

Unit 1

History & Biology

600 B.C.

520 B.C.
Greek philosophers propose that the universe is composed of four elements: earth, air, fire, and water.

400 B.C.
Hippocrates founds the profession of physicians.

100 B.C.

350 B.C.
The first classification of 500 species of animals is created.

105
Tsai Lun invents paper as we know it today.

What is biology?

What You'll Learn

Chapter 1

Biology: The Study of Life

Unit 1 Review

BioDigest & Standardized Test Practice

Why It's Important

Biologists seek answers to questions about living things. For example, a biologist might ask how plants, such as California poppies, convert sunlight into chemical energy that can be used by the plants to maintain life processes. Biologists use many methods to answer their questions about life. During this course, you will gain an understanding of the questions and answers of biology, and how the answers are learned.



▲ Hippocrates

Understanding the Photo ▶

This field of flowers represents not only a collection of living things, but also a community. These plants interact with each other, and form a biological community that provides food, nesting materials, and oxygen for other living things.



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(t)Ed Eckstein/CORBIS, (crossover)Carr Clifton/Minden Pictures

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1452

Gutenberg invents moveable type, allowing mass production of printed materials.

1863

Lincoln delivers the Gettysburg Address.

1600

1700

1800

1900

1627

Francis Bacon publishes work urging that the experimental method should play a key role in the development of scientific theories.

1687

Isaac Newton publishes *Principia*, which details the first scientific methods.

1895

X rays are discovered and the first X ray of the human body is taken.



The first X ray

2000

The first draft of the Human Genome Project, sequencing all human genes, is completed.

Bettmann/CORBIS



Chapter 1

Biology: The Study of Life

What You'll Learn

- You will identify the characteristics of life.
- You will recognize how scientific methods are used to study living things.

Why It's Important

Recognizing life's characteristics and the methods used to study life provides a basis for understanding the living world.

Understanding the Photo

Even though the moose and plants pictured here appear to be completely different from each other, they share certain characteristics that make them both living things. Animals and plants, as well as other organisms such as mushrooms and bacteria, all exhibit the basic characteristics of life.



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Section 1.1

SECTION PREVIEW

Objectives

Recognize some possible benefits from studying biology.

Summarize the characteristics of living things.

New Vocabulary

biology
organism
organization
reproduction
species
growth
development
environment
stimulus
response
homeostasis
energy
adaptation
evolution

What is biology?

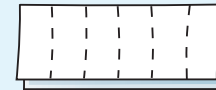
FOLDABLES Study Organizer

Characteristics of Living Things Make the following Foldable to help you organize information about the characteristics of living things.

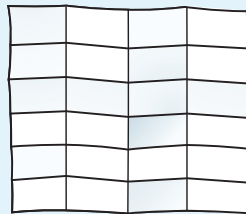
STEP 1 Fold a vertical sheet of paper in half from top to bottom, twice.



STEP 2 Fold the paper widthwise into six sections.



STEP 3 Unfold, lay the paper lengthwise, and draw lines along the folds.



STEP 4 Label your table as shown.

Characteristics	Organism 1	Organism 2	Organism 3

Make a Table As you read Chapter 1, list the characteristics of living things in the far left column. Choose three organisms that seem different from each other and make notes in each column describing how each organism fulfills the requirements of a living thing.

Word Origin

biology from the Greek words *bios*, meaning "life," and *logos*, meaning "study"; Biology is the study of life.

The Science of Biology

People have always been curious about living things—how many different kinds there are, where they live, what they are like, how they relate to each other, and how they behave. The concepts, principles, and theories that allow people to understand the natural environment form the core of **biology**, the study of life. What will you, as a young biologist, learn about in your study of biology?

A key aspect of biology is simply learning about the different types of living things around you. With all the facts in biology textbooks, you might think that biologists have answered almost all the questions about life. Of course, this is not true. There are undoubtedly many life forms yet to be discovered; many life forms haven't even been named yet, let alone studied. Life on Earth includes not only the common organisms you notice every day, but also distinctive life forms that have unusual behaviors.

When studying the different types of living things, you'll ask what, why, and how questions about life. You might ask, "Why does this living thing possess these particular features? How do these features work?" The answers to such questions lead to the development of general biological principles and rules. As strange as some forms of life may appear to be, there is order in the natural world.

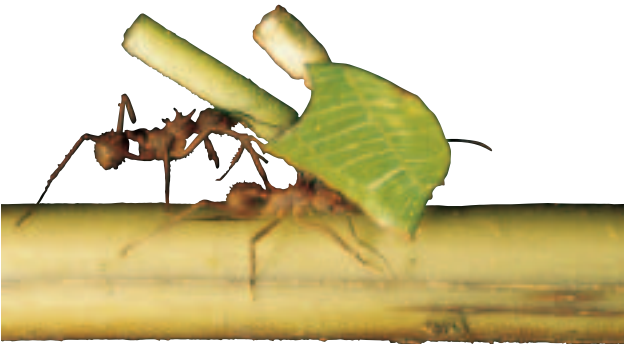
Biologists study the interactions of life

One of the most general principles in biology is that living things do not exist in isolation; they are all functioning parts in the delicate balance of nature. As you can see in *Figure 1.1*, living things interact with their environment and depend upon other living and nonliving things to aid their survival.

Figure 1.1

Questions about living things can sometimes be answered only by finding out about their interactions with their surroundings.

- A** Leaf-cutter ants feed on fungus. They carry bits of leaves to their nest, then chew the bits and form them into moist balls on which the fungus grows.



- B** Leaves of the insect-eating pitcher plant form a lip lined with downward-pointing hairs that prevent insects from escaping. Trapped insects fall into a pool of water and digestive juices at the bottom of the tube.



- C** The seahorse is well hidden in its environment. Its body shape blends in with the shapes of the seaweeds in which it lives.



- D** The spadefoot toad burrows underground during extended periods of dry weather and encases itself in a waterproof envelope to prevent water loss.



Biologists Study the Diversity of Life

Many people study biology simply for the pleasure of learning about the world of living things. As you've seen, the natural world is filled with examples of living things that can be amusing or amazing, and that challenge your thinking. Through your study of biology, you will come to appreciate the great diversity of life on Earth and the way all living organisms fit into the dynamic pattern of life on our planet.

Biologists study the interactions of the environment

Because no living things, including humans, exist in isolation, the study of biology must include the investigation of living interactions. For example, learning about a population of wild rabbits would require finding out what plants they eat and what animals prey on them. The study of one living thing always involves the study of the others with which it interacts.

Human existence, too, is closely intertwined with the existence of other organisms living on Earth. Plants and animals supply us with food and with raw materials like wood, cotton, and oil. Plants also replenish the essential oxygen in the air. The students in *Figure 1.2* are studying organisms that live in a local stream. Activities like this help provide a thorough understanding of living things and the intricate web of nature. It is only through such knowledge that humans can expect to understand how to preserve the health of our planet.


 **Reading Check** Explain why scientists study an organism's environment.



Figure 1.2

By understanding the interactions of living things, you will be better able to impact the planet positively.

Biologists study problems and propose solutions

The future of biology holds many exciting promises. Biological research can lead to advances in medical treatment and disease prevention in humans and in other organisms. It can reveal ways to help preserve organisms that are in danger of disappearing, and solve other problems, like the one described in *Figure 1.3*. The study of biology will teach you how humans function and how we fit in with the rest of the natural world. It will also equip you with the knowledge you need to help sustain this planet's web of life.



Figure 1.3

Honeybees and many other insects are important to farmers because they pollinate the flowers of crop plants, such as fruit trees. In the 1990s, populations of many pollinators declined, raising worries about reduced crop yields.

MiniLab 1.1

Observe

Predicting Whether Mildew

Is Alive What is mildew? Is it alive? We see it “growing” on plastic shower curtains or on bathroom grout. Does it show the characteristics associated with living things?



Mildew

Procedure



1 Copy the data table below.

Data Table	
Prediction	Life Characteristics
First	None
Second	
Third	

- 2 Predict whether or not mildew is alive. Record your prediction in the data table under “First Prediction.”
- 3 Obtain a sample of mildew from your teacher. Examine it for life characteristics. Make a second prediction and record it in the data table along with any observed life characteristics. **CAUTION: Wash hands thoroughly after handling the mildew sample. Do not handle the sample if you are allergic to mildew.**
- 4 Following your teacher’s directions, prepare a wet mount of mildew for viewing under the microscope. **CAUTION: Use caution when working with a microscope, microscope slides, and coverslips.**
- 5 Are there any life characteristics visible through the microscope that you could not see before? Make a third prediction and include any observed life characteristics.

Analysis

1. **Describe** Which life characteristics did you observe?
2. **Interpret Data** Compare your three predictions and explain how your observations may have changed them.
3. **Observe and Infer** Explain the value of using scientific tools to extend your powers of observation.

Figure 1.4

These plants are called *Lithops* from the Greek *lithos*, meaning “stone.” Although they don’t appear to be so, *Lithops* are just as alive as elephants. Both species possess all of the characteristics of life.

Characteristics of Living Things

Most people feel confident that they can tell the difference between a living thing and a nonliving thing, but sometimes it’s not so easy. In identifying life, you might ask, “Does it move? Does it grow? Does it reproduce?” These are all excellent questions, but consider a flame. A flame can move, it can grow, and it can produce more flames. Are flames alive?

Biologists have formulated a list of characteristics by which we can recognize living things. Sometimes, nonliving things have one or more of life’s characteristics, but only when something has all of them can it then be considered living. Anything that possesses all of the characteristics of life is known as an **organism**, like the plants shown in *Figure 1.4*. All living things

- have an orderly structure
- produce offspring
- grow and develop
- adjust to changes in the environment

Practice identifying the characteristics of life by carrying out the *MiniLab* on this page.



unified in having cellular organization. Whether an organism is made up of one cell or billions of cells, all of its parts function together in an orderly, living system.

Living things make more living things

One of the most obvious of all the characteristics of life is **reproduction**, the production of offspring. The litter of mice in *Figure 1.6* is just one example. Organisms don't live forever. For life to continue, they must replace themselves.

Reproduction is not essential for the survival of an individual organism, but it is essential for the continuation of the organism's species (SPEE sheez). A **species** is a group of organisms that can interbreed and produce fertile offspring in nature. If individuals in a species never reproduced, it would mean an end to that species' existence on Earth.

Living things change during their lives

An organism's life begins as a single



Figure 1.5

Like all organisms, earthworms are made up of cells. The cells form structures that carry out essential functions, such as feeding or digestion. The interaction of these structures and their functions result in a single, orderly, living organism.

cell, and over time, it grows and takes on the characteristics of its species. **Growth** results in an increase in the amount of living material and the formation of new structures.

All organisms grow, with different parts of the organism growing at different rates. Organisms made up of only one cell may change little during their lives, but they do grow. On the other hand, organisms made up of numerous cells go through many changes during their lifetimes, such as

Figure 1.6

A variety of mechanisms for reproduction have evolved that ensure the continuation of each species. Some organisms, including mice, produce many offspring in one lifetime.



CAREERS IN BIOLOGY

Nature Preserve Interpreter

If you like people as much as you love nature, you can combine your skills and interests in a career as a nature preserve interpreter.

Skills for the Job

Interpreters are also called naturalists, ecologists, and environmental educators. They might work for a nature preserve or a state or national park, where they give talks, conduct tours, offer video presentations, and teach special programs. Some interpreters are required to have a degree in biology, botany, zoology, forestry, environmental science, education, or a related field. They must also be skilled in communicating with others.

Many interpreters begin as volunteers who have no degrees, just a love for what they do. Over time, volunteers may become interns and eventually be hired. Interpreters often help restore natural habitats and protect existing ones. Part of their job is to make sure visitors do not harm these habitats and to point out the wonders of these natural areas.

For example, many tidepool organisms find protection from too much sunlight by crawling under rocks. A naturalist can explain the importance of replacing rocks exactly as they were found.



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Living things change during their lives

An organism's life begins as a single cell, and over time, it grows and takes on the characteristics of its species. **Growth** results in an increase in the amount of living material and the formation of new structures.

All organisms grow, with different parts of the organism growing at different rates. Organisms made up of only one cell may change little during their lives, but they do grow. On the other hand, organisms made up of numerous cells go through many changes during their lifetimes, such as the changes that will take place in the young nestlings shown in *Figure 1.7*. Think about some of the structural changes your body has already undergone since you were born. All of the changes that take place during the life of an organism are known as its **development**.

Living things adjust to their surroundings

Organisms live in a constant interface with their surroundings, or **environment**, which includes the air, water, weather, temperature, any other organisms in the area, and many other factors. For example, the fox in *Figure 1.8* feeds on small

Figure 1.7

All life begins as a single cell. As cells multiply, each organism grows and develops and begins to take on the characteristics that identify it as a member of a particular species, such as the owls shown here.





Figure 1.8

Living things respond to stimuli and make adjustments to environmental conditions.

A Trees that drop their leaves in the fall conserve water and avoid freezing during winter.



B Keen senses of smell and hearing enable a fox to find prey. Fur allows foxes and other mammals to regulate body temperature. Describe **What are some other examples of how feedback mechanisms help maintain homeostasis?**

animals such as rabbits and mice. The fox responds to the presence of a rabbit by quietly moving toward it, then pouncing. Trees adjust to cold, dry winter weather by losing their leaves. Anything in an organism's external or internal environment that causes the organism to react is a **stimulus**. A reaction to a stimulus is a **response**.

The ability to respond to stimuli in the environment is an important characteristic of living things. It's one of the more obvious ones, as well. That's because many of the structures and behaviors that you see in organisms enable them to adjust to the environment. Try the *BioLab* at the end of this chapter to find out more about how organisms respond to environmental stimuli.

Regulation of an organism's internal environment to maintain conditions suitable for its survival is called **homeostasis** (hoh mee oh STAY sus). Homeostasis is a characteristic of life because it is a process that occurs in all living things. Living things also use internal feedback to respond to internal changes. For example, organisms must make constant adjustments to

maintain the correct amount of water and minerals in their cells and the proper internal temperature. Without this ability to adjust to internal changes, organisms die.

Living things reproduce themselves, grow and develop, respond to external stimuli, and maintain homeostasis by using energy. **Energy** is the ability to cause change. Organisms get their energy from food. Plants make their own food, whereas animals, fungi, and other organisms get their food from plants or from organisms that consume plants.

Living things adapt and evolve

Any inherited structure, behavior, or internal process that enables an organism to respond to environmental factors and live to produce offspring is called an **adaptation** (a dap TAY shun).

Adaptations are inherited from previous generations. There are always some differences in the adaptations of individuals within any population of organisms. As the environment changes, some adaptations are more suited to the new conditions than others. Individuals with more suitable adaptations are more likely to

Figure 1.9

Living things adapt to their environments in a variety of ways.

- A** The desert Ocotillo has leaves only during the rainy season. Lacking leaves during the dry season is an adaptation which helps conserve water.



- B** Many nocturnal animals, such as this owl, possess large eyes for efficient vision at night.



survive and reproduce. As a result, individuals with these adaptations become more numerous in the population. *Figure 1.9* shows some examples of adaptation.

The gradual change in a species through adaptations over time is **evolution** (e vuh LEW shun). Clues to the way the present diversity of life came about may be understood through the study of evolution. You

will study how the theory of evolution can help answer many of the questions people have about living things.

As you learn more about Earth's organisms in this book, reflect on the general characteristics of life. Rather than simply memorizing facts about organisms or the vocabulary terms, try to see how these facts and vocabulary are related to the characteristics of living things.

Section Assessment

Understanding Main Ideas

1. What are some important reasons for studying biology?
2. Identify and describe how an organism could respond to an external stimulus. Describe a response to an internal stimulus.
3. Why is energy required for living things? How do living things obtain energy?
4. Describe how biologists' research contributes to our understanding of the world.

Thinking Critically

5. Describe how energy and homeostasis are related in living organisms.

Skill Review

6. **Observe and Infer** Suppose you discover an unidentified object on your way home from school. What characteristics would you study to determine whether the object is a living or nonliving thing? For more help, refer to *Observe and Infer* in the **Skill Handbook**.



Section 1.2

SECTION PREVIEW

Objectives

Compare different scientific methods.

Differentiate among hypothesis, theory, and principle.

Review Vocabulary

environment: an organism's surroundings (p. 8)

New Vocabulary

scientific methods
hypothesis
experiment
control
independent variable
dependent variable
safety symbol
data
theory

The Methods of Biology

Why does rain bring out the worms?

Using an Analogy Have you noticed that moss grows only in shady, moist locations? Or that earthworms crawl to the surface after a rain? If you have ever wondered why moss grows in certain locations, or why earthworms appear after a rain, then you have used methods like scientists use to develop experiments. You might examine locations such as the one in the photo and make notes on the environment in which moss grows. Scientists use many different methods to answer questions, but all scientific inquiries share some common methods.

Experiment *As you read the section, use your new knowledge of scientific methods to plan an investigative procedure to learn why moss grows only in shady, moist locations.*



Mosses are tiny plants that grow in dense clumps.

Observing and Hypothesizing

Curiosity is often what motivates biologists to try to answer simple questions about everyday observations, such as why earthworms leave their burrows after it rains. Earthworms obtain oxygen through their skin, and will drown in waterlogged soil. Sometimes, answers to questions like these also provide better understanding of general biological principles and may even lead to practical applications, such as the discovery that a certain plant can be used as a medicine. The knowledge obtained when scientists answer one question often generates other questions or proves useful in solving other problems.

The methods biologists use

To answer questions, biologists may use many different approaches, yet there are some steps that are common to all approaches. The common steps that biologists and other scientists use to gather information and answer questions are collectively known as **scientific methods**.

Scientific methods do not suggest a rigid approach to investigating and solving problems. There are no fixed steps to follow, yet scientific

Word Origin

hypothesis from the Greek words *hypo*, meaning “under,” and *thesis*, meaning a “placing”; A hypothesis is a testable explanation of a natural phenomenon.

Figure 1.10

Brown tree snakes (*Boiga irregularis*) were introduced to Guam more than 50 years ago. Since then, their numbers have increased dramatically, and they have severely reduced the native bird population of the island.

investigations generally involve making observations and collecting relevant information as well as using logical reasoning and imagination to make predictions and form explanations. Scientific methods usually begin with scientists identifying a problem to solve by observing the world around them.

The question of brown tree snakes

Have you ever been told that you have excellent powers of observation? This is one trait that is required of biologists. The story of the brown tree snake in **Figure 1.10** serves as an example. During the 1940s, this species of snake was accidentally introduced to the island of Guam from the Admiralty Islands in the Pacific Ocean. In 1965, it was reported in a local newspaper that the snake might be considered beneficial to the island because it is a predator that feeds on rats, mice, and other small rodents. Rodents are often considered pests because they carry disease and contaminate food supplies.

Shortly after reading the newspaper report, a young biologist walking through the forests of Guam made an important observation. She noted that there were no bird songs echoing through the forest. Looking into the trees, she saw a brown tree snake

hanging from a branch. After learning that the bird population of Guam had declined rapidly since the introduction of the snake, she hypothesized that the snake might be eating the birds. A **hypothesis** (hi PAHTH us sus) is an explanation for a question or a problem that can be formally tested. Hypothesizing is one of the methods most frequently used by scientists. A scientist who forms a hypothesis must be certain that it can be tested. Until then, he or she may propose suggestions to explain observations.

As you can see from the brown tree snake example, a hypothesis is not a random guess. Before a scientist makes a hypothesis, he or she has developed some idea of what the answer to a question might be through personal observations, extensive reading, or previous investigations.

After stating a hypothesis, a scientist may continue to make observations and form additional hypotheses to account for the collected data. Eventually, the scientist may test a hypothesis by conducting an experiment. The results of the experiment will help the scientist draw a conclusion about whether or not the hypothesis is correct.

Experimenting

People do not always use the word *experiment* in their daily lives in the same way scientists use it in their work. As an example, you may have heard someone say that he or she was going to experiment with a cookie recipe. Perhaps the person is planning to substitute raisins for chocolate chips, use margarine instead of butter, add cocoa powder, reduce the amount of sugar, and bake the cookies for a longer time. This is not an experiment in the scientific sense because there is no way to know what

effect any one of the changes alone has on the resulting cookies. To a scientist, an **experiment** is an investigation that tests a hypothesis by the process of collecting information under controlled conditions.

What is a controlled experiment?

Some experiments involve two groups: the control group and the experimental group. A control is the part of an experiment that is the standard against which results are compared. The control receives no experimental treatment. The experimental group is the test group that receives experimental treatment.

Suppose you wanted to learn how fertilizer affects the growth of different varieties of soybean plants. Your hypothesis might state that the presence of fertilizer will increase the growth rate of each plant variety. An experimental setup designed to test this hypothesis is shown in *Figure 1.11*. Fertilizer is present in the soil of the experimental plants, but not the controls. All other conditions—including soil, light, and water—are the same for both groups of plants.

Designing an experiment

In a controlled experiment, only one condition is changed at a time. The condition in an experiment that is tested is the **independent variable**, because it is the only factor that affects the outcome of the experiment. In the case of the soybeans, the presence of fertilizer is the independent variable. While testing the independent variable, the scientist observes or measures a second condition that results from the change. This condition is the **dependent variable**, because any changes in it depend on changes made to the independent variable. In the soybean experiment, the dependent variable



Figure 1.11

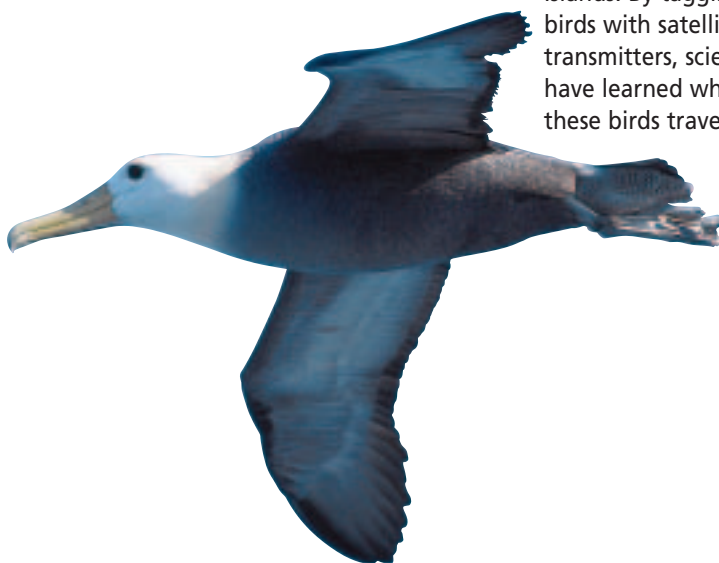
This experiment tested the effect of fertilizer on the growth of several varieties of soybeans. For each experiment there are three rows of each variety. The center rows are the experimental plants. The outer rows are the controls. Infer **What is the independent variable in this experiment?**

is the growth rate of the plants. Controlled experiments are most often used in laboratory settings.

However, not all investigations are controlled. Suppose you were on a group of islands in the Pacific that is the only nesting area for a large seabird known as a waved albatross, shown in *Figure 1.12*. Watching the nesting birds, you observe that the female leaves the nest when her mate flies back from a foraging trip. The birds take turns sitting on the eggs or caring for the chicks, often for two weeks at a time. You might hypothesize that the birds fly around the island, or that they fly to some distant location, in search of food. To test these hypotheses, you might attach a satellite transmitter to some of the birds and record their travels.

Figure 1.12

The waved albatross is a large bird that nests mainly on Hood Island in the Galápagos Islands. By tagging the birds with satellite transmitters, scientists have learned where these birds travel.



MiniLab 1.2

Investigate

Testing for Alcohol Promotional claims for certain over-the-counter products may not tell you that one of the ingredients is alcohol. How can you verify whether or not a certain product contains alcohol? One way is to simply rely on the information provided on a product label or an advertisement. Another way is to investigate and find out for yourself.



Procedure



Data Table		
	Color of Liquid	Alcohol Present
Circle A		
Circle B		
Circle C		
Product name		
Product name		

- 1 Copy the data table.
- 2 Draw three circles on a glass slide. Label them *A*, *B*, and *C*. **CAUTION: Put on safety goggles.**
- 3 Add one drop of water to circle *A*, one drop of alcohol to circle *B*, and one drop of alcohol-testing chemical to circles *A*, *B*, and *C*. **CAUTION: Rinse immediately with water if testing chemical gets on skin or clothing.**
- 4 Wait 2–3 minutes. Note in the data table the color of each liquid and the presence or absence of alcohol.
- 5 Record the name of the first product to be tested.
- 6 Draw a circle on a clean glass slide. Add one drop of the product to the circle.
- 7 Add a drop of the alcohol-testing chemical to the circle. Wait 2–3 minutes. Record the color of the liquid.
- 8 Repeat steps 5–7 for each product to be tested. **CAUTION: Wash your hands with soap and water immediately after using the alcohol-testing chemical.**
- 9 Complete the last column of the data table. If alcohol is present, the liquid turns green, deep green, or blue. A yellow or orange color means no alcohol is present.

Analysis

1. **Infer** Explain the purpose of using the alcohol-testing chemical with water, with a known alcohol, and by itself.
2. **Evaluate** Which products did contain alcohol? No alcohol?

An investigation such as this, which has no control, is the type of biological investigation most often used in fieldwork.

The design of the procedure that is selected depends on what other investigators have done and what information the biologist hopes to gain. Sometimes, a biologist will design a second investigation even while a first one is being conducted, to answer the question. Try your hand at investigation in the *MiniLab* on this page.

Reading Check Describe the roles of a control, independent variable, and dependent variable.

Using tools

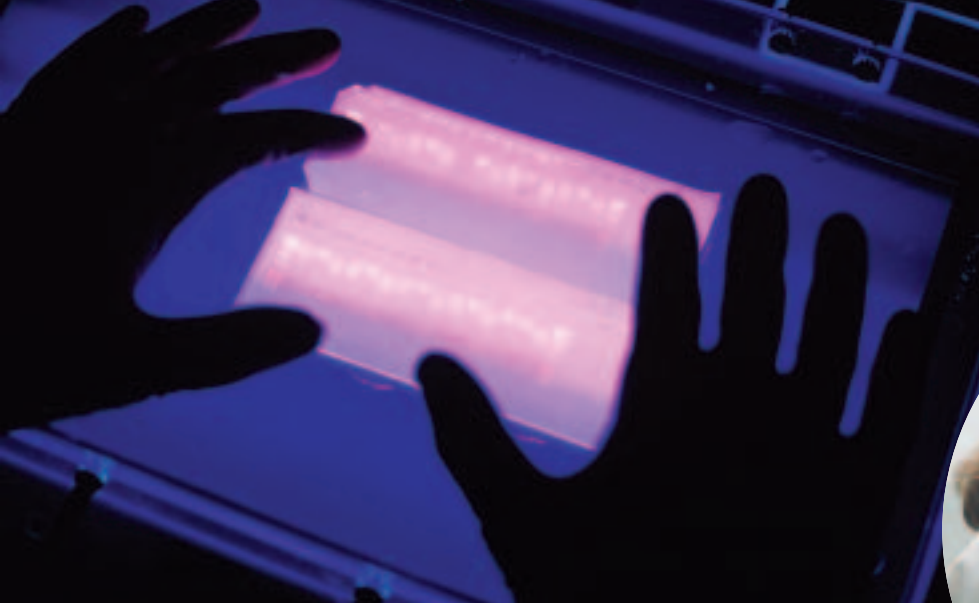
To carry out investigations, scientists need tools that enable them to record information. The growth rate of plants and the information from satellite transmitters placed on albatrosses are examples of important information gained from investigations.

Biologists use a variety of tools to obtain information in an investigation. Common tools include beakers, test tubes, hot plates, petri dishes, thermometers, balances, metric rulers, and graduated cylinders. More complex tools include microscopes, centrifuges, radiation detectors, spectrophotometers, DNA analyzers, and gas chromatographs. *Figure 1.13* shows some complex tools.

Maintaining safety

Safety is another important factor that scientists consider when carrying out investigations. Biologists try to minimize hazards to themselves, the people working around them, and the organisms they are studying.

In the investigations in this textbook, you will be alerted to possible safety hazards by the safety symbols shown in *Table 1.1* and precautions.



A Gel electrophoresis can be used to produce a DNA fingerprint as shown. Comparing DNA reveals how closely related two species are.



B The optical microscope makes small details visible.

Figure 1.13

Biologists use many tools in their studies.

A **safety symbol** is a symbol that warns you about a danger that may exist from chemicals, electricity, heat, or procedures you will use. Refer to the safety symbols at the back of this book before beginning any field investigation or lab activity in this text. It is your responsibility to maintain the highest safety standards to protect yourself as well as your classmates.

Data gathering

To answer their questions about scientific problems, scientists seek information from their investigations. Information obtained from investigations is called **data**. Sometimes, these data are referred to as experimental results.

Often, data are in numerical form, such as the distance covered in an albatross's trip or the height that soybean plants grow per day. Numerical data may be measurements of time, temperature, length, mass, area, volume, or other factors. Numerical data may also be counts, such as the number of bees that visit a flower per day or the number of wheat seeds that germinate at different soil temperatures.

Sometimes data are expressed in verbal form, using words to describe

observations made during an investigation. Scientists who first observed the behavior of pandas in China obtained data by recording what these animals do in their natural habitat and how they respond to their environment. Learning that pandas are solitary animals with large territories helped scientists understand how to provide better care for them in zoos and research centers.

Having the data from an investigation does not end the scientific process. See how data collection relates to other important aspects of research on pages 1060–1061 in the *Focus On*.

Table 1.1 Safety Symbols



Sharp Object Safety This symbol appears when a danger of cuts or punctures caused by the use of sharp objects exists.



Clothing Protection Safety This symbol appears when substances used could stain or burn clothing.



Eye Safety This symbol appears when a danger to the eyes exists. Safety goggles should be worn when this symbol appears.



Chemical Safety This symbol appears when chemicals used can cause burns or are poisonous if absorbed through the skin.

Problem-Solving Lab 1.1

Analyze Information

Are promotional claims valid?

"Our product is new and improved."
"Use this mouthwash and your mouth will feel clean all day." Sound familiar? TV and radio commercials constantly tell us how great certain products are. Are these claims always based on facts?



Solve the Problem

Listen to or view a commercial for a product that addresses a medical problem such as heartburn, allergies, or bad breath. If possible, tape the commercial so that you can replay it as often as needed. Record the following information:

1. What is the major claim made in the commercial?
2. Is the claim based on experimentation?
3. What data, if any, are used to support the claim?

Thinking Critically

1. **Evaluate** In general, was the promotional claim based on scientific methods? Explain your answer.
2. **Evaluate** In general, are promotional claims made in advertisements based on experimental evidence? Explain your answer.
3. **Experiment** Plan an investigative procedure that could be conducted to establish promotional claims made for the product in your advertisement.

Thinking about what happened

Often, the thinking that goes into analyzing data takes the greatest amount of a scientist's time. After careful review of the results, the scientist must come to a conclusion: Was the hypothesis supported by the data? Was it not supported? Are more data needed? Data from an investigation may be considered confirmed only if repeating that investigation several times yields similar results. To review how scientific methods are used in investigations, see *Figure 1.14* on the next page.

After analyzing the data, scientists often have more questions than they had before the investigation. They compare their results and conclusions with the results of other studies by researching the published literature for more information. They also begin to think of other experiments they might carry out. Are all the claims you hear on TV commercials based on data gathered by scientific methods? Find out by conducting the *Problem-Solving Lab* here.

Reporting results

Results and conclusions of investigations are reported in scientific journals, where they are available for examination by other scientists. Hundreds of scientific journals are published weekly or monthly. In fact, scientists usually spend a large part of their time reading journal articles to keep up with new information as it is reported. The amount of information published every day in scientific journals is more than any single scientist could read. Fortunately, scientists also have access to computer databases that contain summaries of scientific articles, both old and new.

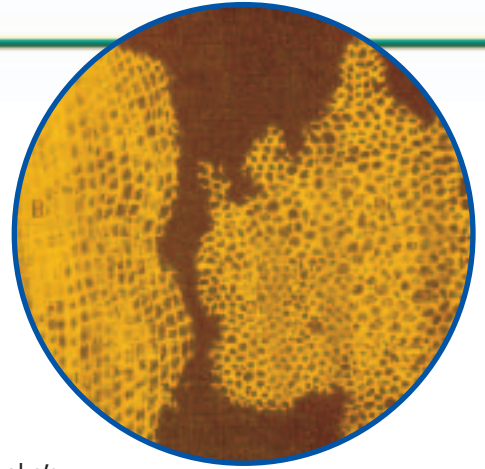
Verifying results

Data and conclusions are shared with other scientists for an important reason. After results of an investigation have been published, other scientists can try to verify the results by repeating the procedure. If they obtain similar results, there is even more support for the hypothesis. When a hypothesis is supported by data from additional investigations, it is considered valid and is generally accepted by the scientific community. When a scientist publishes the results of his or her investigation, other scientists can relate their own work to the published data.

Scientific Methods

Figure 1.14

Scientific methods are used by scientists to answer questions and solve problems. The development of the cell theory, one of the most useful theories in biological science, illustrates how the methods of science work. In 1665, Robert Hooke first observed cells in cork. He made the drawing on the right, showing what he saw. **Critical Thinking** *What is the function of other scientists in the scientific process?*



Cork cells as drawn by Robert Hooke

- A Observing** The first step toward scientific discovery often takes place when a scientist observes something no one has noticed before. After Hooke's discovery, other scientists observed cells in a variety of organisms.
- B Making a hypothesis** A hypothesis is a testable explanation or answer to a question. In 1824, René Dutrochet hypothesized that cells are the basic unit of life.
- C Collecting data** Data can support or disprove a hypothesis. Over the years, scientists who used microscopes to examine organisms found that cells are always present.
- D Publishing results** Results of an investigation are useful only if they are made available to other scientists for a peer review. Many scientists published their observations of cells in the scientific literature. Scientists will analyze the procedure, examine the evidence, identify faulty reasoning, point out statements that go beyond the evidence, and suggest alternative explanations for the same observations.
- E Forming a theory** A theory is a hypothesis that is supported by a large body of scientific evidence. By 1839, many scientific observations supported the hypothesis that cells are fundamental to life. The hypothesis became a theory.
- F Developing new hypotheses** A new theory may prompt scientists to ask new questions or form additional hypotheses. In 1833, Robert Brown hypothesized that the nucleus is an important control center of the cell.
- G Revising the theory** Theories are revised as new information is gathered. The cell theory gave biologists a start for exploring the basic structure and function of all life. Important discoveries, including the discovery of DNA, have resulted.





Figure 1.15

Investigations have shown that male elephants communicate with other males using threat postures and low-frequency vibrations that warn rival males away.

For example, biologists studying the behavior of elephants in Africa published their observations. Other scientists, who were studying elephant communication, used that data to help determine which of the elephants' behaviors are related to communication. Further investigations showed that female elephants emit certain sounds in order to attract mates, and that some of the sounds

produced by bull elephants warn other males away from receptive females, as described in *Figure 1.15*.

Theories and laws

People use the word *theory* in everyday life very differently from the way scientists use this word in their work. You may have heard someone say that he or she has a theory that a particular football team will win the Super Bowl this year. What the person really means is that he or she believes one team will play better for some reason. Much more evidence is needed to support a scientific theory.

In science, a hypothesis that is supported by many separate observations and investigations, usually over a long period of time, becomes a theory. A **theory** is an explanation of a natural phenomenon that is supported by a large body of scientific evidence obtained from many different investigations and observations. A theory results from continual verification and refinement of a hypothesis.

In addition to theories, scientists also recognize certain facts of nature, called laws or principles, that are generally known to be true. The fact that a dropped apple falls to Earth is an illustration of the law of gravity.

Section Assessment

Understanding Main Ideas

1. Suppose you observed that bees prefer a yellow flower that produces more nectar over a purple flower that produces less nectar. List two separate hypotheses that you might make about bees and flowers.
2. Describe a controlled experiment you could perform to determine whether ants are more attracted to butter or to honey.
3. What is the difference between a theory and a hypothesis?
4. Why do some investigations require a control?

Thinking Critically

5. Describe a way that a baker might conduct a controlled experiment with a cookie recipe.

Skill Review

6. **Interpret Scientific Illustrations** Review *Figure 1.14*. What happens when a hypothesis is not supported? How does the strength of a scientific theory compare to the strength of a hypothesis? For more help, refer to *Interpret Scientific Illustrations* in the **Skill Handbook**.



Section 1.3

SECTION PREVIEW

Objectives

Compare and contrast quantitative and qualitative information.

Explain why science and technology cannot solve all problems.

Review Vocabulary

experiment: procedure that tests a hypothesis by collecting information (p. 13)

New Vocabulary

ethics
technology

The Nature of Biology

Two Ways to Describe Things

Using Prior Knowledge How would you describe your homeroom class? Would you mention how many classmates you have? Or would you describe them as good students? Would you tell someone how many boys or how many girls comprise the class? Perhaps you would narrate how your classmates carried out an experiment. Most information you could give would be either quantitative or qualitative. Quantitative information uses numbers or measurements, while qualitative information expresses qualities and behavior.

Organize Information *Make a list of ways you could describe your class. Divide the list into two categories: Quantitative and Qualitative.*



This group of students can be described with quantitative or qualitative information.

Kinds of Information

You have learned that scientists use a variety of methods to test their hypotheses about the natural world. Scientific information can usually be classified into one of two main types, quantitative or qualitative.

Quantitative information

Biologists sometimes conduct controlled experiments that result in counts or measurements—that is, numerical data. These kinds of experiments occur in quantitative research. The data are analyzed by comparing numerical values.

Quantitative data may be used to make a graph or table. Graphs and tables communicate large amounts of data in a form that is easy to understand. Suppose, for example, that a biologist is studying the effects of climate on freshwater life. He or she may count the number of microscopic organisms, called *Paramecium*, that survive at a given temperature. This study is an example of quantitative research.

The data obtained from the *Paramecium* study is presented as a graph in *Figure 1.16*. You can practice using graphs by carrying out the *Problem-Solving Lab* on the next page.

Problem-Solving Lab 1.2

Make and Use Graphs

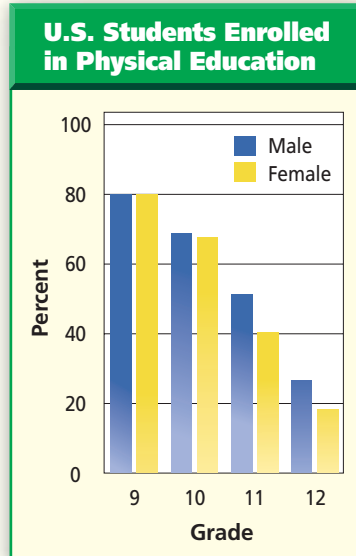
What can be learned from a graph? One way to express information is to present it in the form of a graph. The amount of information available from a graph depends on the nature of the graph itself.

Solve the Problem

Study the graph at right. Answer the questions that follow and note the type of information that can and cannot be answered from the graph itself.

Thinking Critically

- 1. Observe** Is there ever a year in high school when all students are enrolled in physical education? Explain your answer.
- 2. Infer** Is there a relationship between the number of students enrolled in physical education and their year of high school? Explain your answer.
- 3. Observe** Can you tell which states in the country have the largest number of students enrolled in physical education?
- 4. Infer** Based on the graph, can you explain why so few students take physical education in their senior year?



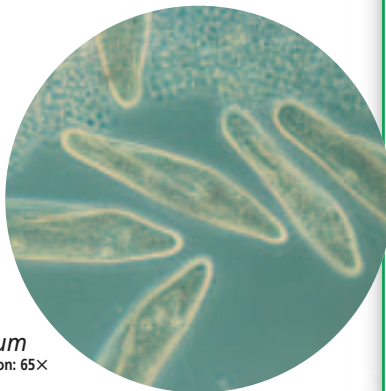
Measuring in the International System

It is important that scientific research be understandable to scientists around the world. For example, what if scientists in the United States reported quantitative data in inches, feet, yards, ounces, pounds, pints, quarts, and gallons? People in many other countries would have trouble understanding these data because they are unfamiliar with the English system of measurement. Instead, scientists always report measurements in a form of the metric system called the International System of Measurement, commonly known as SI.

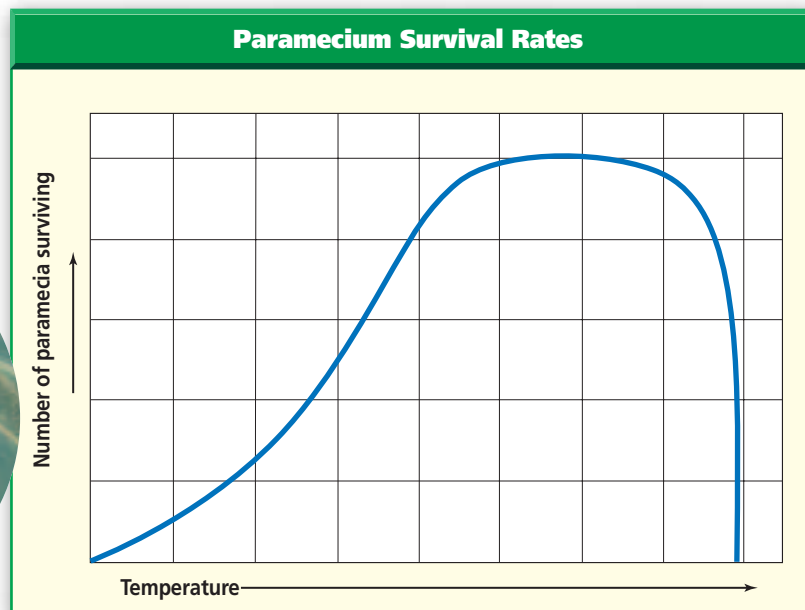
One advantage of SI is that there are only a few basic units, and nearly all measurements can be expressed in these units or combinations of them. The greatest advantage is that SI, like the metric system, is a decimal system. Measurements can be expressed in multiples of tens or tenths of a basic unit by applying a standard set of prefixes to the unit. In biology, the metric units you will encounter most often are meter (length), gram (mass),

Figure 1.16

This graph shows how many paramecia—microscopic organisms—survive as the temperature increases. **Infer** *What type of information is represented by the graph?*



Paramecium
LM Magnification: 65X





A Penguins cannot fly. They use their wings for swimming in the oceans of the southern hemisphere.



B Toucans live in the rain forests of South America.

Figure 1.17
What kinds of information are gained by observing these animals?

liter (volume), second (time), and Celsius degree (temperature). For a thorough review of measurement in SI, see *Math and Problem-Solving Skills* in the **Skill Handbook**.

 **Reading Check** Explain why scientists use the SI system.

Qualitative information

Do you think the behavior of the animals shown in *Figure 1.17* would be easier to explain with numbers or with written descriptions of what the animals did? Observational data—that is, written descriptions of what scientists observe—are often just as important in the solution of a scientific problem as numerical data.

When biologists use purely observational data, they are using qualitative information. Qualitative information is useful because some phenomena aren't easily expressed as quantitative information. For example, the albatross example on page 13 cannot easily be illustrated with numbers. Practice your investigative skills in the *MiniLab* on the next page.

Science and Society

The road to scientific discovery includes making observations, formulating hypotheses, performing

investigations, collecting and analyzing data, drawing conclusions, and reporting results in scientific journals. No matter what methods scientists choose, their research often provides society with important information that can be put to practical use.

Maybe you have heard people blame scientists for the existence of nuclear bombs or controversial drugs. To comprehend the nature of science in general, and biology in particular, people must understand that knowledge gained through scientific research is never inherently good or bad. Notions of good and bad arise out of human social, ethical, and moral concerns. **Ethics** refers to the moral principles and values held by humans. Scientists might not consider all the possible applications for the products of their research when planning their investigations. Society as a whole must take responsibility for the ethical use of scientific discoveries.

Can science answer all questions?

Some questions are simply not in the realm of science. Such questions may involve decisions regarding good versus evil, ugly versus beautiful, or similar judgments. There are also scientific questions that cannot be

Word Origin

technology from the Greek words *techne*, meaning an "art or skill," and *logos*, meaning "study"; Technology is the application of science in our daily lives.

MiniLab 1.3

Observe and Infer

Hatching Dinosaurs Candy “dinosaur eggs” can be found in specially marked packages of oatmeal. You will conduct an investigation to determine what causes these pretend eggs to hatch.

Procedure



Data Table

	Before Treatment	Hot Water Treatment	Cold Water Treatment
Appearance after one minute			

- 1 Copy the data table above.
- 2 Observe the dinosaur eggs provided, and record their characteristics in your table.
- 3 Place an egg in each of two containers.
- 4 Form a hypothesis about the water temperature that will cause the eggs to hatch.
- 5 Pour hot water into one container and cold water in the other. **CAUTION: Be careful with hot water.** Stir for one minute. Record your observations.

Analysis

1. **Analyze Data** Was your hypothesis supported? How would you revise it using the new information?
2. **Experiment** Design an experiment that would test either heat or moisture as the variable. What kind of quantitative data will you gather? What will be your control? How many trials will you run and how many eggs will you test? If time permits, conduct your experiment.

tested using scientific methods. However, this does not mean that these questions are unimportant.

Consider a particular question that is not testable. Some people assert that if a black cat crosses your path, you will have bad luck. On the surface, that hypothesis appears to be one that you could test. But what is bad luck, and how long would you have to wait for the bad luck to occur? How would you distinguish between bad luck caused by the black cat and bad luck that occurs at random? Once you examine the question, you can see there is no way to test it scientifically because you cannot devise a controlled experiment that would yield valid data.

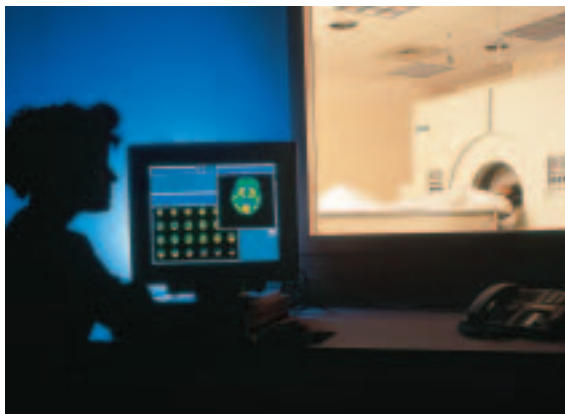
Can technology solve all problems?

Science attempts to explain how and why things happen. Scientific study that is carried out mainly for the sake of knowledge—with no immediate interest in applying the results to daily living—is called pure science.

However, much of pure science eventually does have an impact on people’s lives. Have you ever thought about what it was like to live in the world before the development of water treatment plants, vaccinations, antibiotics, or high-yielding crops? These and other life-saving developments, such as the brain scan shown in *Figure 1.18*, are indirect results of research done by scientists in many different fields over hundreds of years.

Other scientists work in research that has obvious and immediate applications. **Technology** (tek NAH luh jee) is the application of scientific research to society’s needs and problems. It is concerned with making improvements in human life and

Figure 1.18
Technology allows doctors to develop and use better tools to diagnose medical problems.



the world around us. Technology has helped increase the production of food, reduced the amount of manual labor needed to make products and raise crops, and aided in the reduction of wastes and environmental pollution.

The advance of technology has benefited humans in numerous ways, but it has also resulted in some serious problems. For example, fertilizer is often used to boost the production of food crops, such as the corn shown in *Figure 1.19*. If more fertilizer is applied than the plants are able to use, the excess fertilizer can flow into streams or even oceans. Excess nitrogen has been shown to cause problems with some coral reefs by promoting the growth of algae.

Science and technology will never answer all of the questions we ask, nor will they solve all of our problems. However, during your study of biology you will have many of your questions answered, and you will explore many new concepts. As you learn more about living things, remember that you are a part of the living world, and you can use the processes of science to ask and answer questions about that world.



Figure 1.19

Technology allows farmers to use fertilizers that increase their crop production in order to meet the world's food needs. Crop yields from this field of corn are maximized with the use of improved plant breeds and fertilizer in order to feed the world's growing population.

Section Assessment

Understanding Main Ideas

1. Why is it important that scientific investigations be repeated? What happens when other scientists achieve different results when repeating an investigation?
2. Compare and contrast quantitative and qualitative. Explain how both types of information are important to biological studies.
3. Why is science considered to be a combination of information and process?
4. Why is technology not the solution to all scientific problems?

Thinking Critically

5. Biomedical research has led to the development of technology that can keep ill or incapacitated patients alive. How does this technology address the question of when such measures should be used on patients?

Skill Review

6. **Make and Use Graphs** Look at the graph in *Figure 1.16*. Why do you think that the high-temperature side of the graph drops off more sharply than the low-temperature side? For more help, refer to *Make and Use Graphs* in the **Skill Handbook**.



INTERNET BioLab



Before You Begin

Seeing different life forms, and even interacting with them, is pretty much part of a typical day. Petting a dog, swatting at a fly, cutting the grass, and talking to your friends are common examples. But, have you ever asked yourself the question, "What do all of these different life forms have in common?"



Collecting Biological Data

PREPARATION

Problem

What life characteristics can be observed in a pill bug?

Objectives

In this BioLab, you will:

- **Observe** whether life characteristics are present in a pill bug.
- **Measure** the length of a pill bug.
- **Experiment** to determine if a pill bug responds to changes in its environment.
- **Use the Internet** to collect and compare data from other students.



Materials

pill bugs, *Armadillidium* ruler
 watch or classroom clock internet connection
 container, glass or plastic pencil with dull point

Safety Precautions

CAUTION: *Always wear goggles in the lab.*

Skill Handbook

If you need help with this lab, refer to the **Skill Handbook**.

Data Table

Organization and Growth and Development	
Orderly structure?	
Pill bug length in mm	

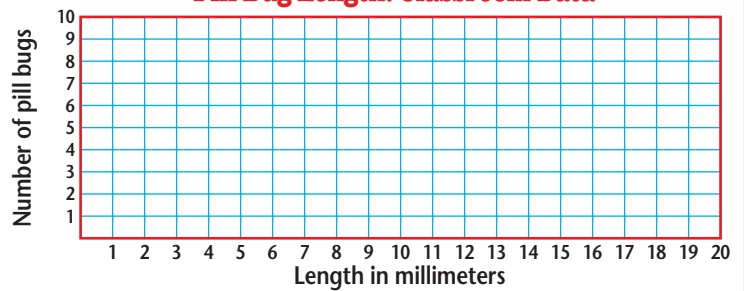
Response to Environment	
Trial	Time in Seconds
1	
2	
3	
4	
5	
Total	
Average time	

PROCEDURE

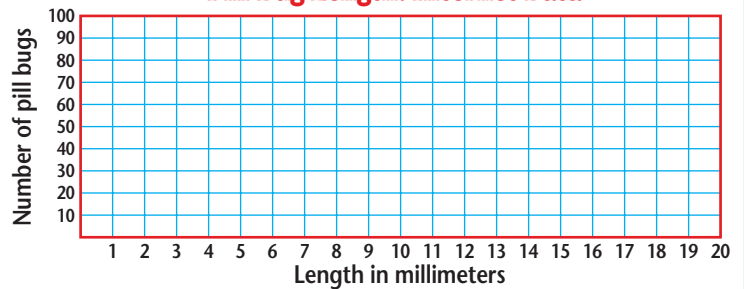
1. Make copies of the data table and graph outlines.
2. Obtain a pill bug from your teacher and place it in a small container.
3. Observe your pill bug to determine if it has an orderly structure. Record your observations in the data table.
4. Using millimeters, measure and record the length of your pill bug in the data table.
5. Using your data and data from your classmates, complete the graph "Pill Bug Length: Classroom Data."

- Go to bdol.glencoe.com/internet_lab to post your data.
- Gently touch the underside of the pill bug with a *dull* pencil point. **CAUTION: Use care to avoid injuring the pill bug.**
- Note its response and time, in seconds, how long the animal remains curled up. Record the time in the data table as Trial 1.
- Repeat steps 7–8 four more times, recording each trial in the data table.
- Calculate the average length of time your pill bug remains curled up.
- Post your data at bdol.glencoe.com/internet_lab.
- CLEANUP AND DISPOSAL** Wash your hands after working with pill bugs. Return the pill bug to your teacher and suggest ways to release or reuse the bugs wisely.

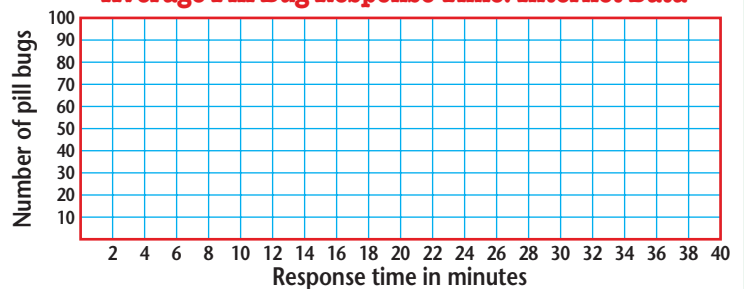
Pill Bug Length: Classroom Data



Pill Bug Length: Internet Data



Average Pill Bug Response Time: Internet Data



ANALYZE AND CONCLUDE

- Think Critically** Define the term “orderly structure.” Explain how this trait also pertains to nonliving things.
- Use the Internet** Explain how data from the classroom and Internet graphs support the idea that pill bugs grow and develop.
- Interpret Data** What was the most common length of time pill bugs remained curled in response to being touched?
- Draw a Conclusion** Explain how the response to being touched is an adaptation.
- Experiment** How might you design an experiment to determine whether or not pill bugs reproduce?
- ERROR ANALYSIS** How might you collect or analyze data to better define a living organism?

Share Your Data

Find this BioLab using the link below, and post your data in the data table provided for this activity. Using the additional data from other students on the Internet, analyze the combined data, and complete your graphs.



bdol.glencoe.com/internet_lab

Organic Food: Is it healthier?

The produce section of the supermarket has two bins of leafy lettuce that look very much alike. One is labeled “organic” and has a higher price. More and more consumers are willing to pay extra for organically grown fruits, vegetables, meats, and dairy products. What are they paying that extra money for?

The term “organic” usually refers to foods that are produced without the use of chemical pesticides, herbicides, or fertilizers. Organic farmers use nonchemical methods to control pests and encourage crop growth. Beneficial insects, such as ladybugs and *Trichogramma* wasps, are brought in to feed on aphids, caterpillars, and other damaging insects. Instead of applying herbicides, organic farmers pull weeds by hand or by machine. In place of fertilizers, they use composting and crop rotation to enrich the soil. Organic farming is very labor intensive, so organic foods are usually more expensive than those produced by conventional methods.

Perspectives People usually buy organic products because they want to be sure they’re getting nutritious food with no chemical residues. But there are differences of opinion about how much better organic food actually is, and even which foods should be called organic.

Is organic food healthier? Agricultural chemicals can leave residues on food and contaminate drinking water supplies. Since exposure to some chemicals is known to cause health problems, including cancer, many consumers think that organic foods are healthier. Chemical pest controls kill beneficial organisms as well as unwanted pests, and can adversely affect the health of other animals, especially those that feed on insects. Organic pest control methods usually target specific pests and have little effect on beneficial organisms.



Produce from an organic farm



Conventionally grown food: Low cost, higher yield? Chemical fertilizers and pesticides make it possible to grow larger crops at lower cost, which makes more food available to more people. Making sure everyone can afford an adequate supply of fruits and vegetables may be more important than the risk of disease posed by agricultural chemicals.

Not everyone agrees about what is organic and what isn’t. Should genetically engineered plant or animal foods be considered organic? What about herbs or meats preserved by irradiation, or lettuce and tomatoes fertilized with sewage sludge?

Forming Your Opinion

Analyze the Issue Use resources to investigate your state’s standards for labeling food products as “organic.” Look for research that shows that organically grown food is safer than conventionally grown food. Describe your findings in your science journal.



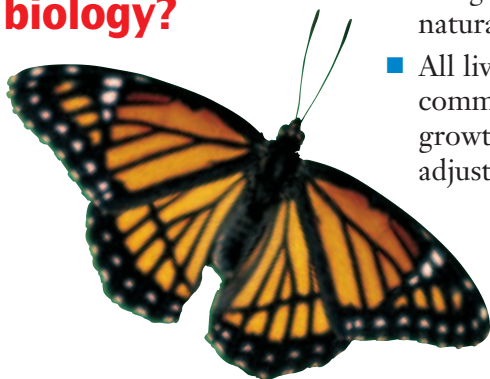
To find out more about organic food, visit bdol.glencoe.com/biology_society

Chapter 1 Assessment

STUDY GUIDE

Section 1.1

What is biology?



Key Concepts

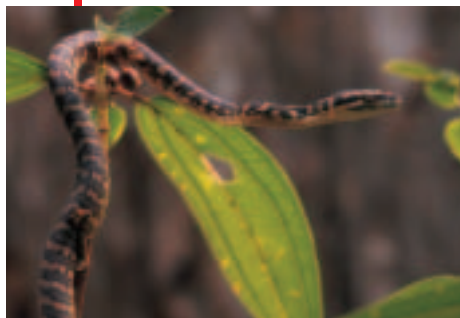
- Biology is the organized study of living things and their interactions with their natural and physical environments.
- All living things have four characteristics in common: organization, reproduction, growth and development, and the ability to adjust to the environment.

Vocabulary

adaptation (p. 9)
biology (p. 3)
development (p. 8)
energy (p. 9)
environment (p. 8)
evolution (p. 10)
growth (p. 8)
homeostasis (p. 9)
organism (p. 6)
organization (p. 7)
reproduction (p. 7)
response (p. 9)
species (p. 7)
stimulus (p. 9)

Section 1.2

The Methods of Biology



Key Concepts

- Biologists use controlled experiments to obtain data that either do or do not support a hypothesis. By publishing the results and conclusions of an experiment, a scientist allows others to try to verify the results. Repeated verification over time leads to the development of a theory.
- Scientific methods are used by scientists to answer questions or solve problems. Scientific methods include observing, making a hypothesis, collecting data, publishing results, forming a theory, developing new hypotheses, and revising the theory.

Vocabulary

control (p. 13)
data (p. 15)
dependent variable (p. 13)
experiment (p. 13)
hypothesis (p. 12)
independent variable (p. 13)
safety symbol (p. 15)
scientific methods (p. 11)
theory (p. 18)

Section 1.3

The Nature of Biology



Key Concepts

- Biologists do their work in laboratories and in the field. They collect both quantitative and qualitative data from their experiments and investigations.
- Scientists conduct investigations to increase knowledge about the natural world. Scientific results may help solve some problems, but not all.

Vocabulary

ethics (p. 21)
technology (p. 22)

FOCUS
Study Guide

To help you review the characteristics of living things, use the Organizational Study Fold on page 3.



Chapter 1 Assessment

Vocabulary Review

Review the Chapter 1 vocabulary words listed in the Study Guide on page 27. Match the words with the definitions below.

- the application of scientific research to society's needs and problems
- any structure, behavior, or internal process that enables an organism to respond to environmental factors and live to produce offspring
- anything that possesses all the characteristics of life
- a group of organisms that can interbreed and produce fertile offspring in nature
- an explanation for a question or problem that can be tested

Understanding Key Concepts

- Which of the following is not an appropriate question for science to consider?
 - How many seals can a killer whale consume in a day?
 - Which type of orchid flower is most beautiful?
 - What birds prefer seeds as a food source?
 - When do hoofed mammals in Africa migrate northward?
- Similar-looking organisms, such as the dogs shown below, that can interbreed and produce fertile offspring are called _____.
 - a living system
 - an adaptation
 - organization
 - a species



- If data from repeated experiments do not support the hypothesis, what is the scientist's next step?
 - Declare the experiment unsuccessful.
 - Revise the hypothesis.
 - Repeat the experiment.
 - Overturn the theory.





- The single factor that is altered in an experiment is the _____.
 - control
 - dependent variable
 - hypothesis
 - independent variable

Constructed Response

- Open Ended** Describe how the human body shows the life characteristic of organization.
- Open Ended** Scientists use quantitative data to derive mathematical models, termed biometrics. Research two definitions and uses of biometrics in today's society.
- Describe** Explain the relationships among an organism's environment, adaptations, and evolution.

Thinking Critically

Table 1.1 Safety Symbols

	Sharp Object Safety This symbol appears when a danger of cuts or punctures caused by the use of sharp objects exists.
	Clothing Protection Safety This symbol appears when substances used could stain or burn clothing.
	Eye Safety This symbol appears when a danger to the eyes exists. Safety goggles should be worn when this symbol appears.
	Chemical Safety This symbol appears when chemicals used can cause burns or are poisonous if absorbed through the skin.

- Interpret** An experiment involves heating chemicals in a test tube over a flame. Which of the safety symbols shown above should be used in the experiment? Which symbol from the **Skill Handbook** is needed above, but missing from this table?
- REAL WORLD BIOCHALLENGE** Recently members of Congress have debated the issue of human cloning. Visit bdol.glencoe.com to investigate this debate. Write an essay expressing your opinion. Use reasoning based on your understanding of the debate to support your opinion. Present your opinion in a debate with members of your class.



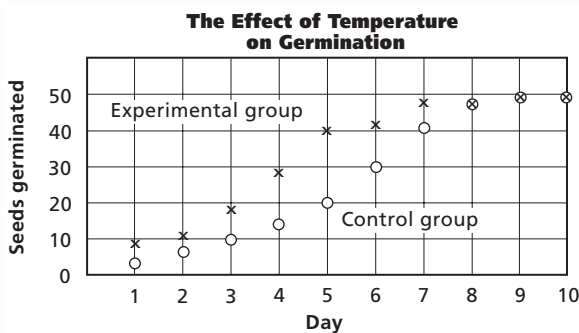
Chapter 1 Assessment

Standardized Test Practice

All questions aligned and verified by



Part 1 Multiple Choice



A team of students measured the number of seeds that germinated over ten days in a control group at 18°C and in an experimental group at 25°C. They graphed their data as shown above. Study the graph and answer questions 15–18.

15. Which of the following best represents the hypothesis tested?
- A. Black seeds are best.
 - B. Seeds germinate faster at warmer temperatures.
 - C. Fertilization of seeds requires heat.
 - D. Seeds germinate when freezing.
16. When did the experiment end?
- A. day 3
 - B. day 6
 - C. day 7
 - D. day 10
17. Which of the following was the independent variable?
- A. kind of seeds
 - B. number germinating
 - C. temperature
 - D. time
18. Which of the following was the dependent variable?
- A. kind of seeds
 - B. number germinating
 - C. temperature
 - D. time
- Use the drawing below to answer question 19.
19. In scientific investigations it is important to collect data and make measurements with precision. A graduated cylinder is often used to measure volumes of liquids accurately and precisely. The surface of many liquids in a graduated cylinder forms a curved surface called a meniscus. What is the volume of fluid in the graduated cylinder shown on the right?
-
- A. 79 mL C. 81 mL
B. 80 mL D. 75 mL
20. Which of the following statements is true of a theory?
- A. A theory is considered true and never changes.
 - B. A theory makes predictions about unknown phenomena.
 - C. A theory is the same thing as a hypothesis.
 - D. A theory is the usual outcome of an experiment.

Part 2 Constructed Response/Grid In

Record your answers on your answer document.

21. **Open Ended** Why does a panel of doctors, lawyers, clergy, and others sometimes convene to determine if an experimental operation should be allowed on human patients?
22. **Open Ended** Consider the following items: a flame, bubbles blown from a bubble wand, and a balloon released into the air. Describe characteristics of each that might indicate life and those that indicate they are not alive.



BioDigest

UNIT 1 REVIEW

What is biology?

Living things abound almost everywhere on Earth—in deep ocean trenches, atop the highest mountains, in dry deserts, and in wet tropical forests. Biology is the study of living organisms and the interactions among them. Biologists use a variety of scientific methods to study the details of life.



Characteristics of Life

Biologists have formulated a list of characteristics by which we can recognize living things.

Organization

All living things are organized into cells. Organisms may be composed of one cell or many cells. Cells are like rooms in a building. You can think of a many-celled organism as a building containing many rooms. Groups of rooms in different areas of the building are used for different purposes. These areas are analogous to the tissues, organs, and body systems of plants and animals.

Homeostasis

A stable internal environment is necessary for life. Organisms maintain this stability through homeostasis, which is a process that requires the controlled use of energy in cells. Plants obtain energy by converting light, water, and carbon dioxide into food. Other organisms obtain their energy indirectly from plants.

Response to a Stimulus

Living things respond to changes in their external environment. Any change, such as a rise in temperature or the presence of food, is a stimulus.

Growth and Development

When living things grow, their cells enlarge and divide. As organisms age, other changes also take place. Development consists of the changes in an organism that take place over time.

Reproduction

Living things reproduce by transmitting their hereditary information from one generation to the next.

Scientific Methods

Scientists employ a variety of scientific methods to investigate questions and solve problems. Not all investigations will use all methods, and the order in which they are used will vary.

Observation

Curiosity leads scientists to make observations that raise questions about natural phenomena.

Hypothesis

A statement that can be tested and presents a possible solution to a question is a hypothesis.

Experiment

After making a hypothesis, the next step is to test it. An experiment is a formal method of testing a hypothesis. In a controlled experiment, two groups are tested and all conditions except one are kept the same for both groups. The single condition that changes is the independent variable. The condition caused by the change in the independent variable is called the dependent variable.

Theory

When a hypothesis has been confirmed by many experiments, it may become a theory. Theories explain natural phenomena.



TEST-TAKING TIP

Maximize Your Score

Ask how your test will be scored. In order to do your best, you need to know if there is a penalty for guessing, and if so, how much of a penalty. If there is no random-guessing penalty at all, you should always fill in an answer.

Part 1 Multiple Choice

- The basic unit of organization of living things is a(n) _____.
 - atom
 - organism
 - cell
 - organ
- Storing and periodically releasing energy obtained from food is an example of _____.
 - evolution
 - homeostasis
 - response
 - growth
- A hypothesis that is supported many times may become a(n) _____.
 - experiment
 - conclusion
 - theory
 - observation
- All of the procedures scientists use to answer questions are _____.
 - life characteristics
 - scientific methods
 - research
 - hypotheses
- The environment includes _____.
 - air, water, and weather
 - response to a stimulus
 - adaptations
 - evolution
- Which of the following is NOT a testable hypothesis?
 - Fertilizer A will make the KW variety of green bean produce more beans.
 - Smart people like the same music.
 - Vitamin C relieves cold symptoms.
 - There is more than one species of African elephant.

Use the lab procedure below to answer questions 7 and 8.

A group of scientists wishes to see if using a new, environmentally friendly pesticide is effective in preventing insect damage to soybeans. Three different soybean plots are planted. The first plot contains soybeans treated with the traditional pesticide. The second plot is treated with the new environmentally friendly pesticide. The third plot is left untreated.

- Which plot is the control group?
 - the first plot with traditional pesticide
 - the second plot with the new pesticide
 - the third plot with no pesticide
 - there is no control group
- What could be concluded if the plot treated with the new pesticide has damage similar to the control plot?
 - The experiment is a failure.
 - The new pesticide may not be effective.
 - The control plot was problematic.
 - The new pesticide should be used.

Part 2 Constructed Response/Grid In

Record your answers on your answer document.

- Open Ended** List the characteristics you would check to see if a pine tree is a living thing. Give an example that shows how the tree exhibits each characteristic.
- Open Ended** Compare the characteristics of life with the flames of a fire. How are they similar and different?
- Open Ended** Why do most experiments have a control? Describe an experiment that does not have a control.
- Open Ended** Evaluate the impact that scientific research has on society.

