What Is Biology?

Unit Overview

This unit includes one chapter that introduces students to the nature, excitement, and methods of biology. Students are first introduced to the characteristics of living organisms. The nature of science and the methods of science are then discussed by using examples intended to spark student interest as they attempt to answer questions and solve problems concerning the world of life.

Introducing the Unit

Ask students to look at the photo and describe some of the adaptations of sunflowers that make them successful. Tell students that they will learn in this unit how to identify the characteristics of all living organisms, including sunflowers. Explain to students that during their studies in this course they will use the methods of science described later in the chapter.

Unit 1

What Is Biology?

Biologists seek answers to questions about living things. For example, a biologist might ask how plants, such as sunflowers, 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.

Unit Contents

Unit Project

interNET CONNECTION Use the Glencoe Science Web Site for more project activities that are connected to this unit. www.glencoe.com/sec/science

Unit 1

Advance Planning

Chapter 1

- Purchase preserved mildew or collect mildew samples for MiniLab 1-1.
- Purchase specially marked packages of Quaker Oatmeal for MiniLab 1-3.
- Order or collect pill bugs and other materials for the BioLab.
- Prepare leaning plants for the Getting Started Demo.
- Obtain a culture of mealworms for the Assessment activity.

Unit Projects

Discover the Diversity of Living Things

Have students do one of the projects for this unit as described on the Glencoe Science Web Site. As an alternative, students can do one of the projects described on these two pages.

Display

Visual-Spatial Students can use photographs or illustrations from magazines and science journals to make a collage showing as many different living things as possible in the available time. L1 ELL

Pond Study

Visual-Spatial Have student groups study a local pond or stream to find out what living organisms are present. Students may wish to make drawings or take photos to illustrate their findings. L1 ELL COOP LEARN

Tape Production

Visual-Spatial Have students use a video camera to make a tape about living things in your area. Students may tape the same area through the seasons to show changes. L1 ELL

Make a Model

Kinesthetic Students can make a three-dimensional model that depicts the kinds of living things found in your area. Alternatively, students can model another area, such as a rain forest. L2 ELL

Final Report

Have students present their group's findings in oral reports that could be understood by students at your local middle school. L3

Chapter 1 Organizer

Biology: The Study of Life

Refer to pages 4T-5T of the Teacher Guide for an explanation of the National Science Education Standards correlations.

Section	Objectives	Activities/Features
Section 1.1 **What Is Biology?** National Science Education Standards UCP.2; A.1, A.2; C.1, C.3, C.4, C.5, C.6; E.1, E.2; F.3, F.4, F.6; G.1 ($^1/_2$ session)	1. **Recognize** some possible benefits from studying biology. 2. **Summarize** the characteristics of living things.	**MiniLab 1-1:** Predicting Whether Mildew is Alive, p. 6 **Careers in Biology:** Nature Preserve Interpreter, p. 8 **Internet BioLab:** Collecting Biological Data, p. 26
Section 1.2 **The Methods of Biology** National Science Education Standards UCP.2; A.1, A.2; B.2; C.6; F.4, F.5; G.1, G.2 (1 session, $^1/_2$ block)	3. **Compare** different scientific methods. 4. **Differentiate** among hypothesis, theory, and principle.	**MiniLab 1-2:** Testing for Alcohol, p. 14 **Focus On** Scientific Theories, p. 16 **Problem-Solving Lab 1-1,** p. 18 **Inside Story:** Scientific Methods, p. 19
Section 1.3 **The Nature of Biology** National Science Education Standards UCP.2; A.1, A.2; E.1, E.2; F.3, F.4, F.5; G.1, G2 (1 session, 1 block)	5. **Compare and contrast** quantitative and descriptive research. 6. **Explain** why science and technology cannot solve all problems.	**Problem-Solving Lab 1-2,** p. 22 **MiniLab 1-3:** Hatching Dinosaurs, p. 23 **Biology & Society:** Organic Food: Is it healthier? p. 28

Need Materials? Contact Carolina Biological Supply Company at 1-800-334-5551 or at **http://www.carolina.com**

MATERIALS LIST

BioLab

p. 26 *Armadillidium* (pill bug), watch or clock, petri dish, paper, pencil, metric ruler, Internet access

MiniLabs

p. 6 mildew sample, microscope, microscope slide, coverslip, dropper, water, paper, pencil

p. 14 microscope slides, dropper, water, isopropyl alcohol, alcohol testing solution, personal hygiene products or cosmetics, wax pencil, paper, pencil

p. 23 artificial dinosaur eggs (2), stirring rods (2), beakers (2), cold and boiling water, paper, pencil

Alternative Lab

p. 12 small jars or beakers (2), graduated cylinder, caffeinated coffee, decaffeinated coffee, labels, pencil

Quick Demos

p. 7 *Lithops* plant

p. 12 sugar cube, ashes, matches

p. 15 assorted scientific journals

p. 22 pine needles or leaves, metric ruler, paper, pencil

Key to Teaching Strategies

- **L1** Level 1 activities should be appropriate for students with learning difficulties.
- **L2** Level 2 activities should be within the ability range of all students.
- **L3** Level 3 activities are designed for above-average students.
- **ELL** ELL activities should be within the ability range of English Language Learners.
- **COOP LEARN** Cooperative Learning activities are designed for small group work.
- **P** These strategies represent student products that can be placed into a best-work portfolio.
- These strategies are useful in a block scheduling format.

Teacher Classroom Resources

Section	Reproducible Masters	Transparencies
Section 1.1 **What Is Biology?**	Reinforcement and Study Guide, pp. 1-2 L2 BioLab and MiniLab Worksheets, p. 1 L2 Concept Mapping, p. 1 L3 ELL Critical Thinking/Problem Solving, p. 1 L3 Content Mastery, pp. 1-2, 4 L1	Section Focus Transparency 1 L1 ELL
Section 1.2 **The Methods of Biology**	Reinforcement and Study Guide, p. 3 L2 BioLab and MiniLab Worksheets, pp. 3-4 L2 Laboratory Manual, pp. 1-4 L2 Tech Prep Applications, pp. 1-2 L2 Content Mastery, pp. 1, 3-4 L1	Section Focus Transparency 2 L1 ELL
Section 1.3 **The Nature of Biology**	Reinforcement and Study Guide, p. 4 L2 BioLab and MiniLab Worksheets, pp. 5, 7-8 L2 Content Mastery, pp. 1, 3-4 L1 Laboratory Manual, pp. 5-8 L2	Section Focus Transparency 3 L1 ELL

Assessment Resources

Chapter Assessment, pp. 1-6
MindJogger Videoquizzes
Performance Assessment in the Biology Classroom
Alternate Assessment in the Science Classroom
Computer Test Bank
BDOL Interactive CD-ROM, Chapter 1 quiz

Additional Resources

Spanish Resources ELL
English/Spanish Audiocassettes ELL
Cooperative Learning in the Science Classroom COOP LEARN
Lesson Plans/Block Scheduling

NATIONAL GEOGRAPHIC Teacher's Corner

Index to National Geographic Magazine

The following articles may be used for research relating to this chapter.

"The Rise of Life on Earth," by Richard Monastersky, March 1998.

"Life Grows Up," by Richard Monastersky, April 1998.

GLENCOE TECHNOLOGY

The following multimedia resources are available from Glencoe.

Biology: The Dynamics of Life

CD-ROM ELL

Video: *Biologist at Work*
Video: *How Organisms Interact*
Video: *Adapted For Survival*
Video: *Bioengineering*
Exploration: *Interpreting Data*

Videodisc Program

Biologist at Work
How Organisms Interact
Bioengineering

The Infinite Voyage

The Keepers of Eden
Unseen Worlds

Getting Started Demo

Visual-Spatial Prepare leaning plants by placing them near a brightly lit window several days before students arrive. The morning before students come to class, mix the leaning plants with straight plants on a table well away from the window. Challenge students to explain why some plants lean and others do not.

Theme Development

Students are introduced to six major themes of biology: **systems and interactions, homeostasis, the nature of science, unity within diversity, evolution, and energy.** These themes are presented as the characteristics of life are discussed and the nature of science and scientific methods are explained.

0:00 Out of Time?

If time does not permit teaching the entire chapter, use the BioDigest at the end of the unit as an overview.

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 provide a basis for understanding the living world.

Getting Started

Testing an Observation

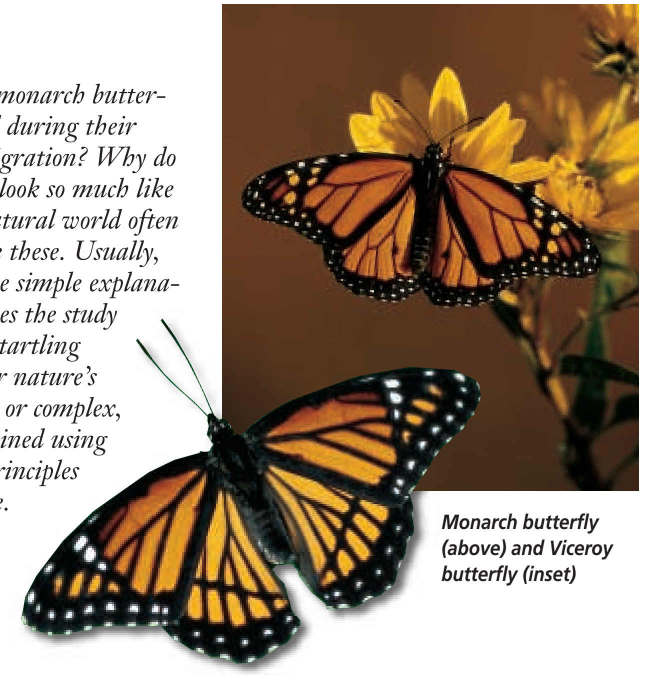
Observe leaning plants in a pot and infer why you think they may have grown this way. *How could you test your inference?*

interNET CONNECTION To find out more about the characteristics of living things, visit the Glencoe Science Web Site.
www.glencoe.com/sec/science

The plants and animals of this forest exhibit all the characteristics of life. The mushrooms, and the unseen bacteria living in the soil and leaf litter of the forest floor, also share the basic characteristics of life.

Section 1.1 What Is Biology?

How far do monarch butterflies travel during their annual migration? Why do viceroy butterflies look so much like monarchs? The natural world often poses questions like these. Usually, such questions have simple explanations, but sometimes the study of biology reveals startling surprises. Whether nature's puzzles are simple or complex, many can be explained using the concepts and principles of biological science.



Monarch butterfly (above) and Viceroy butterfly (inset)

SECTION PREVIEW

Objectives

Recognize some possible benefits from studying biology.

Summarize the characteristics of living things.

Vocabulary

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

The Science of Biology

People have always been curious about living things—how many different species there are, where they live, what they are like, how they relate to each other, and how they behave. These and many other questions about life can be answered. 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; millions of 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?"

Word Origin

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

Section 1.1

Prepare

Key Concepts

In this section, students learn that biology is an organized study and that many questions remain unanswered. The characteristics that living things share in common are presented in relationship to the themes of biology.

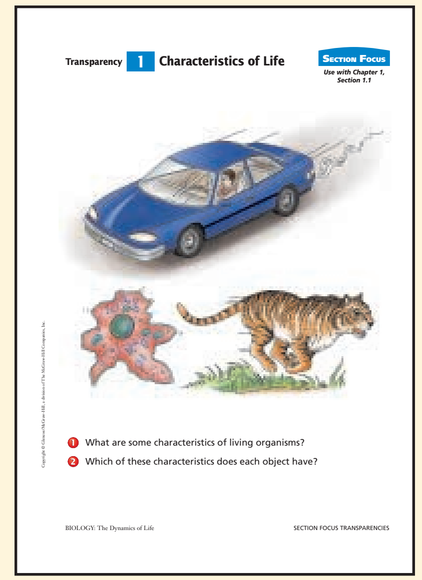
Planning

- Purchase a *Lithops* plant from a nursery for the Quick Demo.
- Gather materials needed for the Activity on page 7.

1 Focus

Bellringer

Before presenting the lesson, display **Section Focus Transparency 1** on the overhead projector and have students answer the accompanying questions. L1 ELL



Multiple Learning Styles

Look for the following logos for strategies that emphasize different learning modalities.

Kinesthetic Meeting Individual Needs, p. 5; Activity, p. 7

Visual-Spatial Getting Started Demo, p. 2; Portfolio, pp. 4, 7, 9; Concept Development, p. 4; Microscope Activity, p. 9; Project, p. 24

Interpersonal Cultural Diversity, p. 8; Meeting Individual Needs, p. 14; Project, p. 19

Linguistic Biology Journal, pp. 4, 9, 16, 18; Portfolio, p. 17

Logical-Mathematical Tying to Previous Knowledge, p. 13; Portfolio, p. 23

Naturalist Quick Demo, p. 22

Assessment Planner

Portfolio Assessment
Portfolio, TWE, pp. 4, 7, 9, 17, 18, 23
Alternative Lab, TWE, pp. 12-13

Performance Assessment
Assessment, TWE, pp. 8, 13
Alternative Lab, TWE, pp. 12-13
BioLab, TWE, pp. 26-27
MiniLab, TWE, pp. 6, 14, 23
MiniLab, SE, pp. 6, 14, 23

Knowledge Assessment
Section Assessment, SE, pp. 10, 20, 25
Chapter Assessment, TWE, pp. 29-31

Skill Assessment
Assessment, pp. 10, 20, 22, 25
Problem-Solving Lab, pp. 18, 22
BioLab, SE, p. 27

Resource Manager

Section Focus Transparency 1 and Master L1 ELL

2 Teach

Visual Learning

Figure 1.1 Ask students to discuss other strange creatures they have read about or seen on television. Explain that even with such diversity, all living things have certain characteristics in common.

Concept Development

Visual-Spatial Take students around the school grounds. Ask them to list in their notebooks all the different kinds of organisms they observe. They should indicate the characteristics they used to categorize each organism as a living thing. L2

Display

Make a bulletin board display that shows unusual structural and behavioral adaptations of plants and animals.

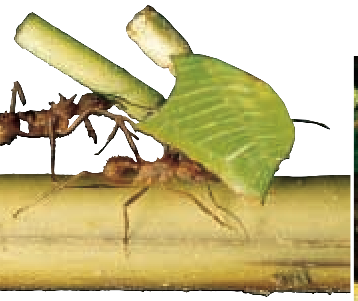
GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
Video: *Biologist at Work*
Disc 1

VIDEODISC
Biology: The Dynamics of Life
Biologist at Work (Ch. 2)
Disc 1, Side 1
28 sec.

Figure 1.1
Few of the creatures you read about in works of fantasy and fiction are as unusual as some of the organisms that actually live on Earth.

A Orcas, also known as killer whales, are highly intelligent marine mammals that live and hunt in social units called pods.



B 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.

C Leaves of the insect-eating pitcher plant form a tube 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.

The answers to such questions lead to the development of general biological principles and rules. As strange as some forms of life such as those shown in *Figure 1.1* 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 1.2*, living things depend upon other living and nonliving things in a variety of ways and for a variety of reasons.

Figure 1.2
Questions about living things can sometimes be answered only by finding out about their interactions with their surroundings.

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

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

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 one's thinking. Through your study of biology, you will come to appreciate the great diversity of species on Earth and the way each species fits into the dynamic pattern of life on our planet.

Biologists study the interactions of the environment

Because no species, including humans, can exist in isolation, the study of biology must include the investigation of interactions among species. 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 species always involves the study of other species 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 1.3* 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.

Figure 1.3
By understanding the interactions of living things, you will be better able to impact the planet in a positive way.

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 species. It can reveal ways to help preserve species that are in danger of disappearing, and solve other problems, including the one described in *Figure 1.4*. 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 1.4
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.

Enrichment

Visual-Spatial Explain that life is found in some unexpected places. Ask students to bring in samples of dustballs from their homes. Have them seal each sample in a plastic bag labeled with the location from which it was taken. Students should then examine the dustballs under the microscope for dust mites. Ask them to compare the numbers of mites in samples from various locations. L1 ELL

Revealing Misconceptions

Students often think that all plants found in an area are native to that area. Point out that many plants may have been imported from other areas. For example, oats and rye imported from Europe have become established in California at the expense of native grasses.

GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
Video: *How Organisms Interact*
Disc 1

VIDEODISC
Biology: The Dynamics of Life
How Organisms Interact (Ch. 4)
Disc 1, Side 1, 40 sec.

The Infinite Voyage
The Keepers of Eden
Extinction and the National Zoo's Tamarin Monkey Project
(Ch. 4), 13 min. 30 sec.

Preserves of Endangered Species: San Diego and Kenya (Ch. 8)
8 min. 30 sec.

BIOLOGY JOURNAL

Investigating New Life Forms

Linguistic Ask students to find out about some of the most recent discoveries of new species. Ask them to report in their journals about how and where these new life forms were discovered and who discovered them. Ask them to discuss the significance of each discovery. L3

Portfolio

Identifying Habitats

Visual-Spatial Provide students with pictures of unusual organisms. Ask them to speculate on the type of habitat in which each might live. Have them explain their reasoning and place their pictures and habitat descriptions in their portfolios. L2

MEETING INDIVIDUAL NEEDS

Learning Disabled

Kinesthetic Have students make a web from string to illustrate the intricate web of nature. On the web, have students place index cards and pictures that illustrate organisms common to your area and their needs for life. L1

MiniLab 1-1

Purpose
Students will look at mildew under the microscope and decide if it is living.

Process Skills
predict, compare and contrast, observe and infer

Teaching Strategies
- Prior to the activity, ask how many students believe mildew is living/not living. Post the results on the chalkboard. Poll students again after the MiniLab and compare both sets of responses.
- Scrape mildew samples from shower grout or plastic shower curtains and bring them to class. Store samples in water to prevent them from drying out. CAUTION: *If live specimens are used, seal them in a plastic bag to protect students who might be allergic to mildew spores.*
- Preserved mildew is available from biological supply houses and can be used in place of live specimens.
- Instruct students on proper use of microscope and microscope slides.
- Demonstrate the technique for making a wet mount. Include proper handling and cleaning of cover glasses and glass slides.

Expected Results
Students may initially predict that mildew is not alive. During microscopic examination, students will see long filaments (hyphae) and tiny circular objects (spores). Some students may see spores enclosed in a spore sac.

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 be considered living. Anything that possesses all of the characteristics of life is known as an **organism,** like the plants shown in ***Figure 1.5.*** All living things have an orderly structure, produce offspring, grow and develop, and adjust to changes in the environment. Practice identifying the characteristics of life by carrying out the *MiniLab* on this page.

MiniLab 1-1 Observing

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.*
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 cover slips.*
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 any life characteristics you observed.
2. Compare your three predictions and explain how your observations may have changed them.
3. Explain the value of using scientific tools to extend your powers of observation.

Figure 1.5
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.

Living things are organized

When biologists search for signs of life, one of the first things they look for is structure. That's because they know that all living things show an orderly structure, or **organization.**

The living world is filled with organisms. All of them, including the earthworm pictured in ***Figure 1.6,*** are composed of one or more cells. Each cell contains the genetic material, or DNA, that provides all the information needed to control the organism's life processes.

Although living things are very diverse—there may be five to ten million species, perhaps more—they are 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.

Figure 1.6
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.

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 1.7*** 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.

Figure 1.7
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.

Quick Demo

Show students a *Lithops* plant and ask how they might determine whether it is living or nonliving. L2

Activity

Kinesthetic Give small groups of students the following materials: a squash seed, a bottle of bubbles and a bubble wand, a fresh fruit such as a tomato, a cut flower in a test tube filled with water, and a warming candle in a jar lid. Light the candle for each group and instruct students to observe the flame. Next, instruct them to blow a few bubbles. Ask them to observe each of the other objects. Have students decide whether or not each item is alive and explain the reasons for their decisions. Discuss responses as a class. You may find it necessary to distinguish between nonliving things and once-living or dead things as part of the discussion. *Students will probably know that bubbles and warming candles are not alive, but because they move, students may say they are alive.* L2

Visual Learning

Figure 1.7 Ask students to give examples of organisms they know about that have many young and those that have few. For example, fish have many young and elephants have few. Bring students to the realization that, normally, the larger the organism, the fewer young it produces and the longer the period between births.

Resource Manager

Concept Mapping, p. 1 L3 ELL
BioLab and MiniLab Worksheets, p. 1 L2

Analysis

1. organization, reproduction, growth, adjusting to environment
2. Answers will vary, depending on the observations made by individual students.
3. Certain life characteristics could not have been seen without the use of a microscope.

Assessment

Performance Have students design an experiment to determine if commercial products reduce or kill mildew as claimed. Use the Performance Task Assessment List for Designing an Experiment in **PASC,** p. 23. L2

Portfolio

Characteristics of Life

Visual-Spatial Set up stations around the classroom with living and nonliving items, such as a rock with lichen, bird's nest, skeleton, potted plant, piece of uncooked steak, strands of hair, drop of pond water with protozoans or algae focused on a microscope slide, potato, peanut, stalk of celery, seeds, goldfish in a bowl, and other interesting material you may have in your area. Ask students to go from one station to the next and decide if the specimens are or ever were alive. Have students justify their answers in their portfolios. L2 P

Discussion

Lead students in a discussion of general developmental stages of various organisms. Examples include complete and incomplete metamorphosis in insects, or birth, infancy, childhood, puberty, adulthood, old age, and death in humans.

CAREERS IN BIOLOGY

Career Path

Courses in high school: biology, speech, language arts, history, and computer skills
College: a degree in biology, forestry, education, or a related field preferred

Career Issue

Nature interpreters and others involved in protecting the environment recognize the conflict between the needs of humans and those of plants, animals, and other nonhuman organisms. Ask students to identify and discuss such a conflict they know about, such as wetlands or forest preservation, or the debate about whether or not whaling should be permitted.

For More Information

For more information about environmental careers, students can contact:

Environmental Careers Organization
286 Congress Street, Third Floor
Boston, MA 02210-1038

Assessment

Performance Assessment in the Biology Classroom, p. 1, *Brine Shrimp Life Functions.* Have students carry out this activity to observe brine shrimp carrying out some of their life functions. L2 ELL

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 of 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.

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.

interNET CONNECTION For more careers in related fields, be sure to check the Glencoe Science Web Site.
www.glencoe.com/sec/science

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 1.8.*** 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 1.9*** feeds on small 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. Any condition in the environment that requires an organism to adjust 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. In addition to responding to external stimuli, living things 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 do work. 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 structure, behavior, or internal process that enables an organism to respond to stimuli and better survive in an environment is called an **adaptation** (ad ap 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

Figure 1.8
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.

Figure 1.9
Living things respond to stimuli and make adjustments to environmental conditions.

A By dropping their leaves in the fall, these trees 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.

Discussion

Discuss with students ways in which the human body maintains homeostasis. *Sweating and shivering are two homeostatic mechanisms for maintaining body temperature.*

Microscope Activity

Visual-Spatial Have students refer to the **Skill Handbook** to review the proper procedures for caring for and using a microscope. Then ask them to examine prepared slides of fertilization and development in a variety of organisms, such as a chick, sea urchin, frog, or mammal embryo. Make sure students understand that all these organisms developed from the union of sperm and egg. L2

The BioLab at the end of the chapter can be used at this point in the lesson. INTERNET BioLab

3 Assess

Check for Understanding

Have students explain how a home heating system models a homeostatic mechanism. L2

GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
Video: *Adapted for Survival*
Disc 2

VIDEODISC
The Secret of Life
Camouflage: Caterpillar Clip

Camouflage: Spider Clip

Cultural Diversity

The History of Biological Discovery

Interpersonal Have students work in groups of three or four and do basic library research to prepare a presentation about the history of biological science in a particular country. Student presentations can include a chronology of important biological science discoveries in the country, or they can be more specific accounts of a particular area of research. Presentations should include names of important scientists, details about the area of research, and how the research may have benefited society. Encourage students to incorporate posters, models, photographs, or videos in their presentations. L3 COOP LEARN

Portfolio

Stimulus and Response

Visual-Spatial Have students cut five pictures from magazines that show organisms responding to stimuli. Ask students to mount each picture on a clean sheet of paper and label the stimulus and response. Have students place their labeled illustrations in their portfolios.
L1 ELL P

BIOLOGY JOURNAL

No More Light

Linguistic Ask students to write a science fiction story about what might happen if Earth stopped getting energy from sunlight. Remind them that temperatures would decrease and photosynthesis would stop. L3

Reteach

Have students draw a diagram to illustrate how the pupil of the eye responds to bright light. Students can observe this homeostatic mechanism in the classroom using flashlights or lamps. L2

Extension

Ask students working in groups to investigate the latest developments in robotics. Have them list the characteristics of robots and compare and contrast these characteristics with those of living organisms. Have them point out key characteristics that distinguish robots as nonliving. L3

Assessment

Skill Ask students to explain how they would test to see which color of light would cause a bean plant to grow fastest. L2

4 Close

Demonstration

Show slides and photographs that illustrate the six major themes of biology. Discuss each theme as a class.

Resource Manager

Reinforcement and Study Guide, pp. 1-2 L2
Content Mastery, p. 2 L1

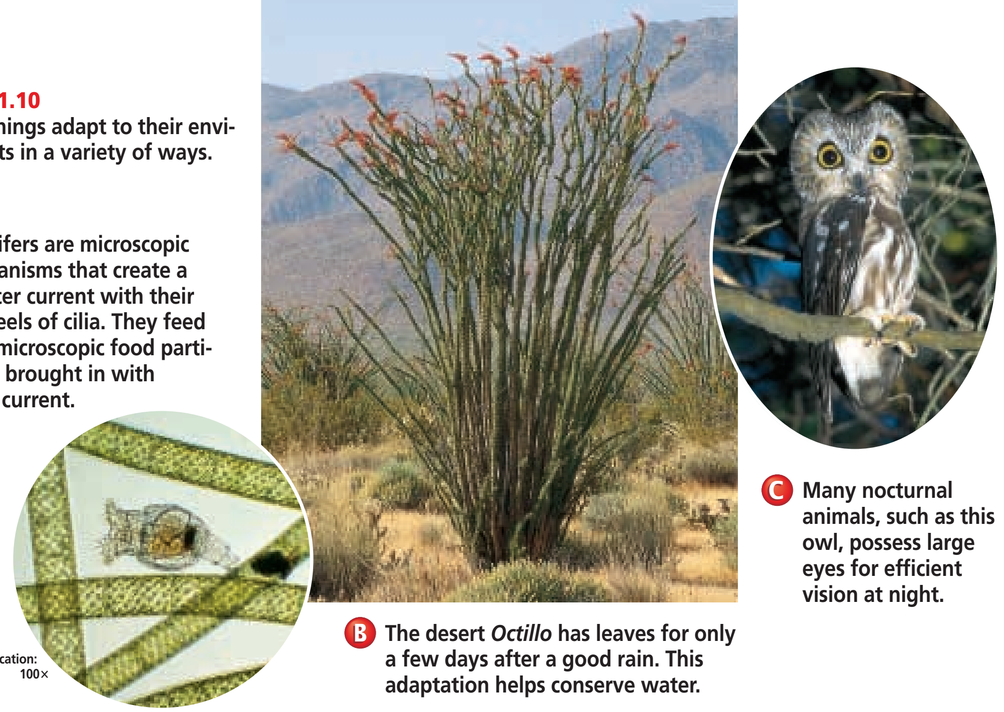


Figure 1.10
Living things adapt to their environments in a variety of ways.

A Rotifers are microscopic organisms that create a water current with their wheels of cilia. They feed on microscopic food particles brought in with the current.

B The desert *Octillo* has leaves for only a few days after a good rain. This adaptation helps conserve water.

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

suited to the new conditions than others. Individuals with more suitable adaptations are more likely to survive and reproduce. As a result, individuals with these adaptations become more numerous in the population. ***Figure 1.10*** shows some examples of adaptation.

The gradual accumulation of adaptations over time is **evolution** (ev uh LEW shun). Clues to the way the present diversity of life came about may be understood through the study of evolution. In later chapters of this book, 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. Explain the difference between a stimulus and a response and give an example of each. How do these terms relate to an organism's internal environment?
3. Why is energy required for living things? How do living things obtain energy?
4. How are evolution and reproduction related?

Thinking Critically

5. How are energy and homeostasis related in living organisms?

Skill Review

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

Section

1.2 The Methods of Biology

Why do earthworms crawl onto sidewalks after it rains? Why do mosses grow only in wet, shady areas? Biologists ask questions like these every day. Different approaches may be used to answer different questions. Scientists who discovered that earthworms crawl out of rain-soaked soil to avoid drowning used different methods from those who learned that mosses require water for reproduction. Yet all scientific inquiries share some methods in common.

Mosses are tiny plants that grow in dense clumps.

SECTION PREVIEW

Objectives

Compare different scientific methods.

Differentiate among hypothesis, theory, and principle.

Vocabulary

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

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 water-logged 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, different 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 **scientific methods.**

Scientists often identify problems to solve—that is, questions to ask and answer—simply by observing the world around them. For example, a laboratory scientist who is investigating questions about the reproduction of pea plants may come up with a new question about their development. Or, a scientist may ask a question about the feeding habits of prairie dogs after first observing prairie dog behavior in the field.

Section 1.2

Prepare

Key Concepts

Students study the methods used in scientific investigations. They identify the methods as they relate to problems in various areas of biology.

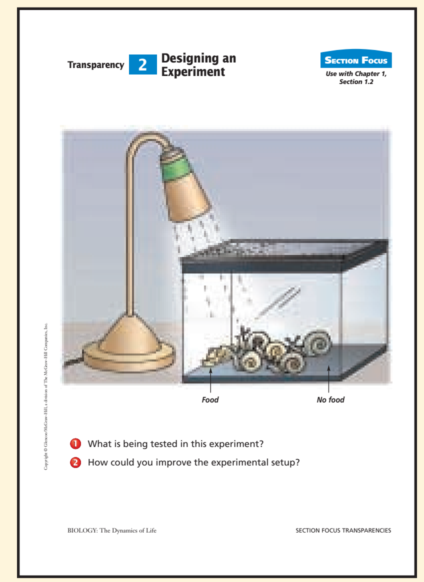
Planning

- Obtain several kinds of cough syrup and mouthwash to test in MiniLab 1-2.

1 Focus

Bellringer

Before presenting the lesson, display **Section Focus Transparency 2** on the overhead projector and have students answer the accompanying questions. L1 ELL



Section Assessment

1. for the pleasure of learning about living things, or to appreciate the diversity of species and the way each fits into the dynamic patterns of life on Earth
2. A stimulus is anything in the environment that requires an organism to adjust. The adjustment made is the response. Sweating in humans is a response to the stimulus of high temperature.
3. Energy is required for organisms to carry on all life processes. Organisms such as plants obtain energy from sunlight, but most organisms obtain their energy by consuming living or dead organisms.
4. Reproduction provides the variability among organisms that is required for evolution in a species.
5. Energy is necessary to maintain homeostasis.
6. Examine its organization and see if it is cellular or not; see if it grows, or develops; see if it responds to stimuli or adapts to a change in its environment; see if it maintains homeostasis.

Internet Address Book

interNET CONNECTION Note Internet addresses that you find useful in the space below for quick reference.

Resource Manager

Section Focus Transparency 2 and Master L1 ELL

2 Teach

Brainstorming

Ask students to brainstorm a list of questions they have that relate to biology. Write the questions as a list on the board. Allow students to give examples of how they might find answers to their questions if they were given access to any equipment or technology they can imagine.

Using Scientific Terms

Ask students to state a hypothesis about some question. Point out that a hypothesis is not a question, but rather a statement that answers a question.

Quick Demo

Try to set a sugar cube on fire using a lighted match. *It does not burn.* Rub the edge of the cube in ashes and attempt to ignite it. *It burns.* Ask students to hypothesize why the cube burns after it is rubbed in ashes. *Responses may include that the ashes—not the sugar cube—burn, that the ashes served as kindling, or that the ashes catalyze, or speed up, the reaction between the sugar and the oxygen in air (burning).* Ask students how they might test their explanations. *Responses might include trying to set the ashes on fire separately or exposing the sugar to a hotter flame for a longer time.*

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.

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 1.11*** 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 responsible.

Figure 1.11
Brown tree snakes *(Boiga irregularis)* were introduced to Guam more than 50 years ago. Since then, their numbers have increased to a population of more than a million and they have severely reduced the native bird population of the island.

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 experiments.

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 a procedure 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. The **control** is the group in which all conditions are kept the same. The experimental group is the test group, in which all conditions are kept the same except for the single condition being tested.

Suppose you wanted to learn how bacteria affect the growth of different varieties of soybean plants. Your hypothesis might state that the presence of certain bacteria will increase the growth rate of each plant variety. An experimental setup designed to test this hypothesis is shown in ***Figure 1.12.*** Bacteria are present on the roots of the experimental plants, but not the controls. All other conditions—including soil, light, water, and fertilizer—are held constant 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 changed is the **independent variable,** because it is the only variable that affects the outcome of the experiment. In the case of the soybeans, the presence of bacteria is the independent variable. While changing 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 is the growth rate of the plants. Controlled experiments are most often used in laboratory settings.

However, not all experiments are controlled. Suppose you were on a group of islands in the Pacific that is the only nesting area for a large sea bird known as a waved albatross, shown in ***Figure 1.13.*** 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 in circles around the island, or that they fly to some distant location. To test one of these hypotheses, you might attach a satellite transmitter to some of the birds and record their travels. An experiment such as this, which

Figure 1.12
This experiment tested the effect of bacteria 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.

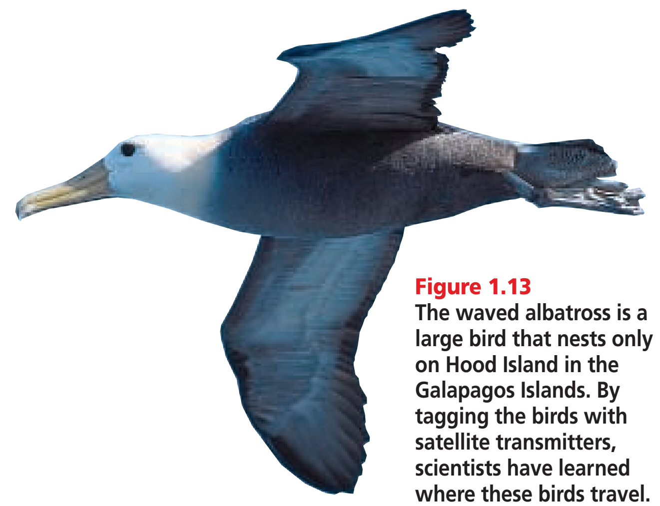


Figure 1.13
The waved albatross is a large bird that nests only on Hood Island in the Galapagos Islands. By tagging the birds with satellite transmitters, scientists have learned where these birds travel.

Visual Learning

Figure 1.13 Ask students to explain how a satellite transmitter is useful in tracking waved albatrosses. *Because albatrosses fly long distances over open ocean, a transmitter is useful because it can continuously relay information that would be difficult or impossible to attain in any other way.*

Tying to Previous Knowledge

Logical-Mathematical Present the following hypothesis to your students: "If yeast is living, then it will be composed of cells." Ask students to: (a) Describe an experimental procedure that could be used to verify the hypothesis. *Observe yeast under the microscope.* (b) Describe reasoning that was used to form the hypothesis. *Yeast cells require food and give off carbon dioxide gas. All living matter is composed of cells.* L2

Assessment

Performance Give students a sample of mealworms and oatmeal. Ask them to write the following terms on their paper, leaving several lines between each term: observations, hypothesis, experiment, data, conclusion. Tell students to write in the spaces as they try to determine the life cycle of a mealworm. L1

Alternative Lab

Conducting an Experiment

Purpose
Students will follow the steps of scientific methods to solve a problem. The question to be answered is, Will the caffeine present in coffee prevent mold growth?

Preparation
Have students wear lab aprons, safety goggles, and disposable latex gloves, and wash their hands after checking for mold growth. Some students may be allergic to mold spores.

Materials
2 small jars (baby food jars), graduated cylinder, labels, caffeinated coffee, decaffeinated coffee

Procedure
Give the following directions to students.

1. Form and record a hypothesis.
2. Write your name and the date on the labels. Write #1 on one label and #2 on the other. Place the labels on the jars.
3. Add the following to each jar. Jar 1: 30 mL caffeinated coffee; Jar 2: 30 mL decaffeinated coffee.
4. Place both jars in the same location.
5. Make daily observations of your jars for one week. Check for the presence of mold.
6. Record your observations in a suitable data table by making diagrams of the coffee liquid surfaces.

Analysis

1. Which type of coffee allows mold to grow? *both*
2. Was your hypothesis supported by your data? *will depend on hypothesis*
3. What was the control, independent variable, and dependent variable? *decaffeinated coffee, caffeinated coffee, mold growth*

Assessment

Portfolio Have students write a report of their experimental findings. Ask them to record any other questions that arose during this experiment and explain how they might be answered. Use the Performance Task Assessment List for Lab Report in **PASC,** p. 47.

MiniLab 1-2

Purpose
Students will experiment to determine which products contain alcohol.

Process Skills
draw a conclusion, experiment, interpret data, observe and infer

Safety Precautions
- Review safety precautions regarding goggles and the use of an acid solution.

Teaching Strategies
- For preparation instructions for the alcohol-testing reagent, see page 40T of the Teacher Guide.
- Make circles on slides with a China marking or eyebrow pencil. Students could use small test tubes rather than glass slides. Use caution when cleaning glassware.
- For circle C, use isopropyl (rubbing) alcohol. Products to be tested may include aftershave lotion, cough syrups, mouthwash.

Expected Results
Student data will vary with the products tested. Circle A will appear yellow-orange, circle B green to blue, and circle C yellow.

Analysis
1. to determine which colors indicate the presence or absence of alcohol
2. Answers will depend on products tested.

Assessment
Performance Provide students with several different types of alcohol (rubbing, ethyl, methyl) and ask them to determine which types the alcohol-testing chemical can detect. Use the Performance Task Assessment List for Carrying Out a Strategy and Collecting Data in **PASC**, p. 25. L2 ELL

MiniLab 1-2 Experimenting

Testing for Alcohol Commercials 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 during a commercial. Another way is to experiment and find out for yourself.

Procedure
1. Copy the data table.

Data Table

	Color of liquid	Alcohol present
Circle A		
Circle B		
Circle C		
Product name		
Product name		

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

has no control, is the type of biological investigation most often used in field work.

The experimental design that is selected depends on what other experimenters have done and what information the biologist hopes to gain. Sometimes, a biologist will design a second experiment even while a first one is being conducted, if he or she thinks the new experiment will help answer the question. Try your hand at experimenting in the *MiniLab* on this page.

Using tools

To carry out experiments, 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 experiments.

Biologists use a wide variety of tools to obtain information in an experiment. Some common tools include beakers, test tubes, hot plates, petri dishes, thermometers, dissecting instruments, balances, metric rulers, and graduated cylinders. More complex tools include microscopes, centrifuges, radiation detectors, spectrophotometers, DNA analyzers, and gas chromatographs. ***Figure 1.14*** shows some of these more complex tools.

Maintaining safety

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

In the experiments in this textbook, you will be alerted to possible safety hazards by safety symbols like those shown in ***Table 1.1.*** 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 in ***Appendix C*** at the back of this book before beginning any 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

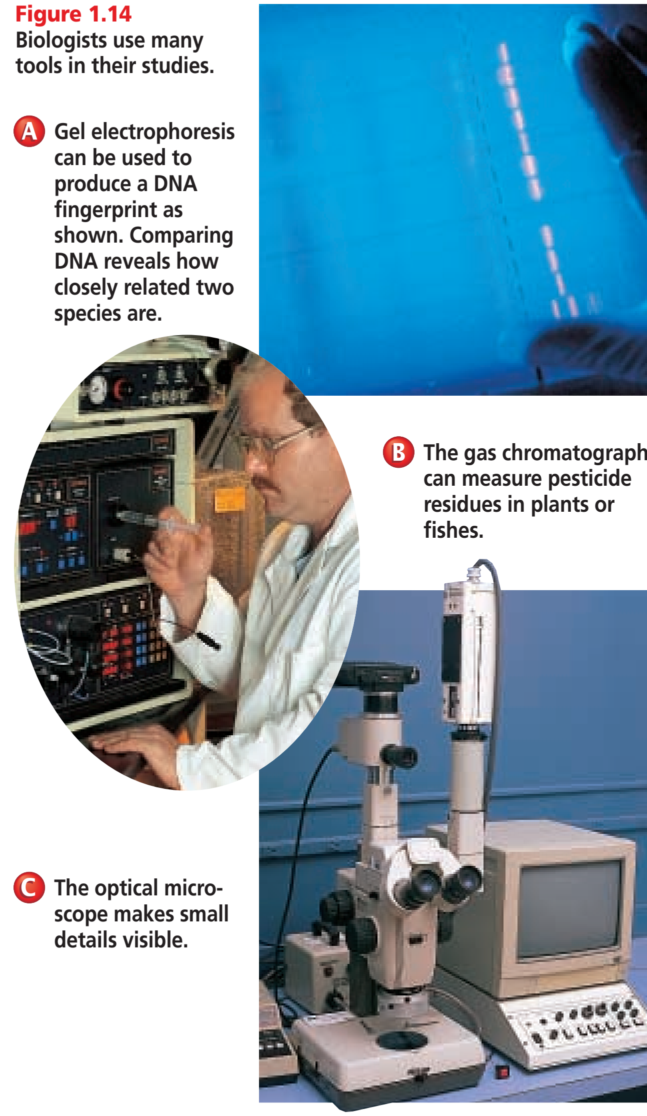
To answer their questions about scientific problems, scientists seek information from their experiments. Information obtained from experiments is called **data.** Sometimes, data from experiments are referred to as experimental results.

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 experiment. 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 experiment does not end the scientific process. Read the *Focus On* on the next page to see how data collection relates to other important aspects of research.

Figure 1.14
Biologists use many tools in their studies.



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

B The gas chromatograph can measure pesticide residues in plants or fishes.

C The optical microscope makes small details visible.

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.

Quick Demo

Bring copies of scientific journals to class and allow students to examine them. Ask students to speculate as to which branch of science each journal addresses.

Brainstorming
A student repeats an experiment several times and each time records different data. Have students offer possible reasons why an experiment might yield different data for different trials. *Reasons include failure to keep all factors but one the same, errors in data recording, errors in mathematical treatment of the data, or naturally occurring variability in experimental outcome.* L2

GLENCOE TECHNOLOGY

VIDEODISC
The Secret of Life
Microscopy Segment

The Infinite Voyage
Unseen Worlds, Technology Reconstructs Egyptian Mummies
(Ch. 1), 6 min. 30 sec.

Resource Manager

Tech Prep Applications, pp. 1-2 L2
Critical Thinking/Problem Solving, p. 1 L3
BioLab and MiniLab Worksheets, pp. 3-4 L2

Meeting Individual Needs

Learning Disabled
Interpersonal Group students appropriately. Have them use scientific methods to alter a cookie recipe. Ask students to name the control to be used, the independent variable, and the dependent variable. L1 ELL COOP LEARN

Meeting Individual Needs

Hearing Impaired
Interpersonal Supply students with the following data showing how many seeds were germinated by three laboratory groups over a three-day period. Group A had two seeds germinate on day 1, four seeds on day 2, and four seeds on day 3. Group B had one seed germinate on day 1, six on day 2, and five on day 3. Group C had two seeds germinate on day 1, four on day 2, and three on day 3. Have students work in groups to prepare a class histogram of the number of seeds germinating each day for all three groups. L2

NATIONAL GEOGRAPHIC

Focus On

Scientific Theories

Purpose

Students will learn from examples how theories are formed from repeated observations, comparative studies, and discussions among scientists over many decades.

Teaching Strategies

- Ask students to discuss what they know about dinosaurs. Ask them how they have learned about these amazing, extinct animals.
- Have students put forward their own ideas on how dinosaurs lived from day to day. Ask them if their ideas are hypotheses, speculations, beliefs, or theories. Have them begin to distinguish among these different ideas by asking them to state in a complete sentence what they know about another topic, such as computers.
- If possible, visit a dinosaur display in a local museum, and have students make notes in their journals about the different theories of dinosaur behavior explained in the exhibits. L2

GLENCOE TECHNOLOGY

VIDEODISC
VIDEOTAPE
The Secret of Life
On the Brink: Portraits of Modern Science

IGUANODON

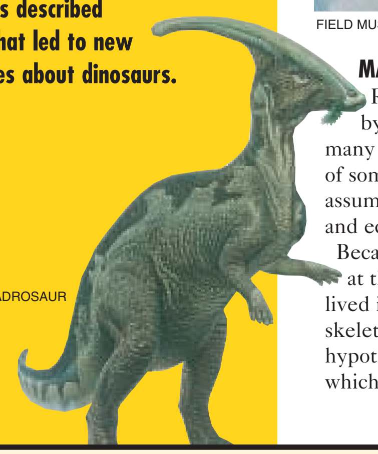
FOCUS ON Scientific Theories

What is a scientific theory? In casual usage, "theory" means an unproven assumption about a set of facts. A scientific theory is an explanation of a natural phenomenon supported by a large body of scientific evidence obtained from various investigations and observations. The scientific process begins with observations of the natural world. These observations lead to hypotheses, data collection, and experimentation. If weaknesses are observed, hypotheses are rejected or modified and then tested again and again. When little evidence remains to cause a hypothesis to be rejected, it may become a theory. Follow the scientific process described here that led to new theories about dinosaurs.

OBSERVING

People have been unearthing fossils for hundreds of years. The first person to reconstruct a dinosaur named it *Iguanodon*, meaning "iguana tooth," because its bones and teeth resembled those of an iguana. By 1842 these extinct animals were named *dinosaurs*, meaning "terrible lizards."

FIELD MUSEUM OF NATURAL HISTORY, CHICAGO



HADROSAUR

MAKING HYPOTHESES

Reptiles are ectotherms—animals with body temperatures influenced by their external environments. Early in the study of dinosaur fossils, many scientists assumed that because dinosaur skeletons resembled those of some modern reptiles, dinosaurs, too, must have been ectotherms. This assumption led scientists to conclude that many dinosaurs, being both huge and ectothermic, were slow-growing, slow-moving, and awkward on land.

Because the most complete dinosaur skeletons occurred in rocks formed at the bottom of bodies of water, scientists hypothesized that dinosaurs lived in water and that water helped to support their great weight. When skeletons of duck-billed dinosaurs, called hadrosaurs, were discovered, this hypothesis gained support. Hadrosaurs had broad, flat ducklike bills, which, scientists suggested, helped them collect and eat water plants.

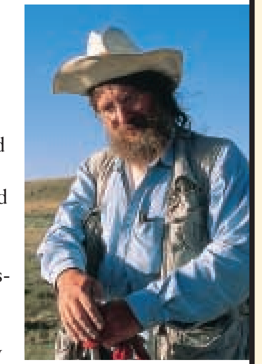
ROBERT BAKKER WITH BRONTOSAUR FEMUR

BREAD PALM, CYCAD FAMILY

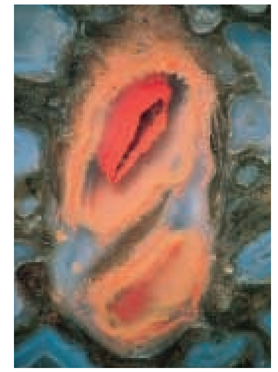
NATIONAL GEOGRAPHIC

THINKING CRITICALLY

In the 1960s, paleontologist Robert Bakker (right) hypothesized that dinosaurs were not sluggish ectotherms but fast-moving, land-dwelling endotherms—animals like birds and mammals. Bakker observed that many dinosaurs had feet and legs built for life on land. If hadrosaurs had led a semiaquatic life, Bakker reasoned, their feet would have been webbed with long, thin, widely spaced toes. But hadrosaurs had short, stubby toes and feet, obviously suited for land. In addition to Bakker's observations, studies of fossilized stomach contents revealed that hadrosaurs dined on the cones and leaves of cycads (above) and other terrestrial plants. After considering these data carefully, Bakker proposed that many dinosaurs were quick, agile endotherms that roamed Earth's ancient landscape.



ROBERT BAKKER



DINOSAUR BONE SHOWING CHANNELS FOR BLOOD VESSELS
Magnification: 25 x

COLLECTING DATA

To test his hypotheses, Bakker intensified his research on dinosaur skeletons and bone structure. He found reports from the 1950s comparing thousands of cross sections of dinosaur bones with those of reptiles, birds, and mammals. These reports noted that many dinosaur bones were less dense than those of modern reptiles and riddled with channels for blood vessels. In short, many dinosaur bones resembled those of endotherms not ectotherms. Bakker confirmed his observations by collecting supporting evidence from other sources.

FORMING THEORIES

Bakker's hypotheses—supported by data gathered by other paleontologists and by dinosaur bones, growth patterns, and behavior—prompted scientists to reexamine theories about dinosaurs. Were some dinosaurs endotherms and others ectotherms? Did dinosaurs have their own unique physiology resembling neither reptiles nor mammals? Scientific theories about dinosaurs continue to evolve as new fossils are discovered and new tools to study those fossils are developed.

PALEONTOLOGIST WORKING ON FOSSIL

EXPANDING Your View

1. **APPLYING CONCEPTS** Robert Bakker's research led to a different theory regarding the physiology of dinosaurs. As new fossils are found and new tools developed to study them, paleontologists will continue to replace existing theories with newer ones. What are some reasons for a scientific theory to be changed?

NATIONAL GEOGRAPHIC

Visual Learning

Have students study the art of *Iguanodon* and the hadrosaur. Have them list the structures that support the hypotheses that hadrosaurs lived in water and on land. L1

Answers to Expanding Your View

1. **Applying Concepts** Scientific theories must be changed to accommodate new or conflicting data.

GLENCOE TECHNOLOGY

VIDEODISC
The Infinite Voyage:
The Great Dinosaur Hunt
Dinosaur Tracks: Footprint Analysis (Ch. 6), 5 min.

Communication Theories (Ch. 9)
5 min. 30 sec.

CD-ROM
Biology: The Dynamics of Life
Exploration: *Interpreting Data*
Disc 1

BIOLOGY JOURNAL

A Dino-Bird?

Linguistic A dinosaur fossil discovered in China appears to have had downy feathers along its neck and backbone. Ask students to hypothesize about how and why feathers first evolved. Have them write down supporting evidence for their hypothesis. L2 P

Portfolio

New Research on Dinosaurs

Linguistic Although Dr. Bakker's bone evidence shows a link between dinosaurs and endotherms, other researchers dispute this and point to factors, such as nasal cavities, that show dinosaurs were more like ectotherms. Have students research the newest hypotheses about dinosaurs by reading recent articles in magazines. Ask them to write a summary of the articles for their portfolios and list the factors that support both ectothermy and endothermy as the homeostatic mechanisms for dinosaur metabolism. L3 P

Problem-Solving Lab 1-1

Purpose

Students will analyze the claims made in a commercial.

Process Skills

analyze information, draw a conclusion, experiment, think critically

Teaching Strategies

■ You may wish to have the entire class analyze the same commercial. Tape a specific commercial and play it back to the class. Or provide students with the printed dialogue from a radio commercial. L2

Thinking Critically

1. Student answers will vary. Many commercials make claims without specifying any scientific backing.
2. Student answers will vary. Many commercials do not use experimental evidence but base their claims on inference.
3. Students should describe a hypothesis, control, dependent and independent variables, trials, data accumulation, and a conclusion based on data.

Assessment

Portfolio Ask students to design a video commercial that bases its claims on experimental data. Have them include their data and analyses as part of the commercial. Use the Performance Task Assessment List for Video in **PASC,** p. 81. L2

Problem-Solving Lab 1-1 — Analyzing Information

Are the claims valid? "Our product is new and improved." "Use this mouth wash 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?

Analysis

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. In general, was the claim based on scientific methods? Explain your answer.
2. In general, are product claims made in commercials based on experimental evidence? Explain your answer.
3. Describe a scientific experiment that could be conducted to establish claims made for the product in your commercial.

Thinking about what happened

Often, the thinking that goes into analyzing experimental 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 experiment may be considered confirmed only if repeating that experiment several times yields similar results. To review how scientific methods are carried out, read the *Inside Story.*

After analyzing the data, most scientists have more questions than they had before the experiment. 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 the scientific method? Find out by conducting the *Problem-Solving Lab* here.

Reporting results

Results and conclusions of experiments are reported in scientific journals, where they are open to 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.

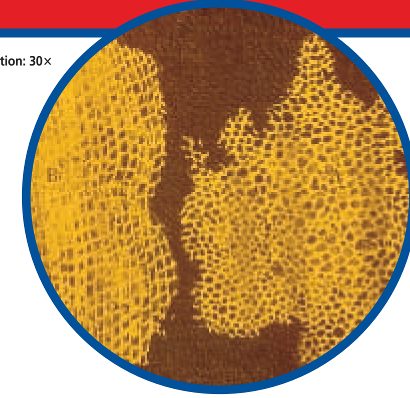
Verifying results

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 experiment. If they obtain similar results, there is even more support for the hypothesis. When a hypothesis is supported by data from additional experiments, 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.

INSIDE STORY

Scientific Methods

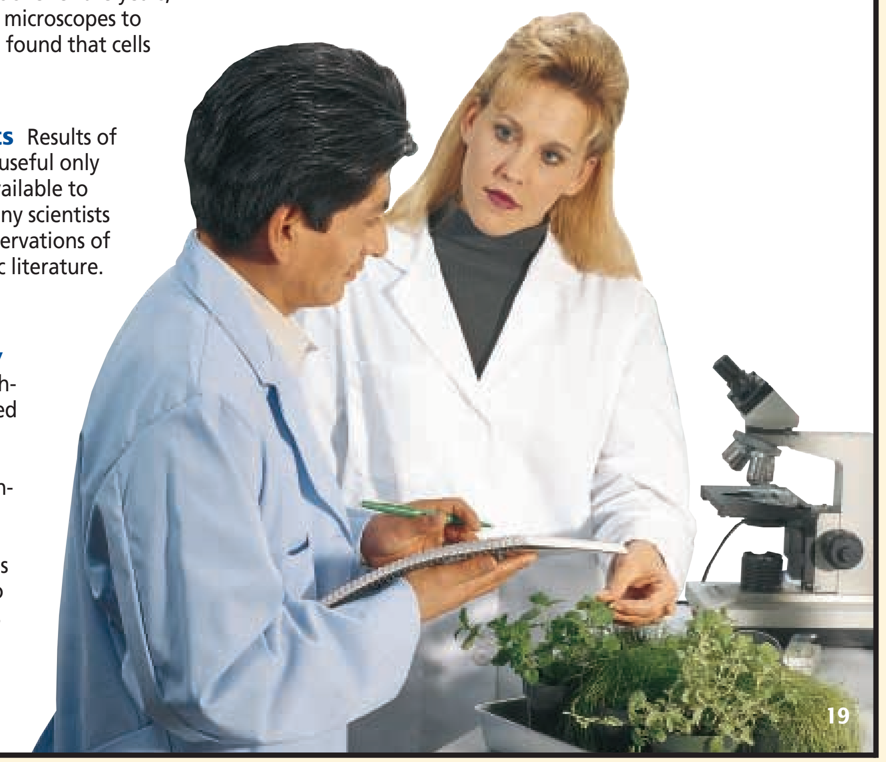
Scientific methods are used by scientists to answer questions and solve problems. The development of the cell theory, one of the most useful theories in biological science, illustrates how the methods of science work. In 1665, Robert Hooke first observed cells in cork.



Cork cells as drawn by Robert Hooke

Thinking Critically *What is the function of other scientists in the scientific process?*

1. **Observing** The first step toward scientific discovery 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.
2. **Making a hypothesis** A hypothesis is a testable answer to a question. In 1824, René Dutrochet hypothesized that cells are the basic unit of life.
3. **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.
4. **Publishing results** Results of an experiment are useful only if they are made available to other scientists. Many scientists published their observations of cells in the scientific literature.
5. **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.
6. **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.
7. **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.



INSIDE STORY

Purpose

Students will review methods used in scientific investigations.

Teaching Strategies

■ Point out that not every scientific investigation uses every method, nor do all investigations lead to a published theory.

■ Provide students with biological journals such as *Nature* or *Scientific American*. Ask them to read the articles and identify the methods of science used.

Visual Learning

■ Have students look at cork cells through a microscope and compare them with the photo on this page, then ask them to compare the capabilities of their microscopes with the one used by Robert Hooke.

Critical Thinking

Other scientists repeat the same experiment to validate original results. Scientists extend understanding by performing experiments to answer related questions.

3 Assess

Check for Understanding

Provide students with scientific methods listed in a scrambled order. Ask students to sequence steps in the correct order. L1

Reteach

Ask students to outline the steps used in scientific methods. For each level of the outline, have them provide an example taken from studies described in the text. L2

BIOLOGY JOURNAL

Field Research

Linguistic Have students look in *Discover, National Geographic,* or similar publications to find an article that describes field research. Ask them to write a report on the article, contrasting the scientist's work in the field with the work the scientist had to continue back in the laboratory. L3

Working as a Food Chemist

Linguistic Tell students to imagine they are the chief food chemist working in a candy factory. They are trying to improve on the taste of a "Smacking Good Bar." Have them describe some things they would suggest to their staff to attempt, in a controlled manner, to find a better candy bar recipe. L1

PROJECT

Using Scientific Methods

Interpersonal Have students work in groups on a biological problem they select, such as the behavior of a particular species of bird, reptile, or mammal in your area. At the conclusion of the project, students should be able to explain the methods of science they used. L2

COOP LEARN

Resource Manager

Laboratory Manual, pp. 1-4 L2

Extension

Have students look up cell theory in this text. Ask them to speculate about the hypotheses that may have been made by each of the scientists who first discovered cells. L2

Assessment

Skill Provide each student with a piece of laboratory equipment. Have them list five observations about the equipment and suggest how the equipment might be used. L1

4 Close

Demonstration

Display laboratory equipment and safety equipment and clothing students will use in their study of biology. For each item, identify its function and proper use. As a follow-up, set up lab stations at which students are required to demonstrate their knowledge of each item. L2

Resource Manager

Reinforcement and Study Guide, p. 3 L2

Figure 1.15
Experiments 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 experiments 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. 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 experiments, 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 made the observation that bees seem to prefer a yellow flower that produces abundant amounts of pollen and nectar over a purple flower that produces less pollen and 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 experiments usually require a control?

Thinking Critically

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

Skill Review

6. **Interpreting Scientific Illustrations** Review the *Inside Story.* What happens when a hypothesis is not confirmed? What does the position of the word *theory* indicate about the strength of a scientific theory compared to the strength of a hypothesis? For more help, refer to *Thinking Critically* in the **Skill Handbook.**

Section

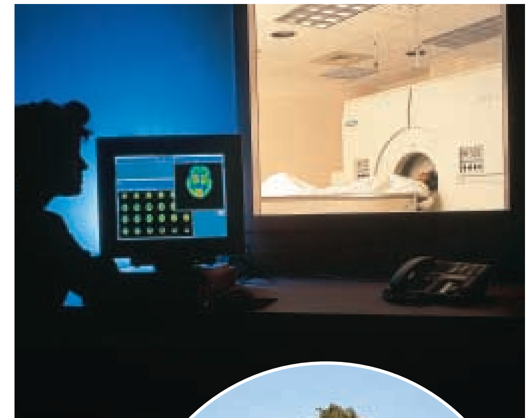
1.3 The Nature of Biology

SECTION PREVIEW

Compare and contrast quantitative and descriptive research.
Explain why science and technology cannot solve all problems.

Vocabulary
ethics
technology

Scientific study includes learning many known facts about the world around us. Biologists use known facts to discover new problems, make hypotheses, design experiments, interpret data, and draw conclusions. Biology is also an active process that includes making observations and conducting experiments in the laboratory and in the field. Science is both a body of facts and ideas and a process by which we come to understand the natural world.



Biologists study the structure of the human brain (top) and observe animal behavior (inset).

Kinds of Research

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

Quantitative research

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.

Data obtained in quantitative research 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.

Section 1.3

Key Concepts

Students differentiate between quantitative and descriptive research methods. The role of research and its application and use by society as technology is examined.

Planning

- Obtain materials for the MiniLab.

1 Focus

Bellringer

Before presenting the lesson, display **Section Focus Transparency 3** on the overhead projector and have students answer the accompanying questions. L1 ELL


Transparency 3 Systems of Measurement
SECTION FOCUS
Use with Chapter 1, Section 1.3

1. The person in the picture is measuring in cubits—an ancient Egyptian measurement that equals the distance from a person's elbow to the tip of the middle finger. What problems might occur if everyone used this unit?
2. What characteristics should a measurement system have to make it accurate and easily understood by everyone?

BIOLOGY: The Dynamics of Life SECTION FOCUS TRANSPARENCIES

Section Assessment

1. Students might hypothesize that bees prefer yellow flowers to purple flowers or that bees prefer flowers with more abundant pollen.
2. Set up an experimental chamber. Within a specific amount of time, count and record how many ants move to butter placed a specific distance from the ants. Repeat several times. Repeat using honey in place of the butter.
3. A hypothesis is a testable explanation for a question. A theory is a refined explanation supported by many different experiments.
4. A control provides greater certainty that observed results are not due to chance or other variables.
5. Prepare one batch of cookies (the control) by following a recipe and another batch of cookies (the experimental group) by varying a single variable in the recipe, such as amount of sugar.
6. A new, revised hypothesis is tested, or the experiment may be changed. Theories are supported by the results of a variety of experiments.

Resource Manager

Reinforcement and Study Guide, p. 4 L2
Section Focus Transparency 3 and Master L2 ELL
Content Mastery, p. 1, 3-4 L1
Laboratory Manual, pp. 5-8 L2

Biology Journal

Quantitative Data

Linguistic Have students review articles on biological research in *Scientific American*, *Science News*, *Newsweek*, or local newspapers. Ask students to write a short essay identifying the quantitative measurements taken in each study and describing how the measurements were taken. L2

2 Teach

Quick Demo

Naturalist Provide students with a metric ruler and a clump of pine needles. Ask them to make two lists of observations: one that describes the needles with words and another that uses measurements. Have students compare their lists with classmates. L1

Problem-Solving Lab 1-2

Purpose
Students will analyze a graph and determine that the amount of information obtained from a graph is limited.

Process Skills
acquire information, interpret data, think critically

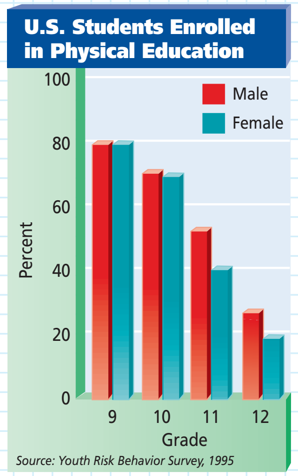
Teaching Strategies
■ Review the terminology associated with graphs or refer students to the **Skill Handbook.**

Thinking Critically
1. No. No bar extends to the 100% line.
2. The number of students enrolled in physical education declines as students progress from freshman to senior year.
3. Data needed to answer the question are not supplied.
4. No. The graph does not provide this information.

Assessment
Skill Have students design a graph to illustrate why fewer seniors take physical education. Students can make up the questions to be graphed and estimate the number of 'yes' responses. Use the Performance Task Assessment List for Conducting a Survey and Graphing the Results in **PASC,** p. 35. L2

Problem-Solving Lab 1-2 — Making and Using 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.



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

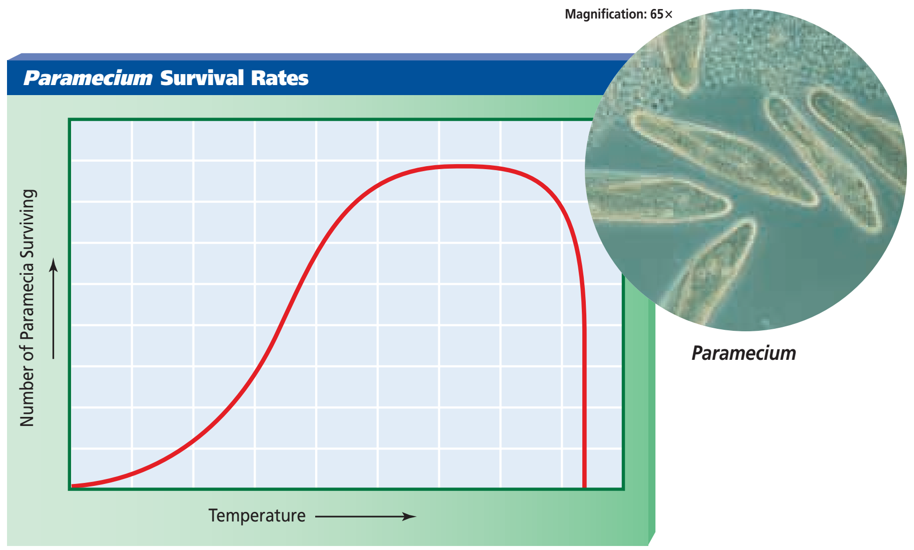
The data obtained from the *Paramecium* study is presented as a graph in ***Figure 1.16.*** You can practice using graphs by carrying out the *Problem-Solving Lab* on this page.

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), liter (volume), second (time), and Celsius degree (temperature). For a thorough review of measurement in SI, see Practicing Scientific Methods in the **Skill Handbook.**

Figure 1.16
This graph shows how many paramecia survive as the temperature increases.



Cultural Diversity

Units and Standards

The SI system is used in 95% of the countries in the world. It provides a standardized system of measurement that makes scientific communication easier. Many early systems of measurement were not standardized. The ancient Egyptians used a unit called the cubit, which was based on the length of the arm from elbow to fingertips. Because sizes of individuals varied, the size of the unit varied. In England, the foot was equal to the length of the foot of the king. When a new king came to power, the length changed according to the size of his foot. Have students research measuring systems used around the world and create a visual display of their findings. L3

Descriptive research

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 carrying out descriptive research. Descriptive research is useful because some phenomena aren't appropriate for quantitative research. For example, how a particular wild animal reacts to events in its environment cannot easily be illustrated with numbers. Practice your descriptive research skills in the *MiniLab* on this page.

MiniLab 1-3 — Observing and Inferring

Hatching Dinosaurs "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
1 Copy the data table below.

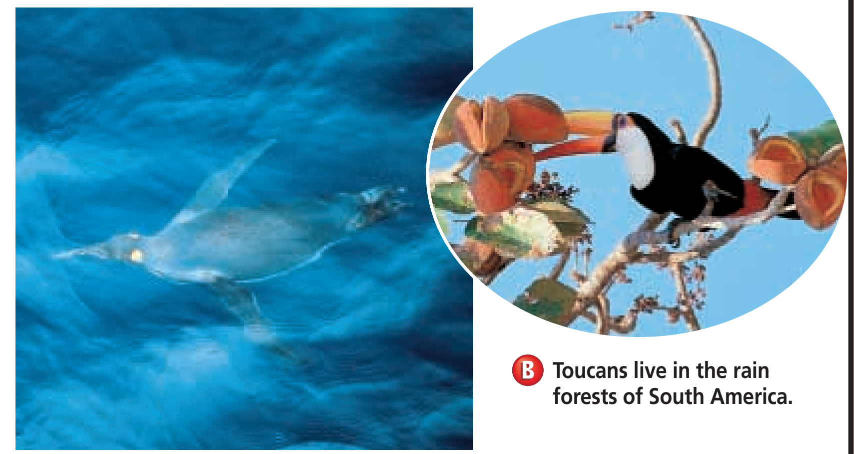
Data Table

	Before treatment	Hot water treatment	Cold water treatment
Appearance after one minute			

2 Observe the dinosaur eggs provided and record their characteristics in your table.
3 Place an egg in each of two containers.
4 Make a hypothesis about the water temperature that will cause the eggs to hatch.
5 Pour boiling water into one container and cold water in the other. Stir for one minute. Record your observations.

Analysis
1. Infer whether heat or moisture was more important for hatching eggs.
2. Design an experiment that would test either heat or moisture as the variable. What kind of quantitative data will you gather?
3. What will be your control?
4. How many trials will you run and how many eggs will you test? If time permits, conduct your experiment.

Figure 1.17
Do you think these animals behave in the same way in zoos as they do in nature?



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.

Portfolio

Making Predictions

Logical-Mathematical Ask students to carry out the following activity. Have them predict the chance that a coin, when flipped, should come up heads. *50%* How many heads should appear if a coin is flipped 10 times? *1/2 x 10 or 5* How many heads will appear if a coin is flipped 100 times? *1/2 x 100 or 50* Ask them to carry out the coin tosses and record their results. Have them use the activity to explain in their portfolios if scientists can predict the results of an experiment with 100% certainty. Have them explain the advantage of using a large sample or many trials in an experiment. *Large samples increase the likelihood that the sample is representative.* L2 P

MiniLab 1-3

Purpose
Students make observations and inferences and design an experiment that tests a hypothesis.

Process Skills
observe and infer, hypothesize, collect data, design an experiment

Safety Precautions
Caution students to be careful when pouring boiling water.

Teaching Strategies
■ Provide each group of students with two "dinosaur eggs" from specially marked packages of Quaker Oatmeal. Each serving packet in the box contains about 14 eggs.
■ Ask students to explain why this experiment would not be possible with real eggs.

Expected Results
The outer candy layer of a "dinosaur egg" melts away in boiling water in less than a minute, leaving a tiny dinosaur-shaped candy.

Analysis
1. heat or moisture
2. To test heat, students might put eggs under a heat lamp. To test moisture, students might place eggs in various temperatures of water.
3. Variable is heat or moisture. Control is the basis of comparison for the tested condition. Students could measure "hatching" time.
4. Use as many eggs and trials as time permits.

Assessment
Performance Have students conduct the experiment they design. Use the Performance Task Assessment List for Carrying Out a Strategy and Collecting Data in **PASC,** p. 25. L2

Resource Manager
BioLab and MiniLab Worksheets, p. 5 L2

Enrichment

Have students list quantitative and descriptive data about five common animals. Have them present their data to the class and have the class use the data to identify the animals being described. Ask which type of data was most useful in attempting to identify the animals and have students explain why. *Quantitative data such as size and number of appendages may be too similar for many of the animals, whereas descriptive data such as presence of fur or feathers, common colors, and descriptions of behavioral traits may be more specific.* L2

TECHPREP

Technological Advance

Have student groups prepare a report on one technological advance that has had a direct impact on the life of one of the members of the group.
L2

GLENCOE TECHNOLOGY

VIDEODISC
Biology: The Dynamics of Life
Bioengineering (Ch. 37)
Disc 1, Side 1, 57 sec.

CD-ROM
Biology: The Dynamics of Life
Video: *Bioengineering*
Disc 2

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.

Science and Society

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

Figure 1.18
If bad luck caused by black cats occurred as reliably and as swiftly in real life as it does in cartoons, it really would be scientifically testable.

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 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, as shown in the cartoon in ***Figure 1.18***, 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 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 NAHL uh jee) is the application of scientific research to society's needs and problems. It is concerned with making improvements in human life and 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, irrigation technology is often used to boost the production of food crops. If irrigation is used over too many years in one area, the soil may become depleted of minerals or the evaporation of the irrigation water may leave deposits of mineral salts in the soil. Eventually the soil may become useless for growing crops, as illustrated in ***Figure 1.19***.

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
One example of a possible harmful side effect of technology is the deterioration of soil caused by irrigation. In the field shown here, irrigation technology initially appeared to solve the problem of low crop yield, but later caused a different problem—the buildup of excess mineral salts that prevent crop growth.

Section Assessment

Understanding Main Ideas

1. Why is it important that scientific experiments be repeated?
2. Compare and contrast quantitative and descriptive research.
3. Why is science considered to be a combination of fact 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 elderly, very ill patients alive. How does the statement "The results of research aren't good or bad; they just are," apply to such research?

SKILL REVIEW

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

3 Assess

Check for Understanding

Have students provide an example of: quantitative research, descriptive research, a contribution of technology, and an ethical issue in science. L2

Reteach

Ask students to prepare an outline of the major concepts of this section. L2

Extension

Logical-Mathematical Have students research the idea of "being able to beat cancer with a strong positive mental attitude." Have them explain why it may be difficult to evaluate scientifically how a positive mental attitude contributes to recovery from disease. L3

Assessment

Skill Have students measure their arm spans and palm widths in centimeters. Convert these measurements to millimeters and meters. L2

4 Close

Discussion

Describe one possible benefit or spin-off that might come from the study of: how birds find their way during migration; longer lasting batteries; bat echolocation. L3

MEETING INDIVIDUAL NEEDS

Gifted

Have students list the heights of their classmates in centimeters. Ask them to use their list to calculate average height, describe the range of heights, determine the most common height, and explain whether the original data and computational results are descriptive or quantitative. L3

PROJECT

Recognizing Technology

Visual-Spatial Ask students to work in cooperative groups to prepare a time line that shows the technological advances in one area of biology, such as genetics, biotechnology, or oceanography.
L2 COOP LEARN

Section Assessment

1. to see if the results are repeatable, thus confirming their authenticity
2. Quantitative research reports data in numerical values based on measuring. Descriptive research reports data in written descriptions based on observations.
3. A scientist needs a background of knowledge in his or her field. The scientific process increases that knowledge.
4. Some problems do not have a scientific basis. Some technological solutions may pose more problems than they solve.
5. The biomedical researchers sought to increase knowledge. The application of the resulting technology is a question society must answer.
6. Paramecia die above a certain temperature. This results in a rapid drop in numbers once this temperature is reached. They are better able to survive as low temperatures rise, thus the graph reflects this increased survival.

INTERNET BioLab

Time Allotment
One class period

Process Skills
collect data, define operationally, experiment, observe and infer, acquire information, think critically, communicate

Safety Precautions
Remind students to treat live animals gently and follow directions carefully. Have students wear goggles, lab aprons, and disposable latex gloves.

PREPARATION

■ Pill bugs—also called sow bugs, wood lice, or isopods—may be collected locally or purchased from a biological supply house. *Armadillidium vulgare* is the only species that will roll tightly into a "pill," so it is preferred for this activity.

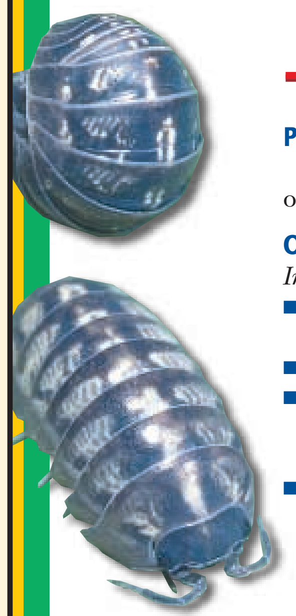
ANALYZE AND CONCLUDE

1. Student answers will vary and may include the following: shows organization; has specific parts for certain jobs; all pill bugs look alike. Yes, orderly structure also applies to nonliving things. Many nonliving things are organized, including buildings, books, computers.
2. The graph shows that pill bugs vary in length, but most reach a maximum size of about 10 mm.
3. Pill bugs remain curled for an average of approximately 20 seconds.
4. The pill bug's outer shell is rather tough; rolling into a ball could prevent predators from attacking its soft underside and fragile appendages.

INTERNET BioLab

Collecting Biological Data

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?" Let's try to find out.



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*
watch or classroom clock
container, glass or plastic
pencil with dull point
ruler
computer with Internet connection

Safety Precautions
Always wear goggles in the lab.

Skill Handbook
Use the **Skill Handbook** if you need additional help with this lab.

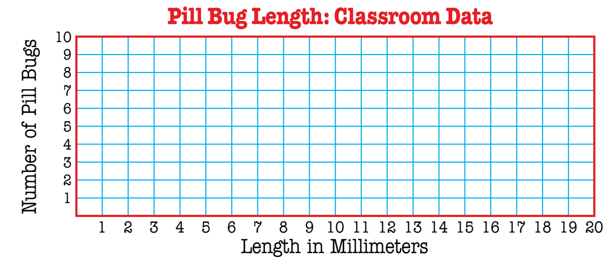
PROCEDURE

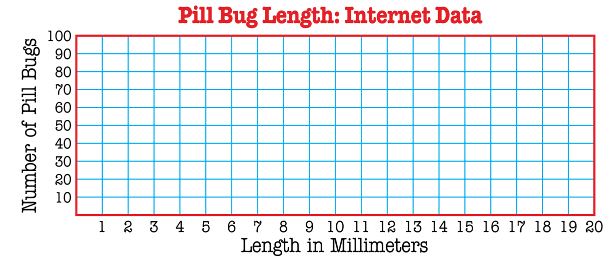
Data Table

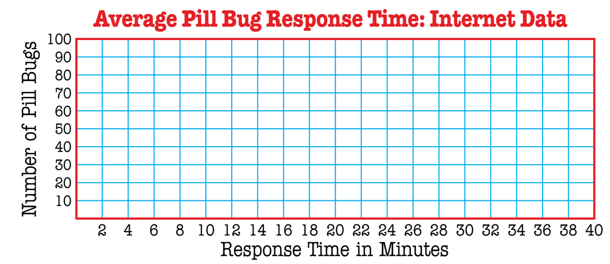
Organization and growth and development	
Orderly structure?	
Pill bug length in mm	

Response to environment	
Trial	Time in seconds
1	
2	
3	
4	
5	
Total	
Average time	

1. Make copies of the data table and graph outlines shown here.
2. Obtain a pill bug from your teacher and place it in a small container.
3. Observe your pill bug to determine whether or not it has an orderly structure. Record your answer 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."
6. Go to the Glencoe Science Web Site at the address shown below to **post your data.**
7. *Gently* touch the underside of the pill bug with a *dull* pencil point. It may be necessary to gently flip the pill bug over with the pencil to get at its underside. **CAUTION:** ***Use care to avoid injuring the pill bug.***
8. Note its response and time, in seconds, how long the animal remains curled up. Record the time in the data table as Trial 1.
9. Repeat steps 7-8 four more times, recording each trial in the data table.
10. Calculate the average length of time your pill bug remains curled up in a ball.
11. **Post your data** on the Glencoe Science Web Site.
12. Return the pill bug to your teacher. **CAUTION:** ***Wash your hands with soap and water after working with pill bugs.***







ANALYZE AND CONCLUDE

1. **Thinking Critically** Explain how you would define the term "orderly structure." Explain how this trait might also pertain to nonliving things.
2. **Using the Internet** Explain how data from the classroom and Internet graphs support the idea that pill bugs grow and develop.
3. **Interpreting Data** What was the most common length of time pill bugs remained curled in response to being touched?
4. **Drawing a Conclusion** Explain how the response to being touched is an adaptation.
5. **Experimenting** How might you design an experiment to determine whether or not pill bugs reproduce?

Sharing Your Data

interNET CONNECTION Find this BioLab on the Glencoe Science Web Site at **www.glencoe.com/sec/science.** Post your data in the data table provided for this activity. Use the additional data from other students on the Internet, analyze the combined data, and complete your graphs.

INTERNET BioLab

5. Student answers will vary. Place several pill bugs in a sealed container and add food and moisture as needed. Observe pill bugs weekly and compare numbers present to those originally placed in container. Or, look for immature forms that may appear in the container.

Assessment

Skill Ask students to prepare a graph of data that would be representative of the experimental results from "Sharing Your Data." Refer students to *Making and Using Graphs* in the **Skill Handbook**. Use the Performance Task Assessment List for Graph from Data in **PASC**, p.39. L2

Sharing Your Data

interNET CONNECTION To navigate to the Internet BioLabs, choose the *Biology: The Dynamics of Life* icon at the Glencoe Science Web Site. Click on the student site icon, then the BioLabs icon. To expand this activity, have students design and conduct an experiment to determine if pill bugs have preferences for certain food types. L2

Resource Manager

BioLab and MiniLab Worksheets, pp. 7-8 L2

PROCEDURE

Troubleshooting
Students may have difficulty assessing whether pill bugs show an orderly structure. Advise them to make a "best guess" to answer this question.

Teaching Strategies
■ Allow students to work in small groups of two or three.
■ Make sure that students have already covered the section dealing with life characteristics before attempting this laboratory activity.
■ Laboratory finger bowls or plastic dishes from supermarkets or fast food restaurants can be used as small containers.
■ Review the procedure for determining an average. Have students round off their average data on the length of time in seconds the pill bug remains rolled up.
■ Review the technique for preparing a histogram.

Data and Observations
Students should conclude that pill bugs show organization, undergo growth and development, and adjust to their environment. Pill bugs will remain rolled in a ball for approximately 20 seconds. Typical length of a mature pill bug is 10 mm.

Biology & SOCIETY

Purpose

This feature allows students to analyze claims made about organically grown produce. Students are encouraged to formulate and present their own views.

Teaching Strategies

- Provide recent newspaper and magazine articles regarding claims about organically grown produce.
- Ask students to discuss the advantages and disadvantages of using herbicides, pesticides, and fertilizers on crops.
- Have students interview produce managers in several supermarkets to obtain their views concerning organically grown produce. L3
- Have students investigate the methods used for displaying produce in supermarkets. Ask them to write a summary of their findings. L2

Investigating the Issue

Student standards will differ, and this produces fuel for the debate. Standards might include the exclusion of all agricultural chemicals, or the reduction of chemicals.

Going Further

Bring samples of organic and conventional produce to class. Ask students to compare the appearance and taste of the samples and discuss how price, appearance, and taste might affect consumer purchase decisions. L1

Biology & SOCIETY

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.

Different Viewpoints

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.

Produce from an organic farm

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.

Is conventionally grown food healthier? 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?

INVESTIGATING THE ISSUE

Comparing and Contrasting Propose your own set of standards for defining organic fruits and vegetables. Organize a debate in which you and your classmates present arguments to support your proposed standards.

interNET CONNECTION To find out more about the organic food debate, visit the Glencoe Science Web Site.
www.glencoe.com/sec/science

Chapter 1 Assessment

SUMMARY

Section 1.1 What Is Biology?

Main Ideas
- 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

Main Ideas
- 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.

Vocabulary
control (p.13)
data (p.15)
dependent variable (p.13)
experiment (p.12)
hypothesis (p.12)
independent variable (p.13)
safety symbol (p.14)
scientific methods (p.11)
theory (p.20)

Section 1.3 The Nature of Biology

Main Ideas
- Biologists do their work in laboratories and in the field. They collect both quantitative and descriptive 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.24)
technology (p.25)

UNDERSTANDING MAIN IDEAS

1. For experiments to be considered valid, the results must be ________.
   a. verified
   b. inductive
   c. published
   d. repeatable
2. Reproduction is an important life characteristic because all living things ________.
   a. replace themselves
   b. show structure
   c. grow
   d. adjust to surroundings

Chapter 1 Assessment

Main Ideas

Summary statements can be used by students to review the major concepts of the chapter.

Using the Vocabulary

To reinforce chapter vocabulary, use the Content Mastery Booklet and the activities in the Interactive Tutor for Biology: The Dynamics of Life on the Glencoe Science Web Site.
www.glencoe.com/sec/science

THE PRINCETON REVIEW *All Chapter Assessment questions and answers have been validated for accuracy and suitability by The Princeton Review.*

UNDERSTANDING MAIN IDEAS

1. d
2. a

GLENCOE TECHNOLOGY

VIDEOTAPE
MindJogger Videoquizzes
Chapter 1: *Biology: The Study of Life*
Have students work in groups as they play the videoquiz game to review key chapter concepts.

Resource Manager

Chapter Assessment, pp. 1-6
MindJogger Videoquizzes
Computer Test Bank
BDOL Interactive CD-ROM, Chapter 1 quiz

3. c
4. a
5. b
6. d
7. a
8. c
9. b
10. d
11. data
12. technology
13. experiment
14. scientific methods
15. theory
16. control
17. independent
18. stimulus; response
19. theory
20. control

Chapter 1 Assessment

3. The photograph to the right is an example of which characteristic of life?
   a. evolution
   b. reproduction
   c. development
   d. response to a stimulus

4. Which of the following is an appropriate scientific question?
   a. How do paramecia behave when a pond begins to dry up?
   b. Which perfume smells the best?
   c. Which religion is most sound?
   d. Are llamas less valuable than camels?
5. If data from repeated experiments do not support the hypothesis, what is the scientist's next step?
   a. Give up.
   b. Revise the hypothesis.
   c. Repeat the experiment.
   d. Overturn the theory.
6. Similar-looking organisms, such as the dogs shown below, that can interbreed and produce fertile offspring are called _______.
   a. a living system c. organization
   b. an adaptation d. a species

THE PRINCETON REVIEW — TEST-TAKING TIP

Words Are Easy to Learn
Make a huge stack of vocabulary flashcards and study them. Use your new words in daily conversation. The great thing about learning new words is the ability to express yourself more specifically.

7. The environment includes _______.
   a. air, water, weather
   b. response to a stimulus
   c. adaptations
   d. evolution
8. Which of the following terms are most related to each other?
   a. adaptation—response
   b. stimulus—growth
   c. adaptation—evolution
   d. stimulus—evolution
9. Which of the following is not an appropriate question for science to consider?
   a. How many seals can a killer whale consume in a day?
   b. Which type of orchid flower is most beautiful?
   c. What birds prefer seeds as a food source?
   d. When do hoofed mammals in Africa migrate northward?
10. The single factor that is altered in an experiment is the _______.
   a. control
   b. dependent variable
   c. hypothesis
   d. independent variable
11. The information gained from an experiment is called _______.
12. The application of scientific research to society's needs is _______.
13. A procedure that tests a hypothesis is a(n) _______.
14. Processes that scientists use to solve a problem are called _______.
15. An explanation of a natural phenomenon with a high degree of confidence is a(n) _______.
16. The group that is not altered in an experiment is the _______.
17. The single change in the manipulated group in an experiment is a(n) _______ variable.
18. When a horse swats a fly with its tail, the fly is a _______ and the swat of the tail is a _______.

Chapter 1 Assessment

19. The idea that germs are the cause of disease has been continuously supported by experiments and has, therefore, been elevated to the status of a _______.
20. The standard group against which others are measured in an experiment is a _______.

Applying Main Ideas

21. Describe how the human body shows the life characteristic of organization.
22. Explain the relationships among an organism's environment, adaptations, and evolution.

Thinking Critically

23. **Comparing and Contrasting** Consider the following items: a flame, bubbles blown from a bubble wand, and a balloon released into the air. List characteristics of each that might indicate life and those that indicate they are not alive.
24. **Concept Mapping** Complete the concept map by using the following vocabulary terms: experiment, theory, hypothesis, scientific methods

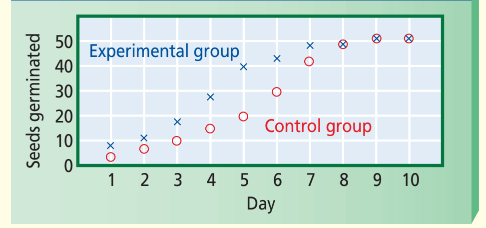
1.
may begin with an observation, which leads to a(n)
2.
that is tested by a(n)
3.
and, after many repetitions, may result in a(n)
4.

CD-ROM
For additional review, use the assessment options for this chapter found on the ***Biology: The Dynamics of Life Interactive CD-ROM*** and on the Glencoe Science Web Site.
www.glencoe.com/sec/science

Assessing Knowledge & Skills

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 below.

The Effect of Fertilizer on Germination



Interpreting Data Study the graph and answer the following questions.

1. Which of the following would represent 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.
2. When was the first appropriate day to end the experiment?
   a. day 3 c. day 7
   b. day 6 d. day 9
3. Which of the following was the independent variable?
   a. kind of seeds c. temperature
   b. number germinating d. time
4. Which of the following was the dependent variable?
   a. kind of seeds c. temperature
   b. number germinating d. time
5. **Interpreting Data** Describe the germination rate between days 3 and 5 in the control group.

Applying Main Ideas

21. It is composed of cells, which are organized into tissues and organs, which are organized into body systems.
22. Evolution is the result of organisms adapting to environmental changes.

Thinking Critically

23. A flame has energy and may appear to grow and reproduce. Bubbles blown from a wand move and may grow. A balloon released into air moves. These objects cannot adapt to changes in the environment or maintain homeostasis.
24. 1. Scientific methods; 2. Hypothesis; 3. Experiment; 4. Theory

Assessing Knowledge & Skills

1. b
2. d
3. c
4. b
5. Between days 3 and 5, approximately 5 seeds germinated per day.

BioDigest

National Science Education Standards
UCP.1, A.2, G.1, G.2

Prepare

Purpose

This BioDigest can be used as a brief overview of the nature of science and the characteristics of life. If time is limited, you may wish to use this unit summary to teach these concepts in place of Chapter 1.

Key Concepts

Students are introduced to the characteristics of life and the methods of science. They learn about the nature and limitations of science and technology.

1 Focus

Bellringer

Show students a candle flame and a caged mouse. Ask students to explain the similarities and differences of the two to elicit the characteristics of living things. L1

2 Teach

Quick Demo

Visual-Spatial Display a small animal such as an earthworm. Ask students to describe its observable characteristics of life. Then ask them how they could observe life characteristics they cannot see. L2

BioDigest

For a **preview** of the what is biology unit, study this BioDigest before you read the chapter. After you have studied the chapter, you can use the BioDigest to **review** the unit.

What Is Biology?

All living things share certain characteristics. What characteristics tell you these robins are living organisms?

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.

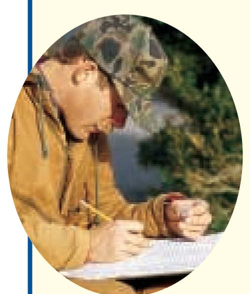
Homeostasis

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.

Focus on Careers



If you enjoy working outdoors, a career in field biology may be for you.

Biology at Work

Thousands of career opportunities are available in the biological sciences. Some of these careers require only a high school education. Others require a college degree, or even an advanced degree. Many careers in biology involve work as a research biologist in the field or in a laboratory setting.

Other careers also rely on skills or knowledge about biology. Doctors and dentists, nurses and laboratory technicians, florists, foresters, and zookeepers all must have a knowledge of biology. Careers related to the biological sciences also include food processing, farming, and ranching. Can you think of some other careers in which biology plays an important role?

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 answer 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. A condition caused by the change in the independent variable is a dependent variable.

Theory

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

Many experiments are conducted in the laboratory, where conditions can be easily controlled.

BioDigest Assessment

Understanding Main Ideas

1. The basic unit of organization of living things is ________.
   a. an atom c. a cell
   b. an organism d. an organ
2. Storing energy obtained from food is an example of ________.
   a. evolution c. response
   b. homeostasis d. growth
3. A hypothesis that is supported many times becomes ________.
   a. an experiment c. a theory
   b. a conclusion d. an observation
4. All of the procedures scientists use to answer questions are ________.
   a. life characteristics c. research
   b. scientific methods d. hypotheses
5. To test a hypothesis, a scientist may ________.
   a. do an experiment
   b. write a theory
   c. do research in a library
   d. make some observations

Thinking Critically

1. 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.
2. Compare the characteristics of life with the flames of a fire. How are they similar and different?
3. Why do most experiments have a control? Describe an experiment that does not have a control.

Multiple Learning Styles

Look for the following logos for strategies that emphasize different learning modalities.

Visual-Spatial Quick Demo, p. 32; Microscope Activity, p. 33; Reteach, p. 33; Extension, p. 33

Resource Manager

Reinforcement and Study Guide, p. 5-6 L2
Content Mastery, p. 5-8 L1

BioDigest Assessment

Understanding Main Ideas

1. c
2. b
3. c
4. b
5. a

Thinking Critically

1. Cells would show cellular structure; homeostasis is shown by making and using energy from sunlight; growing toward the light is a response to stimulus; growth and development would be shown in the changes since the plant was a seed; reproduction occurs when it produces new seeds.
2. Fires can grow, use energy, and reproduce. Fires are not composed of cells.
3. A control is a basis for comparison. A behavior experiment may not have a control.

BioDigest

Microscope Activity

Visual-Spatial Have students examine slides of protists. Ask what characteristics of life the organisms share. L2 ELL

3 Assess

Check for Understanding

Have students explain why science and technology cannot answer all questions. L2

Reteach

Visual-Spatial Ask students to observe a seed and make a hypothesis about whether it is alive. Have them plant the seed and record the characteristics of life they note over the period of a week or two. L1 ELL

Extension

Visual-Spatial Have students make a bulletin board collage of pictures of living organisms. L1 ELL

Assessment

Skill Provide students with examples of living organisms and nonliving objects. Ask them to group the living organisms together and the nonliving objects together. Include some once-living objects to make a third group. L2

4 Close

Discussion

Ask students to discuss specific examples of a stimulus and the resulting response they may have observed in common animals. Have students identify both the stimulus and response, and speculate about how the response might help the organism maintain homeostasis.