

Section 1-3

1 FOCUS

Objectives

1.3.1 Describe some characteristics of living things.

1.3.2 Explain how life can be studied at different levels.

Guide for Reading

Vocabulary Preview

Pronounce each of the Vocabulary words for the class, and have students repeat the pronunciation in unison. Note any words that English language learners have trouble pronouncing, and work with them to correct their problems.

Reading Strategy

Students should write one sentence describing each of the eight characteristics listed on page 16. You might have students rewrite the items in the list and revise their sentences as they read the section.

2 INSTRUCT

Characteristics of Living Things

Build Science Skills

Comparing and Contrasting

Divide the class into small groups, and allow each group to examine two objects: a watch or clock with a working second hand and an active, living animal such as a fish or an insect. Ask groups to compare the two, noting similarities and differences. Have group members collaborate on writing a paragraph explaining what makes one object a living thing and the other object not.

L2

1-3 Studying Life

Guide for Reading

Key Concepts

- What are some characteristics of living things?
- How can life be studied at different levels?

Vocabulary

biology
cell
sexual reproduction
asexual reproduction
metabolism
stimulus
homeostasis
evolution

Reading Strategy:

Summarizing As you read, make a list of the properties of living things. Write one sentence describing each property.




Beneath the sparkling waves near a South Pacific island, divers carry cameras and underwater notepads as they crisscross a coral reef. Outside an Antarctic research station, a lone figure searches the ice around her for signs of life. In a high-security facility in Atlanta, a man dressed like an astronaut passes through a double airlock into a sterile laboratory. Sweltering in the heat and humidity of sub-Saharan Africa, volunteers collect blood samples from women and children with AIDS. What do these people have in common? They are all biologists.

The word *biology* means the study of life. (The Greek word *bios* means “life,” and *-logy* means “study of.”) **Biology** is the science that seeks to understand the living world. A biologist is someone who uses scientific methods to study living things. The work of biologists can be quite varied, because organisms are complex and vary so greatly.

Characteristics of Living Things

Are the firefly and the fire in **Figure 1-14** alive? They are both giving off energy. Describing what makes something alive is not easy. No single characteristic is enough to describe a living thing. Also, some nonliving things share one or more traits with living things. Mechanical toys, automobiles, and clouds move around, for example, whereas mushrooms and trees live their lives in one spot. Other things, such as viruses, exist at the border between organisms and nonliving things. (You’ll read more about viruses in Chapter 19.)

Despite these difficulties, it is possible to describe what most living things have in common.  **Living things share the following characteristics:**

- Living things are made up of units called cells.
- Living things reproduce.
- Living things are based on a universal genetic code.
- Living things grow and develop.
- Living things obtain and use materials and energy.
- Living things respond to their environment.
- Living things maintain a stable internal environment.
- Taken as a group, living things change over time.

Figure 1-14 A Colorado firefly beetle (top) has all of the characteristics of living things. Even though fire (bottom) uses materials and can grow as living things do, fire is not alive because it does not have other characteristics of living things. **Applying Concepts** What characteristics of living things are missing from a fire?



SECTION RESOURCES

Print:

- **Teaching Resources**, Section Review 1-3
- **Reading and Study Workbook A**, Section 1-3
- **Adapted Reading and Study Workbook B**, Section 1-3
- **Lesson Plans**, Section 1-3

Technology:

- **iText**, Section 1-3
- **Transparencies Plus**, Section 1-3

Made Up of Cells Living things, or organisms, are made up of small, self-contained units called cells. A **cell** is a collection of living matter enclosed by a barrier that separates the cell from its surroundings. Cells are the smallest units of an organism that can be considered alive. Cells can grow, respond to their surroundings, and reproduce. Despite their small size, cells are complex and highly organized.

Many living things consist of only a single cell and are therefore called unicellular organisms. (The Latin prefix *uni-* means “one,” so *unicellular* means “single-celled.”) Many of the microorganisms involved in Spallanzani’s and Pasteur’s experiments were unicellular organisms.

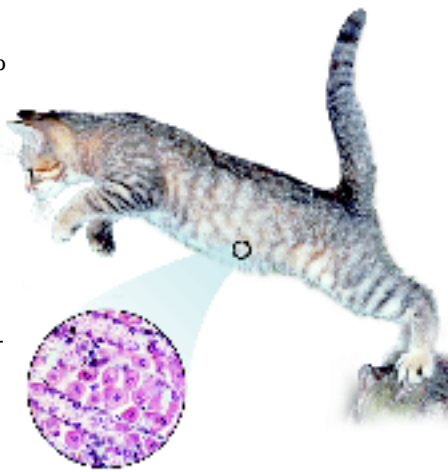
The organisms you are most familiar with—for example, animals and plants—are multicellular. You can see one type of multicellular organism in **Figure 1-15**. (The Latin prefix *multi-* means “many.” Thus, *multicellular* means “many-celled.”) Multicellular organisms contain hundreds, thousands, or even trillions of cells. The cells in these organisms are often remarkably diverse, existing in a variety of sizes and shapes. In some multicellular organisms, each type of cell is specialized to perform a different function. The human body alone is made up of at least 85 different cell types. You will learn more about cells in Chapter 7.

Reproduction All organisms produce new organisms through a process called reproduction. There are two basic kinds of reproduction: sexual and asexual. The vast majority of multicellular organisms—from maple trees to birds and humans—reproduce sexually. In **sexual reproduction**, cells from two different parents unite to produce the first cell of the new organism. In **asexual reproduction**, the new organism has a single parent. In some forms of asexual reproduction, a single-celled organism divides in half to form two new organisms. In the type of asexual reproduction shown in **Figure 1-16**, a portion of an organism splits off to form a new organism.

CHECKPOINT What is sexual reproduction?

Based on a Genetic Code Offspring usually resemble their parents. With asexual reproduction, offspring and their parents have the same traits. With sexual reproduction, offspring differ from their parents in some ways. However, there are limits to these differences. Flies produce flies, dogs produce dogs, and seeds from maple trees produce maple trees.

Explaining how organisms inherit traits is one of the greatest achievements of modern biology. Biologists now know that the directions for inheritance are carried by a molecule called deoxyribonucleic acid, or DNA. This genetic code, with a few minor variations, determines the inherited traits of every organism on Earth. You will learn how this is possible in Unit 4.



▲ **Figure 1-15** 🟢 **Living things are made of cells.** Cats and most other familiar organisms are made of many cells. The inset shows cells from a cat’s stomach (magnification: 500×).



▲ **Figure 1-16** 🟢 **All living things reproduce.** Here, one hydra is being formed from another through a type of asexual reproduction called budding. Shortly, the new organism will break away from the parent and live independently.

Build Science Skills

Comparing and Contrasting Ask students to compare the two organisms shown in the figures on this page, the cat in Figure 1-15 and the hydra in Figure 1-16. Explain that a hydra is a freshwater animal in the same animal phylum as the jellyfish. Ask students: **What characteristics of life do both of these organisms exhibit?** (Both exhibit all the eight characteristics of life. Students should note that the cat is made of cells and that the hydra reproduces. Allow students to speculate about how each animal exhibits the other characteristics.) **How are these two living things similar, and how are they different?** (They are similar in that they are both animals. They are different in size, shape, structure, and habitat, among many other ways.)

L2

Use Visuals

Figure 1-16 Explain to students that a hydra is a freshwater organism that is related to ocean-dwelling jellyfishes and corals. Then, ask: **Since there are two organisms shown in the photo, why doesn’t this represent an example of sexual reproduction?** (This isn’t sexual reproduction, because there is only one parent organism shown. The other, smaller organism is the new organism produced in the process.) **Does the reproductive process shown in the photo represent the way a majority of multicellular organisms reproduce?** (No, because the vast majority of multicellular organisms reproduce sexually.)

L1 L2

Differentiated

Instruction Solutions for All Learners

Less Proficient Readers

Make sure students grasp the difference between sexual and asexual reproduction, because this distinction will be important in chapters to come. Point out that the prefix *a-* simply means “not,” and thus *asexual reproduction* literally means “not sexual reproduction.” To help students compare and contrast the two, have them make a Venn diagram that notes how the two processes are alike and different. L1

English Language Learners

Help students create a personal science glossary that can be added to as they learn new terms in reading each chapter of this text. Encourage these students to dedicate a small notebook for this purpose or to devise another way to keep an organized glossary. Students can keep an alphabetized list, or they might simply make a list for each chapter. For each term, students should write a definition and note its pronunciation. L1 L2

Answers to . . .

CHECKPOINT A type of reproduction in which cells from two different parents unite to produce the first cell of the new organism.

Figure 1-14 A fire is not made up of cells, does not reproduce, is not based on a universal genetic code, and does not maintain a stable internal environment. In addition, fires in general do not change over time.

1–3 (continued)

Build Science Skills

Comparing and Contrasting

Emphasize to students the difference between growth in living and growth in nonliving things. A good comparison to make is the growth of a child compared with that of a garbage heap. Point out that as a child eats food—pasta, fruits, vegetables, meat—he or she grows. In contrast, if you were to throw the same foods into a pile, the garbage heap would also grow. Ask: **Based on the example given, how would you compare the growth of living and nonliving things?** (Answers may include the concepts of assimilation and organization, development of specific structures, and/or organized growth rather than a “pile.”) **Do organisms always grow and develop at the same rate?** (Most students will know that organisms don’t.) **When do organisms stop growing and developing?** (The process goes on at different rates but does not completely stop until death.)

L1 L2

Use Visuals

Figure 1–18 Ask students: **How does the chameleon obtain the energy it needs to live?** (It eats the grasshopper and other organisms for the energy stored in their bodies.) **Where do you think the grasshopper obtained the energy it needed to live?** (It obtained energy from plants it ate.) **Where did the plants the grasshopper ate obtain the energy they needed to live?** (From the sun through the process of photosynthesis) Point out that all the living things on Earth ultimately obtain the energy they need from the energy of sunlight, as students will learn in greater detail in subsequent chapters.

L2



Figure 1–17 All living things grow and develop. These photographs show how a spicebush swallowtail butterfly develops from an egg into a caterpillar (larva), a pupa, and, finally, an adult butterfly.

Growth and Development All living things grow during at least part of their lives. For some single-celled organisms, such as bacteria, growth is mostly a simple increase in size. Multicellular organisms, however, typically go through a process called development. During development, a single fertilized egg cell divides again and again to produce the many cells of mature organisms. As those cells divide, they change in shape and structure to form cells such as liver cells, brain cells, and muscle cells. This process is called differentiation, because it forms cells that look different from one another and perform different functions.

For many organisms, development includes periods of rapid and dramatic change, as shown in **Figure 1–17**. In fact, although you will not sprout wings, your body is currently experiencing one of the most intense spurts of growth and development of your entire life!

Need for Materials and Energy Think of what an organism needs as it grows and develops. Just as a building grows taller because workers use energy to assemble new materials, an organism uses energy and a constant supply of materials to grow, develop, and reproduce. Organisms also need materials and energy just to stay alive. The combination of chemical reactions through which an organism builds up or breaks down materials as it carries out its life processes is called **metabolism**.

All organisms take in selected materials that they need from their surroundings, or environment, but the way they obtain energy varies. Plants, some bacteria, and most algae obtain their energy directly from sunlight. Through a process called photosynthesis, these organisms convert light into a form of energy that is stored in certain molecules. That stored energy is ready to be used when needed.

Most other organisms rely on the energy stored during photosynthesis. Some organisms, such as grasshoppers and sheep, obtain their energy by eating plants and other photosynthesizing organisms. Other organisms, such as birds and wolves, get energy by eating the grasshoppers or sheep. The chameleon in **Figure 1–18** gets the materials it needs by eating insects and other small animals. And some organisms, called decomposers, obtain energy from the remains of organisms that have died.

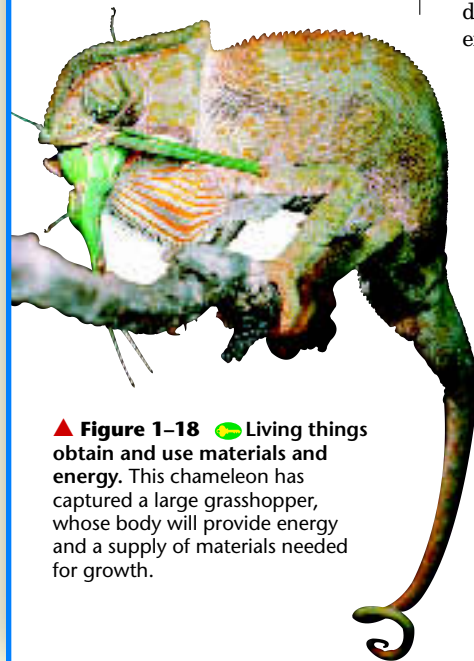


Figure 1–18 Living things obtain and use materials and energy. This chameleon has captured a large grasshopper, whose body will provide energy and a supply of materials needed for growth.

ENCAPSULATING What is metabolism?



TEACHER TO TEACHER

To get students to think about the characteristics of life, I give them the following scenario:

You are a member of a local research laboratory. One afternoon, you receive a shoebox marked “Handle with care.” In it, you find three gelatinous, orange-colored masses of material. Each mass is approximately 5 cm in diameter. You also find a message from a local resident: “I found these things along the roadside at the bridge near a creek. Can you tell me if they are alive and what I should do with them? They started showing up right after the

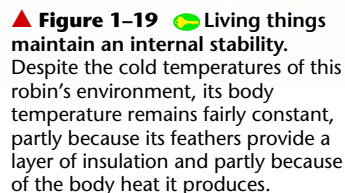
spring rains this year and seem to be growing fast.”

Have students answer the following questions:
(1) As you observe the masses, what evidence would make you think they are living things?
(2) List the questions that you would ask as you begin your investigation.

—Debbie Richards
Biology Teacher
Bryan High School
Bryan, TX

Response to the Environment Organisms detect and respond to stimuli from their environment. A **stimulus** is a signal to which an organism responds. External stimuli, which come from the environment outside an organism, include factors such as light and temperature. For example, when there is sufficient water and the ground is warm enough, a plant seed responds by germinating. The roots respond to gravity and grow down into the soil. The new leaves and stems grow toward light. In contrast, internal stimuli come from within an organism. The level of the sugar glucose in your blood is an example of an internal stimulus. If this level becomes low enough, your body responds by making you feel hungry.

Maintaining Internal Balance Even though conditions in the external environment may vary widely, most organisms must keep internal conditions, such as temperature and water content, fairly constant to survive. The process by which they do this is called **homeostasis** (hoh-mee-oh-STAY-sis). Homeostasis often involves internal feedback mechanisms that work in much the same way as a thermostat. Just as a thermostat in your home turns on the heat when room temperature drops below a certain point, you have an internal “thermostat” that makes your body shiver if your internal temperature drops too low. The muscle action involved in shivering produces heat, thus warming your body. In contrast, if you get too hot, your biological thermostat turns on “air conditioning” by causing you to sweat. Sweating helps to remove excess heat from your skin. When birds get cold, they hunch down and adjust their feathers to provide maximum insulation, as shown in **Figure 1-19**. Often internal stimuli help maintain homeostasis. For example, when your body needs more water to maintain homeostasis, internal stimuli make you feel thirsty.



▲ **Figure 1-19** 🟢 Living things maintain an internal stability. Despite the cold temperatures of this robin's environment, its body temperature remains fairly constant, partly because its feathers provide a layer of insulation and partly because of the body heat it produces.

Quick Lab

Objective Students will be able to infer some characteristics of living things. **L2**

Skill Focus **Formulating Hypotheses**

Materials hand lens, dormant brine shrimp eggs, water, hatched brine shrimp eggs, bowls covered with fabric

Time 15 minutes

Advance Prep Obtain dormant brine shrimp eggs—also called “sea monkeys”—from a biological supply house. A day, or at least several hours, before the activity begins, put some of the dormant eggs in water so that students can observe live hatchlings in step 3.

Safety Make sure students wash their hands with soap and warm water after handling the dormant eggs or live shrimp.

Strategy Have the hatchlings in bowls covered with fabric and stationed around the classroom. After students have written their predictions, uncover the bowls and invite students to observe.

Expected Outcomes Students will recognize that the line between living and nonliving is not as clear as they might have thought.

Analyze and Conclude

1. Answers will depend on students' predictions. Most students will not have predicted that the objects they observed in step 1 would become live shrimp or anything else alive.

2. Students should recognize that the objects they observed in step 3 were alive and infer that the objects they observed in step 1 were also alive.

3. Accept any reasonable response, provided that the arguments are logical and based on observation.

Quick Lab

What are the characteristics of living things?

Materials hand lens, unknown objects (dry), same objects soaked in water

Procedure 🧠 🖱️

1. Examine the dry unknown object your teacher provides. Record your observations.
2. **Predicting** In step 3, you will observe the same kind of object after it has been soaked in water. Write a prediction describing what you expect to see.

3. Examine one of the objects that has been soaking in water for a period of time. Record your observations. Wash your hands when you have finished.

Analyze and Conclude

1. **Evaluating** Was the prediction you made in step 2 correct? Explain your answer.
2. **Inferring** Were the objects you observed in step 1 living or nonliving? Were the objects you observed in step 3 living or nonliving? Use the observations you made as supporting evidence for your answers.
3. **Formulating Hypotheses** Suggest one or more ways to explain the differences between the dry and wet objects.



HISTORY OF SCIENCE

A constant “internal milieu”

In 1851, French physiologist Claude Bernard (1813–1878) discovered that nerves in an animal's body control the dilation and constriction of blood vessels. He observed that on hot days the blood vessels of the skin became dilated, whereas on cold days those same blood vessels become constricted. Bernard concluded that the function of these changes has to do with regulating the body's internal temperature. On hot

days, dilated, blood-filled vessels radiate heat away from the body. On cold days, constricted, blood-depleted vessels conserve body heat. Thus, even when the external environment changes, an animal has a way of maintaining a constant “internal milieu.” His concept of the maintenance of an internal balance within an animal is incorporated in the modern concept of homeostasis, which literally means “same condition.”

Answer to . . .

CHECKPOINT *Metabolism is the combination of chemical reactions through which an organism builds up or breaks down materials as it carries out its life processes.*

1–3 (continued)

Use Visuals


Figure 1–20 Ask students: **What does it mean in your everyday life when you become “adapted” to a situation?** (*You adjust to the situation by making small changes in the way you act or feel.*) **How could an organism such as a plant become “adapted” to a changing environment?** (*Some students might suggest that plants could somehow adjust to dryness or coldness by growing new structures.*) Explain that the biological term *adaptation* implies changes over time—a great deal of time. An individual organism doesn’t adapt; rather, a group of organisms changes over time. **L1 L2**

Branches of Biology

Build Science Skills

Asking Questions To introduce the topic of branches of biology to students, play a game of 20 questions with the class. Think of a familiar plant or animal, such as a dandelion, an ant, or a sparrow. Tell students that you are thinking of a certain organism and that they are allowed 20 yes-or-no questions to determine what this organism is. As the game progresses, you might suggest questions to the class; do not let them stray too far from the correct answer. Tell students that whether they realized it or not, they were conducting a scientific investigation. They were presented with a problem, and they needed to ask the right questions to reach a solution. Emphasize that in science, answers are often available—it’s figuring out the right questions that is difficult. Explain that scientists from different branches of biology ask different questions—approaching living things at different levels of organization. **L1 L2**




Figure 1–20  Taken as a group, all living things change over time. If you suddenly moved most plants to this Namibian desert (left), they would be killed by the heat and lack of water. But a few types of plants have become adapted to these hot and dry conditions, surviving periods of drought to grow and flower after a rainfall (right).

Evolution Although individual organisms experience many changes during their lives, the basic traits they inherited from their parents usually do not change. As a group, however, any given kind of organism can evolve, or change over time.

Over a few generations, the changes in a group may not seem significant. But over hundreds of thousands or even millions of years, the changes can be dramatic. The ability of certain plants, such as those in **Figure 1–20**, to survive periods without water is one example. Another example concerns fishes. Scientists study deposits containing the remains of animals that lived long ago to learn about the evolution of organisms. From the study of very early deposits, scientists know that at one time there were no fishes in Earth’s waters. Yet, in more recent deposits, the remains of fishes and other animals with backbones are abundant. The ability of a group of organisms to change over time is invaluable for survival in a world that is always changing. You will read about the processes of **evolution** in Unit 5.

Branches of Biology

Living things come in an astonishing variety of shapes, sizes, and habits. Living systems also range in size from groups of molecules that make up structures inside cells to the collections of organisms that make up the biosphere. No single biologist could study all this diversity, so biology is divided into different fields. Some fields are based on the types of organisms being studied. Zoologists study animals. Botanists study plants. Other fields study life from a particular perspective. For example, paleontologists study ancient life.

Some fields focus on the study of living systems at different levels of organization, as shown in **Figure 1–21**.  **Some of the levels at which life can be studied include molecules, cells, organisms, populations of a single kind of organism, communities of different organisms in an area, and the biosphere. At all these levels, smaller living systems are found within larger systems.** Molecular biologists and cell biologists study some of the smallest living systems. Population biologists and ecologists study some of the largest systems in nature. Studies at all these levels make important contributions to the quality of human life.



FACTS AND FIGURES

Branches of biology

The branches of biology are too numerous to list. Zoologists, botanists, paleontologists, and ethologists are just a few of the great variety of biologists. Biochemists study the chemistry of living things. Geneticists study heredity and variation among organisms. Cytologists, or cell biologists, study the structure and function of cells. Ecologists study the interaction of organ-

isms in ecosystems. Microbiologists study the structure and function of microorganisms. The list goes on, and those mentioned are just the biologists who pursue knowledge in what is sometimes called theoretical science. There are also many biologists who work in applied or practical science, including physicians, medical researchers, wildlife managers, foresters, and agricultural researchers, to name just a few.






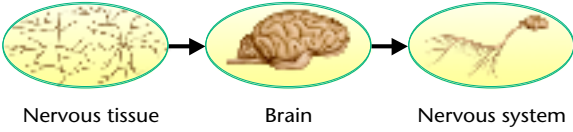
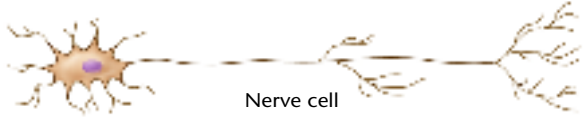
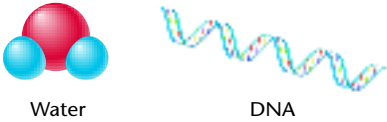

Levels of Organization		
Biosphere	The part of Earth that contains all ecosystems	
Ecosystem	Community and its nonliving surroundings	 Hawk, snake, bison, prairie dog, grass, stream, rocks, air
Community	Populations that live together in a defined area	 Hawk, snake, bison, prairie dog, grass
Population	Group of organisms of one type that live in the same area	 Bison herd
Organism	Individual living thing	 Bison
Groups of Cells	Tissues, organs, and organ systems	 Nervous tissue Brain Nervous system
Cells	Smallest functional unit of life	 Nerve cell
Molecules	Groups of atoms; smallest unit of most chemical compounds	 Water DNA

Figure 1–21  Living things may be studied on many different levels. The largest and most complex level is the biosphere. The smallest level is the molecules that make up living things.

Use Visuals

Figure 1–21 Make sure students understand the hierarchy implied in the figure: molecular, cellular, multicellular, organism, population, community, ecosystem, and biosphere. Have students use a dictionary to clarify the meaning of these terms. Then, ask students to make a graphic organizer that could represent relationships among the terms, such as a series of larger and larger circles. **L1 L2**

Build Science Skills

Asking Questions Display the same pictures of natural environments that students examined for the Assess Prior Knowledge activity on page 2. Ask students again to choose one of the pictures to examine closely and to compile a list of 20 questions a biologist might ask about the organisms in the picture. Explain that these questions could concern anything from the molecular level to the biosphere level. Have students compare the 20 questions they wrote after having read these sections with the 20 questions they wrote previously. **L2**

1-3 (continued)

Biology in Everyday Life

Build Science Skills

Applying Concepts Ask students to choose a commercial product that they use every day, such as a certain soap, type of makeup, kind of chewing gum, or brand of deodorant. Ask them to explain in a paragraph how they could use what they have learned so far in this chapter to find out how the product affects their bodies and whether it could be harmful in some way. **L2**

3 ASSESS

Evaluate Understanding

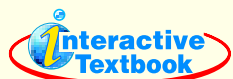
Have students explain in writing how a cat, such as the one shown in Figure 1-15, exhibits all of the characteristics of living things.

Reteach

Point out a living thing and a nonliving thing in the classroom, such as a computer and a fish in an aquarium. Have students compare and contrast the two using the eight characteristics of living things.

Connecting Concepts

Students could observe whether the object ingests or excretes materials, whether it increases in size over time, and whether it responds to stimuli from the environment.



If your class subscribes to the iText, use it to review the Key Concepts in Section 1-3.

Answer to . . .

Figure 1-22 A typical response might suggest that researchers will find cures for many diseases.



▲ **Figure 1-22** Progress in biology has meant huge improvements in health not just for you and your family but, in some societies, for pets as well. **Predicting** How do you expect advances in biology to change health care during your lifetime?

Biology in Everyday Life

As you begin studying biology, you may be thinking of it as just another course, with a textbook to read plus labs, homework, and tests. It's also a *science* course, so you may worry that it will be too difficult. But you will see that more than any other area of study, biology touches your life every day. In fact, it's hard to think of anything you do that isn't affected by it. It helps you understand and appreciate every other form of life, from pets such as the dog in **Figure 1-22** to dinosaurs no longer present on Earth. It provides information about the food you need and the methods for sustaining the world's food supplies.

It describes the conditions of good health and the behaviors and diseases that can harm you. It is used to diagnose and treat medical problems. It identifies environmental factors that might threaten you, such as disposal of wastes from human activities. More than any other science, biology helps you understand what affects the quality of your life.

Biologists do not make the decisions about most matters affecting human society or the natural world; citizens and governments do. In just a few years, you will be able to exercise the rights of a voting citizen, influencing public policy by the ballots you cast and the messages you send public officials. With others, you will make decisions based on many factors, including customs, values, ethical standards, and scientific knowledge. Biology can provide decision makers with useful information and analytical skills. It can help them envision the possible effects of their decisions. Biology can help people understand that humans are capable of predicting and trying to control their future and that of the planet.

1-3 Section Assessment

1. **Key Concept** Describe five characteristics of living things.
2. **Key Concept** What topics might biologists study at the community level of organization?
3. Compare sexual reproduction and asexual reproduction.
4. What biological process includes chemical reactions that break down materials?
5. What is homeostasis? Give an example of how it is maintained.
6. **Critical Thinking Applying Concepts** Suppose you feel hungry, so you reach for a peach you see in a fruit bowl. Explain how both external and internal stimuli are involved in your action.

Connecting Concepts

Making Observations

List some observations that could be made to determine whether an object that is not moving is living or nonliving. Refer to Section 1-1 to help yourself recall what an observation is.

1-3 Section Assessment

1. Students should describe any five of the eight characteristics listed on page 16.
2. Students should describe topics about populations that live in an area, such as interactions among different populations and changes in size or habits.
3. In sexual reproduction, two cells from different parents unite to produce the first cell of a new organism. In asexual reproduction, the new organism has a single parent.
4. Metabolism
5. Homeostasis is the process by which organisms keep internal conditions fairly constant. Examples will vary, though most students will describe an internal feedback mechanism, such as temperature regulation.
6. External stimuli might include the sight and smell of the peach. Internal stimuli might include feeling hungry or the thought that this food would be good to eat.

When Scientists Have a Conflict of Interest

Scientists are expected to be completely honest about their investigations. Doctors are expected to place the welfare of their patients first. Yet, conflicts of interest can often threaten the credibility of a researcher. A conflict of interest exists when a person's work can be influenced by personal factors such as financial gain, fame, future work, or favoritism. For example, suppose scientists have received funds to test a potential anti-cancer drug. If experiments show that the drug is not very effective, the researchers may be tempted to conceal the results in order to avoid losing their funding.

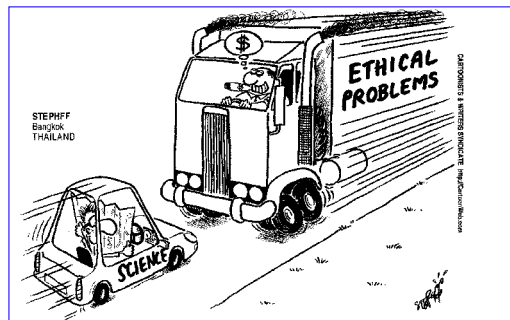
The Viewpoints

Regulation Is Necessary

Some scientists argue that, because the public must be able to trust the work of science, some rules are essential for preserving scientific integrity. Every profession should regulate its members, and every science publication should have strict rules about avoiding conflicts of interest. In any published work, announcements of potential conflicts should be required. In some cases, scientists should avoid or be forbidden to do work that involves personal gain in addition to the usual payment for doing the work. Some form of government regulation may be needed.

Regulation Is Unnecessary

Other scientists insist that conflict-of-interest regulations are unnecessary for the majority of researchers, who are honest and objective about their work. It is unfair to assume that a researcher's discoveries would be different because of the nature of the financial support for the research. In fact, without the opportunity for scientists to get additional funding for successful work, many new drugs or new techniques would never have been developed. So it is important that scientists be allowed to investigate any topic, even those in which they have the opportunity for personal gain.



Research and Decide

- Analyzing the Viewpoints** To make an informed decision, learn more about this issue by consulting library or Internet sources. Then answer the following question: How might the views about a possible conflict of interest differ among a group of scientists, the company employing a scientist, and people seeking information from a scientist?
- Forming Your Opinion** How should this problem of possible conflicts of interest be decided? Include information or reasoning that answers people with the opposite view.
- Role-Playing** Suppose doctors who own a company developing a new medicine want their patients to help test the medicine. Let one person represent a doctor, a second person a patient, and a third person a medical reporter asking: Should the patients take part in the tests?

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BACKGROUND

Reasons to be concerned

There are no sciencewide rules about reporting conflicts of interest, nor is there government regulation requiring biologists to do so. Various publications and professional organizations have their own code of ethics. In recent years, there has been a growing concern about how such conflicts might be affecting scientific research, especially the great amount of research done in universities. By 1997, U.S. companies were spend-

ing \$1.7 billion a year on university-based science and engineering research. By the late 1990s, more than 90 percent of companies connected to the life sciences had some kind of relationship with university scientists. Yet, in a survey of science journals, 142 of 210 did not publish a single disclosure of conflict of interest in 1997. Some observers also worry about scientists' skewing their work toward government interests, because federal funding of research is common.

After students respond to question 3 in Research and Decide, have student volunteers role-play the situation for the class. Follow that by a class discussion of the issue. Then, ask each student to write a statement about his or her own assessment of such a conflict of interest.

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- Students might find a variety of viewpoints about this issue in books, periodicals, or Internet sites about current affairs. Answers to the question will vary. A typical response might suggest that the group of scientists might be dedicated to pursuing scientific truth but also be intent on satisfying those who have funded the research. Additionally, the company employing the scientists might want both the truth and results that will help its profit. People seeking information from a scientist may simply want unbiased data, though they might not want results that somehow upset their view of the world.
- A typical response might suggest that journals and professional organizations should adopt strict guidelines about conflicts of interest and that there should even be some government regulation. Students should back their positions with logical arguments.
- Have students write a dialogue that includes viewpoints from the doctor and the patient, with the reporter questioning each. The reporter might press the doctor on whether owning the company is a conflict of interest that would invalidate the test. The reporter might ask the patient whether the doctor can be trusted and whether the test will be conducted in a safe way.

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Students can research conflicts of interest on the site developed by authors Ken Miller and Joe Levine.