Chapter 1

Introduction to Life Science

The BIG Idea

Nature of Science and Inquiry

How do scientists investigate the natural world?

Chapter Preview

1 What Is Science?
- *Discover* How Keen Are Your Senses?
- *Analyzing Data* Chimp Food
- *At-Home Activity* "Pastabilities"

2 Scientific Inquiry
- *Discover* What Can You Learn About Mealworms?
- *Skills Activity* Controlling Variables
- *Active Art* The Nature of Inquiry

3 Understanding Technology
- *Discover* What Are Some Examples of Technology?
- *Skills Activity* Predicting

4 Safety in the Science Laboratory
- *Discover* Where Is the Safety Equipment in Your School?
- *Design Your Own Lab* Keeping Flowers Fresh

The food scientist is busy at work in a laboratory.

Discovery Channel School

What Is Science?

- ▶ Video Preview
- Video Field Trip
- Video Assessment

Lab zone™ Chapter **Project**

Is It Really True?

Does fertilizer make plants grow taller? Is yawning contagious? Do fresh eggs sink in water, but older eggs float? Does moss always grow on the north side of trees? Each of these questions relates to a common belief about living things. But are those beliefs true? In this chapter project, you will use scientific methods to find out.

Your Goal To design and conduct a scientific experiment to test whether a common belief about living things is true or false

To complete this project, you must

- select one specific question to investigate
- determine the procedure you will follow to investigate your question
- collect data and use it to draw conclusions
- follow the safety guidelines in Appendix A

Plan It! Make a list of some common beliefs you could explore. Then preview the chapter to learn what types of questions can be explored by scientific methods. When you select a question, write the procedure you will follow. After your teacher approves your plan, begin your experiment.

Section 1

What Is Science?

Reading Preview

Key Concepts

- What skills do scientists use to learn about the world?

Key Terms

- science
- observing
- quantitative observation
- qualitative observation
- inferring
- predicting
- classifying
- making models
- life science

Target Reading Skill

Asking Questions Before you read, preview the red headings. In a graphic organizer like the one below, ask a *what*, *how*, or *why* question for each heading. As you read, write answers to your questions.

Thinking Like a Scientist

Question	Answer
What does observing involve?	Observing involves . . .

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Lab zone Discover Activity

How Keen Are Your Senses?

1. Your teacher has arranged for an unexpected event to occur. At the count of three, the event will begin.
2. List as many details as you can remember about the event.
3. Compare your list with those of your classmates.

Think It Over

Observing How many details could you list? Which of your senses did you use to gather information?

Once, as I walked through thick forest in a downpour, I suddenly saw a chimp hunched in front of me. Quickly I stopped. Then I heard a sound from above. I looked up and there was a big chimp there, too. When he saw me he gave a loud, clear wailing *wraaaaah*—a spine-chilling call that is used to threaten a dangerous animal. To my right I saw a large black hand shaking a branch and bright eyes glaring threateningly through the foliage. Then came another savage *wraaaah* from behind. Up above, the big male began to sway the vegetation. I was surrounded.

These words are from the writings of Jane Goodall, a scientist who studies wild chimpanzees in Gombe National Park in Tanzania, Africa. What would you have done if you were in Jane's shoes? Would you have screamed or tried to run away? Jane did neither of these things. Instead, she crouched down and stayed still so she wouldn't startle the chimps. Not feeling threatened by her, the chimps eventually moved on.

Jane Goodall was determined to learn all she could about chimps. Her studies are an example of science in action. **Science** is a way of learning about the natural world. Science also includes all of the knowledge gained by exploring the natural world. **Scientists use skills such as observing, inferring, predicting, classifying, and making models to learn more about the world.** However, these skills are not unique to scientists. You, too, think like a scientist every day.

FIGURE 1 Observing
By patiently observing chimpanzees, Jane Goodall learned many things about chimpanzee behavior. The smaller photo shows one of Jane's earliest discoveries—that chimps use sticks as tools to fish for termites.

Observing

Jane Goodall has spent countless hours among the chimpanzees—quietly following them, taking notes, and carefully observing. **Observing** means using one or more of your senses to gather information. Your senses include sight, hearing, touch, taste, and smell. By using her senses, Jane learned what chimpanzees eat, what sounds they make, and even what games they play! During her time in Gombe, Jane made many surprising observations. For example, she observed how chimpanzees use stems or long blades of grass as tools to "fish" out a tasty meal from termite mounds.

Like Jane, you use your senses to gather information. Look around you. What do you see? What do you hear and smell? You depend on your observations to help you make decisions throughout the day. For example, if it feels chilly when you wake up, you'll probably dress warmly.

Observations can be either quantitative or qualitative. **Quantitative observations** deal with a number, or amount. Seeing that you have eight new e-mails in your inbox is a quantitative observation. **Qualitative observations,** on the other hand, deal with descriptions that cannot be expressed in numbers. Noticing that a bike is blue or that a grape tastes sour are qualitative observations.

Reading Checkpoint **What senses can the skill of observation involve?**

Inferring

One day, Jane Goodall saw something peculiar. She watched as a chimpanzee peered into a hollow in a tree. The chimp picked off a handful of leaves from the tree and chewed on them. Then it took the leaves out of its mouth and pushed them into the tree hollow. When the chimp pulled the leaves back out, Jane saw the gleam of water. The chimp then put the wet leaves back in its mouth.

What was the chimpanzee doing? Jane reasoned that the chimpanzee might be using the chewed leaves like a sponge to soak up water. Seeing the chimp chew on leaves, put them in the hollow, and then squeeze the liquid out is an example of an observation. But Jane went beyond simply observing when she reasoned why the chimpanzee was doing these things. When you explain or interpret the things you observe, you are **inferring,** or making an inference.

Making an inference doesn't mean guessing wildly. Inferences are based on reasoning from what you already know. Jane knew that chimpanzees, like all other animals, need water, and that rainwater collects in tree hollows. She reasoned that the chimp was using chewed leaves to get the water out of the tree.

You, too, make inferences all the time. Because your brain processes observations and other information so quickly, you may not even realize when you have made an inference. For example, if you see your friend smile after getting back an exam, you might automatically infer that she got a good grade. Inferences are not always correct, however. Your friend's smile might not have anything to do with the test.

Reading Checkpoint What is inferring?

FIGURE 2 Inferring
When you explain or interpret your observations, you are making an inference. **Inferring** *List three inferences you can make about this chimp.*

Predicting

Sometimes, Jane could even predict what a chimp was going to do next. **Predicting** means making a forecast of what will happen in the future based on past experience or evidence.

Through her observations, Jane learned that when a chimpanzee is frightened or angry, its hairs stand on end. This response is sometimes followed by threatening gestures such as charging, throwing rocks, and shaking trees, or even an attack. Therefore, if Jane sees a chimp with its hairs on end, she can predict that the chimp might attack her in a short time. She then leaves the area.

Likewise, you would probably move away if you saw a dog growling or baring its teeth. Why? Because predicting is part of your everyday thinking. You might predict, for example, that your basketball team will win tonight's game if you have always beaten the other team in the past. Predictions, of course, are not always correct. New players this year may increase the other team's chances of winning.

Predictions and inferences are closely related. An inference is typically an attempt to explain what is happening or *has* happened. A prediction is a forecast of what *will* happen. If you see a broken egg on the floor by a table, you might infer that the egg had rolled off the table. If, however, you see an egg rolling toward the edge of a table, you can predict that it's about to create a mess.

Reading Checkpoint **What are predictions based on?**

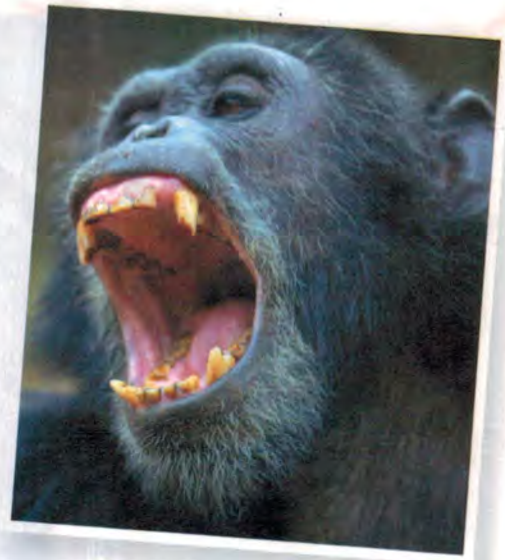


FIGURE 3
Predicting
Predictions are forecasts of what will happen next. Like many animals, chimps bare their teeth when they are frightened or angry.
Predicting *What do you think the chimp will do next?*

Math Analyzing Data

Chimp Food

This graph shows the diet of chimps at Gombe National Park during May of one year.

1. **Reading Graphs** According to the graph, what foods do chimps eat?
2. **Interpreting Data** Did chimps feed more on seeds or leaves during this month?
3. **Calculating** What percentage of the diet did blossoms, seeds, leaves, and fruit make up?
4. **Predicting** Suppose you learn that November is the main termite-fishing season, when chimps spend a large part of their time eating termites. Predict how the chimp diet might change in November.

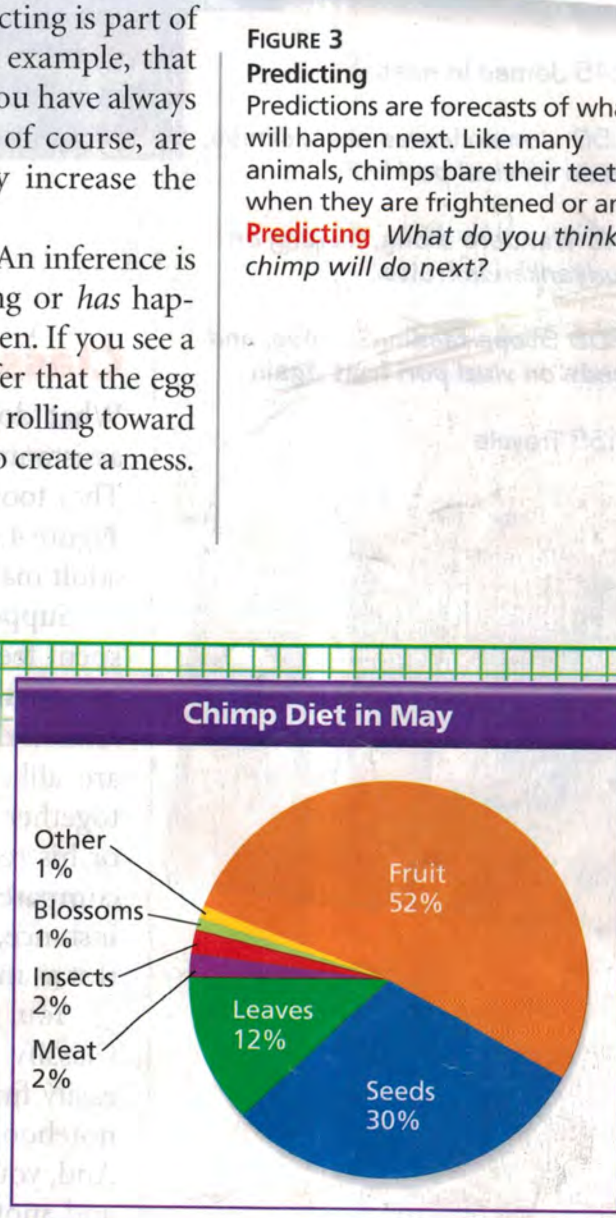


FIGURE 4 Classifying
Field notes like these contain many details about a chimp's daily activities. By grouping together all the information related to resting, climbing, or feeding, Jane can better understand the chimp's behavior.


Resting

6:45 Jomeo in nest

6:50 Jomeo leaves nest, climbs, feeds on *viazi pori* fruit

7:16 Wanders along, feeding on *budyankende* fruits

8:08 Stops feeding, climbs, and feeds on *viazi pori* fruit again

8:35 Travels

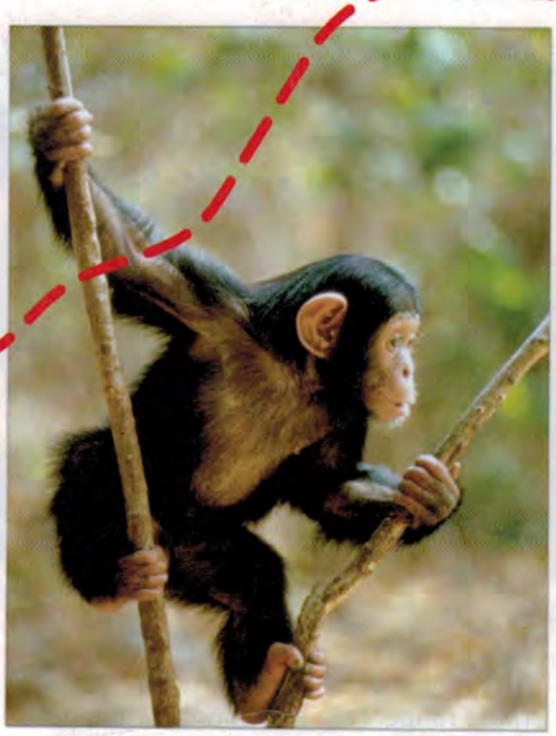
Classifying

What do chimps do all day? To find out, Jane and her assistants followed the chimpanzees through the forest. They took detailed field notes about the chimps' behaviors. Figure 4 shows a short section of notes about Jomeo, an adult male chimp.

Suppose Jane wanted to know how much time Jomeo spent feeding or resting that morning. She could find out by classifying Jomeo's actions into several categories. **Classifying** is the process of grouping together items that are alike in some way. For example, Jane could group together all the information about Jomeo's feeding habits or his resting behavior. This would also make it easier to compare Jomeo's actions to those of other chimps. For instance, she could determine if other adult males feed or rest as much as Jomeo does.

You, too, classify objects and information all the time. Classifying things helps you to stay organized so you can easily find and use them later. When you put papers in a notebook, you might classify them by subject or date. And, you might have one drawer in your dresser for shirts and another for socks.

Reading Checkpoint **How is classifying objects useful?**



Climbing

Feeding

Making Models

How far do chimpanzees travel? Where do they go? Sometimes, Jane's research team would follow a particular chimpanzee for many days at a time. Figure 5 illustrates Jomeo's journey through the forest over the course of one day. The diagram is one example of a model. **Making models** involves creating representations of complex objects or processes. Models help people study and understand things that are complex or that can't be observed directly. Using a model like the one in Figure 5, Jane and her assistants could share information that would otherwise be difficult to explain.

Models are all around you. They include physical objects, such as globes or the sets used in filming your favorite TV show. Some models are generated by computer, like the ones some architects use to design new buildings. It's important to keep in mind that models are only representations of the real object or process. Because some information may be missing from a model, you may not be able to understand everything about the object or process the model represents.

Reading Checkpoint **What is a model?**

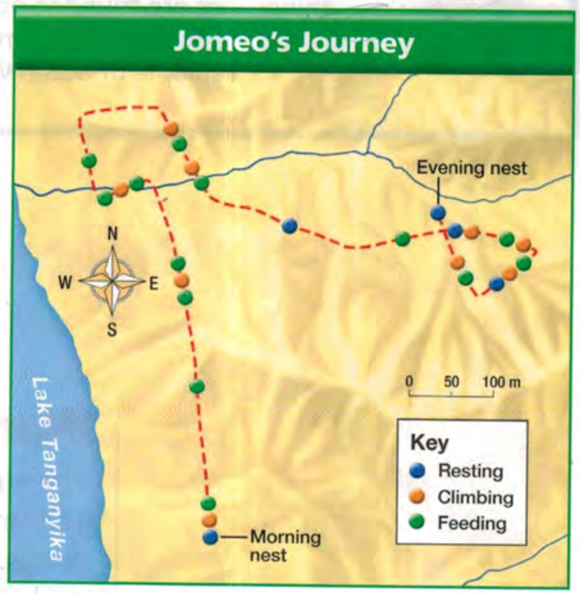


FIGURE 5
Making Models
This map is a model that traces Jomeo's journey through the forest. It represents information that would be hard to explain in words. **Interpreting Maps** *What is the total distance that Jomeo traveled between his morning and evening nests?*

FIGURE 6

Life Science Careers

You can find life scientists at work in such diverse places as forests, laboratories, farms, and animal hospitals. **Comparing and Contrasting** *How are the careers of botanist and forestry technician similar?*

Botanist ◄
Botanists study plants. Many botanists, such as the one shown here, work with farmers to help increase crop yields. Other botanists study plants growing in their natural environment.

Park Rangers ▲
Park rangers work in government parks. These rangers are attaching a tag to a bird so they can track its movements. Other rangers lead tours that educate park visitors.

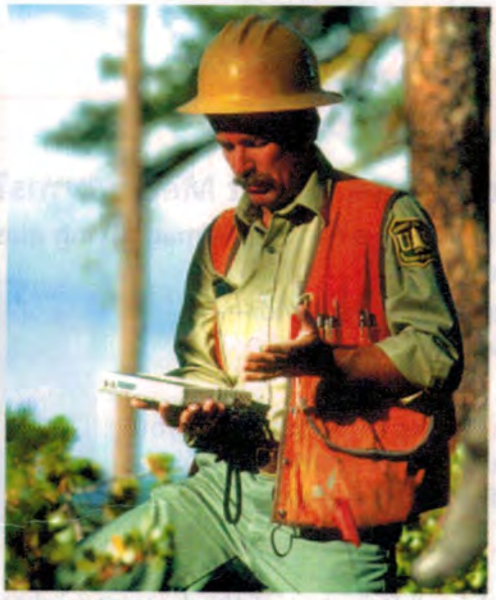
► Marine Biologist
Marine biologists study living things that are found in oceans. This marine biologist is examining a sample of ocean water.

Working in Life Science

The study of the behavior of animals such as chimpanzees is one branch of life science. **Life science** is the study of living things. Life science is also known as biology, and scientists who study living things are called biologists.

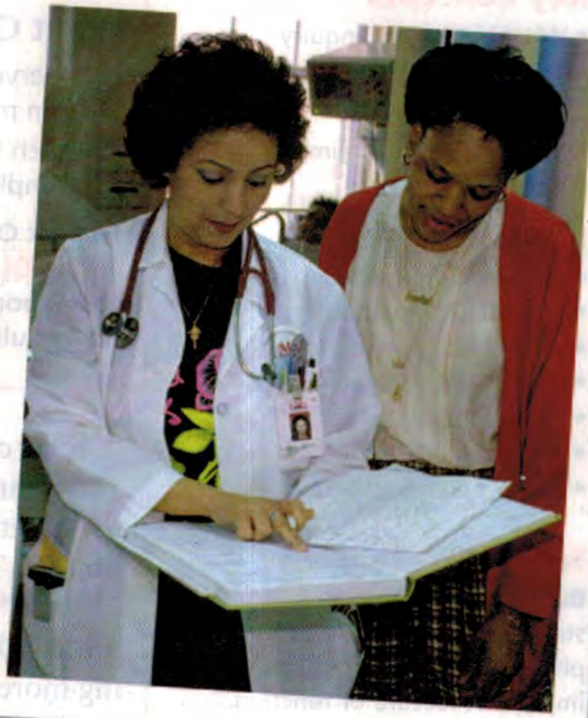
If you are interested in living things, you might one day enjoy working in life science. You don't need to be a biologist to use life science in your career. Many different jobs involve knowing about life science. You can see some of these jobs in Figure 6.

Reading Checkpoint What is life science?



Forestry Technician ▲
Forestry technicians mostly work outdoors. They determine which trees can be cut down for lumber. They check trees for disease and insect damage. These workers also plant tree seedlings.

Health-Care Workers ▼
Health-care workers do jobs such as examine patients, treat injuries, and research cures for diseases. The doctor (left) and nurse (right) are discussing their notes.



Section 1 Assessment

Target Reading Skill **Asking Questions** Use the answers to the questions you wrote about the headings to help you answer the questions below.

Reviewing Key Concepts

1. a. **Listing** Name five skills that are important in scientific thinking.
   b. **Comparing and Contrasting** How do observations differ from inferences?
   c. **Classifying** Is this statement an observation or an inference? *The cat must be ill.* Explain your reasoning.
   d. **Applying Concepts** Choose a career described on these pages. Give examples of how observations and inferences might be important in that career.

Lab zone **At-Home Activity**

"Pastabilities" Collect pasta of various shapes and sizes. You and a family member should each devise a system to classify the pasta into three groups. You and your family member should each identify the characteristics you used in your classifications. How similar were your groupings?

Section 2

Scientific Inquiry

Reading Preview

Key Concepts

- What is scientific inquiry?
- What makes a hypothesis testable?
- What attitudes are important in science?

Key Terms

- scientific inquiry
- hypothesis • variable
- controlled experiment
- manipulated variable
- responding variable
- operational definition
- data • communicating

Target Reading Skill

Building Vocabulary A definition states the meaning of a word or phrase by telling about its most important feature or function. After you read this section, reread the paragraphs that contain definitions of Key Terms. Use all the information you have learned to write a definition of each Key Term in your own words.

Lab zone Discover Activity

What Can You Learn About Mealworms?

1. Observe mealworms in a tray. Use a magnifying glass to see them more clearly.
2. Watch the mealworms' behavior—for example, how they move.

Think It Over

Posing Questions Write three questions you have about mealworms and their behavior. How could you find out the answers?

"Chirp, chirp, chirp." It is one of the hottest nights of summer and your bedroom windows are wide open. On most nights, the quiet chirping of crickets gently lulls you to sleep, but not tonight. The noise from the crickets is almost deafening!

Why do all the crickets in your neighborhood seem determined to keep you awake tonight? Could the crickets be chirping more because of the heat? How could you find out?

As you lie awake, you are probably not thinking much about science. But, in fact, you are thinking just as a scientist would. You made observations—you heard the loud chirping of the crickets and felt the heat of the summer night. Your observations led you to infer that heat might cause increased chirping. You might even make a prediction: "If it's cooler tomorrow night, the crickets will be quieter."

▼ A snowy tree cricket

The Scientific Process

Although you might not know it, your thinking and questioning can be the start of the scientific inquiry process. **Scientific inquiry refers to the diverse ways in which scientists study the natural world and propose explanations based on the evidence they gather.** If you have ever tried to figure out why a plant has wilted, then you have used scientific inquiry. Similarly, you could use scientific inquiry to find out whether there is a relationship between the air temperature and crickets' chirping.

Posing Questions Scientific inquiry often begins with a problem or question about an observation. In the case of the crickets, your question might be: Does the air temperature affect the chirping of crickets? Of course, questions don't just come to you from nowhere. Instead, questions come from experiences that you have and from observations and inferences that you make. Curiosity plays a large role as well. Think of a time that you observed something unusual or unexpected. Chances are good that your curiosity sparked a number of questions.

Some questions cannot be investigated by scientific inquiry. Think about the difference between the two questions below.

- Does my dog eat more food than my cat?
- Which makes a better pet—a cat or a dog?

The first question is a scientific question because it can be answered by making observations and gathering evidence. For example, you could measure the amount of food your cat and dog each eat during a week. In contrast, the second question has to do with personal opinions or values. Scientific inquiry cannot answer questions about personal tastes or judgments.

Developing a Hypothesis How could you explain your observation of noisy crickets on that summer night? "Perhaps crickets chirp more when the temperature is higher," you think. In trying to answer the question, you are in fact developing a hypothesis. A **hypothesis** (plural: *hypotheses*) is a possible explanation for a set of observations or answer to a scientific question. In this case, your hypothesis would be that cricket chirping increases at higher air temperatures.

In science, a hypothesis must be testable. This means that researchers must be able to carry out investigations and gather evidence that will either support or disprove the hypothesis. Many trials will be needed before a hypothesis can be accepted as true.

Reading Checkpoint What is a hypothesis?

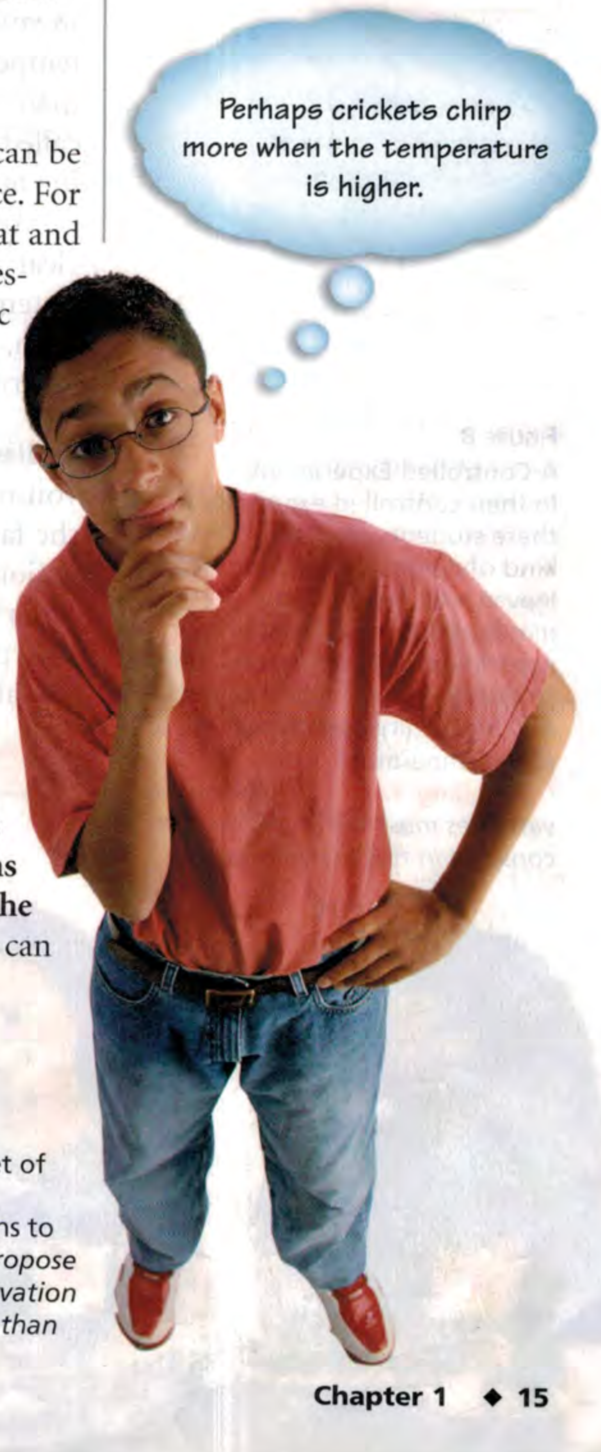


FIGURE 7 Developing Hypotheses
A hypothesis is one possible way to explain a set of observations. A hypothesis must be testable—scientists must be able to carry out investigations to test the hypothesis. **Developing Hypotheses** *Propose another hypothesis that could explain the observation that crickets seem to be noisier on some nights than others.*

Lab zone Skills **Activity**

Controlling Variables

Suppose you are designing an experiment to determine whether birds eat a larger number of sunflower seeds or millet seeds. What is your manipulated variable? What is your responding variable? What other variables would you need to control?

Designing an Experiment To test your hypothesis, you will need to observe crickets at different air temperatures. All other **variables,** or factors that can change in an experiment, must be exactly the same. Other variables include the kind of crickets, the type of container you test them in, and the type of thermometer you use. By keeping all of these variables the same, you will know that any difference in cricket chirping must be due to temperature alone.

An experiment in which only one variable is manipulated at a time is called a **controlled experiment.** The one variable that is purposely changed to test a hypothesis is called the **manipulated variable** (also called the independent variable). In your cricket experiment, the manipulated variable is the air temperature. The factor that may change in response to the manipulated variable is called the **responding variable** (also called the dependent variable). The responding variable here is the number of cricket chirps.

Another aspect of a well-designed experiment is having clear operational definitions. An **operational definition** is a statement that describes how to measure a variable or define a term. For example, in this experiment you would need to determine what sounds will count as a single "chirp."

Collecting and Interpreting Data For your experiment, you need a data table in which to record your data. **Data** are the facts, figures, and other evidence gathered through observations. A data table is an organized way to collect and record observations. After the data have been collected, they need to be interpreted. A graph can help you interpret data. Graphs can reveal patterns or trends in data.

Reading Checkpoint **What are data?**

FIGURE 8
A Controlled Experiment
In their controlled experiment, these students are using the same kind of containers, thermometers, leaves, and crickets. The manipulated variable in this experiment is temperature. The responding variable is the number of cricket chirps per minute at each temperature.
Controlling Variables *What other variables must the students keep constant in this experiment?*

Drawing Conclusions A conclusion is a summary of what you have learned from an experiment. In drawing your conclusion, you should ask yourself whether the data support the hypothesis. You also need to consider whether you collected enough data. After reviewing the data, you decide that the evidence supports your original hypothesis. You conclude that cricket chirping does increase with temperature. It's no wonder that you have trouble sleeping on those warm summer nights!

Scientific inquiry usually doesn't end once a set of experiments is done. Often, a scientific inquiry raises new questions. These new questions can lead to new hypotheses and new experiments. Also, scientific inquiry is not a rigid sequence of steps. Instead, it is a process with many paths, as shown in Figure 9.

Communicating An important part of the scientific inquiry process is communicating your results. **Communicating** is the sharing of ideas and experimental findings with others through writing and speaking. Scientists share their ideas in many ways. For example, they give talks at scientific meetings, exchange information on the Internet, and publish articles in scientific journals. When scientists communicate their research, they describe their procedures in full detail so that other scientists can repeat their experiments.

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What Is Science?

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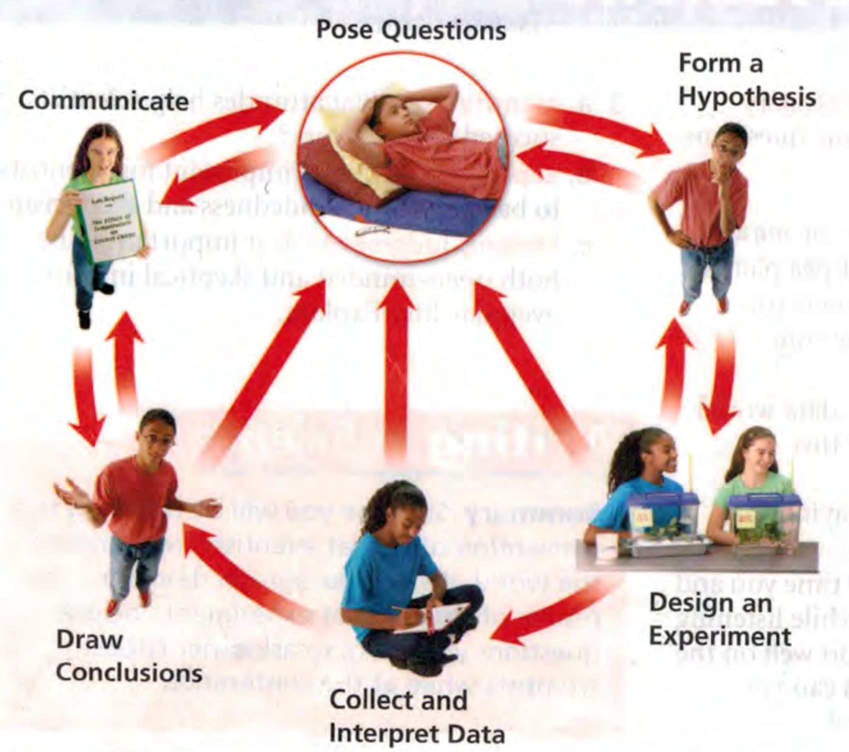

FIGURE 9
Scientific Inquiry
There is no set path that a scientific inquiry must follow. Observations at each stage of the process may lead you to modify your hypothesis or experiment. Conclusions from one experiment often lead to new questions and experiments.

FIGURE 10 Curiosity
Curiosity has led Dr. Daphne Soares to study how alligators interact with their environment.

Scientific Attitudes

Why has Jane Goodall been very successful at studying chimps? **Successful scientists possess certain important attitudes, or habits of mind, including curiosity, honesty, open-mindedness, skepticism, and creativity.**

Curiosity An important attitude that drives scientists is curiosity. Successful scientists are eager to learn more about the topics they study. They stick with problems in spite of setbacks.

Honesty Good scientists always report their observations and results truthfully. Honesty is especially important when a scientist's results go against previous ideas or predictions.

Open-Mindedness and Skepticism Scientists need to be open-minded, or capable of accepting new and different ideas. However, open-mindedness should always be balanced by skepticism, which is an attitude of doubt.

Creativity Whether scientists study chimps or earthquakes, problems may arise in their studies. Sometimes, it takes a bit of creativity to find a solution. Creativity means coming up with inventive ways to solve problems or produce new things.

Section 2 Assessment

Target Reading Skill Building Vocabulary Use your definitions to help answer the questions.

Reviewing Key Concepts

1. a. **Defining** Define the term *scientific inquiry*.
   b. **Explaining** A friend claims that pea plants grow faster than corn plants. Could you investigate this idea through scientific inquiry? Explain.
   c. **Problem Solving** What kind of data would you need to collect to carry out this experiment?
2. a. **Reviewing** What is meant by saying that a hypothesis must be testable?
   b. **Developing Hypotheses** Every time you and your friend study for an exam while listening to classical music, both of you do well on the exam. What testable hypothesis can you develop from your observations?
3. a. **Identifying** What attitudes help scientists succeed in their work?
   b. **Explaining** Why is it important for scientists to balance open-mindedness and skepticism?
   c. **Making Judgments** Is it important to be both open-minded and skeptical in your everyday life? Explain.

Writing in Science

Summary Suppose you will be traveling to a convention of cricket scientists from around the world. Write a paragraph describing the results of your cricket experiment. Include questions you'd like to ask other cricket scientists while at the conference.

Section 3

· Tech & Design ·

Understanding Technology

Reading Preview

Key Concepts

- What is the goal of technology?
- How does technology differ from science?
- How does technology affect society?

Key Terms

- technology • engineer

Target Reading Skill

Previewing Visuals When you preview, you look ahead at the material to be read. Preview Figure 12. Then write two questions you have about the diagram. As you read, answer your questions.

Science and Technology

Q. What does technology have to do with science?
A.
Q.

Lab zone Discover Activity

What Are Some Examples of Technology?

1. Look at the objects in the photographs.
2. With a partner, discuss whether or not each object is an example of technology. Write your reasons for each decision.

Think It Over

Forming Operational Definitions On what basis did you and your partner decide whether an object was an example of technology? What is your definition of the term *technology?*

In the fourth quarter of a football game between San Jose State and Nevada, the crowd went wild. Neil Parry had just joined the San Jose players on the field. Cries of "PAR-ry, PAR-ry, PAR-ry" filled the stadium.

It was Neil's first football game after his right leg below the knee had been amputated, or removed in an operation. Neil now has an artificial leg, or prosthesis. Because of his determination and hard work, Neil Parry can play football again. His ability to run and tackle is also due to the design of his artificial leg.

◀ Neil Parry plays football.

Lab zone Skills Activity

Predicting

Choose a type of technology, such as medical technology or video technology. Talk to older people about how this type of technology has changed during their lives. Then predict how this technology may continue to change.

What Is Technology?

Artificial legs are examples of technology. So are football helmets, shoulder pads, and shoes with cleats. When you see or hear the word *technology*, you may think of such things as electronic scoreboards, computers, and DVD players. But technology consists of more than modern inventions. **Technology** is how people change the world around them to meet their needs and solve practical problems.

Technology includes things people make, such as computers. It also consists of the knowledge needed to design those products. Finally, technology includes the processes, such as manufacturing and transportation, that get products to the people who use them. Figure 11 shows examples of technology.

The goal of technology is to improve the way people live. Your refrigerator, for example, improves your life by making food stay fresh longer. If you wear glasses or contact lenses, you know that they help people see better. A medical thermometer makes it easier to determine whether you are sick.

Reading Checkpoint What are some examples of technology?

FIGURE 11
Examples of Technology
Technology includes things people make to meet their needs. **Applying Concepts** *How does farm machinery help people meet their needs?*

▼ **Farm machinery**

▼ **Heart monitor**

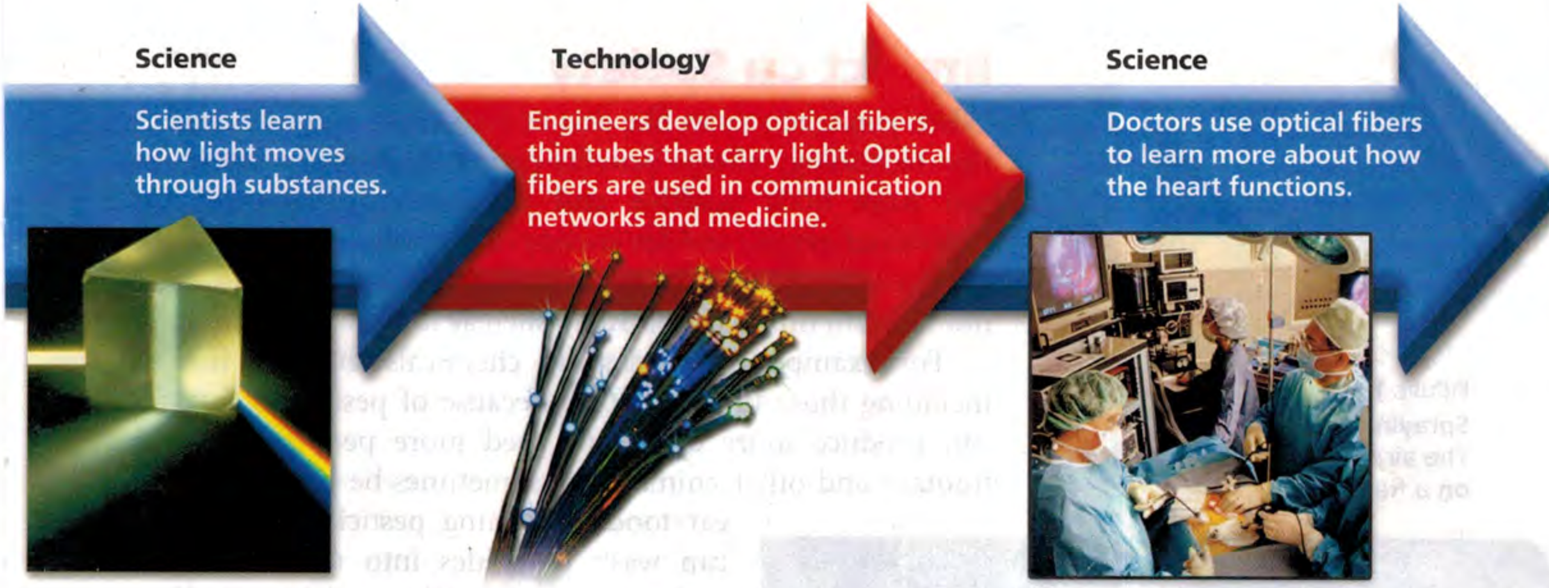

FIGURE 12
Science and Technology
Advances in science contribute to advances in technology, which in turn can contribute to science. Understanding the characteristics of light (science) led to the development of optical fibers and endoscopes (technology).
Relating Cause and Effect *How might endoscopes help scientists learn more about the human body?*

Comparing Technology and Science

Science and technology are related, but they are not the same thing. **Science is the study of the natural world to understand how it functions. Technology, on the other hand, changes, or modifies, the natural world to meet human needs or solve problems.**

To understand this difference, contrast the ways in which a biologist and an engineer might study insects. (An **engineer** is a person who is trained to use both technological and scientific knowledge to solve practical problems.) The biologist might investigate the structure of insects' bodies and how insects obtain oxygen. The engineer might study insects to learn how to keep them from damaging crops. In other words, a scientist studies something to learn about the topic itself. An engineer studies a topic to solve a problem or develop a process or product for human use.

Often, advances in science and technology depend on one another, as shown in Figure 12. Endoscopes are tiny medical instruments that allow doctors to view organs within the human body. Endoscopes transmit light using long, thin strands of glass called optical fibers. The design of these fibers would not have been possible without the work of scientists. Once scientists understood how light travels through substances, technologists were able to use this knowledge to design optical fibers and endoscopes. Endoscopes, in turn, have helped scientists learn more about the human body.

Reading Checkpoint **What is an endoscope?**

Go Online SCI LINKS NSTA
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Web Code: scn-1631

Impact on Society

When you read stories like that of Neil Parry, you might think that technology always benefits people. **However, technology can have both positive and negative consequences for individual people and for society as a whole.** The term *society* refers to any group of people who live together in an area and have certain things in common, such as form of government.

For example, pesticides are chemicals that kill insects, including those that eat crops. Because of pesticides, farmers can produce more crops and feed more people. However, humans and other animals can sometimes be harmed if they eat food containing pesticides. Also, rain can wash pesticides into rivers, streams, and water supplies. The pesticides can then affect plants and animals that live in the water, as well as people who depend on the water supply.

Technology does not provide perfect solutions to the problems it helps solve. People must make informed decisions to use technology wisely.

FIGURE 13
Spraying Pesticide
The airplane is spraying pesticide on a field.

Reading Checkpoint **What are pesticides?**

Section 3 Assessment

Target Reading Skill **Previewing Visuals** Refer to your questions and answers about Figure 12 to help you answer Question 2 below.

Reviewing Key Concepts

1. a. **Defining** What is technology?
   b. **Explaining** Explain why a toothbrush is an example of technology.
   c. **Applying Concepts** What is the goal of technology? Explain how a toothbrush achieves this goal.
2. a. **Comparing and Contrasting** Compare science and technology.
   b. **Explaining** Is a human leg prosthesis an example of science or technology? Explain.
   c. **Relating Cause and Effect** Explain how both science and technology must have been involved in the development of a leg prosthesis.
3. a. **Listing** List the positive consequences of using pesticides. Then list the negative consequences.
   b. **Explaining** Explain the following statement: "Technology does not provide perfect solutions to problems." Use pesticides as an example.

Writing in Science

Technology and You Choose an example of technology that has had an important impact on your life. Describe the technology and explain how it has affected you.

Section 4

Safety in the Science Laboratory

Reading Preview

Key Concepts

- Why is preparation important when carrying out scientific investigations in the lab and in the field?
- What should you do if an accident occurs?

Target Reading Skill

Outlining As you read, make an outline about science safety that you can use for review. Use the red headings for the main ideas and the blue headings for supporting ideas.

Safety in the Science Laboratory

I. Safety in the lab
  A. Preparing for the lab
  B.
  C.
II. Safety in the field

Lab zone Discover Activity

Where Is the Safety Equipment in Your School?

1. Look around your classroom or school for any safety-related equipment.
2. Draw a floor plan of the room or building and clearly label where each item is located.

Think It Over

Predicting Why is it important to know where safety equipment is located?

You and your family have just arrived at a mountain cabin for a vacation. The view of the mountaintops is beautiful, and the fresh scent of pine trees fills the air. In the distance, you can glimpse a lake through the pines.

You put on a bathing suit and head down the trail toward the lake. The sparkling, clear water looks inviting. You're tempted to jump in and swim. However, you wait for the rest of your family to join you. It isn't safe for a person to swim alone.

Safety During Investigations

Just as when you go swimming, you have to take steps to be safe during any scientific investigation. **Good preparation helps you stay safe when doing science activities.** Do you know how to use lab equipment? What should you do if something goes wrong? Thinking about these questions ahead of time is an important part of being prepared.

Preparing for the Lab Preparing for a lab should begin the day before you will perform the lab. It is important to read through the procedure carefully and make sure you understand all the directions. Also, review the general safety guidelines in Appendix A, including those related to the specific equipment you will use. If anything is unclear, be prepared to ask your teacher about it before you begin the lab.

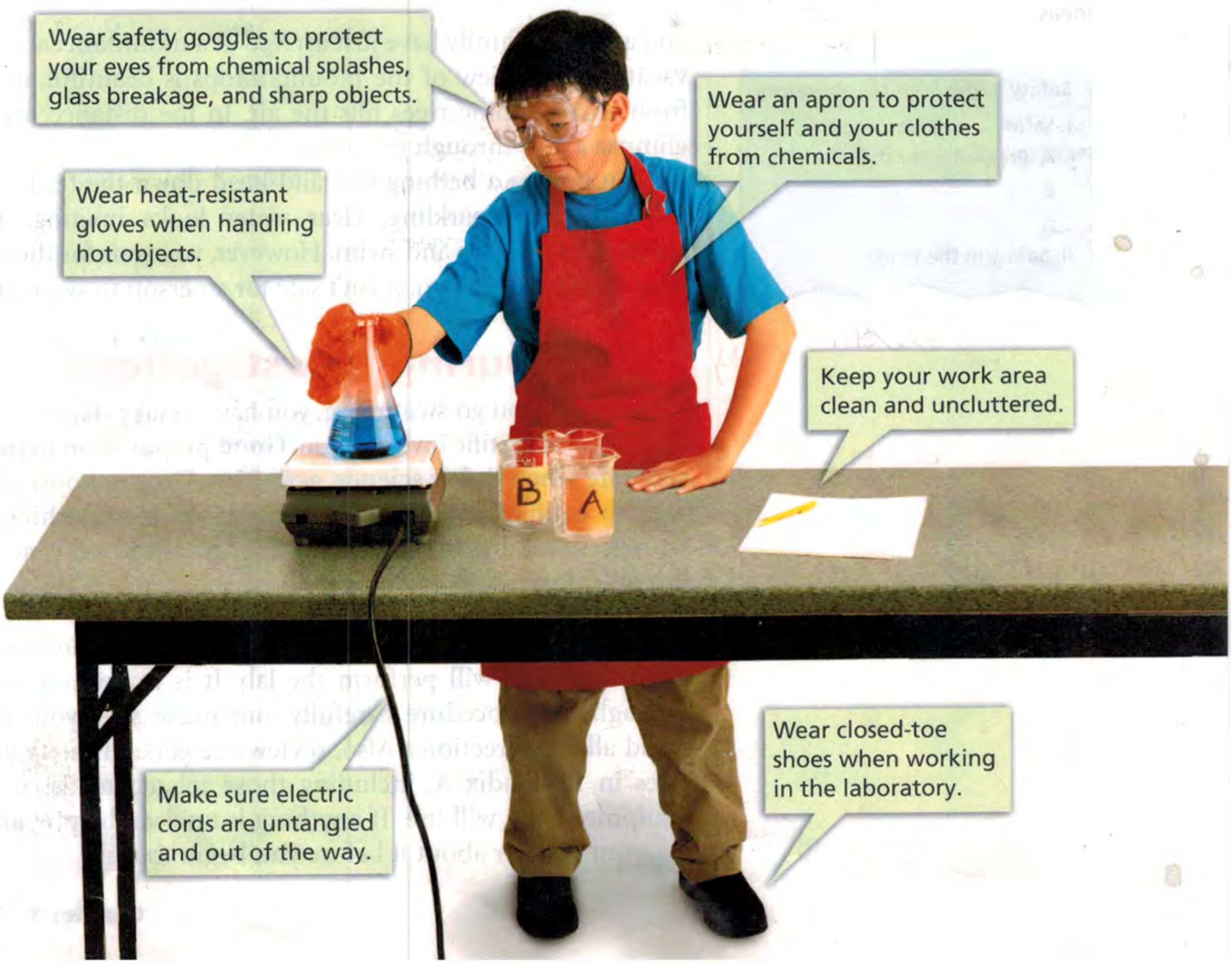
Go Online
SCI LINKS NSTA

For: Links on laboratory safety
Visit: www.SciLinks.org
Web Code: scn-1624

Performing the Lab Whenever you perform a science lab, always follow your teacher's instructions and the textbook directions exactly. You should never try anything on your own without asking your teacher first. Keep your work area clean and organized. Also, do not rush through any of the steps. Finally, always show respect and courtesy to your teacher and classmates.

Labs and activities in this textbook include the safety symbols shown on the next page. These symbols alert you to possible dangers in performing the lab and remind you to work carefully. They also identify any safety equipment that you should use to protect yourself from potential hazards. The symbols are explained in detail in Appendix A. Make sure you are familiar with each safety symbol and what it means.

FIGURE 14
Safety in the Lab
Good preparation for an experiment helps you stay safe in the laboratory. **Observing** *List three precautions each student is taking while performing the labs.*



End-of-Lab Procedures When you have finished a lab, clean your work area. Turn off and unplug equipment and return it to its proper place. Dispose of any wastes as your teacher instructs you to. Finally, wash your hands thoroughly.

Safety in the Field You work in the "field" whenever you work outdoors—for example, in a forest, park, or schoolyard. Always tell an adult where you will be. Never carry out a field investigation alone. Ask an adult or classmate to go with you.

Possible safety hazards outdoors include such things as severe weather, traffic, wild animals, and poisonous plants. Planning ahead can help you avoid some hazards. For example, the weather report can alert you to severe weather. Use common sense to avoid any potentially dangerous situations.

Reading Checkpoint **What should you do with equipment at the end of a lab?**

Safety Symbols

- Safety Goggles
- Lab Apron
- Breakage
- Heat-Resistant Gloves
- Plastic Gloves
- Heating
- Flames
- No Flames
- Corrosive Chemical
- Poison
- Fumes
- Sharp Object
- Animal Safety
- Plant Safety
- Electric Shock
- Physical Safety
- Disposal
- Hand Washing
- General Safety Awareness

In Case of Emergency

ALWAYS NOTIFY YOUR TEACHER IMMEDIATELY

Injury	What to Do
Burns	Immerse burns in cold water.
Cuts	Cover cuts with a clean dressing. Apply direct pressure to the wound to stop bleeding.
Spills on Skin	Flush the skin with large amounts of water.
Foreign Object in Eye	Flush the eye with large amounts of water. Seek medical attention.

FIGURE 15 First-Aid Tips
These first-aid tips can help guide your actions during emergency situations. Remember, always notify your teacher immediately if an accident occurs.

In Case of an Accident

Good preparation and careful work habits can go a long way toward making your lab experiences safe ones. But, at some point, an accident may occur. A classmate might accidentally knock over a beaker or a chemical might spill on your sleeve. Would you know what to do?

When any accident occurs, no matter how minor, notify your teacher immediately. Then, listen to your teacher's directions and carry them out quickly. Make sure you know the location and proper use of all the emergency equipment in your lab room. Knowing safety and first-aid procedures beforehand will prepare you to handle accidents properly. Figure 15 lists some first-aid procedures you should know.

Reading Checkpoint What should you do when an accident occurs?

Section 4 Assessment

Target Reading Skill Outlining Use the information in your outline about science safety to help you answer the questions below.

Reviewing Key Concepts

1. a. **Reviewing** Why is good preparation important in lab investigations?
   b. **Identifying** Identify two steps you should take to prepare for a lab.
   c. **Predicting** What might happen if you did not follow the steps you identified in Question (b)?
2. a. **Describing** What should you do immediately after any lab accident?
   b. **Applying Concepts** Your lab partner cuts herself and stops the bleeding with a tissue from her pocket. Did she follow the proper procedure? Explain.
   c. **Relating Cause and Effect** Explain how your partner might have prevented the accident if she had been more familiar with the safety symbols on page 25.

Writing in Science

Field Trip Safety Think of an outdoor area that you know, such as a park, field, or vacant lot, where you might observe wild plants. Write safety instructions that would help students prepare for a field trip to that place. You might add illustrations to help make the instructions clear.

Lab zone **Design Your Own Lab**

Keeping Flowers Fresh

Problem

How can cut flowers stay fresher for a longer period of time?

Skills Focus

developing hypotheses, designing experiments, drawing conclusions

Suggested Materials

- plastic cups
- cut flowers
- spoon
- water
- sugar

Design a Plan

1. You have just been given a bouquet of cut flowers. You remember once seeing a gardener put some sugar into the water in a vase before putting flowers in. You wonder if the gardener did that so that the flowers would stay fresh longer. Write a hypothesis for an experiment you could perform to answer your question.
2. Working with a partner, design a controlled experiment to test your hypothesis. Make a list of all of the variables you will need to control. Also decide what data you will need to collect. For example, you could count the number of petals each flower drops. Then write out a detailed experimental plan for your teacher to review.
3. If necessary, revise your plan according to your teacher's instructions. Then set up your experiment and begin collecting your data.

Analyze and Conclude

1. **Developing Hypotheses** What hypothesis did you decide to test? On what information or experience was your hypothesis based?
2. **Designing Experiments** What was the manipulated variable in the experiment you performed? What was the responding variable? What variables were kept constant?
3. **Graphing** Use the data you collected to create one or more graphs of your experimental results. (For more on creating graphs, see the Skills Handbook.) What patterns or trends do your graphs reveal?
4. **Drawing Conclusions** Based on your graphs, what conclusion can you draw about sugar and cut flowers? Do your results support your hypothesis? Why or why not?
5. **Communicating** In a paragraph, describe which aspects of your experimental plan were difficult to carry out. Were any variables hard to control? Was it difficult to collect accurate data? What changes could you make to improve your experimental plan?

More to Explore

Make a list of some additional questions you would like to investigate about how to keep cut flowers fresh. Choose one of the questions and write a hypothesis for an experiment you could perform. Then design a controlled experiment to test your hypothesis. *Obtain your teacher's permission before carrying out your investigation.*

Chapter 1 Study Guide

The BIG Idea

Nature of Science and Inquiry Scientists investigate the natural world by posing questions, developing hypotheses, designing experiments, analyzing data, drawing conclusions, and communicating results.

1 What Is Science?

Key Concepts

- Scientists use skills such as observing, inferring, predicting, classifying, and making models to learn more about the world.

Key Terms

• science • observing
• quantitative observation
• qualitative observation
• inferring • predicting • classifying
• making models • life science

2 Scientific Inquiry

Key Concepts

- Scientific inquiry refers to the diverse ways in which scientists study the natural world and propose explanations based on the evidence they gather.
- In science, a hypothesis must be testable. This means that researchers must be able to carry out investigations and gather evidence that will either support or disprove the hypothesis.
- Successful scientists possess certain attitudes, or habits of mind, including curiosity, honesty, open-mindedness, skepticism, and creativity.

Key Terms

scientific inquiry
hypothesis
variable
controlled experiment
manipulated variable
responding variable
operational definition
data
communicating

3 Understanding Technology

Key Concepts

- The goal of technology is to improve the way people live.
- Science is the study of the natural world to understand how it functions. Technology, on the other hand, changes, or modifies, the natural world to meet human needs or solve problems.
- Technology can have both positive and negative consequences for individual people and for society as a whole.

Key Terms

technology engineer

4 Safety in the Science Laboratory

Key Concepts

- Good preparation helps you stay safe when doing science activities.
- When any accident occurs, no matter how minor, notify your teacher immediately. Then, listen to your teacher's directions and carry them out quickly.

Review and Assessment

Go Online PHSchool.com
For: Self-Assessment
Visit: PHSchool.com
Web Code: cha-1010

Organizing Information

Identifying Main Ideas Copy the graphic organizer about scientific skills onto a separate sheet of paper. Then complete it and add a title. (For more on Identifying Main Ideas, see the Skills Handbook.)

Main Idea

Scientists use many different skills to learn more about the world.

Detail	Detail	Detail	Detail	Detail
a. ___?___	b. ___?___	c. ___?___	d. ___?___	e. ___?___

Reviewing Key Terms

Choose the letter of the best answer.

1. When you note that a rabbit has white fur, you are making a
   a. quantitative observation.
   b. qualitative observation.
   c. prediction.
   d. model.
2. Music stores arrange CDs according to the type of music—rock, country, folk, and so on. This is an example of
   a. observation. **b.** inferencing.
   c. posing questions. **d.** classifying.
3. A statement that describes how to measure a variable or define a term is a(n)
   a. controlled variable.
   b. manipulated variable.
   c. hypothesis.
   d. operational definition.
4. Which of the following is NOT an example of technology?
   a. a teaspoon **b.** a computer
   c. a leaf **d.** a microscope
5. In labs in this book, which of the following indicates the danger of breakage?
   a.  **b.** 
   c.  **d.** 

If the statement is true, write *true*. If it is false, change the underlined word or words to make the statement true.

6. When you interpret what you have observed, you are <u>inferring</u>.
7. When you <u>pose questions</u>, you create representations of complex objects or processes.
8. The <u>responding variable</u> is changed to test a hypothesis.
9. <u>Technology</u> changes the natural world to meet human needs.
10. You should begin preparing for a lab <u>15 minutes</u> before you perform the lab.

Writing in Science

Description Think about the ways in which the police who investigate crimes act like scientists. In a paragraph, describe the scientific skills that police use in their work.

Discovery Channel School

What Is Science?
Video Preview
Video Field Trip
▶ Video Assessment

Review and Assessment

Checking Concepts

11. When you observe something, what are you doing?

12. What is life science?

13. What is a hypothesis? Why is it important to develop a scientific hypothesis that is testable?

14. In an experiment, why is it important to control all variables except one?

15. What does *data* mean?

16. What does an engineer do?

17. Identify three things that you should do to prepare for a lab.

Thinking Critically

18. Inferring Suppose you come home to the scene below. What can you infer happened while you were gone?

19. Problem Solving Suppose you would like to find out which dog food your dog likes best. What variables would you need to control in your experiment?

20. Making Judgments You read an ad claiming that scientific studies prove that frozen fruit is more nutritious than canned vegetables. What questions would you want answered before you accept this claim?

21. Applying Concepts This textbook is an example of technology. What need does it meet? What practical problem does it solve?

Applying Skills

Use the data table below to answer Questions 22–26.

Three students conducted a controlled experiment to find out how walking and running affected their heart rates.

Effect of Activity on Heart Rate (in beats per minute)

Student	Heart Rate (at rest)	Heart Rate (walking)	Heart Rate (running)
1	70	90	115
2	72	80	100
3	80	100	120

22. Controlling Variables What is the manipulated variable in this experiment? What is the responding variable?

23. Developing Hypotheses What hypothesis might this experiment be testing?

24. Predicting Based on this experiment and what you know about exercising, predict how the students' heart rates would change while they are resting after a long run.

25. Designing Experiments Design a controlled experiment to determine which activity has more of an effect on a person's heart rate—jumping rope or doing push-ups.

26. Drawing Conclusions What do the data indicate about the increased physical activity and heart rate?

Lab zone Chapter Project

Performance Assessment Create a poster that summarizes your experiment for the class. Your poster should include the question you tested, how you tested it, the data you collected, and what conclusion you drew from your experiment. What problems did you encounter while carrying out your experiment? Is additional testing necessary?