

What Is Life Science?

CALIFORNIA

Standards Preview

S 7.5 The anatomy and physiology of plants and animals illustrate the complementary nature of structure and function.

S 7.6 Physical principles underlie biological structures and functions.

S 7.7 Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations. Students will:

- c. Communicate the logical connection among hypotheses, science concepts, tests conducted, data collected, and conclusions drawn from the scientific evidence.
- e. Communicate the steps and results from an investigation in written reports and oral presentations.

This food scientist is busy ►
at work in a laboratory.





Video Preview

Discovery Channel School

What Is Science?



Focus on the
BIG Idea



S 7.7

How do scientists make progress in understanding the natural world?

Check What You Know

Which of the following questions can be answered by scientific investigation? Explain your reasoning.

- How does the type of soil affect plant growth?
- What kind of music should I listen to?
- Do wool sweaters keep you warmer than cotton sweaters?
- Is life science more interesting than Earth science?

Build Science Vocabulary

The images shown here represent some of the Key Terms in this chapter. You can use this vocabulary skill to help you understand the meaning of some Key Terms in this chapter.

Vocabulary Skill

High-Use Academic Words

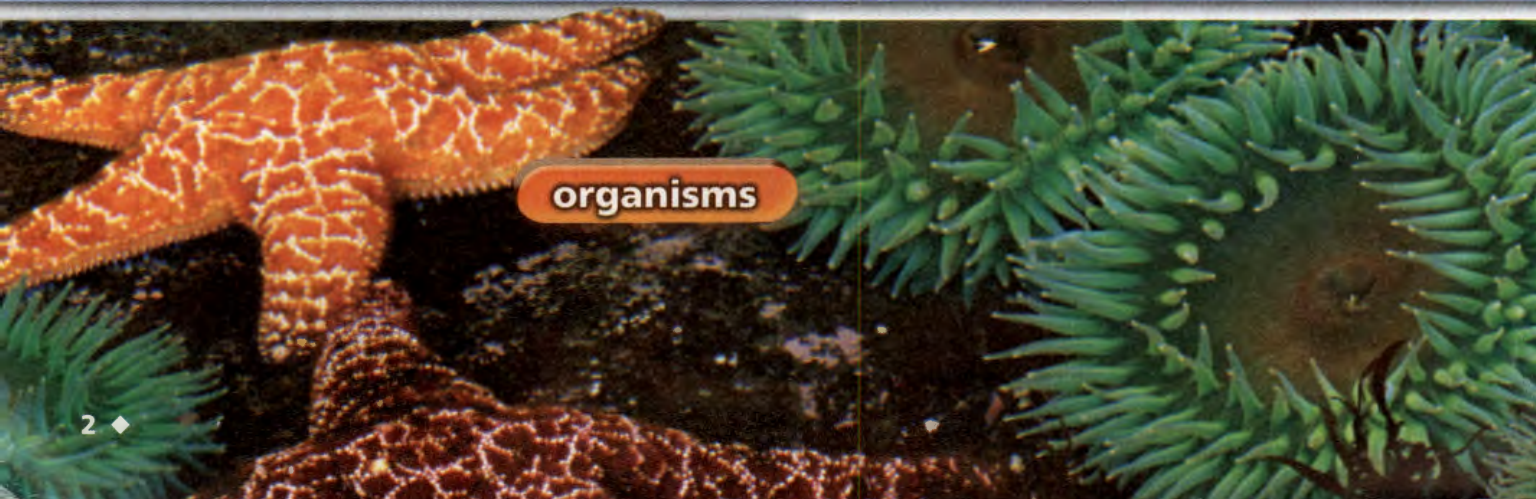
High-use academic words are words that are used frequently in classrooms. Look for the words below as you read this chapter.

Word	Definition	Example Sentence
concept (KAHN sept) pp. 14, 15	<i>n.</i> An idea or thought, especially a general idea or understanding	Each section in this textbook contains key <u>concepts</u> , which are the section's most important ideas.
process (PRAH ses) pp. 10, 15, 16	<i>n.</i> A series of actions or events; a particular way of doing things	Science is an ongoing <u>process</u> of discovery.
evidence (EV uh duns) p. 18	<i>n.</i> Facts, figures, or signs to show that something exists or is true	Scientists propose explanations based on <u>evidence</u> they gather.
research (REE surch) p. 21	<i>n.</i> Careful study of a subject to discover new facts or test new ideas	<u>Research</u> into the causes of cancer may lead to a cure.

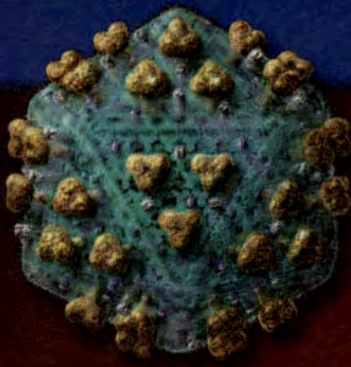
Apply It!

Choose the word that best completes each sentence.

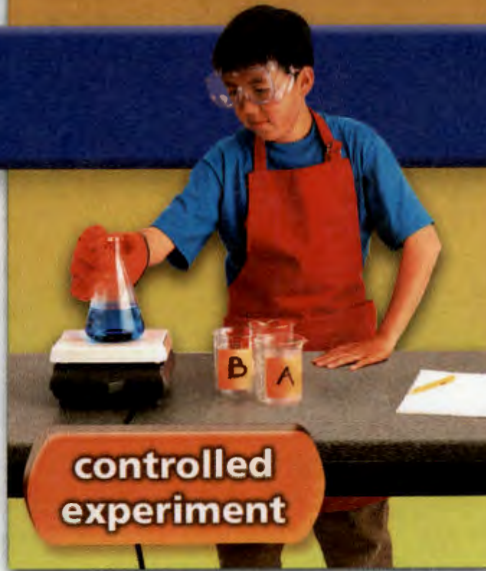
1. Laboratory safety is an important _____ in this chapter.
2. Jane Goodall conducted _____ on the behavior of chimpanzees.
3. Scientists do research and gather _____ to test their ideas.



Chapter 1 Vocabulary



scale model



controlled
experiment

Section 1 (page 6)

science
observing
quantitative observation
qualitative observation
inferring
predicting
classifying
making models
scale model

.....

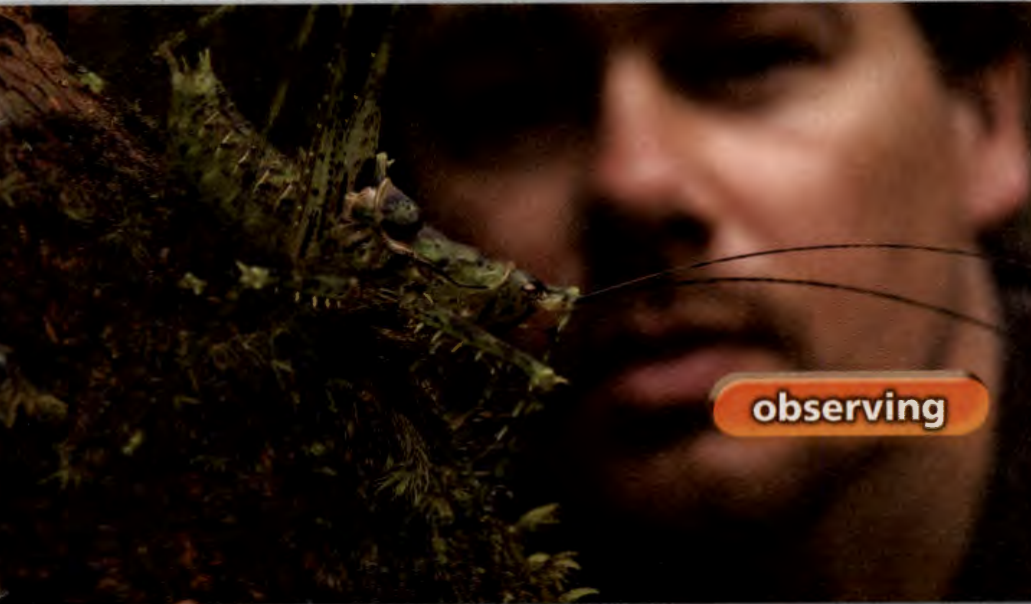
Section 2 (page 13)

life science
biology
organism
development
structure
function
complementary

.....

Section 3 (page 18)

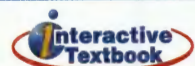
scientific inquiry
hypothesis
variable
controlled experiment
control
manipulated variable
responding variable
operational definition
data
communicating



observing



quantitative
observation



**Build Science Vocabulary
Online**

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How to Read Science

Reading Skill



Preview Text Structure

The information in this textbook is organized with red headings and blue subheadings. You can preview these headings to help you take notes about what you read. Organize your notes by dividing a sheet of paper into three columns.

- Write the heading in the first column.
- Write a question in the second column. Look for important words in the heading to guide you in asking a question.
- Answer your question in the third column.

The partially completed notes below are based on the first heading of Section 2 in this chapter.

Section 2: The Study of Life		
Heading	Question	Answer
Branches of Life Science	What are the branches of life science?	There are many branches of life science, but the branches overlap. Molecular biology—study of the building blocks of cells Genetics—how information is passed from parents to offspring Ecology—organisms and environment Physiology—functions of organisms

Apply It!

Review the notes above. Then answer the questions.

1. What are the key words in the heading in the first column?
2. What question has been asked about the heading?
3. The answer says that the branches of life science overlap. What does this mean?

When you read Section 2, take notes for all the headings. Also use this method to preview and take notes on Section 4.

Ideas and Scientific Evidence

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? Do brightly colored flowers attract more insects? Each of these questions relates to a common idea about living things. But are those ideas true? What is the evidence? In this investigation, you will use scientific methods to find out.

Your Goal

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

To complete this investigation, 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 ideas 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.



Thinking Like a Scientist

CALIFORNIA
Standards Focus

S 7.7 Scientific progress is made by asking meaningful questions and conducting careful investigations.

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

Key Terms

- science
- observing
- quantitative observation
- qualitative observation
- inferring
- predicting
- classifying
- making models
- scale model

Lab zone
Standards Warm-Up
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 wraaaaah 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 and make scientific progress.** However, these skills are not unique to scientists. You, too, think like a scientist every day.

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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 sticks 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.



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.



**Reading
Checkpoint**

What senses can the skill of observation involve?

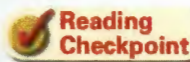
Inferring

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 are a type of inference. An inference is any explanation or interpretation. A prediction is an inference about the future. Suppose you see a broken egg on the floor by a table. Which of the following statements is a prediction?

- The egg rolled off the table.
- Somebody walking by will step on the egg.



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?

Reviewing Math: Algebra and Functions 6.2.0

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** November is the main termite-fishing season, when chimps spend a large part of their time eating termites. Predict how the percentage of foods might change in November.

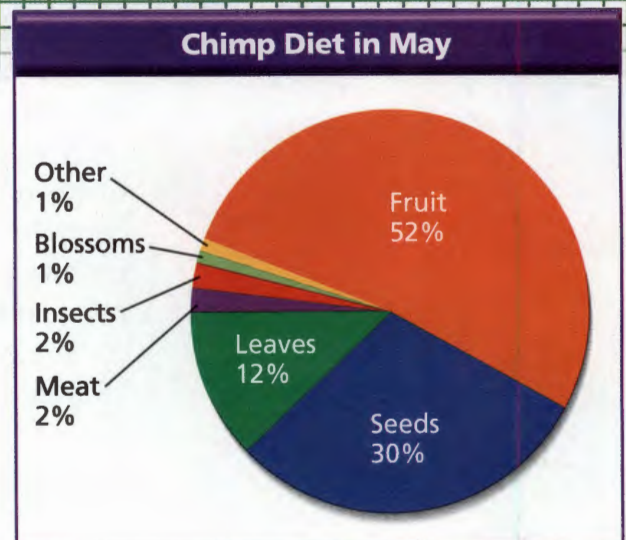


FIGURE 4
Classifying

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.

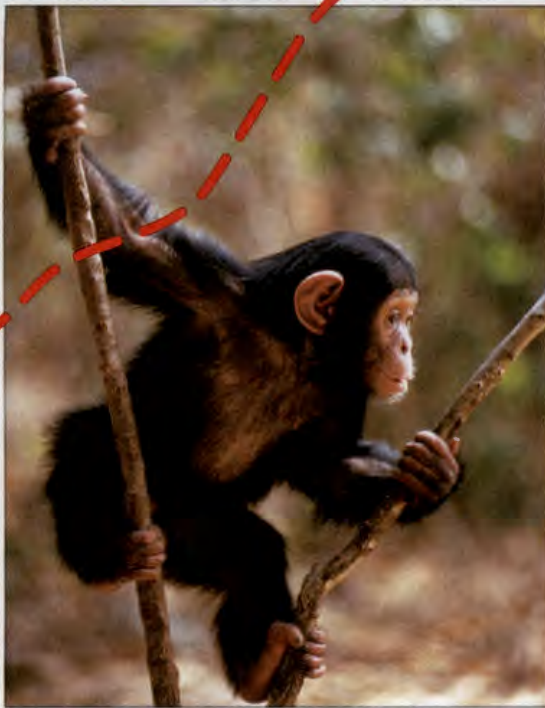
Classifying is the process of grouping together items that are alike in some way. For example, Jane could group together all the information about Jomeo's feeding habits or his resting behavior. This would also make it easier to compare Jomeo's actions to those of other chimps. For instance, she could 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.

Types of Models 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.

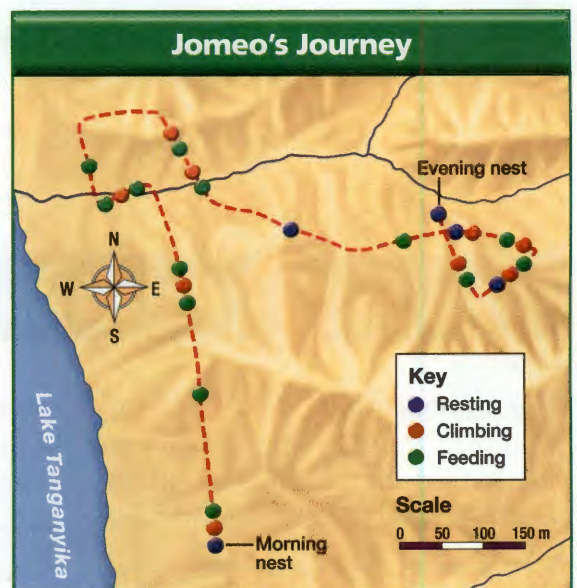


FIGURE 5
Making Models

This map is a model that traces Jomeo's journey through the forest. It represents information that would be hard to explain in words. Notice the scale on the map.

Interpreting Maps Estimate the total distance that Jomeo traveled between his morning and evening nests.

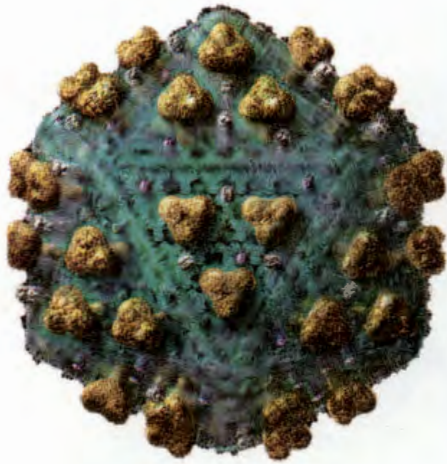


FIGURE 6
Model of a Virus

This scale drawing of the human immunodeficiency virus (HIV) shows the structures on its surface. The yellow knobs allow the virus to attach to a cell. Scientists use such models to develop ways to fight HIV.

Scale Models A **scale model** accurately shows the proportions between its parts. A scale is a proportion used in determining the relationship between a model and the object that it represents. You may be familiar with the scales on maps. A map may have a scale with the proportion of 1 centimeter to 1 kilometer. This means that 1 centimeter on the map stands for 1 kilometer in “real life.”

Suppose a map has a scale of 1 centimeter to 500 meters. The distance between two locations on the map measures 10 centimeters. To determine the actual distance in meters, you can perform the following calculation:

$$\text{Distance traveled} = 10 \text{ cm} \times \frac{500 \text{ m}}{1 \text{ cm}} = 5,000 \text{ m}$$

A scale model may be bigger or smaller than the object it represents. For example, Figure 6 shows a model of the human immunodeficiency virus (HIV), which causes AIDS. Viruses are too small to see without a microscope. Therefore, the model is many times bigger than the actual virus.

Models may be built to different scales. For example, a scale model of the Golden Gate Bridge built at a scale of 1 centimeter to 1 kilometer could fit in the palm of your hand. The bridge at a scale of 1 centimeter to 1 meter would be about as long as a basketball court.



Reading
Checkpoint

What is a scale?

Section 1 Assessment

S 7.7, E-LA: Reading: 7.1.0

Vocabulary Skill High-Use Academic Words

Complete the following sentence to show that you understand the meanings of *process* and *classifying*.
Classifying is the process in which _____.

Reviewing Key Concepts

- Listing** Name five skills that are important in scientific thinking.
- Comparing and Contrasting** How do observations differ from inferences?
- Classifying** Is this statement an observation or an inference? *The cat must be ill.* Explain your reasoning.

Lab
zone

At-Home Activity



Something About Plants Take a walk through a park or garden with a family member. Make five qualitative observations and five quantitative observations about the plants you see. Then, make an inference based on your observations. Explain to your family member the difference between an observation and an inference.

The Study of Life

CALIFORNIA
Standards Focus

S 7.5 The anatomy and physiology of plants and animals illustrate the complementary nature of structure and function.

S 7.6 Physical principles underlie biological structures and functions.

-  How are the branches of life science related?
-  What are some big ideas in life science?

Key Terms

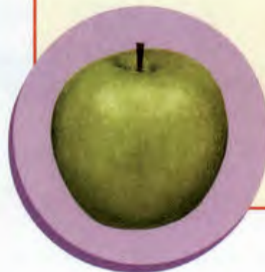
- life science
- biology
- organism
- development
- structure
- function
- complementary

Lab zone
Standards Warm-Up
How Is Structure Related to Function?

1. Study the photo of the bird and list its characteristics.
2. Next, study the photos of the three food items below.

Think It Over

Inferring Based on your observations, which of the food items do you think the bird feeds on? Explain your reasoning.



In a laboratory, detectives are solving a crime by comparing the genetic makeup of different suspects. On a beach, a scientist studies the nesting behavior of sea turtles. Deep in a tropical rain forest, another scientist discovers a new kind of beetle. In a hospital laboratory, doctors study a deadly form of bird flu. At a cancer research institute, a team of scientists develops new treatments for a rare form of cancer. What do all of these people have in common? All these people are working in the field of life science.

Life science is the study of living things. Another name for life science is biology. The word biology comes from two Greek words. *Bios* means “life” and *logos* means “reason” or “the study of.” Thus **biology** is the study of life. Biologists are scientists who study living things.

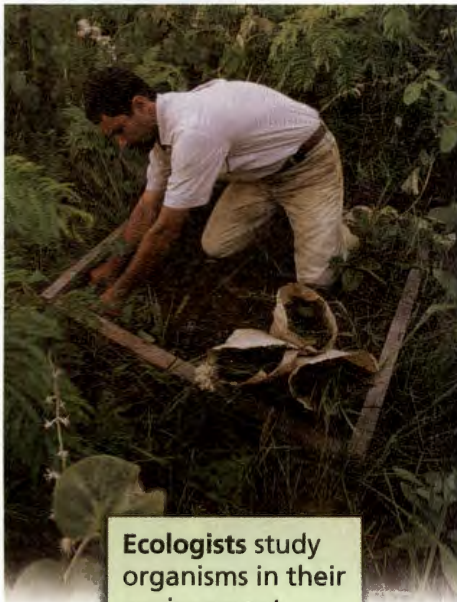
Biologists study all kinds of living things. The general term for a living thing is an **organism**. An organism may be an animal, a plant, a fungus or a microbe.



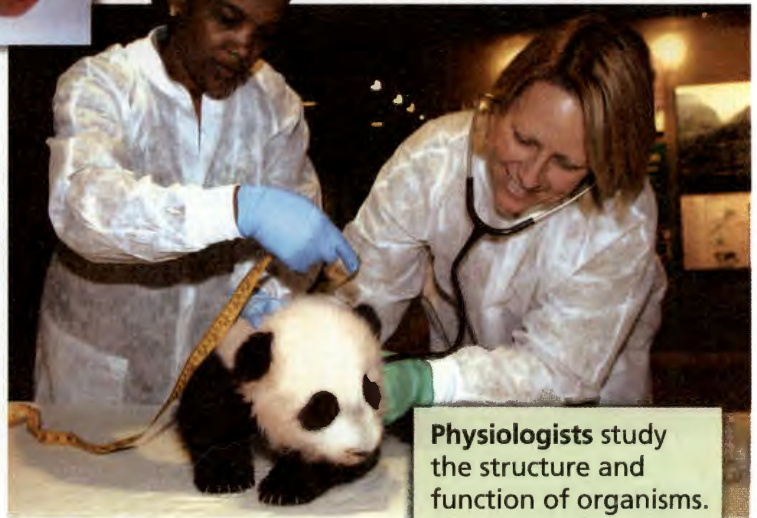
Molecular biologists study the chemicals in cells.



Entomologists study insects.



Ecologists study organisms in their environment.



Physiologists study the structure and function of organisms.

Branches of Life Science

Biologists can work outside or in a laboratory. They may work for universities, private companies, or government agencies. Biologists, like other scientists, usually work as part of a team studying a common topic.

Life science includes many different branches, or fields of study. Molecular biology, genetics, physiology, and ecology are just some fields of life science. Molecular biology is the study of the chemical building blocks of cells. Genetics is the study of how information about organisms is passed from parent to offspring. Physiology is the study of the structures and functions of organisms. Ecology is the study of how organisms interact with each other and with their surroundings. Other branches of life science include cell biology, plant biology, and microbiology. What do you think these fields involve?

➡ **Though life science can be divided into branches, the different fields of study often overlap.** For example, understanding what controls plant development relies on concepts from molecular biology and plant biology. Progress in one field of life science often contributes to progress in another field.

FIGURE 7
Life Scientists at Work
You can find life scientists at work in such diverse places as forests, laboratories, zoos, and museums.

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Big Ideas in Life Science

Biologists investigate an incredible range of questions. But underlying all of their work are certain big ideas, or concepts. These big ideas connect the study of living things. It is helpful to keep these big ideas in mind as you study life science. As you read this textbook, notice how they come up again and again.

🔑 **The big ideas in life science include the following:**

- **Organisms are diverse, yet share similar characteristics.**
- **Groups of organisms change over time.**
- **The structure and function of organisms are complementary.**
- **Organisms operate on the same physical principles as the rest of the natural world.**

Diverse but Similar Living things come in a great variety of shapes and sizes, from microbes to giant redwood trees and blue whales. Although living things vary greatly, they have many basic similarities.

All organisms are made up of tiny building blocks called cells. Cells are far too small to be seen by the eye, but they carry out all the activities necessary for life. Some organisms are composed of just one cell. Others contain trillions.

The chemical composition of all living things is remarkably similar. Every living thing is made up mainly of water, a relatively simple compound. But organisms also contain highly complex chemicals. For example, most organisms contain DNA, the chemical that controls all the activities of the cell and allows organisms to pass information to their offspring.

All living things require energy. Plants are able to capture energy from sunlight. Other organisms must obtain energy by eating other living things.

Organisms can grow and develop. Growth is the process by which an organism becomes larger. **Development** is the process of change that causes an organism to become more complex during its lifetime. And finally, all living things reproduce, or produce more of their own kind.



How is development different from growth?



FIGURE 8

Diversity and Similarity of Life

This poison arrow frog and mushroom look very different. However, both are made of cells, use energy, grow, develop, and reproduce.



▲ Owl



▲ Octopus



▲ Fly

FIGURE 9

Animal Eyes

Eyes come in many shapes, sizes, and, in some cases, numbers. Although each of these animals sees things differently, all of their eyes operate on similar physical principles. **Inferring** How do you think the structure of each eye helps the organism to function?

Change Over Time The characteristics of any group of organisms can change over time. The gradual process of change that occurs in groups of organisms is called evolution. Evolution differs from the growth and development that occurs in an individual organism's lifetime, such as when a tadpole becomes a frog. Evolution is a process that occurs over many generations, often over millions of years.

Complementary Structure and Function The form of each living thing is closely related to the way that it lives. In other words, the structure of an organism allows it to function. **Structure** is the way that an organism is put together as a whole. **Functions** are the processes that enable an organism to survive. The structure and function of an organism are **complementary**, or work together to meet the needs of the organism.

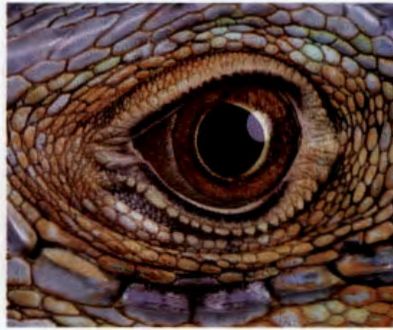
Look at the owl and fly eyes in Figure 9. Owls are adapted to life at night, when they actively hunt for food. An owl's large eyes allow it to see when there is little light. In contrast, flies see well in bright light. Flies have compound eyes, meaning that each eye is made up of thousands of smaller units. Compound eyes are very effective in detecting even the slightest movement—making flies very hard to catch!

Physical Principles Scientists once questioned whether living things operate on the same set of rules as the rest of the natural world. Did living things have unique qualities that could not be explained by chemistry or physics? But today scientists know that life follows the same rules, or principles, as the rest of nature.

For example, the principles of chemistry explain the processes that allow plants to capture the sun's energy. Chemical processes also explain how animals digest their food. And the rules of heredity are based on the chemical structure of DNA.



▲ Cat



▲ Lizard



▲ Spider

The principles of physics also help explain life processes. Consider, for example, the relationship between the physics of light and the way that eyes function. To understand how eyes function, scientists must know what light is and how light travels. Scientists can compare the structure of an eye to that of a camera. Like a camera, an eye uses a lens to focus light and form an image. The principles that allow a camera to take a picture also allow an eye to see.

Compare the variety of eyes in Figure 9. Although each of the animals may see slightly differently, all of the eyes operate on similar physical principles.

Section 2 Assessment

S 7.5, 7.6 E-LA: Reading: 7.2.0

Target Reading Skill Preview Text
Structure When you took notes on Section 2, what question did you ask for the heading Change Over Time? What was your answer?

Reviewing Key Concepts

1. a. **Defining** What is life science?
 b. **Describing** List three branches of life science and describe what is studied in each.
 c. **Making Judgments** Your friend wants to be a plant biologist and says she only needs to take courses in plant biology. Why might it be a good idea for your friend to study other branches of life science as well?
2. a. **Listing** What are four big ideas in life science?
 b. **Comparing and Contrasting** What are some ways that a cat and a tree are similar? What are some ways they are different?

Lab zone



At-Home Activity

It's Complementary Explain to a family member what "complementary structure and function" means. Then look through books or magazines for photos of organisms that illustrate this concept. Find five examples to show your family member. Describe how a structure on each of the organisms is adapted to its function.

Scientific Inquiry

CALIFORNIA
Standards Focus

S 7.7.c Students will communicate the logical connection among hypotheses, science concepts, tests conducted, data collected, and conclusions drawn from the scientific evidence.

-  What is scientific inquiry?
-  What makes a hypothesis testable?

Key Terms

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

A snowy tree cricket ▼


Lab zone
Standards Warm-Up
What Can You Learn About Mealworms?

1. Study mealworms in a tray. Use a magnifying glass to see their structure more clearly.
2. Observe the mealworms' functions—for example, how they move or eat.

Think It Over

Posing Questions Write three questions you have about mealworms and their functions. 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.”

The Scientific Process

You might not know it, but your questioning can be the start of **scientific inquiry**.  **Scientific inquiry refers to the diverse ways in which scientists investigate 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.



Video Field Trip

Discovery Channel School

What Is Science?

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.



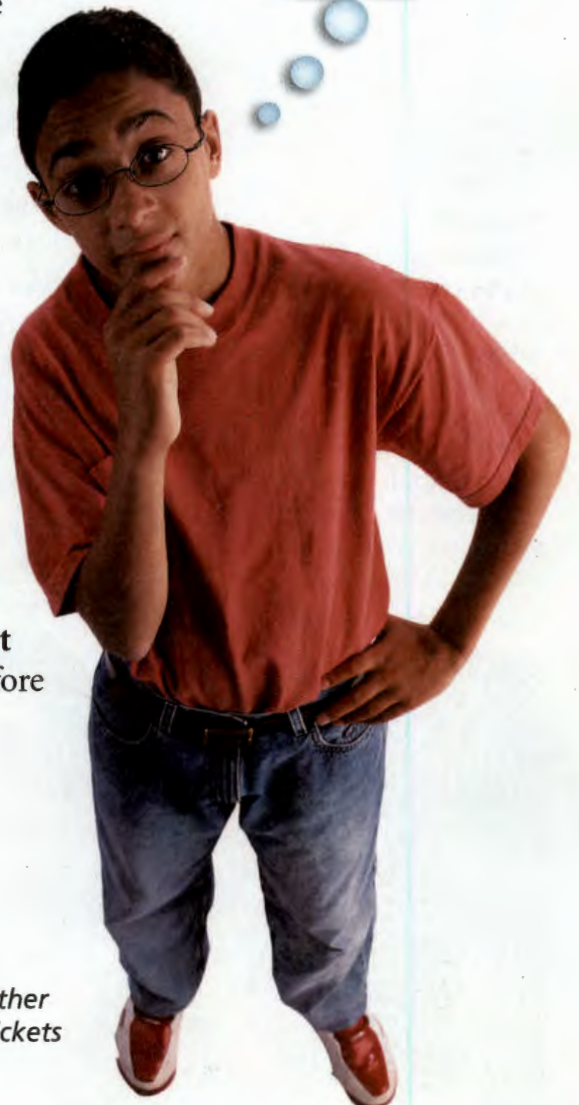
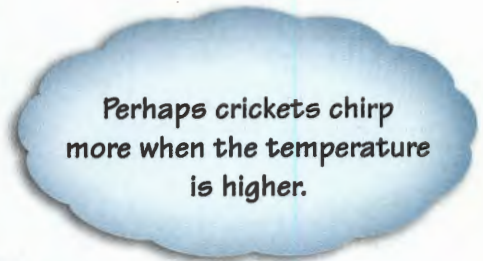
Reading
Checkpoint

What is a hypothesis?

FIGURE 10

Developing Hypotheses

A hypothesis is one possible way to explain a set of observations. **Developing Hypotheses** Propose another hypothesis that could explain the observation that crickets seem to be noisier on some nights than others.



Controlling Variables

Suppose you are designing an experiment to determine whether different varieties of apples contain the same number of seeds. What is your manipulated variable? What is your responding variable? What other variables would you need to control?

Designing an Experiment Hypotheses lead to predictions that can be tested. In this case, your prediction would be, “*If the temperature increases, crickets will chirp more frequently.*”

To test your prediction, 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 in an experiment 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.

In life science, a controlled experiment often has a control. A **control** is a part of the experiment to which you can compare the results of the other tests. In the control, the conditions are the same except for the manipulated variable. For the cricket experiment, you would test your control crickets at a constant temperature. That way, you can better recognize the effects of increased temperature on chirping.

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.”

FIGURE 11

A Controlled Experiment

In this controlled experiment, the experimental group crickets are tested at 15°C, 20°C, and 25°C. The students are using the same kinds of containers, leaves, thermometers, and crickets. The manipulated variable is temperature. The responding variable is cricket chirps per minute at each temperature.



Reading
Checkpoint

What is a control?



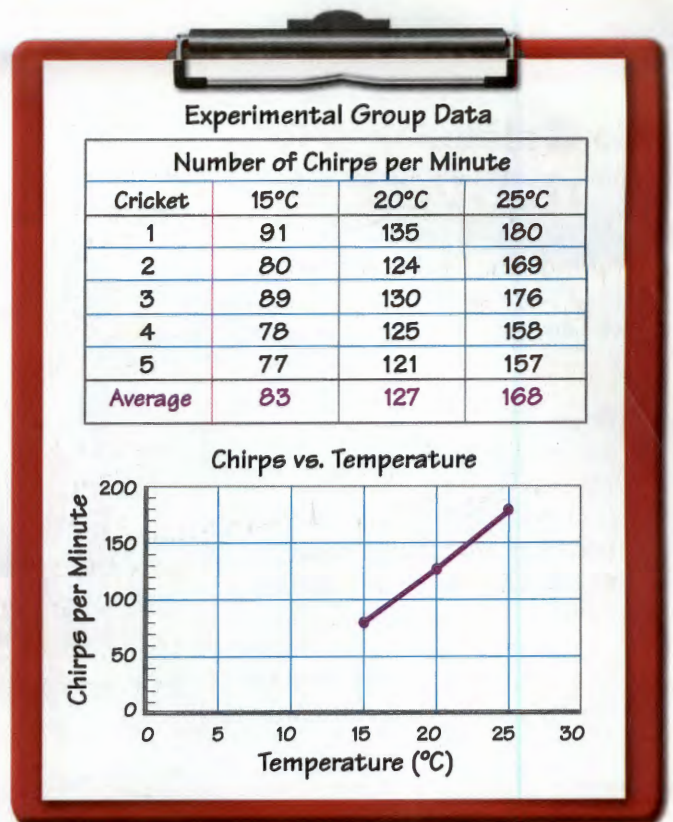


FIGURE 12

Collecting and Interpreting Data

A data table helps you organize the information you collect in an experiment. Graphing the data may reveal patterns.

Interpreting Data *Did all of the crickets chirp more at 25°C than at 20°C? Did you use the data table or the graph to answer this question?*

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.

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!

Communicating An important part of scientific inquiry is communicating your results. **Communicating** is the sharing of ideas and experimental findings with others through writing and speaking. For example, scientists can give talks at scientific meetings and publish articles in journals and on the Internet. When scientists communicate their research, they describe the logical connections between their procedures and results. Other scientists can then repeat and build on their experiments.

FIGURE 13

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.



The Nature of Inquiry Scientific inquiry usually doesn't end once a set of experiments is done and results are communicated. Often, a scientific inquiry raises new questions, that lead to new hypotheses and experiments, as shown in Figure 13.

Section 3 Assessment

S 7.7.c, E-LA: Reading 7.1.0
Writing 7.2.5

Vocabulary Skill High-Use Academic Words Explain why *evidence* is an important part of scientific *research*.



Reviewing Key Concepts

- Defining** Define the term *scientific inquiry*.
 - Explaining** A friend claims that pea plants grow faster than corn plants. Could you investigate this idea through scientific inquiry? Explain.
 - Problem Solving** What kind of data would you need to collect to do this experiment?
- Reviewing** What is meant by saying that a hypothesis must be testable?
 - 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?

Writing in Science

Summary You're going 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 at the conference.

Safety in the Laboratory

CALIFORNIA

Standards Focus

S 7.7 Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations.

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

Lab zone

Standards Warm-Up

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 conduct careful scientific investigations by planning for safety.** 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

SciLINKSSM

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.

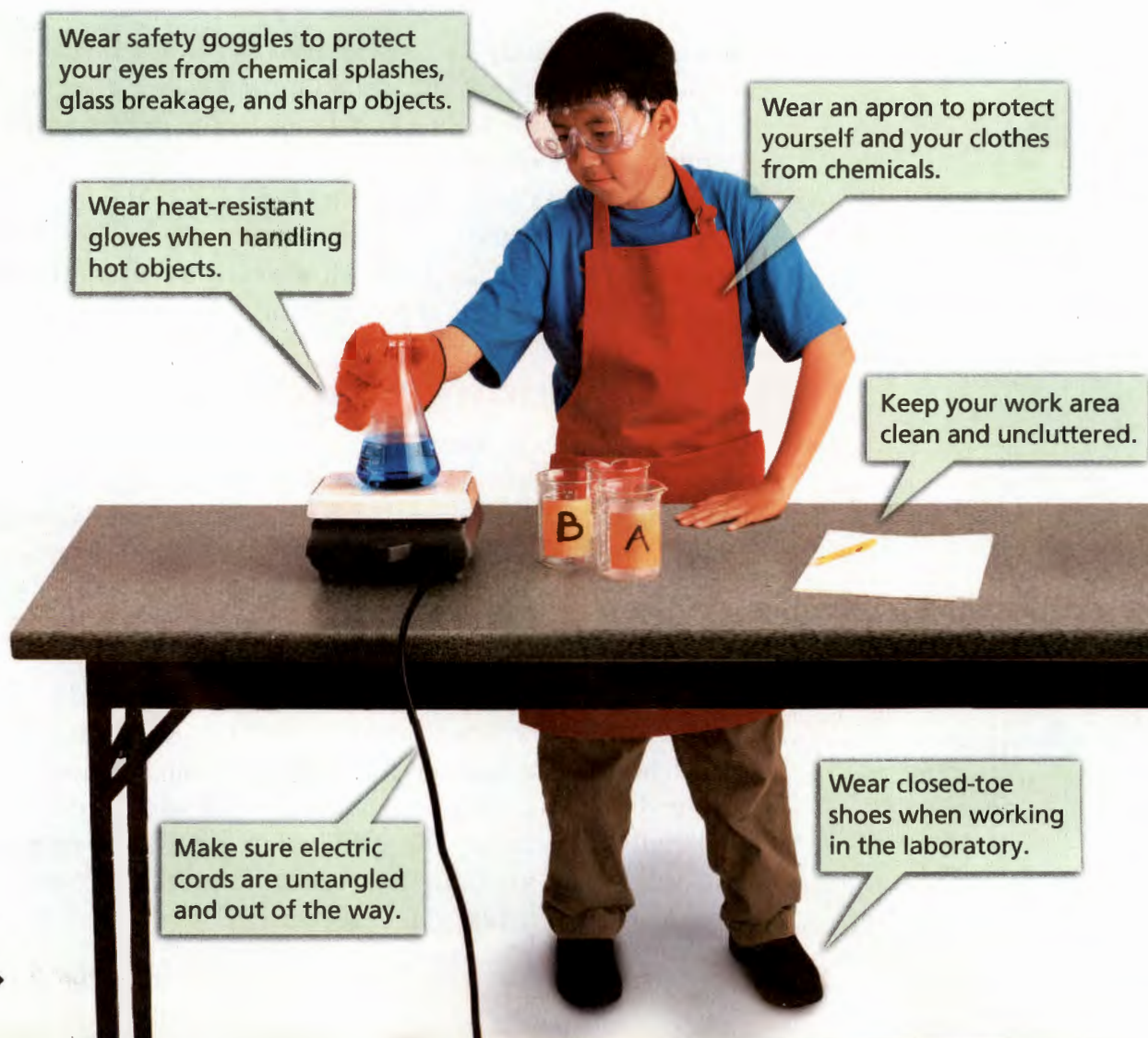
Labs and activities in this textbook include the safety symbols shown on the next page. These symbols alert you to possible dangers in performing the lab and remind you to work carefully. They also identify any safety equipment that you should use to protect yourself from potential hazards. The symbols 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.

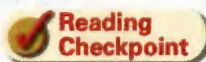
Observing List three precautions each student is taking while performing the labs.



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**

Why is knowing the location of emergency equipment important?

Section 4 Assessment

S 7.7, E-LA: Reading 7.2.0,
Writing 7.2.0

🔗 Target Reading Skill Preview Text Structure

Use your notes to help answer the questions below.

➡ Reviewing Key Concepts

- 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)?
- 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.



Keeping Flowers Fresh

S 7.5, 7.7.c, 7.7.e

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. Plants have structures that function in the transport of materials. 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 sugar is a material that helps flowers 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 and what you know about plant structure? 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.*



The **BIG Idea**

Scientific progress is made by asking meaningful questions and conducting careful investigations.

1 Thinking Like a Scientist**Key Concepts**

S 7.7

- Scientists use skills such as observing, inferring, predicting, classifying, and making models to learn more and make scientific progress.

Key Terms

science
observing
quantitative observation
qualitative observation
inferring
predicting
classifying
making models
scale model

2 The Study of Life**Key Concepts**

S 7.5, 7.6

- Life science can be divided into branches; the different fields of study often overlap.
- The big ideas in life science include the following: Organisms are diverse, yet share similar characteristics. Groups of organisms change over time. The structure and function of organisms are complementary. Organisms operate on the same physical principles as the rest of the natural world.

Key Terms

life science
biology
organism
development
structure
function
complementary

**3 Scientific Inquiry****Key Concepts**

S 7.7.c

- Scientific inquiry refers to the diverse ways in which scientists investigate 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.

Key Terms

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

4 Safety in the Laboratory**Key Concepts**

S 7.7

- Good preparation helps you conduct careful scientific investigation by planning for safety.
- When any accident occurs, no matter how minor, notify your teacher immediately. Then, listen to your teacher's directions and carry them out quickly.

Target Reading Skill





To help you review part of Section 1, copy and complete the graphic organizer at the right.

Heading	Question	Answer
Developing a Hypothesis	a. _____ ?	b. _____ ?
	c. _____ ?	d. _____ ?

Reviewing Key Terms

Choose the letter of the best answer.

- The process of change that occurs during an organism's life that produces a more complicated organism is called
 - structure.
 - function.
 - development.
 - variable.
- When you note that a rabbit has white fur, you are making a
 - quantitative observation.
 - qualitative observation.
 - prediction.
 - model.
- Music stores arrange CDs according to the type of music—rock, country, folk, and so on. This is an example of
 - observation.
 - inferring.
 - posing questions.
 - classifying.
- A statement that describes how to measure a variable or define a term is a(n)
 - controlled variable.
 - manipulated variable.
 - hypothesis.
 - operational definition.
- In labs in this book, which of the following indicates the danger of breakage?

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Complete the following sentences so that your answers clearly explain the Key Terms.

- Studying how the human body works and how different animals interact with one another are examples of topics in **life science**, which is _____ .
- Obtaining oxygen is an example of a **function**, which is a process that _____ .
- Noticing how much food is on your lunch tray is a **quantitative observation** because _____ .
- Recording how many times your dog eats each day and how much he eats are examples of collecting **data**, which are _____ .
- Giving a talk about the results of a scientific project is an example of **communicating** because _____ .

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.

Video Assessment

Discovery Channel School

What Is Science?

Review and Assessment

Checking Concepts

- List five skills that a scientist uses to learn more about the world.
- When you observe something, what are you doing?
- How are models useful to scientists?
- In your own words, explain what is meant by the statement: *Physical principles underlie biological structures and functions.*
- What is a hypothesis? Why is it important to develop a scientific hypothesis that is testable?
- In an experiment, why is it important to control all variables except one?
- Identify three things that you should do to prepare for a lab.

Thinking Critically

- Applying Concepts** Describe how the structure of your hands are complementary to their functions.
- Comparing and Contrasting** Compare and contrast qualitative and quantitative observations.
- Inferring** Suppose you come home to the scene below. What can you infer happened while you were gone?



- Problem Solving** Suppose you would like to find out which brand of glue holds better. What variables would you need to control in your experiment?

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

- Controlling Variables** What is the manipulated variable in this experiment? What is the responding variable?
- Developing Hypotheses** What hypothesis might this experiment be testing?
- 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.
- 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.
- Drawing Conclusions** What do the data indicate about the increased physical activity and heart rate?

Lab
zone

Standards Investigation

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?

Choose the letter of the best answer.

- During a lab, if you spill a chemical on your skin, you should
 - apply pressure to the area.
 - rub the chemical off with a clean tissue.
 - flush the skin with large amounts of water.
 - throw the chemical in a waste basket. **S 7.7**

Use the table below to answer Questions 2–4.

Animals in a Field

Kind of Animal	Number of Animals	
	July	August
Grasshoppers	5,000	1,500
Birds	100	100
Spiders	200	500

- Which statement accurately expresses what happened in the field between July and August?
 - The numbers of all the animals increased.
 - The number of grasshoppers increased.
 - The number of spiders decreased.
 - The number of birds stayed the same. **S 7.7.c**
- Which of the following statements about the data is true?
 - In July, there were more grasshoppers than birds.
 - In August, there were more birds than spiders.
 - Between July and August, the number of grasshoppers increased by 500.
 - In both months, there were more spiders than grasshoppers. **S 7.7.c**
- Which of the following is a logical question that a scientist might pose based on the data in the table?
 - What killed off the spiders in the field?
 - Are spiders feeding on grasshoppers?
 - Do all birds fly south for the winter?
 - Are grasshoppers related to beetles? **S 7.7**

- Your brother has a cold and you think you will probably get a cold, too. Which of the following are you doing?
 - posing a question based on an inference
 - predicting based on an observation
 - making a model based on an observation
 - designing a controlled experiment **S 7.7.c**

- Which of the following statements about structure and function in organisms is NOT true?
 - An organism's functions are the processes that enable it to survive.
 - An organism contains structures that are related to its functions.
 - All organisms have the same structure and function.
 - An organism needs energy to carry out its functions. **S 7.5**

Apply the BIG Idea

- Read each question and explain whether it can be answered by conducting a scientific investigation.
 - Can dogs see in the dark?
 - How did pet dogs develop from wild dogs?
 - Which type of dog is the most fun?
 - How does a dog's tail help it survive?

Select one question that can be investigated scientifically. State a hypothesis. Then describe how you might conduct a scientific investigation to test your hypothesis. **S 7.7**