have evolved traits that benefit both.

Using Key Terms

1. In your own words, write a definition for the term *carrying capacity*.
2. Use each of the following terms in a separate sentence: *mutualism*, *commensalism*, and *parasitism*.

Understanding Key Ideas

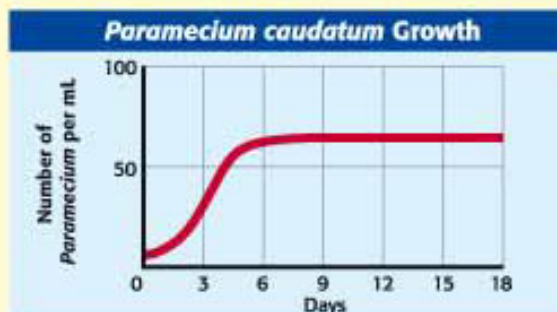
3. Which of the following is NOT a prey adaptation?
a. camouflage c. warning coloration
b. chemical defenses d. parasitism
4. Identify two things organisms compete with one another for.
5. Briefly describe one example of a predator-prey relationship. Identify the predator and the prey.

Critical Thinking

6. **Making Comparisons** Compare coevolution with symbiosis.
7. **Identifying Relationships** Explain the probable relationship between the giant *Rafflesia* flower, which smells like rotting meat, and the carrion flies that buzz around it. (Hint: *Carrion* means "rotting flesh.")
8. **Predicting Consequences** Predict what might happen if all of the ants were removed from an acacia tree.

Interpreting Graphics

The population graph below shows the growth of a species of *Paramecium* (single-celled microorganism) over 18 days. Food was added to the test tube occasionally. Use this graph to answer the questions that follow.



9. What is the carrying capacity of the test tube as long as food is added?
10. Predict what will happen if no more food is added?
11. What keeps the number of *Paramecium* at a steady level?

SciLINKS

NSTA

Developed and maintained by the
National Science Teachers Association

For a variety of links related to this chapter, go to www.scilinks.org

Topic: Predator/Prey; Coevolution

SciLinks code: HSM1205; HSM0309



OBJECTIVES

Estimate the size of a “population” of beans.

Calculate the difference between your estimation and the actual number of beans.

MATERIALS

- bag, paper lunch, small
- beans, pinto
- calculator (optional)
- marker, permanent

Capturing the Wild Bean

When wildlife biologists study a group of organisms in an area, they need to know how many organisms live there. Sometimes, biologists worry that a certain organism is outgrowing the environment’s carrying capacity. Other times, scientists need to know if an organism is becoming rare so that steps can be taken to protect it. However, animals can be difficult to count because they can move around and hide. Because of this challenge, biologists have developed methods to estimate the number of animals in a specific area. One of these counting methods is called the *mark-recapture method*.

In this activity, you will enter the territory of the wild pinto bean to estimate the number of beans that live in the paper-bag habitat.

Procedure

- 1 Prepare a data table like the one below.

Mark-Recapture Data Table				
Number of animals in first capture	Total number of animals in recapture	Number of marked animals in recapture	Calculated estimate of population	Actual total population
DO NOT WRITE IN BOOK				

- 2 Your teacher will provide you with a paper bag containing an unknown number of beans. Carefully reach into the bag, and remove a handful of beans.





- Count the number of beans you have “captured.” Record this number in your data table under “Number of animals in first capture.”
- Use the permanent marker to carefully mark each bean that you have just counted. Allow the marks to dry completely. When all the marks are dry, place the marked beans back into the bag.
- Gently mix the beans in the bag so that the marks won’t rub off. Once again, reach into the bag. “Capture” and remove a handful of beans.
- Count the number of beans in your “recapture.” Record this number in your data table under “Total number of animals in recapture.”
- Count the beans in your recapture that have marks from the first capture. Record this number in your data table under “Number of marked animals in recapture.”
- Calculate your estimation of the total number of beans in the bag by using the following equation:

$$\frac{\text{number of beans in recapture} \times \text{number of beans marked}}{\text{number of marked beans in recapture}} = \text{calculated estimate of population}$$

Enter this number in your data table under “Calculated estimate of population.”

- Place all the beans in the bag. Then empty the bag on your work table. Be careful that no beans escape! Count each bean as you place them one at a time back into the bag. Record the number in your data table under “Actual total population.”



Analyze the Results

- Evaluating Results** How close was your estimate to the actual number of beans?

Draw Conclusions

- Evaluating Methods** If your estimate was not close to the actual number of beans, how might you change your mark-recapture procedure? If you did not recapture any marked beans, what might be the cause?

Applying Your Data

How could you use the mark-recapture method to estimate the population of turtles in a small pond? Explain your procedure.



Chapter Review

USING KEY TERMS

- 1 Use each of the following terms in a separate sentence: *symbiosis*, *mutualism*, *commensalism*, and *parasitism*.

Complete each of the following sentences by choosing the correct term from the word bank.

biotic abiotic
ecosystem community

- 2 The environment includes _____ factors including water, rocks, and light.
- 3 The environment also includes _____, or living, factors.
- 4 A community of organisms and their environment is called a(n) _____.

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

- 5 *community* and *population*
- 6 *ecosystem* and *biosphere*
- 7 *producers* and *consumers*

UNDERSTANDING KEY IDEAS

Multiple Choice

- 8 A tick sucks blood from a dog. In this relationship, the tick is the _____ and the dog is the _____.
- a. parasite, prey c. parasite, host
b. predator, host d. host, parasite
- 9 Resources such as water, food, or sunlight are likely to be limiting factors
- a. when population size is decreasing.
b. when predators eat their prey.
c. when the population is small.
d. when a population is approaching the carrying capacity.
- 10 Nature's recyclers are
- a. predators. c. producers.
b. decomposers. d. omnivores.
- 11 A beneficial association between coral and algae is an example of
- a. commensalism. c. mutualism.
b. parasitism. d. predation.
- 12 The process by which energy moves through an ecosystem can be represented by
- a. food chains.
b. energy pyramids.
c. food webs.
d. All of the above
- 13 Which organisms does the base of an energy pyramid represent?
- a. producers c. herbivores
b. carnivores d. scavengers
- 14 Which of the following is the correct order in a food chain?
- a. sun→producers→herbivores→scavengers→carnivores
b. sun→consumers→predators→parasites→hosts
c. sun→producers→decomposers→consumers→omnivores
d. sun→producers→herbivores→carnivores→scavengers



- 15 Remoras and sharks have a relationship that is best described as
- a. mutualism.
 - b. commensalism.
 - c. predator and prey.
 - d. parasitism.

Short Answer

- 16 Describe how energy flows through a food web.
- 17 Explain how the food web changed when the gray wolf disappeared from Yellowstone National Park.
- 18 How are the competition between two trees of the same species and the competition between two different species of trees similar?
- 19 How do limiting factors affect the carrying capacity of an environment?
- 20 What is coevolution?

CRITICAL THINKING

- 21 **Concept Mapping** Use the following terms to create a concept map: *herbivores, organisms, producers, populations, ecosystems, consumers, communities, carnivores, and biosphere.*
- 22 **Identifying Relationships** Could a balanced ecosystem contain producers and consumers but not decomposers? Why or why not?



- 23 **Predicting Consequences** Some biologists think that certain species, such as alligators and wolves, help maintain biological diversity in their ecosystems. Predict what might happen to other organisms, such as gar fish or herons, if alligators were to become extinct in the Florida Everglades.
- 24 **Expressing Opinions** Do you think there is a carrying capacity for humans? Why or why not?

INTERPRETING GRAPHICS

Use the energy pyramid below to answer the questions that follow.



- 25 According to the energy pyramid, are there more prairie dogs or plants?
- 26 What level has the most energy?
- 27 Would an energy pyramid such as this one exist in nature?
- 28 How could you change this pyramid to look like one representing a real ecosystem?



Standardized Test Preparation

READING

Read each of the passages below. Then, answer the questions that follow each passage.

Passage 1 Two or more individuals trying to use the same resource, such as food, water, shelter, space, or sunlight is called *competition*. Because resources are in limited supply in the environment, the use of them by one individual or population decreases the amount available to other organisms. Competition also occurs between individuals within a population. The elk in Yellowstone National Park are herbivores that compete with each other for the same food plants in the park.

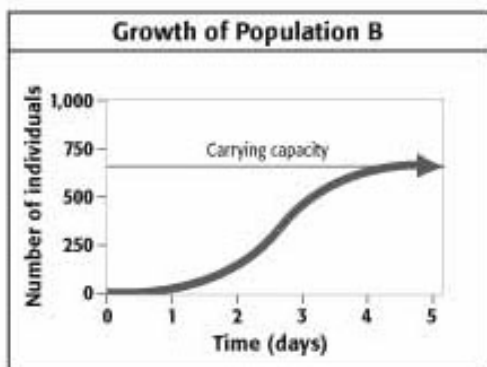
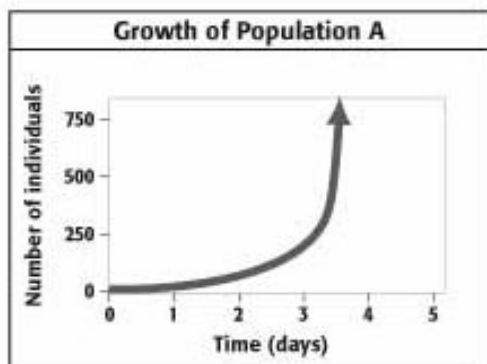
1. According to the passage, competition occurs between which of the following?
 - A individuals trying to use the same resource
 - B elk and carnivores
 - C food and shelter
 - D individuals trying to use different resources
2. According to the passage, food, water, shelter, space, and sunlight are examples of
 - F populations.
 - G things found in Yellowstone National Park.
 - H competition.
 - I resources.
3. Based on the passage, which of the following statements is a fact?
 - A Competition occurs only between individuals of different populations.
 - B Competition occurs between individuals within a population and between individuals of different populations.
 - C Competition increases the amount of resources available to individuals.
 - D Because resources are abundant in the environment, competition rarely happens between individuals of different populations.

Passage 2 In the deserts of northern Africa and the Middle East, water is a scarce and valuable resource. In this area, no permanent streams flow except for the Nile. More than 1.6 million square kilometers of this region typically have no rainfall for years at a time. However, much of this area has large aquifers. The water that these aquifers contain dates back to much wetter times thousands of years ago. Occasionally, water reaches the surface to form an oasis. Wells supply the rest of the water used throughout the region. In some regions of Saudi Arabia and Kuwait, wells drilled for water more often strike oil.

1. According to the passage, an aquifer contains what resource?
 - A oil
 - B water
 - C wells
 - D oasis
2. Based on the passage, which of the following statements is a fact?
 - F The Nile no longer flows through northern Africa and the Middle East.
 - G The water found in aquifers is from recent rainfall.
 - H Wells drilled in Saudi Arabia and Kuwait are more likely to strike oil than water.
 - I The desert regions of northern Africa and the Middle East receive rainfall almost every day.
3. According to the passage, an oasis forms under what conditions?
 - A when water stays beneath the surface
 - B when water is drilled from a well
 - C when it rains
 - D when water reaches the surface

INTERPRETING GRAPHICS

The graphs below show the population growth for two populations. Use these graphs to answer the questions that follow.

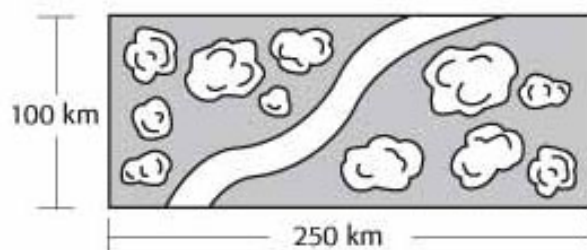


- After 2 days, which population has more individuals?
A Population A has more individuals.
B Population B has more individuals.
C The populations are the same.
D There is not enough information to determine the answer.
- After 5 days, which population has more individuals?
F Population A has more individuals.
G Population B has more individuals.
H The populations are the same.
I There is not enough information to determine the answer.
- On day 10, which statement is probably true?
A Population B is larger than population A.
B Population A is the same as it was on day 5.
C Population A and B are the same.
D Population B is the same as it was on day 5.

MATH

Read each question below, and choose the best answer.

- The figure below is a map of a forest ecosystem. What is the area of this ecosystem?



- A** 25,000 km²
B 32,000 km²
C 1,200 km²
D 2,500 km²
- If an antelope eats 7 kg of vegetation in 2 days, how many kilograms of vegetation does it eat per day?
F $\frac{2}{7}$ kg
G $\frac{3}{5}$ kg
H $3\frac{1}{2}$ kg
I $7\frac{1}{2}$ kg
- If $x = 3$ and $y = x + 2$, what is y ?
A 2
B 4
C 5
D 8
- If $x = 4$ and $y = x + 2$, what is y ?
F 2
G 5
H 6
I 8

Science in Action



Scientific Debate

How Did Dogs Become Pets?

Did humans change dogs to be the social and helpful creatures they are today? Or were dogs naturally social? Did dogs start moving closer to our campfires long ago? Or did humans find dogs and bring them into our homes? The way in which dogs became our friends, companions, and helpers is still a question. Some scientists think humans and training are the reasons for many of our dogs' best features. Other scientists think dogs and humans have both changed over time to form their strong and unique bond.

Math ACTiViTy

Scientists have found fossils of dogs that are 15,000 years old. Generation time is the time between the birth of one generation and the next. If the generation time for dogs is 1.5 years, how many generations have there been in the last



Weird Science

Follicle Mites

What has a tiny tubelike body and short stumpy legs and lives in your eyebrows and eyelashes? Would you believe a small animal lives there? It's called a follicle mite, and humans are its host. Studies show that more than 97% of adults have these mites. Except in rare cases, follicle mites are harmless.

Like all large animals, human beings are hosts to a variety of smaller creatures that live in or on our bodies and share our bodies' resources. Bacteria that live in our lower digestive tracks help to produce vitamins such as folic acid and vitamin K. Other bacteria may help maintain proper pH levels in our bodies.

Language Arts ACTiViTy

WRITING SKILL

Imagine that you were shrunk to the size of a follicle mite. How would you get food? Where would you sleep? Write a short story describing one day in your new, tiny life.

Dalton Dockery

Horticulture Specialist Did you know that instead of using pesticides to get rid of insects that are eating the plants in your garden, you can use other insects? "It is a healthy way of growing vegetables without the use of chemicals and pesticides, and it reduces the harmful effects pesticides have on the environment," says Dalton Dockery, a horticulture specialist in North Carolina. Some insects, such as ladybugs and praying mantises, are natural predators of many insects that are harmful to plants. They will eat other bugs but leave your precious plants in peace. Using bugs to drive off pests is just one aspect of natural gardening. Natural gardening takes advantage of relationships that already exist in nature and uses these interactions to our benefit. For Dockery, the best parts about being a horticultural specialist are teaching people how to preserve the environment, getting to work outside regularly, and having the opportunity to help people on a daily basis.



Social Studies **ACTiViTy**

WRITING SKILL Research gardening or farming techniques in other cultures. Do other cultures use any of the same aspects of natural gardening as horticultural specialists? Write a short report describing your findings.



To learn more about these Science in Action topics, visit go.hrw.com and type in

Current Science

Check out Current Science® articles related to this chapter by visiting go.hrw.com. Just type in the keyword **HL5CS18**.