CHAPTER

10 Introduction to Multicellular Organisms

the BIG idea

Multicellular organisms live in and get energy from a variety of environments.

How does an organism get energy and materials from its environment?

Key Concepts

SECTION 1 **Multicellular organisms meet their needs in different ways.**
Learn about specialized cells, tissues, and organs.

SECTION 2 **Plants are producers.**
Learn how plants get energy and respond to the environment.

SECTION 3 **Animals are consumers.**
Learn how animals get energy and how they interact with the environment.

SECTION 4 **Most fungi are decomposers.**
Learn about fungi and how they get energy.

FCAT Practice

Prepare and practice for the FCAT
- Section Reviews, pp. 339, 347, 354, 361
- Chapter Review, pp. 364–366
- FCAT Practice, p. 367

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

EXPLORE the BIG idea

Where Does It Come From?

Think about the things you use every day. Just like any other organism, you depend on the environment to meet your needs. The food you eat comes from plants and animals. Also, much of what you use is made of materials processed from living matter.

Observe and Think Identify three nonfood items you come into contact with every day. Where does the material for these products come from?

How Can a Multicellular Organism Reproduce on Its Own?

Take an old potato and cut it in half, making sure that there are eyes on both halves. Plant each half in a pot of soil. Water the pots once a day. After two weeks, remove the potato halves from the pots and examine.

Observe and Think
What happened to the potato halves?

Internet Activity: Bee Dance

Go to **ClassZone.com** to explore how bees communicate.

Observe and Think
What type of information can a bee communicate to other bees in a hive?

NSTA scilinks.org SCILINKS
Animal Behavior **Code: MDL040**

CHAPTER 10

Getting Ready to Learn

CONCEPT REVIEW

- Living things are arranged in groups based on similarities.
- Bacteria are single-celled organisms without a nucleus.
- Because viruses are not living things, they use living cells to reproduce.
- Most protists are single-celled organisms.

VOCABULARY REVIEW

Archaea p. 263

host cell p. 272

algae p. 277

FLORIDA REVIEW
CLASSZONE.COM
Content Review and FCAT Practice

TAKING NOTES

MAIN IDEA AND DETAILS

Make a two-column chart. Write the main ideas, such as those in the blue headings, in the column on the left. Write details about each of those main ideas in the column on the right.

VOCABULARY STRATEGY

Write each new vocabulary term in the center of a **four square** diagram. Write notes in the squares around each term. Include a definition, some characteristics, and some examples of the term. If possible, write some things that are not examples of the term.

SCIENCE NOTEBOOK

MAIN IDEAS	DETAILS
Plants respond to their environment.	1. Plants respond to different stimuli. 2. A stimulus is something that produces a response.

Definition	Characteristics
Group of same type of cells performing similar functions	Cells are similar. Different tissues do different jobs.
Examples	**Nonexamples**
skin tissue nerve tissue muscle tissue	a single cell

TISSUE

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

KEY CONCEPT

10.1 Multicellular organisms meet their needs in different ways.

Sunshine State STANDARDS

SC.F.1.3.2: The student knows that the structural basis of most organisms is the cell and most organisms are single cells, while some, including humans, are multicellular.

SC.F.1.3.4: The student knows that the levels of structural organization for function in living things include cells, tissues, organs, systems, and organisms.

SC.F.2.3.3: The student knows that generally organisms in a population live long enough to reproduce because they have survival characteristics.

BEFORE, you learned

- Organisms get energy and materials from the environment
- All organisms are organized, grow, respond, and reproduce
- Differences in genetic material lead to diversity

NOW, you will learn

- About the functions of cells in multicellular organisms
- How multicellular organisms are adapted to different environments
- About sexual reproduction

FCAT VOCABULARY

tissue p. 334
organ p. 334
sexual reproduction p. 338
meiosis p. 338

VOCABULARY

fertilization p. 338

MAIN IDEA AND DETAILS

Make a chart and add notes about the main idea: *Multicellular organisms have cells that are specialized.*

THINK ABOUT

Why is teamwork important?

For any team to be successful, it is important for people to work well together. Within a team, each person has a different role. For example, the team in this restaurant includes people to greet diners and seat them, people to buy and cook the food, and people to take food orders and serve the food. By dividing different jobs among different people, a restaurant can serve more customers at the same time. What would happen in a large restaurant if the diners were seated, cooked for, and served by the same person?

Multicellular organisms have cells that are specialized.

In single-celled organisms, all the functions of life are performed by one cell. These functions include getting energy and materials, removing wastes, and responding to changes in the environment. In multicellular organisms, however, different jobs are done by different cells—the cells are specialized. A blood cell carries oxygen. A nerve cell sends and receives signals. Just as the different jobs of running a restaurant are divided among different people, in multicellular organisms different functions are divided among different cells.

In this chapter, you will read about plants, animals, and fungi. These three kingdoms are made up almost entirely of multicellular organisms. The cells in multicellular organisms are organized in ways that enable them to survive and reproduce.

INVESTIGATE Specialization

What are some advantages of specialization?

SKILL FOCUS
Making Models

MATERIALS
- two boxes, each containing 20 paper clips, 2 pieces of paper, and 1 pencil

TIME
10 minutes

PROCEDURE

1. Form into two teams,each representing an organism. The single-celled team will be made up of just one person; the multicellular team will be made up of three. Each team obtains a box of materials from the teacher.
2. Each team must do the following tasks as quickly as possible: make a paper-clip chain, write the alphabet on both sides of one piece of paper, and make a paper airplane from the second piece of paper. The members of the three-person team must specialize, each person doing one task only.

WHAT DO YOU THINK?

- What are some advantages to having each person on the three-person team specialize in doing a different job?
- Why might efficiency be a factor in the activities done by cells in a multicellular organism?

CHALLENGE Suppose the "life" of the multicellular team depended on the ability of one person to make a paper airplane. How would specialization be a disadvantage if that person were not at school?

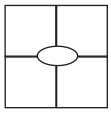
Levels of Organization

For any multicellular organism to survive, different cells must work together. The right type of cell must be in the right place to do the work that needs to be done.

Organization starts with the cell. Cells in multicellular organisms are specialized for a specific function. In animals, skin cells provide protection, nerve cells carry signals, and muscle cells produce movement. Cells of the same type are organized into **tissue,** a group of cells that work together. For example, what you think of as muscle is muscle tissue, made up of many muscle cells.

A structure that is made up of different tissues is called an **organ.** Organs have particular functions. The heart is an organ that functions as a pump. It has muscle tissue, which pumps the blood, and nerve tissue, which signals when to pump. Different organs that work together and have a common function are called an organ system. A heart and blood vessels are different organs that are both part of a circulatory system. These organs work together to deliver blood to all parts of a body. Together, cells, tissues, organs, and organ systems form an organism.

VOCABULARY
Remember to add a four square for *tissue* and *organ* to your notebook.



Organ Systems and the Organism

In almost all multicellular organisms, different organ systems take care of specific needs. Here are a few examples of organ systems found in many animals:

- nervous system enables a response to changing conditions
- muscular system produces movement and supplies heat
- respiratory system takes in oxygen and releases carbon dioxide
- circulatory system delivers oxygen and removes carbon dioxide
- digestive system breaks down food into a usable form

Organ systems allow multicellular organisms to obtain large amounts of energy, process large amounts of materials, respond to changes in the environment, and reproduce.

REMINDER

A system is a group of objects that interact, sharing energy and matter.

CHECK YOUR READING How are the functions of organ systems related to the needs of an organism? Give an example.

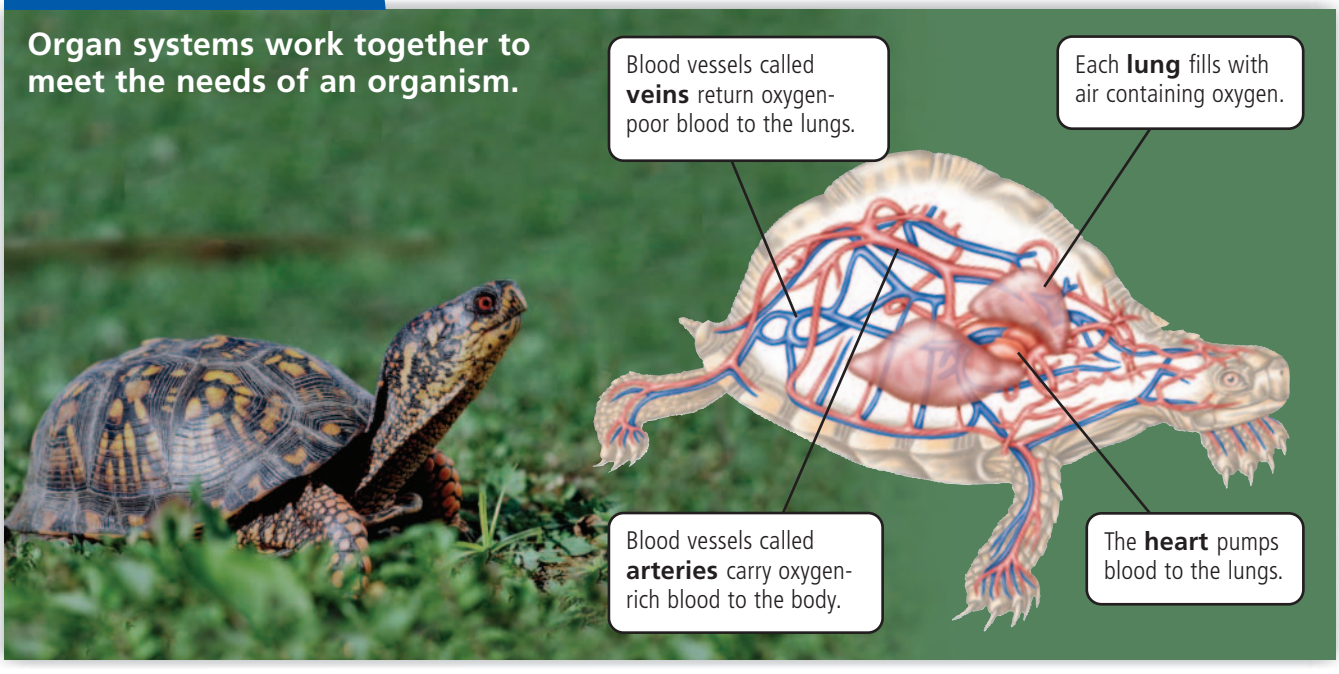
FLORIDA Content Preview

These same levels of organization in living things also occur in humans, as you will learn in grade 7.

Different organ systems work together. For example, the respiratory system works with the circulatory system to deliver oxygen and remove carbon dioxide. When an animal such as a turtle breathes in, oxygen is brought into the lungs. Blood from the circulatory system picks up the oxygen, and the heart pumps the oxygen-rich blood out to the cells of the body. As oxygen is delivered, waste carbon dioxide is picked up. The blood is pumped back to the lungs. The carbon dioxide is released when the turtle breathes out. More oxygen is picked up when the turtle breathes in.

Organ Systems

Organ systems work together to meet the needs of an organism.



Multicellular organisms are adapted to live in different environments.

READING TiP

Offspring is a word used to describe the new organisms produced by reproduction in any organism. Think of it as meaning "to spring off."

All organisms have characteristics that allow them to survive in their environment. An adaptation is any inherited characteristic that increases the chance of an organism's surviving and producing offspring that also reproduce. An adaptation may have to do with the way an organism gets its energy or processes materials. An adaptation may relate to the shape or structure of an organism's body. An adaptation can even be a form of behavior.

Single-celled organisms reproduce through asexual reproduction. Asexual reproduction requires only one parent and produces offspring that are identical to the parent. However, when most multicellular organisms reproduce, the offspring are not exact copies of the parents. There are differences. If a particular difference gives an organism an advantage over other members in its group, then that difference is referred to as an adaptation. Over time, the organism and its offspring do better and reproduce more.

You are probably familiar with the furry animal called a fox. Different species of fox have different adaptations that enable them to survive in different environments. Here are three examples:

- **Fennec** The fennec is a desert fox. Its large ears are an adaptation that helps the fox keep cool in the hot desert. As blood flows through the vessels in each ear, heat is released. Another adaptation is the color of its fur, which blends in with the desert sand.
- **Arctic fox** The Arctic fox lives in the cold north. Its small ears, legs, and nose are adaptations that reduce the loss of heat from its body. Its bluish-gray summer fur is replaced by a thick coat of white fur as winter approaches. Its winter coat keeps the fox warm and enables it to blend in with the snow.
- **Red fox** The red fox is found in grasslands and woodlands. Its ears aren't as large as those of the fennec or as small as those of the Arctic fox. Its body fur is reddish brown tipped in white and black, coloring that helps it blend into its environment.

The diversity of life on Earth is due to the wide range of adaptations that have occurred in different species. An elephant has a trunk for grasping and sensing. A female kangaroo carries its young in a pouch. The largest flower in the world, the rafflesia flower, is almost a meter wide, blooms for just a few days, and smells like rotting meat.

Adaptations are the result of differences that can occur in genetic material. The way multicellular organisms reproduce allows for a mixing of genetic material. You will read about that next.

INFER The strong odor of the rafflesia flower attracts flies into the plant. How might this adaptation benefit the plant?

Adaptations in Different Environments

Fennec

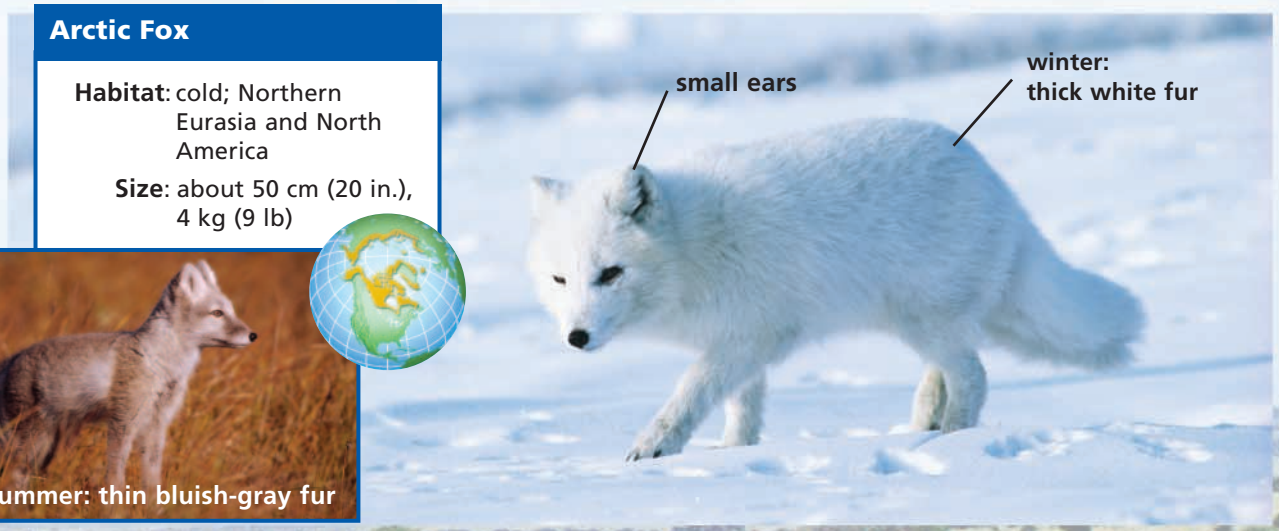
Habitat: warm; Sahara Desert and Saudi Arabia

Size: about 40 cm (15 in.), 1.25 kg (2.7 lb)

Arctic Fox

Habitat: cold; Northern Eurasia and North America

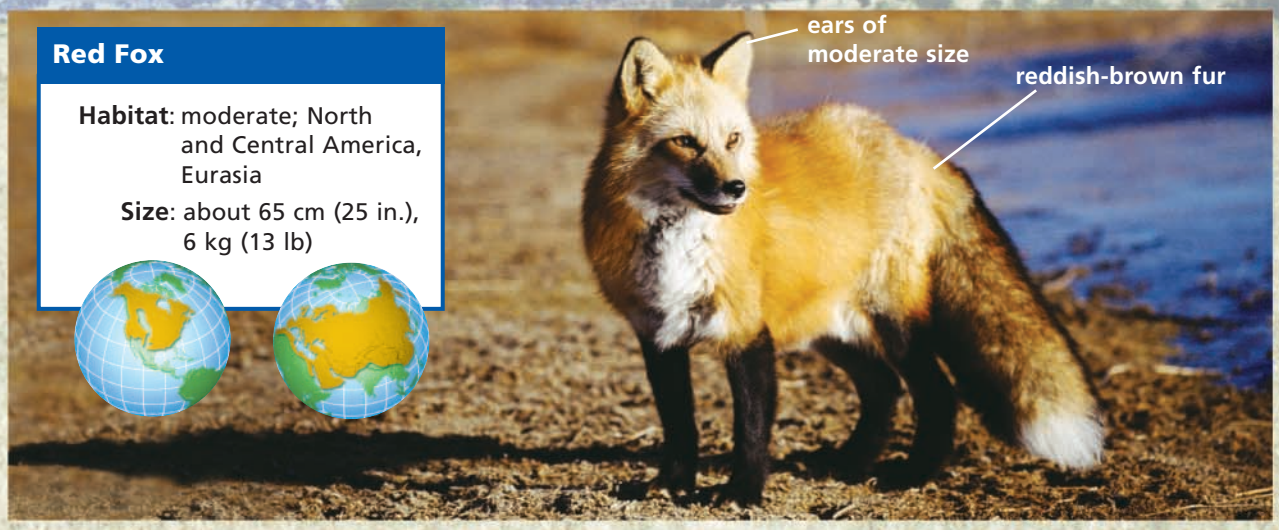
Size: about 50 cm (20 in.), 4 kg (9 lb)



Red Fox

Habitat: moderate; North and Central America, Eurasia

Size: about 65 cm (25 in.), 6 kg (13 lb)



READING VISUALS Foxes are hunters that feed on small animals. How might the coat color of each fox contribute to its survival?

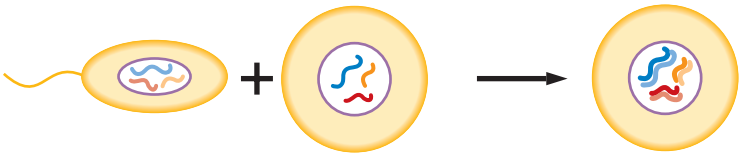
Sexual reproduction leads to diversity.

Most multicellular organisms reproduce sexually. In **sexual reproduction,** the genetic material of two parents comes together, and the resulting offspring have genetic material from both. Sexual reproduction leads to diversity because the DNA in the offspring is different from the DNA in the parents.

One copy of DNA in cell after meiosis

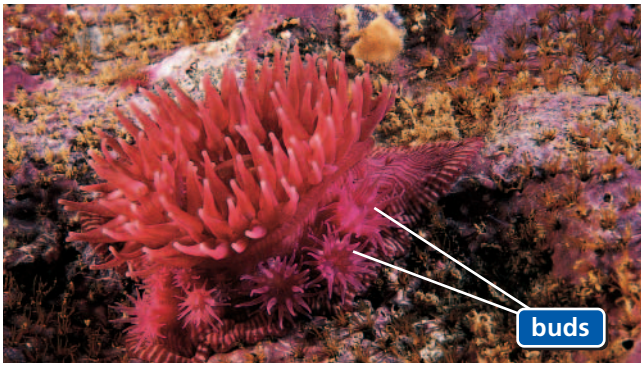
Two different cellular processes are involved in sexual reproduction. The first is **meiosis** (my-OH-sihs), a special form of cell division that produces sperm cells in a male and egg cells in a female. Each sperm or egg cell contains only one copy of DNA, the genetic material. Most cells contain two copies of DNA.

The second process in sexual reproduction is **fertilization.** Fertilization occurs when the sperm cell from the male parent combines with the egg cell from the female parent. A fertilized egg is a single cell with DNA from both parents. Once the egg is fertilized, it divides. One cell becomes two, two cells become four, and so on. As the cells divide, they start to specialize, and different tissues and organs form.



Differences in genetic material and in the environment produce differences in offspring. Whether a tulip flower is red or yellow depends on the genetic material in its cells. How well the tulip grows depends on conditions in the environment as well as genetic materials.

Sexual Reproduction The fertilized eggs of a salamander contain genetic material from two parents.



Asexual Reproduction The buds of a sea coral have the same genetic material as the parent.

Most reproduction that occurs in multicellular organisms is sexual reproduction. However, many multicellular organisms can reproduce by asexual reproduction. With asexual reproduction, a single parent produces offspring.

Budding is a form of asexual reproduction. In budding, a second organism grows off, or buds, from another. Organisms that reproduce asexually can reproduce more often. Asexual reproduction limits genetic diversity within a group because offspring have the same genetic material as the parent.

CHECK YOUR READING How do offspring produced by sexual reproduction compare with offspring produced by asexual reproduction?

With sexual reproduction, there is an opportunity for new combinations of characteristics to occur in the offspring. Perhaps these organisms process food more efficiently or reproduce more quickly. Or perhaps they have adaptations that allow them to survive a change in their environment. In the next three sections, you will read how plants, animals, and fungi have adapted to similar environments in very different ways.

10.1 Review

KEY CONCEPTS

1. How do specialized cells relate to the different levels of organization in a multicellular organism?
2. What is an adaptation? Give an example.
3. What two cellular processes are involved in sexual reproduction?

CRITICAL THINKING

4. **Compare and Contrast** How does the genetic diversity of the offspring differ in sexual reproduction versus asexual reproduction?
5. **Predict** If fertilization occurred without meiosis, how many copies of DNA would be in the cells of the offspring?

CHALLENGE

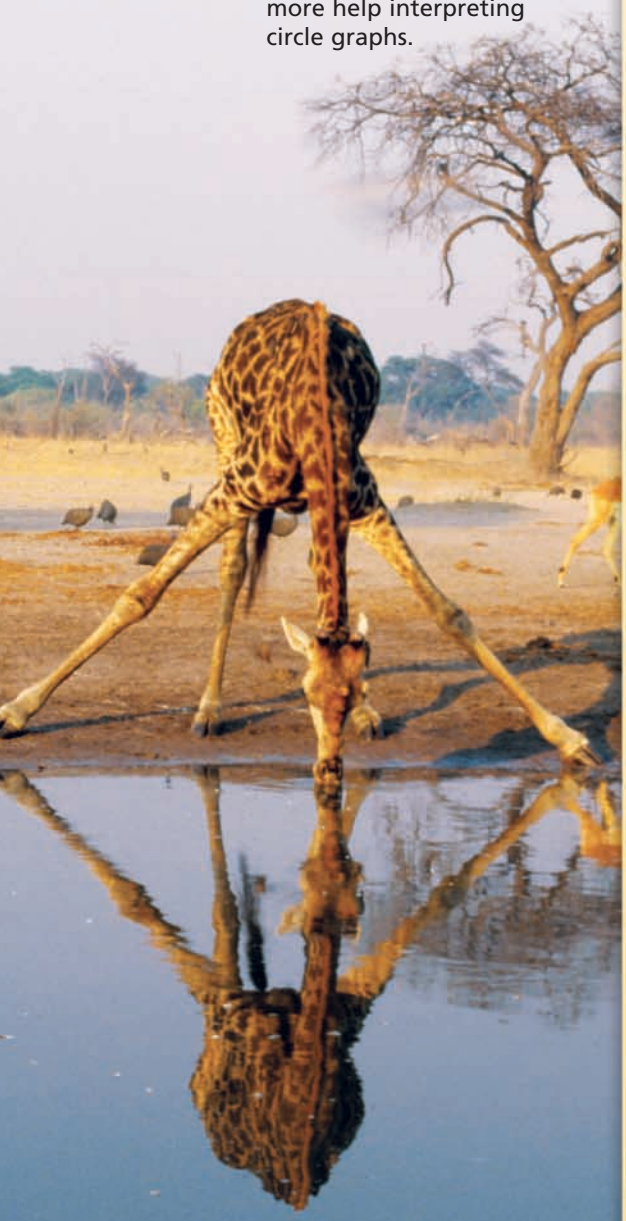
6. **Synthesize** Do you consider the different levels of organization in a multicellular organism an adaptation? Explain your reasoning.

MATH in SCIENCE

SKILL: USING CIRCLE GRAPHS

Making Data Visual

MATH TUTORIAL
CLASSZONE.COM
Click on Math Tutorial for more help interpreting circle graphs.



A circle graph is a good way to see part-to-whole relationships. To use data presented in a circle graph, do the following:

Example

Suppose, at a waterhole in a game preserve, researchers observed ten animals throughout the day. What fraction of the sightings were giraffes?

(1) The circle graph shows the data for the sightings. The whole circle represents the total sightings, 10.

(2) 3 of the 10 equal parts are shaded for giraffes.

(3) Write "3 out of 10" as a fraction $\frac{3}{10}$.

ANSWER Giraffes $= \frac{3}{10}$ of the sightings.

Answer the following questions.

1. What fraction of the sightings were lions?
2. What fraction of the sightings were gazelles?
3. Which animal did the researchers observe in greatest number?
4. Which animal did they observe in the least number? How many sightings occurred for that animal?
5. What fraction of the total does that animal represent?
6. If the researchers had seen one hundred animals, and the graph looked the same as it does, how many giraffe sightings would their graph represent?

CHALLENGE You also record the nighttime visitors: first, 2 young elephants; then a lioness with 2 thirsty cubs; then a giraffe, followed by a hyena and 3 gazelles. Calculate the fraction of the night's population that is represented by each type of animal. Use the fractions to draw a circle graph of the data on "Night Sightings at the Waterhole." Shade and label the graph with the types of animals.

KEY CONCEPT

10.2 Plants are producers.

Sunshine State STANDARDS

SC.F.1.3.7: The student knows that behavior is a response to the environment and influences growth, development, maintenance, and reproduction.

BEFORE, you learned

- Multicellular organisms have tissues, organs, and systems
- Organisms have adaptations that can make them suited to their environment
- Sexual reproduction leads to genetic diversity

NOW, you will learn

- How plants obtain energy
- How plants store energy
- How plants respond to their environment

FCAT VOCABULARY

photosynthesis p. 342

VOCABULARY

autotroph p. 342
cellular respiration p. 343
stimulus p. 345

EXPLORE Stored Energy

In what form does a plant store energy?

PROCEDURE

1. Obtain pieces of potato, celery, and pear that have been placed in small plastic cups.
2. Place a few drops of the iodine solution onto the plant material in each cup. The iodine solution will turn dark blue in the presence of starch. It does not change color in the presence of sugar.

MATERIALS

- pieces of potato, celery, and pear
- 3 plastic cups
- iodine solution
- eye dropper

WHAT DO YOU THINK?

- Observing each sample, describe what happened to the color of the iodine solution after a few minutes.
- Starch and sugars are a source of energy for a plant. What do your observations suggest about how different plants store energy?

Plants capture energy from the Sun.

MAIN IDEA AND DETAILS
Add the main idea *plants capture energy from the Sun* to your notebook and fill in details on photosynthesis and stored energy.

If you stand outside on a warm, sunny day, you may see and feel energy from the Sun. Without the Sun's energy, Earth would be a cold, dark planet. The Sun's heat and light provide the energy almost all organisms need to live.

However, energy from the Sun cannot drive cell processes directly. Light energy must be changed into chemical energy. Chemical energy is the form of energy all organisms use to carry out the functions of life. Plants are an important part of the energy story because plants capture energy from the Sun and convert it to chemical energy.

Producing Sugars

READING TIP

The roots for *photosynthesis* are *photo-*, which means "light," and *synthesis*, which means "to put together." Together they mean "put together by light."

Plants capture energy from sunlight and convert it to chemical energy through the process of **photosynthesis.** The plant takes in water and carbon dioxide from the environment and uses these simple materials to produce sugar, an energy-rich compound that contains carbon. Oxygen is also produced. Plants are referred to as producers because they produce energy-rich carbon compounds using the Sun's energy.

The cells, tissues, and organ systems in a plant work together to supply the materials needed for photosynthesis. Most photosynthesis takes place in the leaves. The leaves take in carbon dioxide from the air, and the stems support the leaves and hold them up toward the Sun. The roots of the plant anchor it in the soil and supply water. The sugars produced are used by the plant for energy and as materials for growth.

CHECK YOUR READING What is the product of photosynthesis?

Another name for a plant is **autotroph** (AW-tuh-TRAHF). Autotroph means self-feeder. Plants do not require food from other organisms. Plants will grow if they have energy from the Sun, carbon dioxide from the air, and water and nutrients from the soil.

INVESTIGATE What Plants Need to Grow

Where does the material for plant growth come from?

DESIGN YOUR OWN EXPERIMENT

Until about 400 years ago, people thought that plants get everything they need from soil. Design an experiment to test this hypothesis: "If a plant grows by taking in material from soil, then the mass of the soil will decrease over time because soil material is taken into the plant."

SKILL FOCUS
Designing experiments

MATERIALS
- potting soil
- pots or paper cups
- bean seedlings or beans
- triple beam balance
- water

TIME
30 minutes

PROCEDURE

1. Design an experiment, choosing from the materials listed.
2. Use the lab handbook, pages R28–32, to help you write your experimental procedure. Identify the variables and constants.

WHAT DO YOU THINK?

Measurement can be an important part of an experiment. What types of measurement do you use?

CHALLENGE An operational definition is a description of how you will measure the dependent variable. Give an operational definition for your experiment.

Storing and Releasing Energy

Plants are not the only organisms that capture energy through photosynthesis. Algae and certain bacteria and protists also use photosynthesis. Plants are different from single-celled producers, however. Plants are multicellular organisms with parts of their bodies specialized for storing energy-rich material. Single-celled producers can store very little energy.

Only part of the energy captured by a plant is used as fuel for cellular processes. Some of the sugar produced is used as building material, enabling the plant to grow. The remaining sugar is stored. Often the sugars are stored as starches. Starch is an energy-rich compound made of many sugars. Starches can store a lot of chemical energy. When a plant needs energy, the starches are broken back down into sugars and energy is released. **Cellular respiration** is the process by which a cell uses oxygen to break down sugars to release the energy they hold.

Some plants, such as carrots and beets, store starch in their roots. Other plants, including rhubarb, have stems adapted for storing starch. A potato is a swollen, underground stem called a tuber. Tubers have buds—the eyes of the potato—that can sprout into new plants. The starch stored in the tuber helps the new sprouts survive.

CHECK YOUR READING What is the original source of a plant's stored energy?

Plants are adapted to different environments.

Almost everywhere you look on land, you'll see plants. Leaves, stems, and roots are adaptations that enable plants, as producers, to live on land. Not all plants, however, look the same. Just as there are many different types of land environments, there are many different types of plants that have adapted to these environments.

Grasses are an example of plants that grow in several environments. Many grasses have deep roots, produce seeds quickly, and can grow in areas with a wide range of temperatures and different amounts of precipitation. Grasses can survive drought, fires, freezing temperatures, and grazing. As long as the roots of the plant survive, the grasses will grow again. Grasses are found in the Arctic tundra, as well as in temperate and tropical climates.

Now compare trees to grasses. If the leaves and stems of a tree die away because of fire or drought, often the plant will not survive. Because of their size, trees require a large amount of water for photosynthesis. A coniferous (koh-NIHF-uhr-uhs) tree, like the pine, does well in colder climates. It has needle-shaped leaves that stay green throughout the year, feeding the plant continually. A deciduous (dih-SIHJ-oo-uhs) tree, like the maple, loses its leaves when temperatures turn cold. The maple needs a long growing season and plenty of water for new leaves to grow.

RESOURCE CENTER
CLASSZONE.COM
Learn more about plant adaptations.

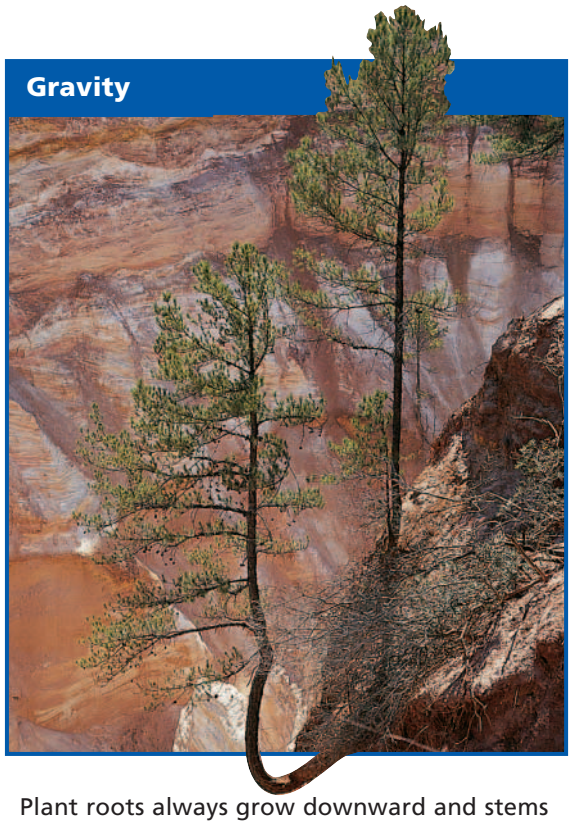
Plants have reproductive adaptations. It may surprise you to learn that flowering plants living on cold, snowy mountaintops have something in common with desert plants. When rain falls in the desert, wildflower seeds sprout very quickly. Within a few weeks, the plants grow, flower, and produce new seeds that will be ready to sprout with the next rainy season. The same thing happens in the mountains, where the snow may thaw for only a few weeks every summer. Seeds sprout, flowers grow, and new seeds are produced—all before the snow returns. You will read more about plant reproduction in Chapter 11.

Some plants have adaptations that protect them. Plants in the mustard family give off odors that keep many plant-eating insects away. Other plants, such as poison ivy and poison oak, produce harmful chemicals. The nicotine in a tobacco plant is a poison that helps to keep the plant from being eaten.

CHECK YOUR READING Name two different types of adaptations plants have.

Some adaptations plants have relate to very specific needs. For example, the Venus flytrap is a plant that grows in areas where the soil lacks certain materials. The leaves of the Venus flytrap fold in the middle and have long teeth all around the edges. When an insect lands on an open leaf, the two sides of the leaf fold together. The teeth form a trap that prevents the captured insect from escaping. Fluids given off by the leaf digest the insect's body, providing materials the plant can't get from the soil.

ANALYZE An insect provides nutrients that this Venus flytrap cannot get from the soil. Is this plant still a producer? Ask yourself where the plant gets its energy.



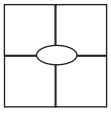
Plant roots always grow downward and stems always grow upward. All plants respond to gravity as a stimulus.

The tendril of a climbing plant grows around a nearby object. The plant responds to touch as a stimulus.

Plants respond to their environment.

During a hot afternoon, parts of the flower known as the Mexican bird of paradise close. As the Sun goes down, the flower reopens. The plant is responding to a stimulus, in this case, sunlight. A **stimulus** is something that produces a response from an organism. Plants, like all organisms, respond to stimuli in their environment. This ability helps them to survive and grow.

VOCABULARY Make a four square for the term *stimulus* in your science notebook.



Gravity

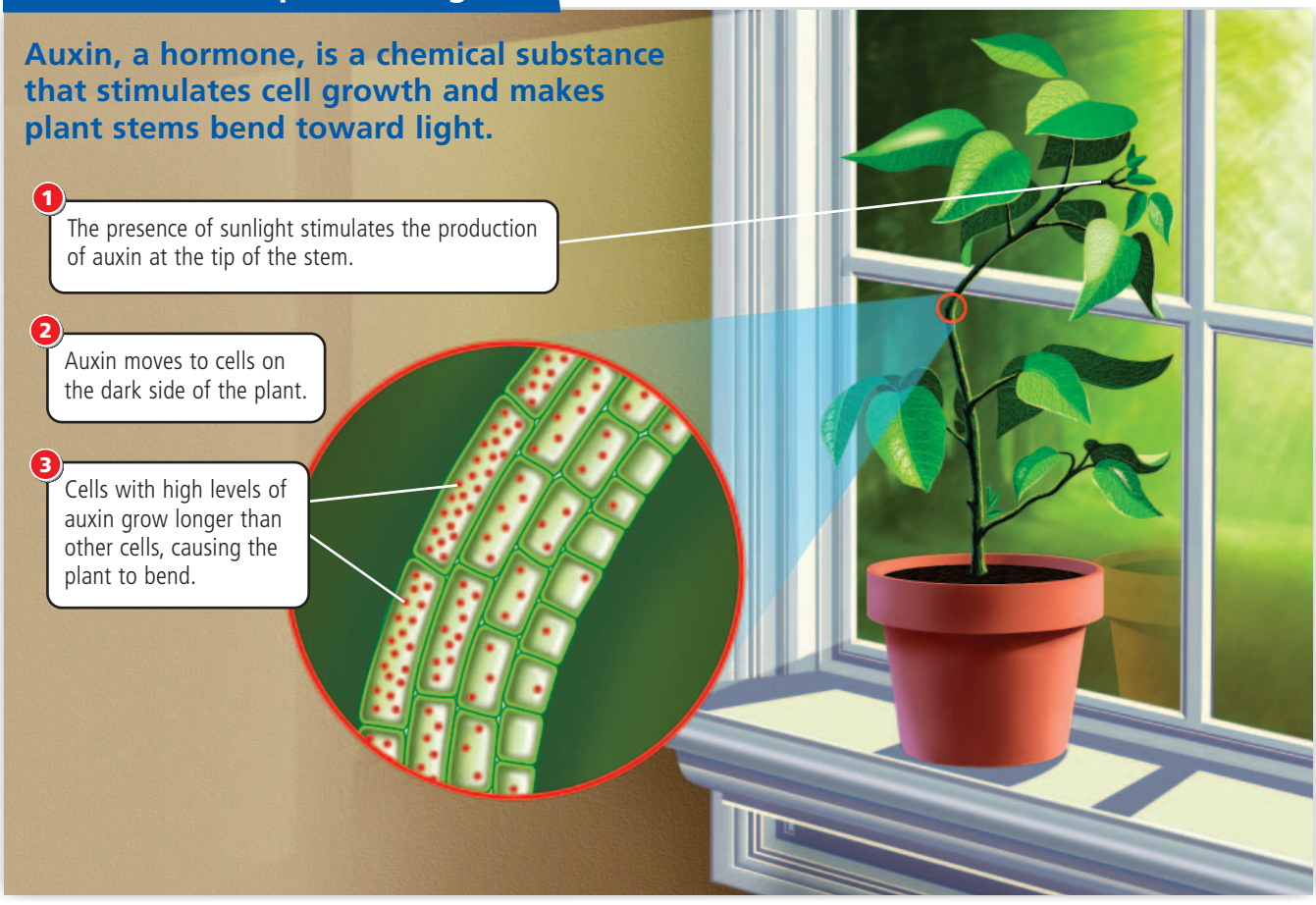
Gravity is the force that keeps you bound to Earth and gives you a sense of up and down. All plants respond to gravity. They also have a sense of up and down—roots grow down and stems grow up. Suppose you place a young seedling on its side, so that its roots and stems stretch out to the side. In a very short time, the tip of the root will begin to turn down, and the tip of the stem will turn up.

Touch

Many plants also respond to touch as a stimulus. Peas, morning glories, tropical vines, and other climbing plants have special stems called tendrils. Tendrils respond to the touch of a nearby object. As the tendrils grow, they wrap around the object. The twining of tendrils around a fence or another plant helps raise a plant into the sunlight.

How Plants Respond to Light

Auxin, a hormone, is a chemical substance that stimulates cell growth and makes plant stems bend toward light.



Light

READING TIP

The words *stimulus, stimuli,* and *stimulate* all have the same root, meaning "to provoke or encourage action."

Light is a powerful stimulus for plants. You can see that stems and leaves grow toward light by placing an indoor plant near a window. After several days, the tips of the stems start to bend toward the window. What happens if you turn the plant around so that those stems reach into the room? The stems will bend as they continue to grow, turning back toward the light.

Plants respond to light with the help of a hormone. A hormone is a chemical substance that is produced in one part of an organism and travels to a different part where it produces a reaction. Hormones act as chemical messengers. They allow an organism to respond to changes in its body or to changes in the environment around it.

Auxin (AWK-sihn), a plant hormone that stimulates cell growth, is produced at the tip of a plant stem. Auxin moves away from light. As a result, the cells on the darker side of a plant stem contain more auxin than those on the lighter side. Higher levels of auxin in plant cells on the darker side cause those cells to grow longer. The longer cells cause the plant stem to bend, moving the tip of the stem toward the light.

VISUALIZATION
CLASSZONE.COM

Examine how plants respond to different stimuli.

Plants respond to seasonal changes.

Most regions of the world go through seasonal changes every year. For example, during the summer in North America, temperatures rise and the days get longer. As winter approaches, temperatures go down and the days become shorter. These types of seasonal changes have an effect on plants.

For plants, a shorter period of daylight will affect the amount of sunlight available for photosynthesis. Shorter days cause many plants to go into a state of dormancy. When plants are dormant, they temporarily stop growing and so require less energy.

In temperate climates, the approach of winter causes the leaves of deciduous trees to die and drop to the ground. The trees enter a state of dormancy during which their growth is slowed. Other plants, such as wild cornflowers, do not survive the change. New cornflowers will grow the following season, from seeds left behind.

CHECK YOUR READING What stimulus causes a deciduous plant to respond by dropping its leaves?

For many plants, reproduction is also affected by seasonal changes. For some plants, the amount of daylight is a factor. A few plants, such as rice and ragweed, produce flowers only in autumn or winter, when days are short. They are short-day plants. Long-day plants flower in late spring and summer, when days are long. Lettuce, spinach, and irises are long day-plants. You will read more about plants in Chapter 11.

10.2 Review

KEY CONCEPTS

1. What process makes a plant a producer, and what does a plant produce?
2. Name three stimuli that plants respond to, and give examples of how a plant responds.
3. How do seasonal changes affect plants? Give an example.

CRITICAL THINKING

4. **Give Examples** Give three examples of ways that plants are adapted to their environments. How do these adaptations benefit the plant?

CHALLENGE

5. **Apply** Some experiments suggest that the hormone auxin is involved in the twining of tendrils. Use what you know about auxin to explain how it might cause tendrils to twine around anything they touch. Draw a diagram.

KEY CONCEPT

10.3 Animals are consumers.

Sunshine State STANDARDS

SC.F.1.3.7: The student knows that behavior is a response to the environment and influences growth, development, maintenance, and reproduction.

BEFORE, you learned

- Plants are producers
- Plants have adaptations for capturing and storing energy
- Plants respond to different stimuli

NOW, you will learn

- How animals obtain energy
- How animals process food
- About different ways animals respond to their environment

FCAT VOCABULARY

consumer p. 348
predator p. 353
prey p. 353

VOCABULARY

heterotroph p. 348
behavior p. 352
migration p. 354
hibernation p. 354

THINK ABOUT

What can you tell from teeth?

Many animals have teeth. Teeth bite, grind, crush, and chew. A fox's sharp biting teeth capture small animals that it hunts on the run. A horse's teeth are flat and strong—for breaking down the grasses it eats. Run your tongue over your own teeth. How many different shapes do you notice? What can the shape of teeth suggest about the food an animal eats?

Animals obtain energy and materials from food.

You probably see nonhuman animals every day, whether you live in a rural area or a large city. If the animals are wild animals, not somebody's pet, then chances are that what you see these animals doing is moving about in search of food.

Animals are consumers. A **consumer** is an organism that needs to get energy from another organism. Unlike plants, animals must consume food to get the energy and materials they need to survive. Animals are heterotrophs. A **heterotroph** (HEHT-uhr-uh-TRAHF) is an organism that feeds on, or consumes, other organisms. By definition, animals are, quite simply, multicellular organisms that have adaptations that allow them to take in and process food.

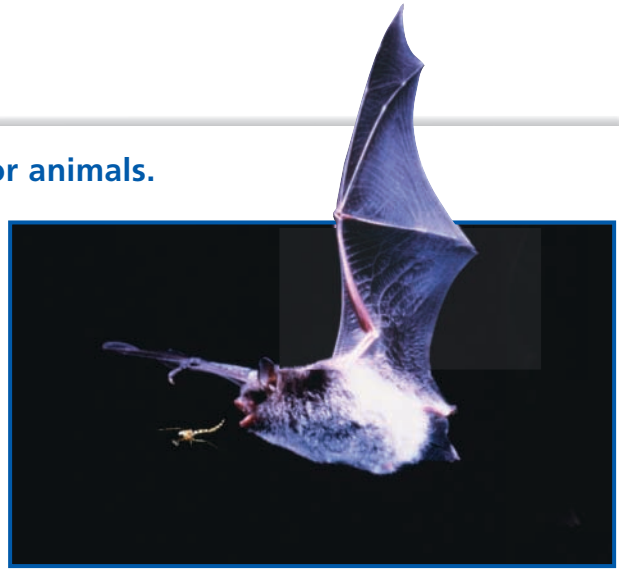
READING TIP

The meaning of *heterotroph* is opposite to that of *autotroph*. The root *hetero-* means "other." *Heterotroph* means "other-feeder," or "feeds on others."

Obtaining Food

Food is a source of energy and materials for animals.

Simple feeding Some animals, such as corals, can filter food from their environment.



Complex feeding Many animals, such as bats, actively search for and capture food.

Animals need food and have many different ways of getting it. For some animals, feeding is a relatively simple process. An adult coral simply filters food from the water as it moves through the coral's body. Most animals, however, must search for food. Grazing animals, such as horses, move along from one patch of grass to another. Other animals must capture food. Most bats use sound and hearing to detect the motion of insects flying at night. Its wings make the bat able to move through the air quickly and silently.

What Animals Eat

Just about any type of living or once-living material is a source of food for some animal. Animals can be grouped by the type of food they eat.

- Herbivores (HUR-buh-VAWRS) feed on plants or algae.
- Carnivores (KAHR-nuh-VAWRS) feed on other animals.
- Omnivores (AWM-nuh-VAWRS) feed on both plants and animals.

Another group are those animals that feed on the remains of once-living animals. Many insects do, as do some larger animals, such as vultures. Other animals, such as worms, act as decomposers.

CHECK YOUR READING Describe how herbivores, carnivores, and omnivores get their energy.

MAIN IDEA AND DETAILS Make a chart about the main idea: *Animals obtain energy and materials from food.* Include *herbivore, carnivore,* and *omnivore* in the details.

Different species of animals have adapted in different ways to take advantage of all the energy-rich material in the environment. To get energy and materials from food, all animals must first break the food down—that is, they must digest it.

Processing Food

RESOURCE CENTER
CLASSZONE.COM
Find out more about animal adaptations.

Energy is stored in complex carbon compounds in food. For the cells in an animal to make use of the energy and materials stored in this food, the large complex compounds must be broken back down into simpler compounds.

CHECK YOUR READING How must food be changed so an animal gets energy?

Digestion is the process that breaks food down into pieces that are small enough to be absorbed by cells. A few animals, such as sponges, are able to take food particles directly into their cells. Most animals, however, take the food into an area of their body where the materials are broken down. Cells absorb the materials they need. Animals such as jellyfish have a single opening in their bodies where food is brought into a central cavity, or gut. The unused materials are released through the same opening.

A digestive system uses both physical and chemical activity to break down food. Many animals have a tubelike digestive system. Food is brought in at one end of the animal, the mouth, and waste is released at the other end. As food moves through the system, it is continually broken down, releasing necessary materials called nutrients to the cells.

INVESTIGATE Owl Pellets

What does an owl eat, and how well does it digest its food?

PROCEDURE

1. Get an owl pellet from your teacher. Open the foil and place the pellet in a tray.
2. Use a needle tool and tweezers to sort through the materials in the pellet and separate them.
3. When you have finished, dispose of the materials according to your teacher's instructions, and wash your hands.

WHAT DO YOU THINK?

- What can you tell about what an owl eats from looking at the remains in the pellet?
- What materials are not digested?

CHALLENGE Use the bone identification key to identify what the owl ate.

SKILL FOCUS
Inferring

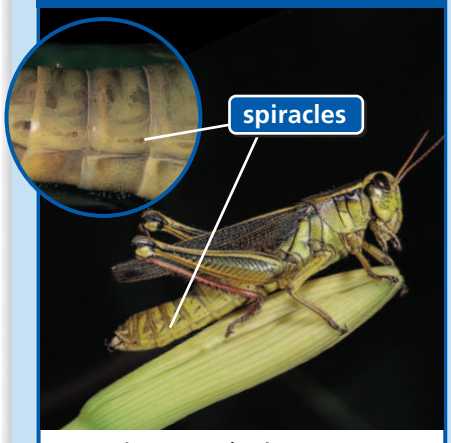
MATERIALS
- owl pellet
- needle tool
- tweezers
- tray
- *for Challenge:* bone identification key

TIME
30 minutes

Obtaining Oxygen

Animals need oxygen to release the energy in food.

Grasshopper



Most insects take in oxygen through body openings called spiracles.

Bass

Fish have gills, which pick up dissolved oxygen as water flows over them.

Tiger

This yawning tiger, like many animals, gets oxygen by inhaling air into its lungs.

Releasing and Storing Energy

Animals obtain energy from sugars and other carbon compounds the same way plants do, through the process of cellular respiration. As you read in Section 10.2, cellular respiration is a process in which energy is released when sugars are broken down inside a cell. The process requires both oxygen and water.

CHECK YOUR READING What is the function of cellular respiration?

Many animals take in water in the same way they take in food, through the digestive system. Oxygen, however, is often taken in through a respiratory system. In many animals, the respiratory system delivers oxygen to the blood, and the blood carries oxygen to the cells.

Animals have different structures for obtaining oxygen. Many insects take in oxygen through spiracles, tiny openings in their bodies. Fish have gills, structures that allow them to pick up oxygen dissolved in the water. Other air-breathing animals take in oxygen through organs called lungs.

Most animals do not feed continuously, so they need to be able to store materials from food in their tissues or organs. Many animals, including humans, take in large amounts of food at one time. This gives an animal time to do other activities, such as caring for young or looking for more food.

Animals interact with the environment and with other organisms.

Animals, as consumers, must obtain food, as well as water, from their environment. An animal's body has many adaptations that allow it to process food. These can include digestive, respiratory, and circulatory systems. Also important are the systems that allow animals to interact with their environment to obtain food. In many animals, muscle and skeletal systems provide movement and support. A nervous system allows the animal to sense and respond to stimuli.

Animals respond to many different types of stimuli. They respond to sights, sounds, odors, light, or a change in temperature. They respond to hunger and thirst. They also respond to other animals. Any observable response to a stimulus is described as a **behavior.** A bird's drinking water from a puddle is a behavior. A lion's chasing an antelope is a behavior, just as the antelope's running to escape the lion is a behavior.

CHECK YOUR READING What is a behavior and how does it relate to a stimulus?

Some behaviors are inherited, which means they are present at birth. For example, a spider can weave a web without being shown. Other behaviors are learned. For example, the young lion in the photograph learns that a porcupine is not a good source of food.

All behaviors fall into one of three general categories:

- individual behaviors
- interactions between animals of the same species
- interactions between animals of different species

ANALYZE Do you consider the defensive behavior of a porcupine an adaptation?

Individual behaviors often involve meeting basic needs. Animals must find food, water, and shelter. They sleep. They groom themselves. Animals also respond to changes in their environment. A lizard may warm itself in the morning sunlight and then move into the shade when the Sun is high in the sky.

Interactions that occur between animals of the same species are often described as social behaviors. Basic social behaviors include those between parents and offspring and behaviors for attracting a mate. Within a group, animals of the same species may cooperate by working together. Wolves hunt in packs and bees maintain a hive. Behaviors among animals of the same species can also be competitive. Animals often compete for a mate or territory.

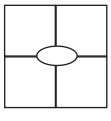
For macaques, grooming is both an individual and a social behavior. Here a mother grooms her young.

CHECK YOUR READING What are some ways that animals of the same species cooperate and compete?

Interactions that occur between animals of different species often involve the search for food. A **predator** is an animal that hunts other animals for food. Predators have behaviors that allow them to search for and capture other organisms. A cheetah first stalks an antelope, then chases it down, moving as fast as 110 kilometers per hour.

An animal that is hunted by another animal as a source of food is the **prey.** Behaviors of prey animals often allow them to escape a predator. An antelope may not be able to outrun a cheetah, but antelopes move in herds. This provides protection for the group since a cheetah will kill only one animal. Other animals, such as the pufferfish and porcupine, have defensive behaviors and structures.

VOCABULARY
Create a pair of four squares for the terms *predator* and *prey.*



Animals of different species can also interact in cooperative ways. Tickbirds remove ticks from the skin of an impala. This behavior provides food for the bird and provides relief for the impala. Sometimes animals take advantage of the behavior of other animals. Many animals eat the remains of prey left over after a predator has finished feeding.

Monarch butterflies migrate each winter to California and Mexico.

Animals respond to seasonal changes.

monarch butterfly

Animals, like plants, are affected by seasonal changes in their environment. Certain types of food may not be available all year round. A region might go through periods of drought. Some animals do not do well in extreme heat or cold. Unlike plants, animals can respond to seasonal changes by changing their location. **Migration** is the movement of animals to a different region in response to changes in the environment.

Each spring, millions of monarch butteflies begin to fly north from Mexico and parts of southern California. They first migrate to the southern United States, where the females lay eggs on milkweed plants. The new generation will travel further north and then lay eggs, too. Summer monarchs live as butterflies for only three to five weeks. After three or four generations, the last generation reaches the northern United States and Canada. Monarchs cannot survive the winter temperatures of the north, so the last generation of butterflies makes the long journey back to Mexico and California in the fall. These buttteflies will live eight or nine months. The fall migration route is shown on the map.

Not all animals migrate in response to seasonal changes. Many nonmigratory animals do change their behaviors, however. For example, when winter cold reduces the food supply, some animals hibernate. **Hibernation** is a sleeplike state that lasts for an extended time period. The body systems of a hibernating animal slow down, so the animal needs less energy to survive. Many animals, including frogs, turtles, fish, and some types of insects, hibernate. You will learn more about different types of animals in Chapters 12 and 13.

10.3 Review

KEY CONCEPTS

1. In what way are animals consumers?
2. Name three body systems that relate to how an animal gets its energy.
3. What is a behavior?

CRITICAL THINKING

4. **Give Examples** Identify three categories of animal behavior and give an example of each.
5. **Analyze** How is migration similar to hibernation? How is it different?

CHALLENGE

6. **Analyze** Scientists often look at feeding patterns as a flow of energy through the living parts of the environment. Describe the flow of energy as it relates to plants, herbivores, and carnivores.

SCIENCE on the JOB

WILDLIFE PHOTOGRAPHER

An Animal's World

Have you ever watched a TV documentary, or flipped through the pages of a magazine and wondered, "How did the photographer ever get that picture?" For a wildlife photographer, understanding animal behavior is essential.

Cover and Protection

Photographers use camera traps and blinds. A blind, made of branches, is built upwind of an animal gathering place. Steve Winter has built camera traps, where a hidden camera emits a beam of light when an animal steps into it.

Specialized Gear

Certain environments—such as snow and cold, swamp and mud, or sea water—present challenges to a person with a camera. Underwater photographers need to use scuba gear to swim with animals like the Caribbean reef shark.

Behavior

To photograph an endangered species like the jaguar, a photographer must learn animal behavior. Steve Winter and a team of scientists used dogs with keen scent-tracking to find jaguars who are active mostly at night. They learned that jaguars have a favorite scratching tree—perfect photo opportunity!

EXPLORE

1. **OBSERVE** With or without a camera, find a spot where you are likely to find wildlife. Sit as still as possible and wait. What animals do you observe? What do they do?
2. **CHALLENGE** Interview a photographer about digital photography, and ask how technology is changing photography.

KEY CONCEPT

10.4 Most fungi are decomposers.

Sunshine State STANDARDS

SC.G.1.3.3: The student understands that the classification of living things is based on a given set of criteria and is a tool for understanding biodiversity and interrelationships.

SC.H.1.3.2: The student knows that the study of the events that led scientists to discoveries can provide information about the inquiry process and its effects.

SC.H.1.3.5: The student knows that a change in one or more variables may alter the outcome of an investigation.

BEFORE, you learned

- All organisms interact with the environment
- Plants transform sunlight into chemical energy
- Animals get energy by eating other organisms

NOW, you will learn

- How fungi get energy and materials
- About different types of fungi
- How fungi interact with other organisms

VOCABULARY

hyphae p. 357
spore p. 357
lichen p. 360

EXPLORE Mushrooms

What does a mushroom cap contain?

PROCEDURE

1. Carefully cut the stem away from the mushroom cap, as near the cap as possible.
2. Place the mushroom cap on white paper and cover it with a plastic cup. Leave overnight.
3. Carefully remove the cup and lift the mushroom cap straight up.
4. Use a hand lens to examine the mushroom cap and the print it leaves behind.

WHAT DO YOU THINK?

- How does the pattern in the mushroom cap compare with the mushroom print?
- What made the print?

MATERIALS

- fresh store-bought mushrooms
- sharp knife
- clear plastic cup
- paper
- hand lens

Fungi absorb materials from the environment.

MAIN IDEA AND DETAILS
Don't forget to make a main idea chart with detail notes on the main idea: *Fungi absorb materials from the environment.*

Plants are producers; they capture energy from the Sun and build complex carbon compounds. Animals are consumers; they take in complex carbon compounds and use them for energy and materials. Fungi (FUHN-jy), at least most fungi, are decomposers. Fungi break down, or decompose, the complex carbon compounds that are part of living matter. They absorb nutrients and leave behind simpler compounds.

Fungi are heterotrophs. They get their energy from living or once-living matter. They, along with bacteria, decompose the bodies of dead plants and animals. They also decompose materials left behind by organisms, such as fallen leaves, shed skin, and animal droppings.

Characteristics of Fungi

Except for yeasts, most fungi are multicellular. The cells of a fungus have a nucleus and a thick cell wall, which provides support. Fungi are different from plants and animals in their organization. Plants and animals have specialized cells, which are usually organized into tissues and organs. Multicellular fungi don't have tissues or organs. Instead, a typical fungus is made up of a reproductive body and network of cells that form threadlike structures called **hyphae** (HY-fee).

A mass of hyphae, like the one shown in the diagram below, is called a mycelium (my-SEE-lee-uhm). The hyphae are just one cell thick. This means the cells in the mycelium are close to the soil or whatever substance the fungus is living in. The cells release chemicals that digest the materials around them, and then absorb the nutrients they need. As hyphae grow, openings can form between the older cells and the new ones. This allows nutrients to flow back to the older cells, resulting in what seems like one huge cell with many nuclei.

READING TiP

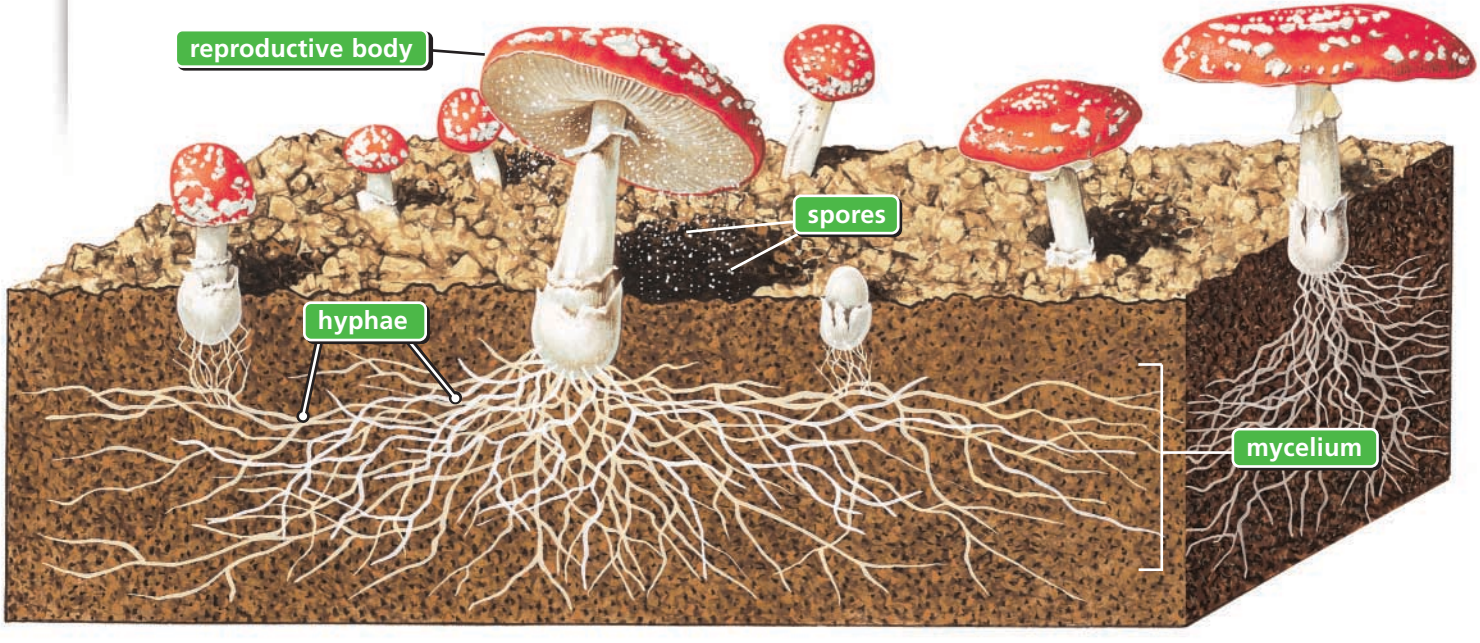
The root of the word *hyphae* means "web." Look at the diagram below to see their weblike appearance.

Reproduction

Fungi reproduce with spores, which can be produced either asexually or sexually. A **spore** is a single reproductive cell that is capable of growing into a new organism. The mushrooms that you buy at the store are the spore-producing structures of certain types of fungi. These spore-producing structures are reproductive bodies of mushrooms. A single mushroom can produce a billion spores.

Parts of a Fungus

The mycelium makes up a large part of a multicellular fungus.



RESOURCE CENTER
CLASSZONE.COM
Learn more about different types of fungi.

Spores are released into the air and spread by the wind. Because they're so small and light, the wind can carry spores long distances. Scientists have found spores 160 kilometers above Earth's surface. Some spores have a tough outer covering that keeps the reproductive cell from drying out. Such spores can survive for many years. If the parent fungus dies, the spores may remain and grow when conditions are right.

Fungi reproduce in other ways. For example, a multicellular fungi can reproduce asexually when hyphae break off and form a new mycelium. Yeasts, which are single-celled fungi, reproduce asexually by simple cell division or by budding. Yeasts can also produce spores.

INFER Where is the mycelium of these mushrooms?

Fungi include mushrooms, molds, and yeasts.

A convenient and simple way to study fungi is to look at their forms. They are mushrooms, molds, and yeasts. You are probably familiar with all of them. The mushrooms on your pizza are a fungus. So is the mold that grows if you leave a piece of pizza too long in the refrigerator. The crust of the pizza itself rises because of the activity of yeast.

Mushrooms

What we call a mushroom is only a small part of a fungus. A single mushroom you buy in the store could have grown from a mycelium that fills an area 30 meters across. When you see a patch of mushrooms, they are probably all part of a single fungus.

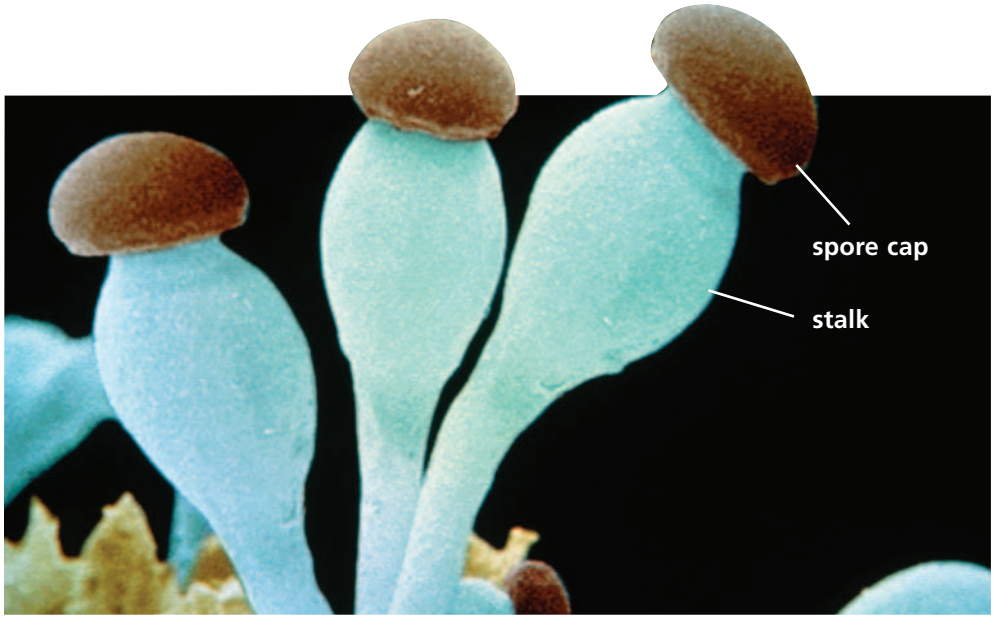
For humans, some mushrooms are edible and some are poisonous. A toadstool is a poisonous mushroom. The cap of a mushroom is where the spores are produced. Both the cap and the stalk it grows on are filled with hyphae.

CHECK YOUR READING What is produced in a mushroom cap?

Molds

What we call mold, that fuzzy growth we sometimes see on food, is the spore-producing part of another form of fungus. The hyphae of the mold grow into the food, digesting it as they grow. Not all food molds are bad. Different species of the fungus *Penicillium* are used in the production of Brie, Camembert, and blue cheeses. Some species of the *Aspergillus* fungus are used to make soy sauce.

One interesting application of a mold is the use of the fungus *Trichoderma.* This mold grows in soil. The digestive chemicals it produces are used to give blue jeans a stonewashed look.



Pilobolus reacts to sunlight as a stimulus. The bend in the stalk will cause the spore cap to fly off.

Many molds cause disease. Fungal molds cause athlete's foot. Molds also affect plants. They are the cause of Dutch elm disease and the powdery white mildews that grow on plants. Compounds made from molds are also used to treat disease. Penicillin is an antibiotic that comes from the *Penicillium* fungus. It is used to fight bacterial diseases, such as pneumonia.

Molds reproduce with spores, which are typically carried by moving air. The "hat thrower" fungus *Pilobolus*, however, has an interesting adaptation for spreading spores. *Pilobolus* grows in animal droppings. It has a spore-containing cap—its hat—that grows on top of a stalk. The stalk responds to light as a stimulus and bends toward the Sun. As the stalk bends, water pressure builds up, causing the spore cap to shoot off, like a tiny cannonball. A spore cap can be thrown up to two meters away. If the spore caps land in grass, then cows and other grazing animals will eat the caps as they graze. A new cycle begins, with more *Pilobolus* being dispersed in the animal's droppings.

Yeasts

Yeasts are single-celled fungi. Some species of fungi exist in both yeast form and as multicellular hyphae. Yeasts grow in many moist environments, including the sap of plants and animal tissues. They also grow on moist surfaces, including shower curtains. Certain yeasts grow naturally on human skin. If the yeast begins to reproduce too rapidly, it can cause disease.

Yeasts are used in many food products. The activity of yeast cells breaking down sugars is what makes bread rise. The genetic material of the yeast *Saccharomyces cerevisiae* has been carefully studied by scientists. The study of this organism has helped scientists understand how genetic material controls the activities of a cell.

Yeasts are single-celled fungi.

Fungi can be helpful or harmful to other organisms.

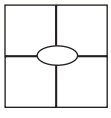
Fungi have a close relationship to the environment and all living things in the environment. Fungi, along with bacteria, function as the main decomposers on Earth. The digestive chemicals that fungi release break down the complex compounds that come from living matter, dead matter, or the waste an organism leaves behind. A fungus absorbs what it needs to live and leaves behind simpler compounds and nutrients. These are then picked up again by plants, as producers, to start the cycle over again. Fungi also live in the sea, recycling materials for ocean-living organisms.

CHECK YOUR READING What beneficial role do fungi play in the environment?

The threadlike hyphae of a fungus can grow into and decompose the material produced by another organism. This means that fungi can be helpful, for example, by releasing the nutrients in a dead tree back into the soil. Or fungi can be harmful, for example, attacking the tissues of a plant, such as the Dutch elm.

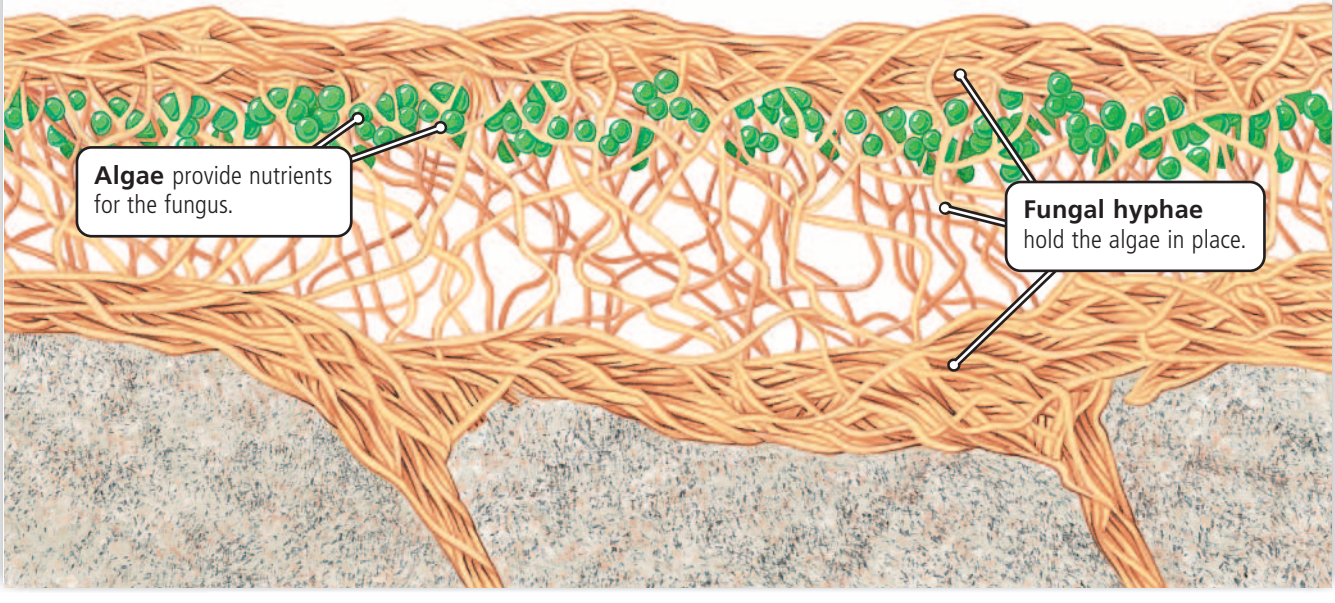
Most plants interact with fungi in a way that is helpful. The hyphae surround the plant roots, providing nutrients for the plant. The plant provides food for the fungus. Some fungi live together with single-celled algae, a network referred to as a **lichen** (LY-kuhn). The hyphae form almost a sandwich around the algae, which produce sugars and other nutrients the fungus needs.

VOCABULARY
Remember to add a four square for *lichen* to your notebook.



Lichen

A lichen is formed by a close association between algae and fungi.



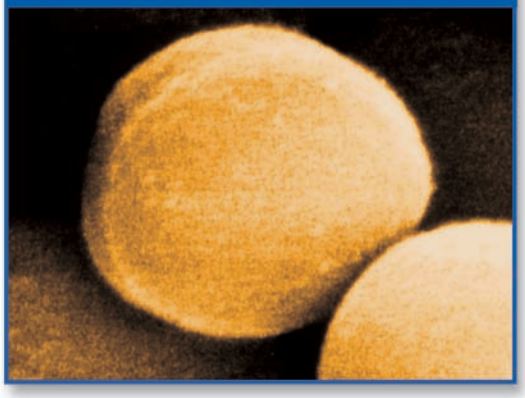
Lichens can live just about anywhere. Lichens are found in the Arctic and in the desert. They can even grow on bare rock. The hyphae can break the rock down, slowly, and capture the particles of newly formed soil. This eventually prepares the ground for new plant growth.

On the harmful side, many fungi produce toxins, harmful chemicals. In 1845, a fungus infected Ireland's potato crop, causing the population of Ireland to drop from 8 million to about 4 million. Many people died from disease. Others died from starvation because of the loss of the important food crop. And hundreds of thousands of Irish left Ireland, many emigrating to the United States. Today, several fungal diseases are spreading through the world's banana crops.

CHECK YOUR READING Name some ways fungi can be harmful to organisms.

The toxic quality of a fungus can be put to good use, as in the case of the antibiotic penicillin. The photographs show what happens when a bacterium comes in contact with penicillin. The antibiotic prevents the bacterial cells from making new cell walls when they divide. This causes the cells to break open and the bacteria to die.

Bacterium before penicillin



Bacterium after penicillin

Penicillin is an antibiotic drug made from compounds taken from a species of the *Penicillium* fungus.

10.4 Review

KEY CONCEPTS

1. Describe the structure of a fungus.
2. How do fungi reproduce?
3. Describe two relationships between fungi and other organisms.

CRITICAL THINKING

4. **Analyze** Scientists used to classify fungi as plants. Today, scientists say that fungi are more like animals than plants. How are fungi like plants? How are they like animals?
5. **Predict** What might change in an environment where there were no fungi?

CHALLENGE

6. **Connect** Think of at least one way your life is affected by fungi in each of their three main forms: mushrooms, molds, and yeast. Are these effects beneficial or harmful to you?

CHAPTER INVESTIGATION

What Do Yeast Cells Use for Energy?

OVERVIEW AND PURPOSE Yeasts are tiny one-celled fungi that require food, water, and a warm place to grow. When they have a food source, they release carbon dioxide gas as a waste product. Yeast is used to make foods such as bread. In this activity, you will

- observe the activity of yeast
- draw conclusions about the effect of three materials on the activity of yeast

MATERIALS

- baking sheet
- flour
- measuring cups
- measuring spoons
- sugar
- artificial sweetener
- salt
- quick-rise yeast
- warm water
- metric ruler
- marker
- clothespins
- clear plastic straws

Problem

Write It Up

How do sugar, salt, and sweetener affect the growth of yeast?

Hypothesize

Write It Up

Write a hypothesis to explain how sugar, sweetener, and salt affect the activity of yeast in bread dough. Your hypothesis should take the form of an "If . . ., then . . ., because . . ." statement.

Procedure

1. Make a data table like the one shown on page 363. Label four sheets of notebook paper *A, B, C,* and *D.*
2. Spread a very thin layer of flour over the baking sheet. Measure $\frac{1}{4}$ cup of flour and place it on the baking sheet as a mound. Repeat three times, forming separate mounds. Label the mounds *A, B, C,* and *D.*

3 Add 3 teaspoons of sugar to mound A. Add 3 tsp of sweetener to mound B. Add 3 tsp of salt to mound C. Add nothing to mound D.

4 Add $\frac{1}{4}$ tsp of the quick-rise yeast to each of the mounds. Slowly add 1 tsp of warm water to each mound to moisten the mixture. Spread a pinch of flour over your hands and knead the mounds by hand. Add water, 1 tsp at a time until the mixture has the consistency of dough. If the mixture gets too sticky, add more flour. Knead well and form each mound into a ball. Wash your hands thoroughly when you are finished. Do not taste or eat the dough.

5 Push 2 straws into each ball of dough, making sure the dough reaches at least 3 cm into the straws.


step 5

6 Squeeze the end of each straw to push the dough from the ends. Place a clothespin on the end of each straw closest to the dough. Fold and tape the other end. Mark both edges of the dough on the straw. Stand each straw upright on the appropriate piece of paper labeled *A, B, C,* or *D.*


step 6

7 Predict which mounds of dough will rise after 30 minutes. Write down your predictions in the data table.

8 After 30 minutes, measure the amount the dough has risen in each straw. Write down the results in the data table.

Observe and Analyze

Write It Up

1. **OBSERVE** In which mounds did the dough rise?
2. **OBSERVE** Did any of the remaining mounds of dough change? Explain.
3. **INFER** What was the purpose of using two straws for each of the mounds?

Conclude

Write It Up

1. **INTERPRET** Which is the most likely source of energy for yeast: salt, sugar, or sweetener? How do you know?
2. **INTERPRET** Compare your results with your hypothesis. How does your data support or disprove your hypothesis?
3. **LIMITATIONS** What limitations or sources of error could have affected your results?
4. **CONNECT** How would you account for the air spaces that are found in some breads?
5. **APPLY** Would you predict that breads made without yeast contain air spaces?

INVESTIGATE Further

CHALLENGE Design an experiment in which you can observe the production of carbon dioxide by yeast.

What Do Yeast Cells Use for Energy?

Table 1. Observations of Dough Rising

Mound	Prediction	Results
A. sugar and yeast		
B. sweetener and yeast		
C. salt and yeast		
D. yeast		

10 Chapter Review

the BIG idea

Multicellular organisms live in and get energy from a variety of environments.

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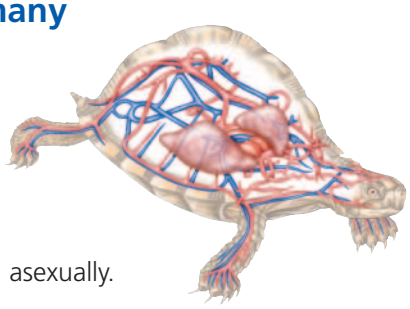
Content Review and FCAT Practice

KEY CONCEPTS SUMMARY

1 Multicellular organisms have many ways of meeting their needs.

- The bodies of multicellular organisms have different levels of organization.
- Multicellular organisms have a wide range of adaptations.
- Multicellular organisms reproduce by sexual reproduction. Some also reproduce asexually.



VOCABULARY
tissue p. 334
organ p. 334
sexual reproduction p. 338
meiosis p. 338
fertilization p. 338

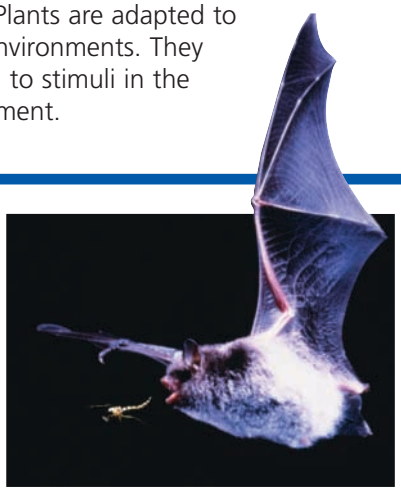
2 Plants are producers.

Plants capture energy from the Sun and store it as sugar and starch. Plants are adapted to many environments. They respond to stimuli in the environment.

VOCABULARY
photosynthesis p. 342
autotroph p. 342
cellular respiration p. 343
stimulus p. 345

3 Animals are consumers.

Animals consume food to get energy and materials. Animals are adapted to many enviroments. They interact with the environment and with other organisms.



VOCABULARY
consumer p. 348
heterotroph p. 348
behavior p. 352
predator p. 353
prey p. 353
migration p. 354
hibernation p. 354

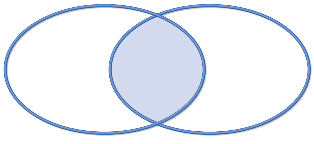
4 Most fungi are decomposers.

Fungi absorb energy from their surroundings. Fungi include mushrooms, molds, and yeasts. They affect people and other organisms in both helpful and harmful ways.

VOCABULARY
hyphae p. 357
spore p. 357
lichen p. 360

Reviewing Vocabulary

Draw a Venn diagram for each pair of terms. Put at least one shared characteristic in the overlap area, and put at least one difference in the outer circles.



1. tissue, organ
2. autotroph, heterotroph
3. photosynthesis, cellular respiration
4. predator, prey
5. producer, consumer
6. migration, hibernation

Reviewing Key Concepts

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

7. Which body system transports materials such as nutrients and oxygen throughout an animal's body?
   a. respiratory system
   b. circulatory system
   c. digestive system
   d. nervous system

8. An example of an adaptation is
   a. a change in climate that increases plant growth
   b. the movement of a group of animals to an area that has more food and water
   c. a change in location of a squirrel's nest
   d. the ability of a plant to resist fungal disease better than other plants

9. Plants capture the Sun's energy through which process?
   a. reproduction **c.** photosynthesis
   b. cellular respiration **d.** digestion

10. Plants produce auxin in response to which stimulus?
   a. light
   b. gravity
   c. temperature
   d. touch

11. A plant is best described as
   a. a herbivore
   b. an omnivore
   c. a carnivore
   d. a producer

12. A carnivore is best described as an animal that
   a. eats plants
   b. eats plants and other animals
   c. eats other animals
   d. makes its own food

13. Mushrooms produce
   a. spores
   b. buds
   c. mold
   d. yeast

14. Fungi and algae together form
   a. hyphae
   b. mushrooms
   c. a lichen
   d. mold

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

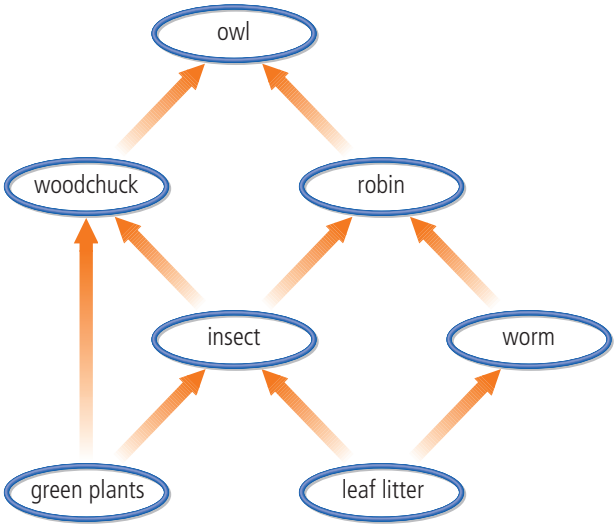
15. Write a short paragraph comparing sexual reproduction with asexual reproduction. How are they the same? How are they different?

16. Write a short paragraph to explain how the sugars and starches stored in plant tissue are important to the survival of animals.

17. Write a short paragraph to explain how fungi are dependent on plants and animals for their energy.

Thinking Critically

The diagram below shows a woodland food web. Each arrow starts with a food source and points to a consumer. Use the diagram to answer the next six questions.



18. ANALYZE What is the original source of energy for all the animals in the food web? Explain your reasoning.

19. CLASSIFY Identify the consumers in this food web.

20. CLASSIFY Identify the animals in the food web as either herbivores, carnivores, omnivores, or decomposers.

21. EVALUATE Does an omnivore have an advantage over carnivores and herbivores in finding food?

22. ANALYZE What role does the worm play in the food web, and why it is important?

23. PREDICT How might this food web change over the course of a year, and how would that affect the feeding activity of animals in the food web?

24. CONNECT A woodchuck is sometimes referred to as a groundhog. Many people celebrate February 2 as groundhog day. The legend is that if a groundhog emerges from its burrow on this day and sees its shadow, then there will be six more weeks of winter. The groundhog is emerging from a long sleeplike state. What is this behavior, and how does it benefit the animal?

25. ANALYZE Do you think the defensive behavior of a porcupine or pufferfish is an adaptation? Explain your reasoning.

26. SYNTHESIZE A plant responds to gravity, touch, and light as stimuli. How does this relate to a plant being a producer?

27. SYNTHESIZE How are the cells of multicellular organisms like those of single-celled organisms? How are they different?

28. ANALYZE What quality of asexual reproduction makes a fungal disease spread so quickly.

the BIG idea

29. SYNTHESIZE Look again at the photograph on pages 330–331. Plants, animals, and fungi are pictured there. How do these organisms get energy and materials from the environment?

30. SUMMARIZE Write a short paragraph to describe how matter and energy move between members of the kingdoms of plants, animals, and fungi. Use the words in the box below. Underline the terms in your answer.

photosysnthesis	consumer
producer	decomposer

UNIT PROJECTS

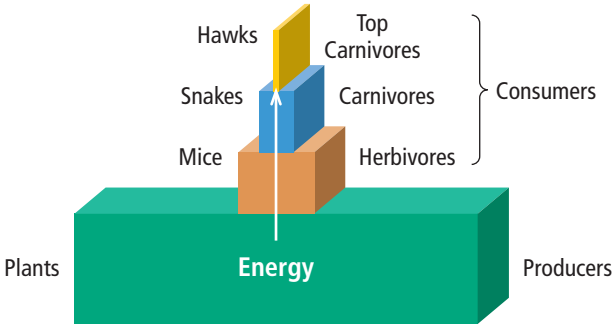
By now you should have completed the following items for your unit project.

- questions that you have asked about the topic
- schedule showing when you will complete each step of your project
- list of resources including Web sites, print resources, and materials

FCAT Practice

Interpreting Diagrams

The diagram shows the feeding relationships between certain animals and plants in a forest environment. The size of the bars represent the relative numbers of each organism. The arrow shows the flow of energy between these groups of organisms.



Feeding Relationships Among Plants and Animals

FCAT TiP

When answering multiple-choice questions involving a diagram, try to answer the question on your own before you look at the possible answers. This will help you eliminate incorrect responses.

Use the diagram to answer the questions below.

MULTIPLE CHOICE

1. Which is the largest group of organisms in the forest?

A. plants
B. mice
C. snakes
D. hawks

2. Most energy in the forest comes from which of the following?

F. top carnivores
G. carnivores
H. herbivores
I. plants

3. Which description best fits the snake?

A. a producer that feeds upon mice
B. a consumer that is eaten by mice
C. a consumer that feeds upon mice
D. a consumer that feeds upon plants

4. Which statement best summarizes the diagram?

F. The energy in a forest environment flows one way, from producers to consumers.
G. Consumers don't need as much energy as producers.
H. Energy in a forest environment goes from plants to animals and then back to plants.
I. The number of producers depends on the number of consumers.

SHORT RESPONSE

5. A top carnivore feeds upon both carnivores and herbivores. Using the diagram, explain the flow of energy from a producer to a top carnivore, using the examples provided.

EXTENDED RESPONSE

6. The diagram above shows the relative number of organisms at each level of a forest environment and the flow of energy from the producers to the consumers. Describe what happens to the amount of energy going from the producer level into the different levels of consumers. Not all the energy produced at a given level is available to organisms in the next level. What has happened to that energy? Use the words in the word box in your answer. Underline the words.

producer	energy	consumer	food

7. How would the number of plants, snakes, and hawks be affected if some disease were to reduce the numbers of mice in the forest?

TIMELINES in Science

DISCOVERIES IN Biodiversity

Scientists have discovered new species in the treetops of tropical forests and in the crannies of coral reefs. The quest to catalog the types and numbers of living things, the biodiversity of Earth, began in the late 1600s. A wave of naturalists set sail from Europe to the Americas and to Africa to find specimens of living things.

In the late 19th century, biologists reached agreement on a system for naming and classifying each new species. The mid-20th century brought an understanding of DNA and how it could be used to compare one species with another. Now new organisms could be pinpointed with precision. To this day, millions of undiscovered species lie deep in the unexplored ocean, in tropical forests, and even in heavily trafficked U.S. cities. A large concentration of Earth's known species now live in named and protected biodiversity "hotspots."

1670

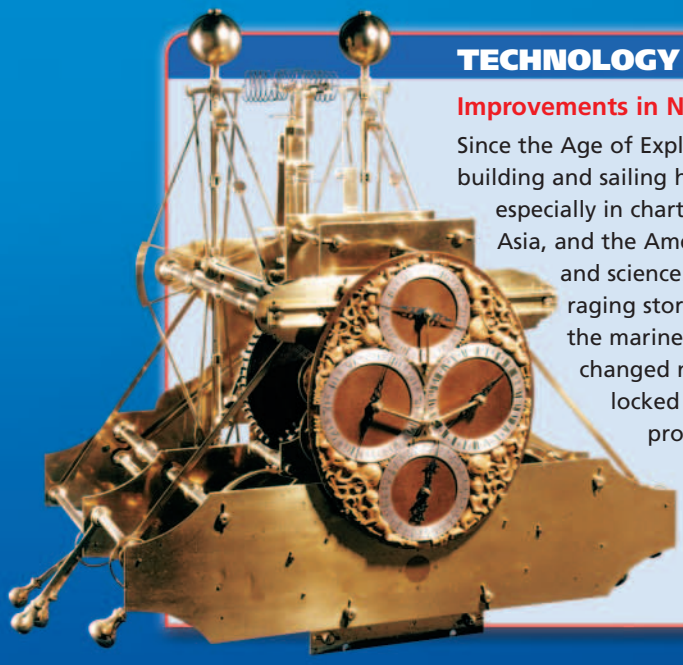
Merian Illustrates from Life

In her day, it was typical to work from preserved specimens, but Maria Merian draws from life. Shown below is her illustration of the Legu Lizard she observes in South America. In 1670, she publishes a richly illustrated book of insects, the first to describe the process of metamorphosis.

EVENTS

1670

APPLICATIONS AND TECHNOLOGY



TECHNOLOGY

Improvements in Navigation

Since the Age of Exploration in the 1500s and 1600s, European shipbuilding and sailing had boomed. Vast improvements had been made, especially in charting and mapping. Travel from Europe to Africa, Asia, and the Americas became an important part of business and science. Still, ships often lost their way or wrecked in raging storms. The invention by John Harrison in 1765 of the marine chronometer, a clock that could work at sea, changed navigation forever. Nobody expected a land-locked clockmaker to solve the puzzle, but the sea clock provided an accurate way to record sightings of stars and planets, and thus plot longitude at sea. The ocean remained a dangerous passage, but now, if tossed off course, a captain could still steer clear.

1775

A Catalog of Living Things

In 1775 Carl Linnaeus completed a book called *Systema Naturae.* His book outlines a system to organize and name plants and animals. The naming system gave scientists a precise and consistent method for sharing discoveries.

1859

Naturalists in the Amazon

Henry Walter Bates travels from England to the Amazon rainforest in South America with Alfred Russell Wallace. Bates sails home in 1859, bringing over 14,000 specimens, mostly insects. About 8000 of Bates's finds are new discoveries. Wallace loses his collection in a shipwreck.

1889

Naming Discoveries

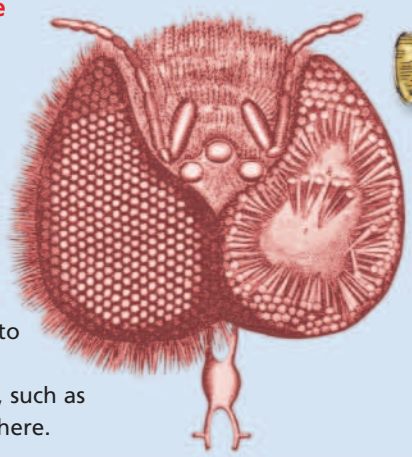
At the height of discovering new species, conflicts arise over who gets to name living things. In 1889, a conference settles the matter. The first person to publish a description of an organism has the right to claim the discovery and to name it.

1770 | 1780 | 1860 | 1870 | 1880

TECHNOLOGY

Living Things Too Small to See

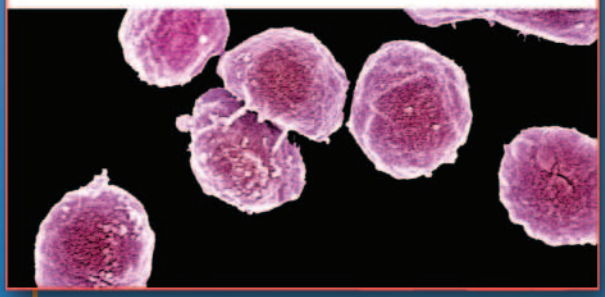
Before the 1600s, scientists were unable to see microorganisms. Anton van Leeuwenhoek, a drapery maker who made microscopes in his spare time, was one of the first to observe these tiny organisms. He made the first observation of bacteria, and viewed lake water through a microscope like the one shown to the far right. Others used microscopes to draw detailed close-ups, such as an insect's compound eye shown here.



1970

The Bacteria Kingdom Divides

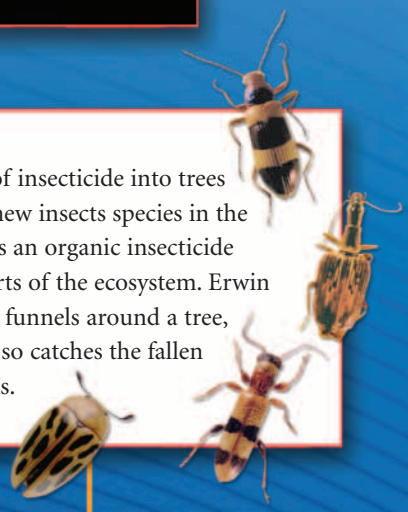
Dr. Carl Woese discovers that bacterialike organisms living in places with extremely high temperatures have genetic material very different from bacteria. Woese suggests a new kingdom or domain called archaebacteria, which is later shortened to Archaea.



1974

Fogging the Rainforest

Terry Erwin spouts plumes of insecticide into trees and discovers thousands of new insects species in the rainforest canopy. Erwin uses an organic insecticide that does not harm other parts of the ecosystem. Erwin spreads ground sheets or big funnels around a tree, sprays, and, after an hour or so catches the fallen insects, which look like jewels.

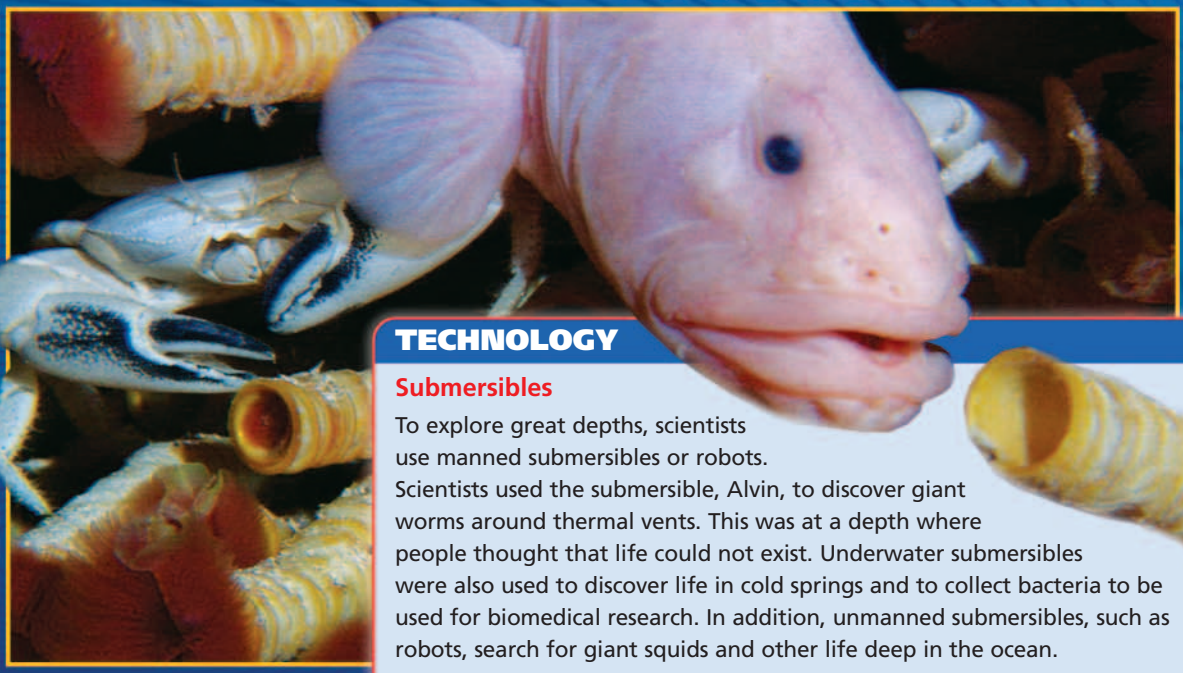


1990

Diver, SCUBA Pioneer, Heads Research

Dr. Sylvia Earle is the first woman to serve as chief scientist at the National Oceanic and Atmospheric Administration (NOAA). Earle uses SCUBA diving and discovers many new fish and marine species—especially new seaweeds in the Gulf of Mexico. Here she shows a sample to a student in a submersible vehicle.

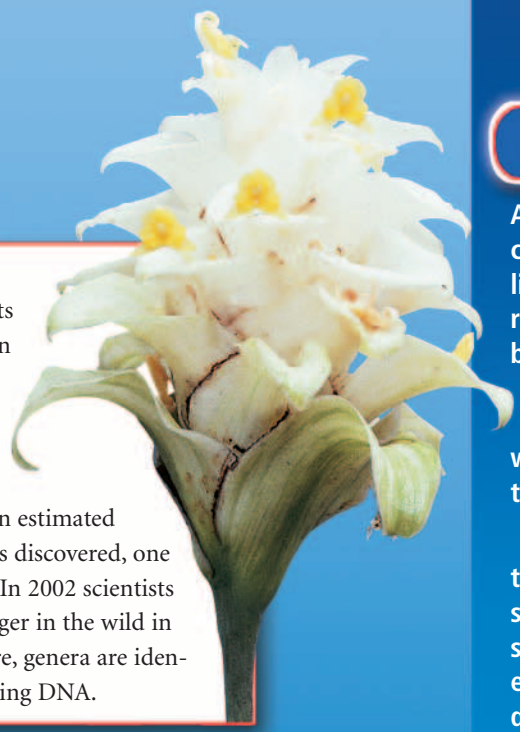
1970 1980 1990



TECHNOLOGY

Submersibles

To explore great depths, scientists use manned submersibles or robots. Scientists used the submersible, Alvin, to discover giant worms around thermal vents. This was at a depth where people thought that life could not exist. Underwater submersibles were also used to discover life in cold springs and to collect bacteria to be used for biomedical research. In addition, unmanned submersibles, such as robots, search for giant squids and other life deep in the ocean.



2002 to Present

New Plant Genera

Scientists who study plants and insects in tropical rain forests discover so many new species that they are sometimes backlogged in naming them. In the plant kingdom, it has been estimated that for every 1000 species discovered, one new genus will be found. In 2002 scientists found a new genus of ginger in the wild in Singapore. More and more, genera are identified in the laboratory using DNA.

RESOURCE CENTER
CLASSZONE.COM

Read about current biodiversity discoveries and research.

2000

INTO THE FUTURE

Although scientists have explored most of the continents, little is known about what life is like in the more remote areas. Deep-sea exploration, for example, is only just beginning, and big surprises surface with each expedition. Technology will continue to delve deeper toward the floor of deep oceans with underwater robotics, manned submersibles, and better mapping and imaging systems.

Science will increasingly rely on organizing the growing data on biodiversity. Currently, scientists who study one area of life mostly share data with others in the same field. For example, scientists studying plants share their data with other botanists. An effort to create global databases to share information about all species is beginning to bring together this data. Databases that catalogue the genes of living things are being created. The better we know the genetic profile of various species, the better we can identify and compare them.

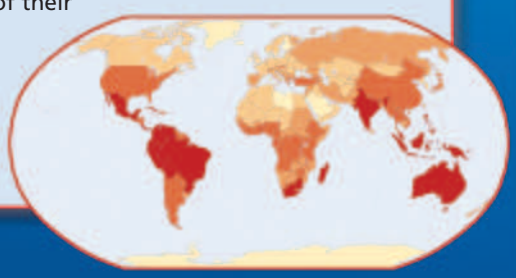
In addition, the attention to the health of biodiversity hotspots and ecosystems everywhere may help stop extinction, the dying off of a whole species. Extinction decreases the diversity of living things, and scientists have recognized that Earth's biodiversity plays a big role in keeping ecosystems healthy.

APPLICATION

Biodiversity Hotspots

In 1988, British ecologist Norman Mike Myers creates a list of 18 areas that he calls biodiversity "hotspots." In 2000, Myers and others increase the number of hotspots to 25. How does an area get to be called a hotspot? It has to have a large number of species that exist only in that location and it has to be a region in great danger of habitat loss. Hotspots cover only 1.5 % of the Earth's surface yet they contain 44 percent of all species of higher plants and 35 percent of all land vertebrates. Scientists place most of their effort in discovering new species in these hotspots.

cold hot



ACTIVITIES

Writing About Science: Documentary

Research one hotspot and report on the diverse species living there. Note any legal steps or other efforts to conserve biodiversity in that area.

Reliving History

Devise an animal classification system based on a criterion such as habitat, diet, or behavior. What are the strengths and weaknesses of your system?