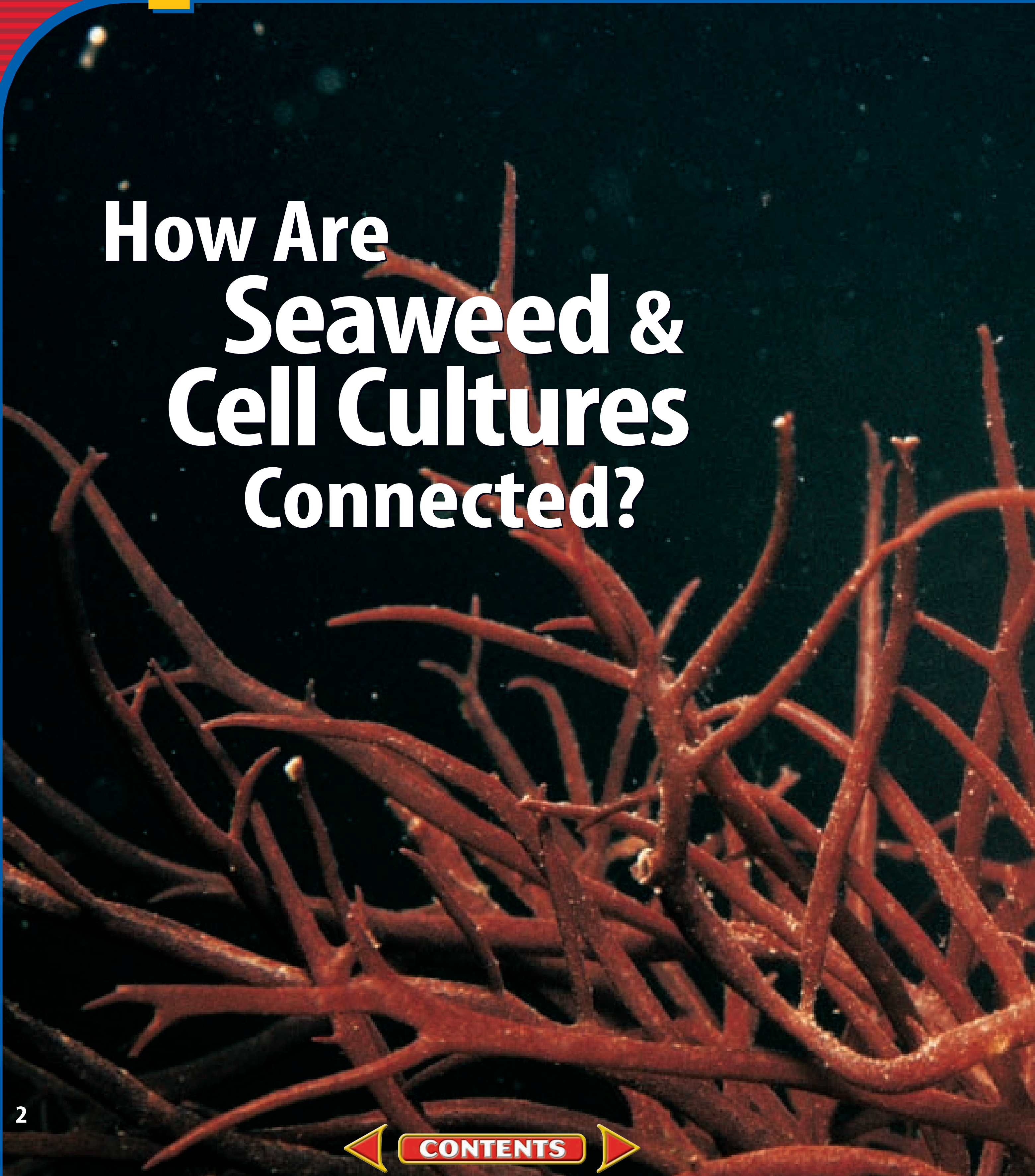
How Are Seaweed & Cell Cultures Connected?



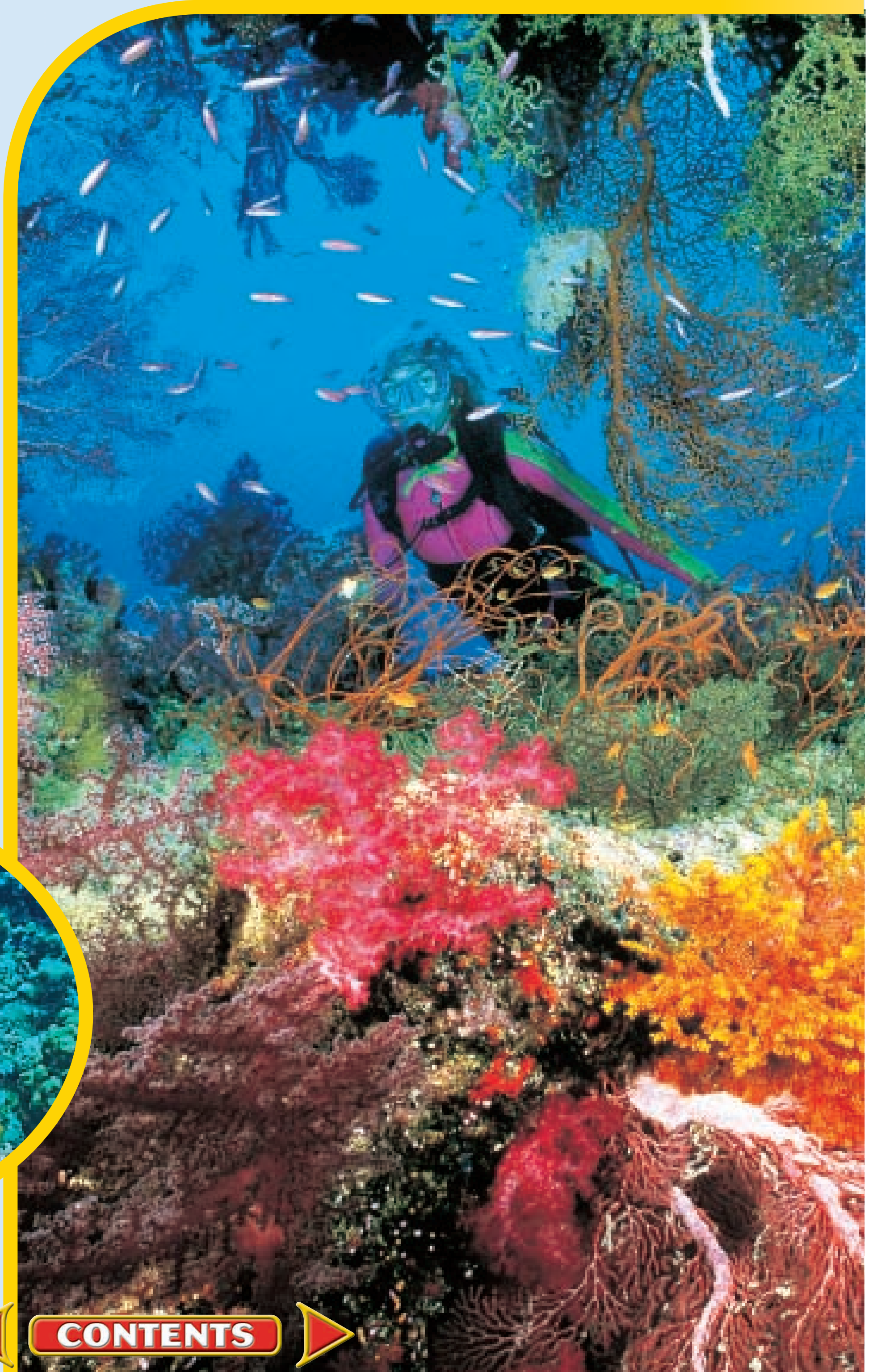
In the 1800s, many biologists were interested in studying one-celled microorganisms. But to study them, the researchers needed to grow, or culture, large numbers of these cells. And to culture them properly, they needed a solid substance on which the cells could grow. One scientist tried using nutrient-enriched gelatin, but the gelatin had drawbacks. It melted at relatively low temperatures—and some microorganisms digested it. Fannie Eilshemius Hesse came up with a better option. She had been solidifying her homemade jellies using a substance called agar, which is derived from red seaweed (such as the one seen in the background here). It turned out that nutrient-enriched agar worked perfectly as a substance on which to culture cells. On the two types of agar in the dishes below, so many cells have grown that, together, they form dots and lines.

SCIENCE CONNECTION

CELL REPRODUCTION Under ideal conditions, some one-celled microorganisms can reproduce very quickly by cell division. Suppose you placed one cell in a dish of nutrient-enriched agar. Twenty minutes later, the cell divided to form two cells. Assuming that the cells continue to divide every twenty minutes, how many would be in the dish an hour after the first division? Two hours after the first division? Make a graph that illustrates the pattern of cell reproduction.

CHAPTER 1

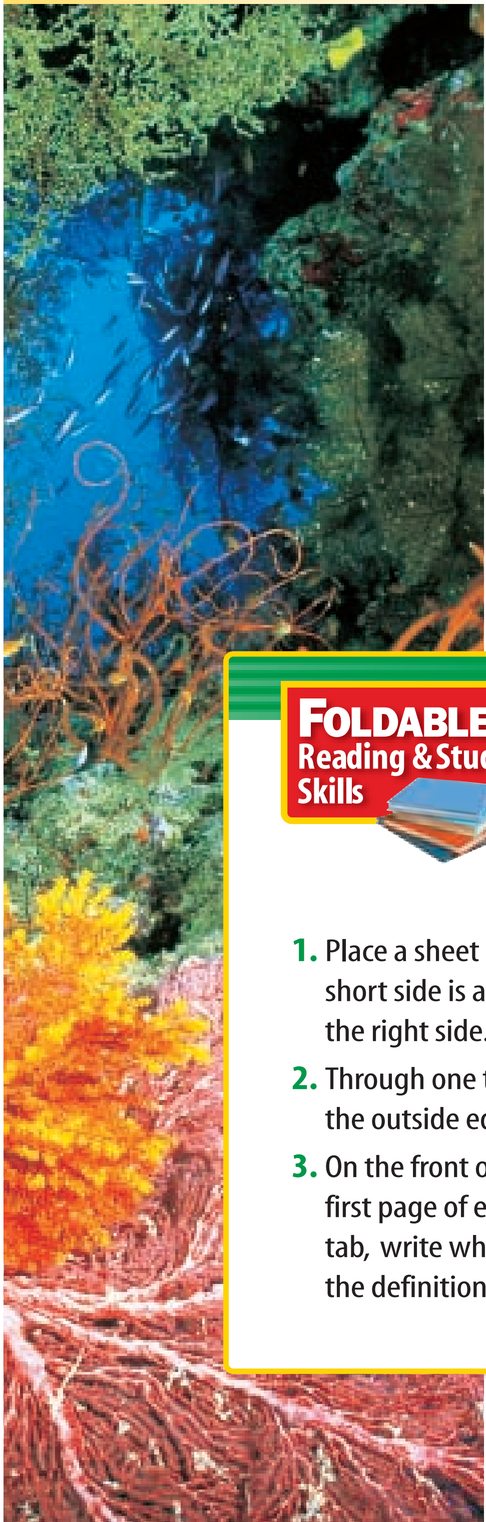
Exploring and Classifying Life



How many different living things do you see in this picture? Did your answer include the living coral? What do all living things have in common? How are they different? In this chapter, you will read the answers to these questions. You also will read how living things are classified. In the first part of the chapter, you will read how scientific methods may be used to solve many everyday and scientific problems.

What do you think?

Science Journal Look at the picture below with a classmate. Discuss what you think these might be. Here's a hint: *You could really clean up with these things.* Write your answer or best guess in your Science Journal.



Explore Activity

Life scientists discover, describe, and name hundreds of organisms every year. How do they decide if a certain plant belongs to the iris or orchid family of flowering plants, or if an insect is more like a grasshopper or a beetle?

Use features to classify organisms

1. Observe the organisms on the opposit collection in your class.
2. Decide which feature could be used to groups, then sort the organisms into t
3. Continue to make new groups using di ism is in a category by itself.

Observe

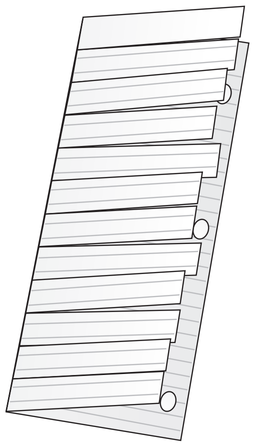
What features would you use to classify th How do you think scientists classify living t Science Journal.

Before You Read

FOLDABLES Reading & Study Skills

Making a Vocabulary Study Fold **To help you study the interactions of life, make the following vocabulary Foldable. Knowing the definition of vocabulary words in a chapter is a good way to ensure you have understood the content.**

1. Place a sheet of notebook paper in front of you so that the short side is at the top. Fold the paper in half from the left to the right side.
2. Through one thickness of paper, cut along every third line from the outside edge to the center fold, forming ten tabs as shown.
3. On the front of each tab, write a vocabulary word listed on the first page of each section in this chapter. On the back of each tab, write what you think the word means. Add to or change the definitions as you read.



SECTION 1

What is science?

As You Read

What You'll Learn

- **Apply** scientific methods to problem solving.
- **Demonstrate** how to measure using scientific units.

Vocabulary

scientific methods	variable
hypothesis	theory
control	law

Why It's Important

Learning to use scientific methods will help you solve ordinary problems in your life.

The Work of Science

Movies and popcorn seem to go together. So before you and your friends watch a movie, sometimes you pop some corn in a microwave oven. When the popping stops, you take out the bag and open it carefully. You smell the mouthwatering, freshly popped corn and avoid hot steam that escapes from the bag. What makes the popcorn pop? How do microwaves work and make things hot? By the way, what are microwaves anyway?

Asking questions like these is one way scientists find out about anything in the world and the universe. Science is often described as an organized way of studying things and finding answers to questions.

Types of Science Many types of science exist. Each is given a name to describe what is being studied. For example, energy and matter have a relationship. That's a topic for physics. A physicist could answer most questions about microwaves.

On the other hand, a life scientist might study any of the millions of different animals, plants, and other living things on Earth. Look at the objects in **Figure 1.** What do they look like to you? A life scientist could tell you that some of the objects are living plants and some are just rocks. Life scientists who study plants are botanists, and those who study animals are zoologists. What do you suppose a bacteriologist studies?

Figure 1
Are all of these objects rocks? **Examine the picture carefully. Some of these objects are actually *Lithops* plants. They commonly are called stone plants and are native to deserts in South Africa.**

Critical Thinking

Whether or not you become a trained scientist, you are going to solve problems all your life. You probably solve many problems every day when you sort out ideas about what will or won't work. Suppose your CD player stops playing music. To figure out what happened, you have to think about it. That's called critical thinking, and it's the way you use skills to solve problems.

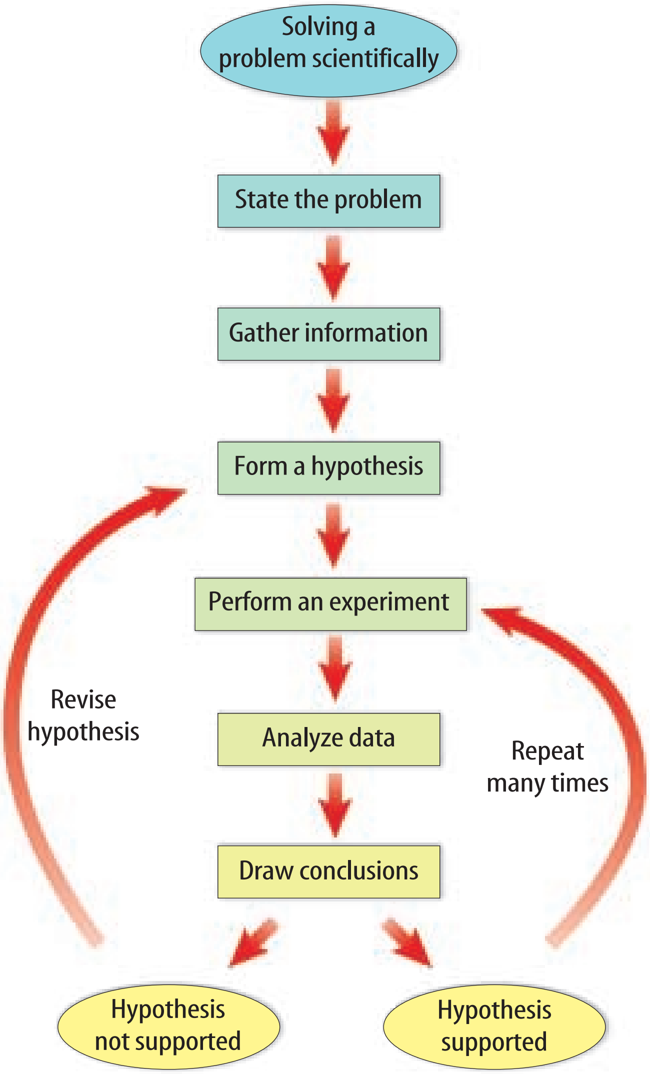
If you know that the CD player does not run on batteries and must be plugged in to work, that's the first thing you check to solve the problem. You check and the player is plugged in so you eliminate that possible solution. You separate important information from unimportant information—that's a skill. Could there be something wrong with the first outlet? You plug the player into a different outlet, and your CD starts playing. You now know that it's the first outlet that doesn't work. Identifying the problem is another skill you have.

Solving Problems

Scientists use the same types of skills that you do to solve problems and answer questions. Although scientists don't always find the answers to their questions, they always use critical thinking in their search. Besides critical thinking, solving a problem requires organization. In science, this organization often takes the form of a series of procedures called **scientific methods. Figure 2** shows one way that scientific methods might be used to solve a problem.

State the Problem Suppose a veterinary technician wanted to find out whether different types of cat litter cause irritation to cats' skin. What would she do first? The technician begins by observing something she cannot explain. A pet owner brings his four cats to the clinic to be boarded while he travels. He leaves his cell phone number so he can be contacted if any problems arise. When they first arrive, the four cats seem healthy. The next day however, the technician notices that two of the cats are scratching and chewing at their skin. By the third day, these same two cats have bare patches of skin with red sores. The technician decides that something in the cats' surroundings or their food might be irritating their skin.

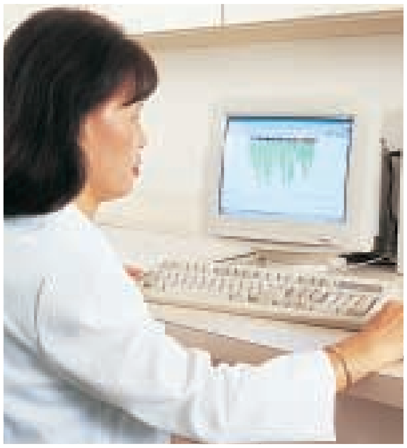
Figure 2
The series of procedures shown below is one way to use scientific methods to solve a problem.



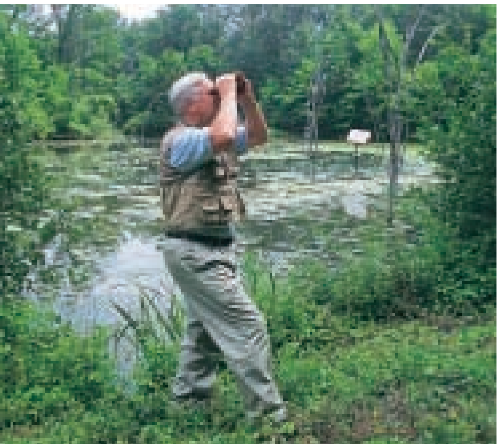
CONTENTS

Figure 3
Observations can be made in many different settings.

A Laboratory investigations



B Computer models



C Fieldwork

Gather Information

Laboratory observations and experiments are ways to collect information. Some data also are gathered from fieldwork. Fieldwork includes observations or experiments that are done outside of the laboratory. For example, the best way to find out how a bird builds a nest is to go outside and watch it. **Figure 3** shows some ways data can be gathered.

The technician gathers information about the problem by watching the cats closely for the next two days. She knows that cats sometimes change their behavior when they are in a new place. She wants to see if the behavior of the cats with the skin sores seems different from that of the other two cats. Other than the scratching and chewing, all four cats' behavior seems to be the same.

The technician calls the owner and tells him about the problem. She asks him what brand of cat food he feeds his cats. Because his brand is the same one used at the clinic, she decides that food is not the cause of the skin irritation. She decides that the cats probably are reacting to something in their surroundings. There are many things in the clinic that the cats might react to. How does she decide what it is?

During her observations she notices that the cats seem to scratch and chew themselves most after using their litter boxes. The cat litter used by the clinic contains a deodorant. The technician calls the owner and finds out that the cat litter he buys does not contain a deodorant.

Form a Hypothesis

Based on this information, the next thing the veterinary technician does is form a hypothesis. A **hypothesis** is a prediction that can be tested. After discussing her observations with the clinic veterinarian, she hypothesizes that something in the cat litter is irritating the cats' skin.

Test the Hypothesis with an Experiment

The technician gets the owner's permission to test her hypothesis by performing an experiment. In an experiment, the hypothesis is tested using controlled conditions. The technician reads the labels on two brands of cat litter and finds that the ingredients of each are the same except that one contains a deodorant.

CLICK HERE

SCIENCE Online

Research Visit the Glencoe Science Web site at **science.glencoe.com** for more information about how scientists use controlled experiments. Communicate to your class what you learn.

CONTENTS

Controls The technician separates the cats with sores from the other two cats. She puts each of the cats with sores in a cage by itself. One cat is called the experimental cat. This cat is given a litter box containing the cat litter without deodorant. The other cat is given a litter box that contains cat litter with deodorant. The cat with deodorant cat litter is the control.

A **control** is the standard to which the outcome of a test is compared. At the end of the experiment, the control cat will be compared with the experimental cat. Whether or not the cat litter contains deodorant is the variable. A **variable** is something in an experiment that can change. An experiment should have only one variable. Other than the difference in the cat litter, the technician treats both cats the same.

✔ Reading Check *How many variables should an experiment have?*

Analyze Data The veterinary technician observes both cats for one week. During this time, she collects data on how often and when the cats scratch or chew, as shown in **Figure 4.** These data are recorded in a journal. The data show that the control cat scratches and chews more often than the experimental cat does. The sores on the skin of the experimental cat begin to heal, but those on the control cat do not.

Draw Conclusions The technician then draws the conclusion—a logical answer to a question based on data and observation—that the deodorant in the cat litter probably irritated the skin of the two cats. To accept or reject the hypothesis is the next step. In this case, the technician accepts the hypothesis. If she had rejected it, new experiments would have been necessary.

Although the technician decides to accept her hypothesis, she realizes that to be surer of her results she should continue her experiment. She should switch the experimental cat with the control cat to see what the results are a second time. If she did this, the healed cat might develop new sores. She makes an ethical decision and chooses not to continue the experiment. Ethical decisions, like this one, are important in deciding what science should be done.

Mini LAB

Analyzing Data

Procedure

1. Obtain a **pan balance.** Follow your teacher's instructions for using it.
2. Record all data in your **Science Journal.**
3. Measure and record the mass of a dry **sponge.**
4. Soak this sponge in **water.** Measure and record its mass.
5. Calculate how much water your sponge absorbed.
6. Combine the class data and calculate the average amount of water absorbed.

Analysis

What other information about the sponges might be important when analyzing the data from the entire class?

Figure 4
Collecting and analyzing data is part of scientific methods.

Report Results When using scientific methods, it is important to share information. The veterinary technician calls the cats' owner and tells him the results of her experiment. She tells him she has stopped using the deodorant cat litter.

The technician also writes a story for the clinic's newsletter that describes her experiment and shares her conclusions. She reports the limits of her experiment and explains that her results are not final. In science it is important to explain how an experiment can be made better if it is done again.

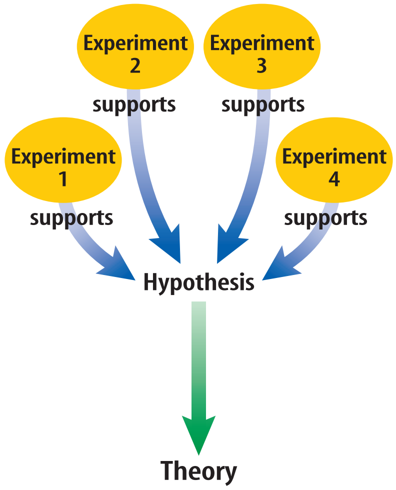


Figure 5
If data collected from several experiments over a period of time all support the hypothesis, it can finally be called a theory.

Developing Theories

After scientists report the results of experiments supporting their hypotheses, the results can be used to propose a scientific theory. When you watch a magician do a trick you might decide you have an idea or "theory" about how the trick works. Is your idea just a hunch or a scientific theory? A scientific **theory** is an explanation of things or events based on scientific knowledge that is the result of many observations and experiments. It is not a guess or someone's opinion. Many scientists repeat the experiment. If the results always support the hypothesis, the hypothesis can be called a theory, as shown in **Figure 5.**

Reading Check *What is a theory based on?*

A theory usually explains many hypotheses. For example, an important theory in life sciences is the cell theory. Scientists made observations of cells and experimented for more than 100 years before enough information was collected to propose a theory. Hypotheses about cells in plants and animals are combined in the cell theory.

A valid theory raises many new questions. Data or information from new experiments might change conclusions and theories can change. Later in this chapter you will read about the theory of spontaneous generation and how this theory changed as scientists used experiments to study new hypotheses.

Laws A scientific **law** is a statement about how things work in nature that seems to be true all the time. Although laws can be modified as more information becomes known, they are less likely to change than theories. Laws tell you what will happen under certain conditions but do not necessarily explain why it happened. For example, in life science you might learn about laws of heredity. These laws explain how genes are inherited but do not explain how genes work. Due to the great variety of living things, laws that describe them are few. It is unlikely that a law about how all cells work will ever be developed.

Scientific Methods Help Answer Questions You can use scientific methods to answer all sorts of questions. Your questions may be as simple as "Where did I leave my house key?" or as complex as "Will global warming cause the polar ice caps to melt?" You probably have had to find the answer to the first question. Someday you might try to find the answer to the second question. Using these scientific methods does not guarantee that you will get an answer. Often scientific methods just lead to more questions and more experiments. That's what science is about—continuing to look for the best answers to your questions.

Problem-Solving Activity

Does temperature affect the rate of bacterial reproduction?

Some bacteria make you sick. Other bacteria, however, are used to produce foods like cheese and yogurt. Understanding how quickly bacteria reproduce can help you avoid harmful bacteria and use helpful bacteria. It's important to know things that affect how quickly bacteria reproduce. How do you think temperature will affect the rate of bacterial reproduction? A student makes the hypothesis that bacteria will reproduce more quickly as the temperature increases.

Identifying the Problem

The table below lists the reproduction-doubling rates at specific temperatures for one type of bacteria. A rate of 2.0 means that the number of bacteria doubled two times that hour (e.g., 100 to 200 to 400).

Bacterial Reproductive Rates

Temperature (°C)	Doubling Rate per Hour
20.5	2.0
30.5	3.0
36.0	2.5
39.2	1.2

Look at the table. What conclusions can you draw from the data?

Solving the Problem

1. Do the data in the table support the student's hypothesis?
2. How would you write a hypothesis about the relationship between bacterial reproduction and temperature?
3. Make a list of other factors that might have influenced the results in the table.
4. Are you satisfied with these data? List other things that you wish you knew.
5. Describe an experiment that would help you test these other ideas.

Figure 6
Your food often is measured in metric units.

A The label of this juice bottle shows you that it contains 473 mL of juice.

B Nutritional information on the label is listed in grams or milligrams.

Measuring with Scientific Units

An important part of most scientific investigations is making accurate measurements. Think about things you use every day that are measured. Ingredients in your hamburger, hot dog, potato chips, or soft drink are measured in units such as grams and milliliters, as shown in **Figure 6.** The water you drink, the gas you use, and the electricity needed for a CD player are measured, too.

In your classroom or laboratory this year, you will use the same standard system of measurement scientists use to communicate and understand each other's research and results. This system is called the International System of Units, or SI. For example, you may need to calculate the distance a bird flies in kilometers. Perhaps you will be asked to measure the amount of air your lungs can hold in liters or the mass of an automobile in kilograms. Some of the SI units are shown in **Table 1.**

Table 1 Common SI Measurements

Measurement	Unit	Symbol	Equal to
Length	1 millimeter	mm	0.001 (1/1,000) m
	1 centimeter	cm	0.01 (1/100) m
	1 meter	m	100 cm
	1 kilometer	km	1,000 m
Volume	1 milliliter	mL	0.001 (1/1,000) L
	1 liter	L	1,000 mL
Mass	1 gram	g	1,000 mg
	1 kilogram	kg	1,000 g
	1 tonne	t	1,000 kg = 1 metric ton

Safety First

Doing science is usually much more interesting than just reading about it. Some of the scientific equipment that you will use in your classroom or laboratory is the same as what scientists use. Laboratory safety is important. In many states, a student can participate in a laboratory class only when wearing proper eye protection. Don't forget to wash your hands after handling materials. Following safety rules, as shown in **Figure 7,** will protect you and others from injury during your lab experiences. Symbols used throughout your text will alert you to situations that require special attention. Some of these symbols are shown below. A description of each symbol is in the Safety Symbols chart at the front of this book.

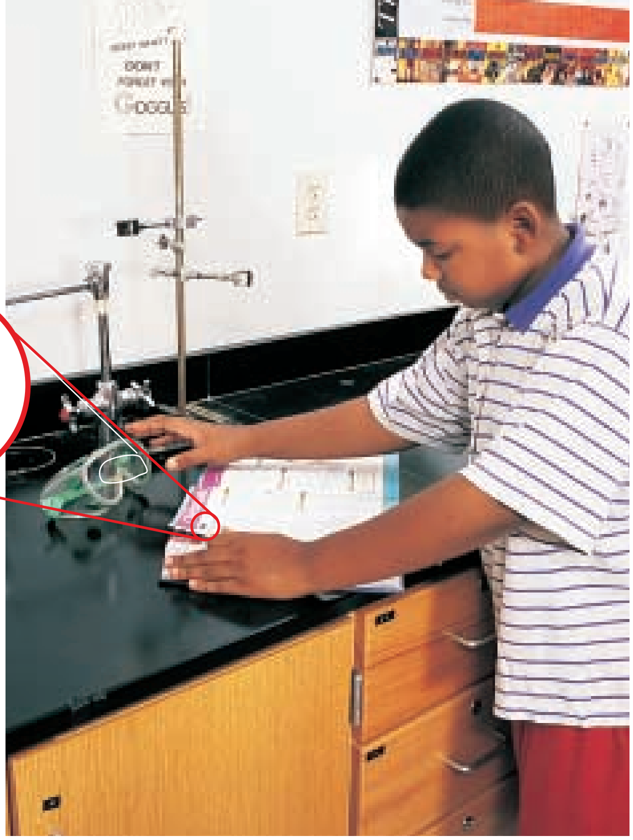


Figure 7
Proper eye protection should be worn whenever you see this safety symbol.

Section 1 Assessment

1. Identify steps that might be followed when using scientific methods.
2. Why is it important to test only one variable at a time during an experiment?
3. What SI unit would you use to measure the width of your classroom?
4. How is a theory different than a hypothesis?
5. **Think Critically** Can the veterinary technician in this section be sure that the deodorant caused the cats' skin problems? What could she change in her experiment to make it better?

Skill Builder Activities

6. **Communicating** Write a newsletter article that explains what the veterinary technician discovered from her experiment. **For more help, refer to the Science Skill Handbook.**
7. **Converting Units** Sometimes temperature is measured in Fahrenheit degrees. Normal human body temperature is 98.6°F. What is this temperature in degrees Celsius? Use the English-to-metric conversion chart at the back of this book. **For more help, refer to the Math Skill Handbook.**

SECTION 2

Living Things

As You Read

What You'll Learn

- **Distinguish** between living and nonliving things.
- **Identify** what living things need to survive.

Vocabulary

organism
cell
homeostasis

Why It's Important

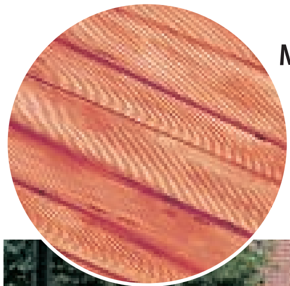
All living things, including you, have many of the same traits.

What are living things like?

What does it mean to be alive? If you walked down your street after a thunderstorm, you'd probably see earthworms on the sidewalk, birds flying, clouds moving across the sky, and puddles of water. You'd see living and nonliving things that are alike in some ways. For example, birds and clouds move. Earthworms and water feel wet when they are touched. Yet, clouds and water are nonliving things, and birds and earthworms are living things. Any living thing is called an **organism.**

Organisms vary in size from the microscopic bacteria in mud puddles to gigantic oak trees and are found just about everywhere. They have different behaviors and food needs. In spite of these differences, all organisms have similar traits. These traits determine what it means to be alive.

Living Things Are Organized If you were to look at almost any part of an organism, like a plant leaf or your skin, under a microscope, you would see that it is made up of small units called cells. A **cell** is the smallest unit of an organism that carries on the functions of life. Some organisms are composed of just one cell while others are composed of many cells. Cells take in materials from their surroundings and use them in complex ways. Each cell has an orderly structure and contains hereditary material. The hereditary material contains instructions for cellular organization and function. **Figure 8** shows some organisms that are made of many cells. All the things that these organisms can do are possible because of what their cells can do.



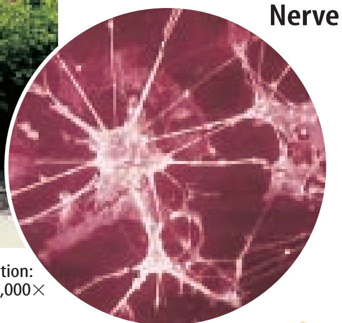


Figure 8
Your body is organized into many different types of cells. Two types are shown.

Living Things Respond Living things interact with their surroundings. Watch your cat when you use your electric can opener. Does your cat come running to find out what's happening even when you're not opening a can of cat food? The cat in **Figure 9** ran in response to a stimulus—the sound of the can opener. Anything that causes some change in an organism is a stimulus (plural, *stimuli*). The reaction to a stimulus is a response. Often that response results in movement, such as when the cat runs toward the sound of the can opener. To carry on its daily activity and to survive, an organism must respond to stimuli.

Living things also respond to stimuli that occur inside them. For example, water or food levels in organisms' cells can increase or decrease. The organisms then make internal changes to keep the right amounts of water and food in their cells. Their temperature also must be within a certain range. An organism's ability to keep the proper conditions inside no matter what is going on outside the organism is called **homeostasis.** Homeostasis is a trait of all living things.

Figure 9
Some cats respond to a food stimulus even when they are not hungry. *Why does a cat come running when it hears a can opener?*

Reading Check *What are some internal stimuli living things respond to?*

Living Things Use Energy Staying organized and carrying on activities like homeostasis requires energy. The energy used by most organisms comes either directly or indirectly from the Sun. Plants and some other organisms use the Sun's energy and the raw materials carbon dioxide and water to make food. You and most other organisms can't use the energy of sunlight directly. Instead, you take in and use food as a source of energy. You get food by eating plants or other organisms that ate plants. Most organisms, including plants, also must take in oxygen in order to release the energy of foods.

Some bacteria live at the bottom of the oceans and in other areas where sunlight cannot reach. They can't use the Sun's energy to produce food. Instead, the bacteria use energy stored in some chemical compounds and the raw material carbon dioxide to make food. Unlike most other organisms, many of these bacteria do not need oxygen to release the energy that is found in their food.

CLICK HERE

SCIENCE Online

Research Visit the Glencoe Science Web site at **science.glencoe.com** for more information about homeostasis. Communicate to your class what you learn.

Living Things Grow and Develop When a puppy is born, it might be small enough to hold in one hand. After the same dog is fully grown, you might not be able to hold it at all. How does this happen? The puppy grows by taking in raw materials, like milk from its female parent, and making more cells. Growth of many-celled organisms, such as the puppy, is mostly due to an increase in the number of cells. In one-celled organisms, growth is due to an increase in the size of the cell.

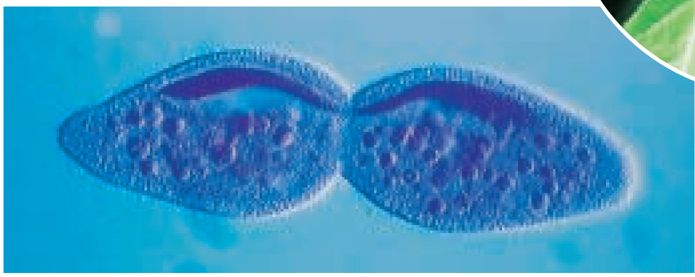
Organisms change as they grow. Puppies can't see or walk when they are born. In eight or nine days, their eyes open, and their legs become strong enough to hold them up. All of the changes that take place during the life of an organism are called development. **Figure 10** shows how four different organisms changed as they grew.

The length of time an organism is expected to live is its life span. Adult dogs can live for 20 years and a cat for 25 years. Some organisms have a short life span. Mayflies live only one day, but a land tortoise can live for more than 180 years. Some bristlecone pine trees have been alive for more than 4,600 years. Your life span is about 80 years.

Figure 10
Complete development of an organism can take a few days or several years. The pictures below show the development of A a dog, B a human, C a pea plant, and D a butterfly.

Figure 11
Living things reproduce themselves in many different ways. A A *Paramecium* reproduces by dividing into two. B Beetles, like most insects, reproduce by laying eggs. C Every spore released by these puffballs can grow into a new fungus.

A



Magnification: 400×

B

C

Living Things Reproduce Cats, dogs, alligators, fish, birds, bees, and trees eventually reproduce. They make more of their own kind. Some bacteria reproduce every 20 minutes while it might take a pine tree two years to produce seeds. **Figure 11** shows some ways organisms reproduce.

Without reproduction, living things would not exist to replace those individuals that die. An individual cat can live its entire life without reproducing. However, if cats never reproduced, all cats soon would disappear.

Reading Check *Why is reproduction important?*

What do living things need?

What do you need to live? Do you have any needs that are different from those of other living things? To survive, all living things need a place to live and raw materials. The raw materials that they require and the exact place where they live can vary.

A Place to Live The environment limits where organisms can live. Not many kinds of organisms can live in extremely hot or extremely cold environments. Most cannot live at the bottom of the ocean or on the tops of mountains. All organisms also need living space in their surroundings. For example, thousands of penguins build their nests on an island. When the island becomes too crowded, the penguins fight for space and some may not find space to build nests. An organism's surroundings must provide for all of its needs.

Health INTEGRATION

Human infants can't take care of themselves at birth. Research to find out what human infants can do at different stages of development. Make a chart that shows changes from birth to one year old.

Figure 12
You and a corn plant each take in and give off about 2 L of water in a day. Most of the water you take in is from water you drink or from foods you eat. *Where do plants get water to transport materials?*

Raw Materials Water is important for all living things. Plants and animals take in and give off large amounts of water each day, as shown in **Figure 12.** Organisms use homeostasis to balance the amounts of water lost with the amounts taken in. Most organisms are composed of more than 50 percent water. You are made of 60 to 70 percent water. Organisms use water for many things. For example, blood, which is about 90 percent water, transports digested food and wastes in animals. Plants have a watery sap that transports materials between roots and leaves.

Living things are made up of substances such as proteins, fats, and sugars. Animals take in most of these substances from the foods they eat. Plants and some bacteria make them using raw materials from their surroundings. These important substances are used over and over again. When organisms die, substances in their bodies are broken down and released into the soil or air. The substances can then be used again by other living organisms. Some of the substances in your body might once have been part of a butterfly or an apple tree.

At the beginning of this section, you learned that things such as clouds, sidewalks, and puddles of water are not living things. Now do you understand why? Clouds, sidewalks, and water do not reproduce, use energy, or have other traits of living things.

Section 2 Assessment

1. What is the main source of energy used by most organisms?
2. List five traits most organisms have.
3. Why would you expect to see cells if you looked at a section of a mushroom cap under a microscope?
4. In order to survive, what things do most organisms need?
5. **Think Critically** Why is homeostasis important to organisms?

Skill Builder Activities

6. **Comparing and Contrasting** What are the similarities and differences between a goldfish and the flame of a burning candle? **For more help, refer to the Science Skill Handbook.**
7. **Using a Database** Use references to find the life span of ten animals. Use your computer to make a database. Then graph the life spans from shortest to longest. **For more help, refer to the Technology Skill Handbook.**

SECTION

3

Where does life come from?

Life Comes from Life

You've probably seen a fish tank, like the one in **Figure 13,** that is full of algae. How did the algae get there? Before the seventeenth century, some people thought that insects and fish came from mud, that earthworms fell from the sky when it rained, and that mice came from grain. These were logical conclusions at that time, based on repeated personal experiences. The idea that living things come from nonliving things is known as **spontaneous generation.** This idea became a theory that was accepted for several hundred years. When scientists began to use controlled experiments to test this theory, the theory changed.

Reading Check *According to the theory of spontaneous generation, where do fish come from?*

Spontaneous Generation and Biogenesis From the late seventeenth century through the middle of the eighteenth century, experiments were done to test the theory of spontaneous generation. Although these experiments showed that spontaneous generation did not occur in most cases, they did not disprove it entirely.

It was not until the mid-1800s that the work of Louis Pasteur, a French chemist, provided enough evidence to disprove the theory of spontaneous generation. It was replaced with **biogenesis** (bi oh JEN uh suhs), which is the theory that living things come only from other living things.

Figure 13
The sides of this tank were clean and the water was clear when the aquarium was set up. Algal cells, which were not visible on plants and fish, reproduced in the tank. So many algal cells are present now that the water is cloudy.

As You Read

What You'll Learn

- **Describe** experiments about spontaneous generation.
- **Explain** how scientific methods led to the idea of biogenesis.
- **Examine** how chemical compounds found in living things might have formed.

Vocabulary

spontaneous generation
biogenesis

Why It's Important

You can use scientific methods to try to find out about events that happened long ago or just last week. You can even use them to predict how something will behave in the future.

VISUALIZING THE ORIGINS OF LIFE

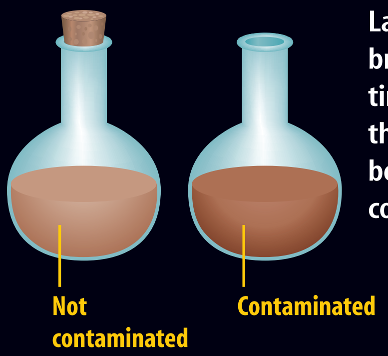
Figure 14

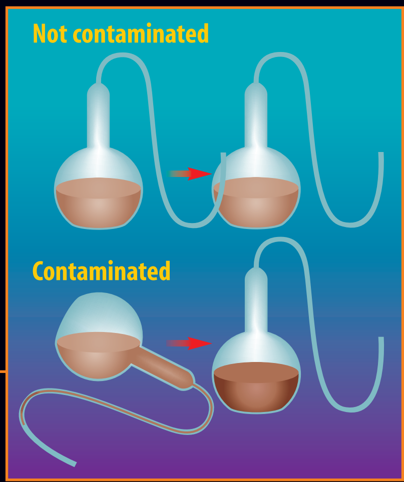
For centuries scientists have theorized about the origins of life. As shown on this timeline, some examined spontaneous generation— the idea that nonliving material can produce life. More recently, scientists have proposed theories about the origins of life on Earth by testing hypotheses about conditions on early Earth.

1668 Francesco Redi put decaying meat in some jars, then covered half of them. When fly maggots appeared only on the uncovered meat (see below, left), Redi concluded that they had hatched from fly eggs and had not come from the meat.

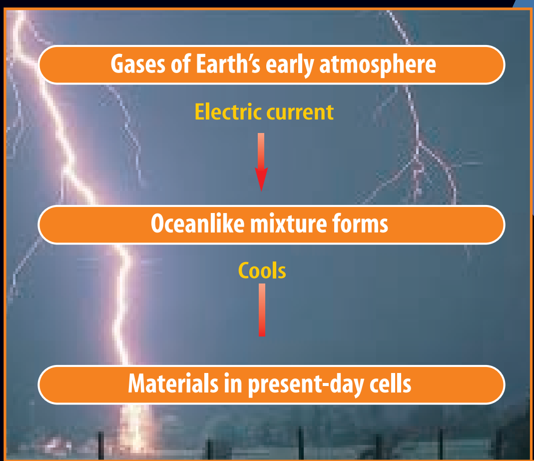
1745 John Needham heated broth in sealed flasks. When the broth became cloudy with microorganisms, he mistakenly concluded that they developed spontaneously from the broth.

1768 Lazzaro Spallanzani broiled broth in sealed flasks for a longer time than Needham did. Only the ones he opened became cloudy with contamination.





1859 Louis Pasteur disproved spontaneous generation by boiling broth in S-necked flasks that were open to the air. The broth became cloudy (see above, bottom right) only when a flask was tilted and the broth was exposed to dust in the S-neck.



1924 Alexander Oparin hypothesized that energy from the Sun, lightning, and Earth's heat triggered chemical reactions early in Earth's history. The newly-formed molecules washed into Earth's ancient oceans and became a part of what is often called the primordial soup.

1953 Stanley Miller and Harold Urey sent electric currents through a mixture of gases like those thought to be in Earth's early atmosphere. When the gases cooled, they condensed to form an oceanlike liquid that contained materials such as amino acids, found in present-day cells.

Life's Origins

Astronomy INTEGRATION

If living things can come only from other living things, how did life on Earth begin? Some scientists hypothesize that about 5 billion years ago, Earth's solar system was a whirling mass of gas and dust. They hypothesize that the Sun and planets were formed from this mass. It is estimated that Earth is about 4.6 billion years old. Rocks found in Australia that are more than 3.5 billion years old contain fossils of once-living organisms. Where did these living organisms come from?

Oparin's Hypothesis In 1924, a Russian scientist named Alexander I. Oparin suggested that Earth's early atmosphere had no oxygen but was made up of the gases ammonia, hydrogen, methane, and water vapor. Oparin hypothesized that these gases could have combined to form the more complex compounds found in living things.

Using gases and conditions that Oparin described, American scientists Stanley L. Miller and Harold Urey set up an experiment to test Oparin's hypothesis in 1953. Although the Miller-Urey experiment showed that chemicals found in living things could be produced, it did not prove that life began in this way.

For many centuries, scientists have tried to find the origins of life, as shown in **Figure 14.** Although questions about spontaneous generation have been answered, some scientists still are investigating ideas about life's origins.

Earth Science INTEGRATION

Scientists hypothesize that Earth's oceans originally formed when water vapor was released into the atmosphere from many volcanic eruptions. Once it cooled, rain fell and filled Earth's lowland areas. Identify five lowland areas on Earth that are now filled with water. Record your answer in your Science Journal.

Section 3 Assessment

1. Compare and contrast spontaneous generation and biogenesis.
2. Describe three controlled experiments that helped disprove the theory of spontaneous generation.
3. List one substance that was used in the Miller-Urey experiment.
4. What were the results of the Miller-Urey experiment?
5. **Think Critically** Why was Oparin's hypothesis about the origins of life important to Miller and Urey?

Skill Builder Activities

6. **Drawing Conclusions** It was thought that in the 1768 experiment some "vital force" in the broth was destroyed. Was it? Based on this experiment, what could have been concluded about where organisms come from? **For more help, refer to the Science Skill Handbook.**
7. **Using Percentages** Earth's age is estimated at 4.6 billion years old. It is estimated that life began 3.5 billion years ago. Life has been present for what percent of Earth's age? **For more help, refer to the Math Skill Handbook.**

SECTION 4

How are living things classified?

As You Read

What You'll Learn

- **Describe** how early scientists classified living things.
- **Explain** the system of binomial nomenclature.
- **Demonstrate** how to use a dichotomous key.

Vocabulary

phylogeny
kingdom
binomial nomenclature
genus

Why It's Important

Knowing how living things are classified will help you understand the relationships that exist among all living things.

Classification

If you go to a library to find a book about the life of Louis Pasteur, where do you look? Do you look for it among the mystery or sports books? You expect to find a book about Pasteur's life with other biography books. Libraries group similar types of books together. When you place similar items together, you classify them. Organisms also are classified into groups.

History of Classification When did people begin to group similar organisms together? Early classifications included grouping plants that were used in medicines. Animals were often classified by human traits such as courageous—for lions—or wise—for owls.

More than 2,000 years ago, a Greek named Aristotle observed living things. He decided that any organism could be classified as either a plant or an animal. Then he broke these two groups into smaller groups. For example, animal categories included hair or no hair, four legs or fewer legs, and blood or no blood. **Figure 15** shows some of the organisms Aristotle would have grouped together. For hundreds of years after Aristotle, no one way of classifying was accepted by everyone.

Figure 15
According to Aristotle's classification system, all animals without hair would be grouped together. *What other animals without hair would Aristotle have put in this group?*

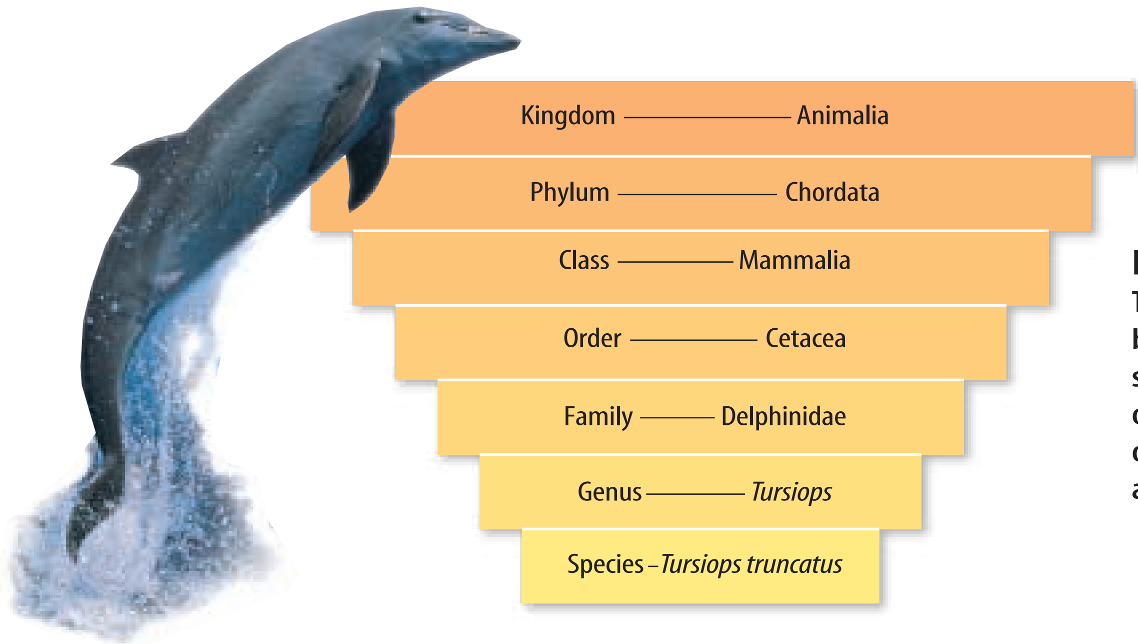


Figure 16
The classification of the bottle-nosed dolphin shows that it is in the order Cetacea. This order includes whales and porpoises.

Linnaeus In the late eighteenth century, Carolus Linnaeus, a Swedish naturalist, developed a new system of grouping organisms. His classification system was based on looking for organisms with similar structures. For example, plants that had similar flower structure were grouped together. Linnaeus's system eventually was accepted and used by most other scientists.

Modern Classification Like Linnaeus, modern scientists use similarities in structure to classify organisms. They also study fossils, hereditary information, and early stages of development. Scientists use all of this information to determine an organism's phylogeny. **Phylogeny** (fi LAH juh nee) is the evolutionary history of an organism, or how it has changed over time. Today, it is the basis for the classification of many organisms.

Reading Check ***What information would a scientist use to determine an organism's phylogeny?***

A classification system commonly used today groups organisms into six kingdoms. A **kingdom** is the first and largest category. Refer to Student Resources, Diversity of Life at the back of your text to find characteristics that place organisms into kingdoms. Kingdoms can be divided into smaller groups. The smallest classification category is a species. Organisms that belong to the same species can mate and produce fertile offspring. To understand how an organism is classified, look at the classification of the bottle-nosed dolphin in **Figure 16.** Some scientists propose that before organisms are grouped into kingdoms, they should be placed in larger groups called domains. One proposed system groups all organisms into three domains.

SCIENCE Online

Data Update For an online update of domains, visit the Glencoe Science Web site at **science.glencoe.com** and select the appropriate chapter. Communicate to your class what you learn.

CLICK HERE

Scientific Names

Using common names can cause confusion. Suppose that Diego is visiting Jamaal. Jamaal asks Diego if he would like a soda. Diego is confused until Jamaal hands him a soft drink. At Diego's house, a soft drink is called *pop.* Jamaal's grandmother, listening from the living room, thought that Jamaal was offering Diego an ice-cream soda.

What would happen if life scientists used only common names of organisms when they communicated with other scientists? Many misunderstandings would occur, and sometimes health and safety are involved. In **Figure 17,** you see examples of animals with common names that can be misleading. A naming system developed by Linnaeus helped solve this problem. It gave each species a unique, two-word scientific name.

Figure 17
Common names can be misleading.

Binomial Nomenclature The two-word naming system that Linnaeus used to name the various species is called **binomial nomenclature** (bi NOH mee ul • NOH mun klay chur). It is the system used by modern scientists to name organisms. The first word of the two-word name identifies the genus of the organism. A **genus** is a group of similar species. The second word of the name might tell you something about the organism—what it looks like, where it is found, or who discovered it.

In this system, the tree species commonly known as red maple has been given the name *Acer rubrum.* The maple genus is *Acer.* The word *rubrum* is Latin for red, which is the color of a red maple's leaves in the fall. The scientific name of another maple is *Acer saccharum.* The Latin word for sugar is *saccharum.* In the spring, the sap of this tree is sweet.

A Sea lions are more closely related to seals than to lions.

B Jellyfish are neither fish nor jelly. *Do you know a misleading common name?*

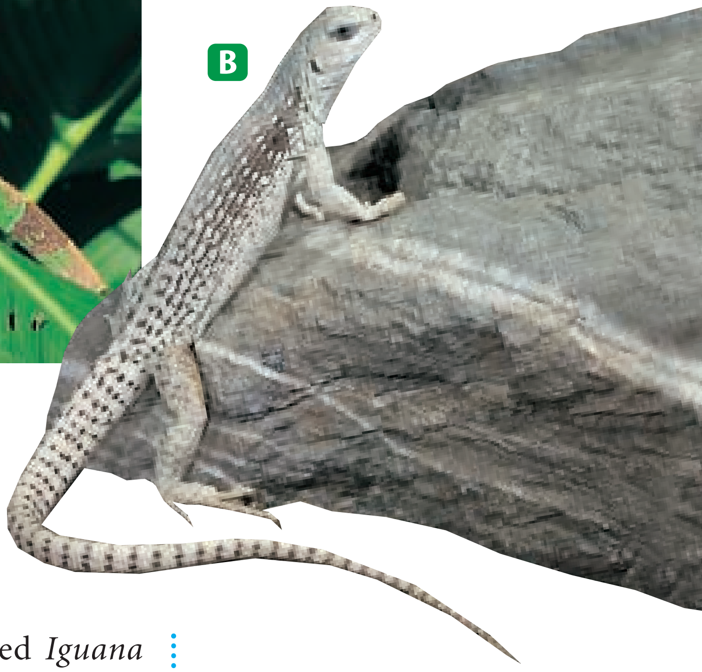


Figure 18
These two lizards have the same common name, iguana, but are two different species.

Uses of Scientific Names Scientific names are used for four reasons. First, they help avoid mistakes. Both of the lizards shown in **Figure 18** have the name *iguana.* Using binomial nomenclature, the green iguana is named *Iguana iguana.* Someone who studied this iguana, shown in **Figure 18A,** would not be confused by information he or she read about *Dispsosaurus dorsalis,* the desert iguana, shown in **Figure 18B.** Second, organisms with similar evolutionary histories are classified together. Because of this, you know that organisms in the same genus are related. Third, scientific names give descriptive information about the species, like the maples mentioned earlier. Fourth, scientific names allow information about organisms to be organized easily and efficiently. Such information may be found in a book or a pamphlet that lists related organisms and gives their scientific names.

✔ **Reading Check** *What are four functions of scientific names?*

Tools for Identifying Organisms

Tools used to identify organisms include field guides and dichotomous (di KAH tuh mus) keys. Using these tools is one way you and scientists solve problems scientifically.

Many different field guides are available. You will find some field guides at the back of this book. Most have descriptions and illustrations of organisms and information about where each organism lives. You can identify species from around the world using the appropriate field guide.

TRY AT HOME Mini LAB

Communicating Ideas

Procedure

1. Find a **magazine picture of a piece of furniture** that can be used as a place to sit and to lie down.
2. Show the picture to ten people and ask them to tell you what word they use for this piece of furniture.
3. Keep a record of the answers in your **Science Journal.**

Analysis

1. In your Science Journal, infer how using common names can be confusing.
2. How do scientific names make communication among scientists easier?

Dichotomous Keys A dichotomous key is a detailed list of identifying characteristics that includes scientific names. Dichotomous keys are arranged in steps with two descriptive statements at each step. If you learn how to use a dichotomous key, you can identify and name a species.

Did you know many types of mice exist? You can use **Table 2** to find out what type of mouse is pictured to the left. Start by choosing between the first pair of descriptions. The mouse has hair on its tail, so you go to 2. The ears of the mouse are small, so you go on to 3. The tail of the mouse is less that 25 mm. What is the name of this mouse according to the key?

Table 2 Key to Some Mice of North America

1. Tail hair	**a.** no hair on tail; scales show plainly; house mouse, *Mus musculus* **b.** hair on tail, go to 2
2. Ear size	**a.** ears small and nearly hidden in fur, go to 3 **b.** ears large and not hidden in fur, go to 4
3. Tail length	**a.** less than 25 mm; woodland vole, *Microtus pinetorum* **b.** more than 25 mm; prairie vole, *Microtus ochrogaster*
4. Tail coloration	**a.** sharply bicolor, white beneath and dark above; deer mouse, *Peromyscus maniculatus* **b.** darker above than below but not sharply bicolor; white-footed mouse, *Peromyscus leucopus*

Section 4 Assessment

1. What is the purpose of classification?
2. What were the contributions of Aristotle and Carolus Linnaeus to classification of living things?
3. How can you identify a species using a dichotomous key?
4. Why can common names cause confusion?
5. **Think Critically** Would you expect a field guide to have common names as well as scientific names? Why or why not?

Skill Builder Activities

6. **Classifying** Create a dichotomous key that identifies types of cars. **For more help, refer to the Science Skill Handbook.**
7. **Communicating** Select a field guide for trees, insects, or mammals. Select two organisms in the field guide that closely resemble each other. Use labeled diagrams to show how they are different. **For more help, refer to the Science Skill Handbook.**

Activity

Classifying Seeds

Scientists use classification systems to show how organisms are related. How do they determine which features to use to classify organisms? In this activity, you will observe seeds and use their features to classify them.

What You'll Investigate

How can the features of seeds be used to develop a key to identify the seed?

Materials

packets of seeds (10 different kinds)
hand lens
metric ruler

Goals

- **Observe** the seeds and notice their features.
- **Classify** seeds using these features.

Safety Precautions

WARNING: Some seeds may have been treated with chemicals. Do not put them in your mouth. Wash your hands after you handle the seeds.

Procedure

1. Copy the following data table in your Science Journal and record the features of each seed. Your table will have a column for each different type of seed you observe.

Seed Data

Feature	Type of Seed		
Color			
Length (mm)			
Shape			
Texture			

2. Use the features to develop a key.
3. Exchange keys with another group. Can you use their key to identify seeds?

Conclude and Apply

1. How can different seeds be classified?
2. Which feature could you use to divide the seeds into two groups?
3. **Explain** how you would classify a seed you had not seen before using your data table.
4. Why is it an advantage for scientists to use a standardized system to classify organisms? What observations did you make to support your answer?

Communicating Your Data

Compare your conclusions with those of other students in your class. **For more help, refer to the Science Skill Handbook.**

CONTENTS

Activity *Design Your Own Experiment*

Using Scientific Methods

Brine shrimp

Brine shrimp are relatives of lobsters, crabs, crayfish, and the shrimp eaten by humans. They are often raised as a live food source in aquariums. In nature, they live in the oceans where fish feed on them. They can hatch from eggs that have been stored in a dry condition for many years. In this investigation, you will use scientific methods to find what factors affect their hatching and growth.

Recognize the Problem

How can you use scientific methods to determine whether salt affects the hatching and growth of brine shrimp?

Form a Hypothesis

Based on your observations, state a hypothesis about how salt affects the hatching and growth of brine shrimp.

Goals

- **Design** and carry out an experiment using scientific methods to infer why brine shrimp live in the ocean.
- **Observe** the jars for one week and notice whether the brine shrimp eggs hatch.

Possible Materials

500-mL, widemouthed containers (3)
brine shrimp eggs
small, plastic spoon
distilled water (500 mL)
weak salt solution (500 mL)
strong salt solution (500 mL)
labels (3)
hand lens

Safety Precautions

Protect eyes and clothing. Be careful when working with live organisms.

Test Your Hypothesis

Plan

1. As a group, agree upon the hypothesis and decide how you will test it. Identify what results will confirm the hypothesis.
2. **List** the steps that you need to test your hypothesis. Be specific. Describe exactly what you will do in each step.
3. **List** your materials.
4. **Prepare** a data table in your Science Journal to record your data.
5. Read over your entire experiment to make sure that all planned steps are in logical order.
6. **Identify** any constants, variables, and controls of the experiment.

Do

1. Make sure your teacher approves your plan before you start.
2. Carry out the experiment as planned by your group.
3. While doing the experiment, record any observations and complete the data table in your Science Journal.
4. Use a bar graph to plot your results.

Analyze Your Data

1. **Describe** the contents of each jar after one week. Do they differ from one another? How?
2. What was your control in this experiment?
3. What were your variables?

Draw Conclusions

1. Did the results support your hypothesis? Explain.
2. **Predict** the effect that increasing the amount of salt in the water would have on the brine shrimp eggs.
3. **Compare** your results with those of other groups.

Communicating Your Data

Prepare a set of instructions on how to hatch brine shrimp to use to feed fish. Include diagrams and a step-by-step procedure.

M

Manicore marmoset

n

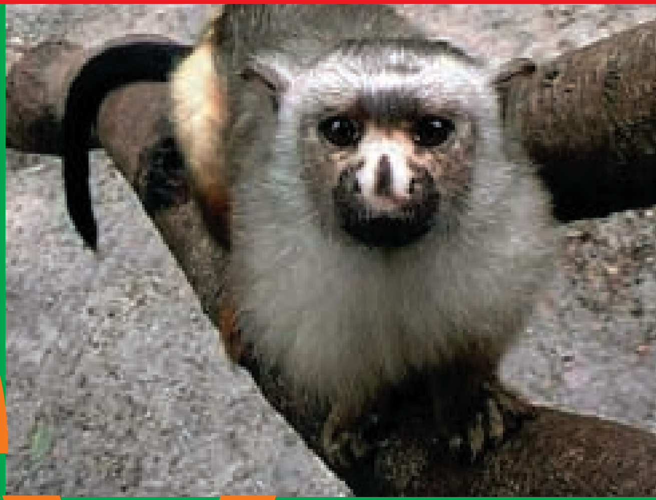
A marmoset stands in a tree. It is about the size of a squirrel.

Deep in the heart of the rain forest lives a small, furry animal. It swings from the trees, searches for food, and sleeps nestled high in the treetop canopy. What makes this animal unique is that it never had been seen by a human being. In fact, there is a whole world of creatures as yet undiscovered by humans. Many of them reside in the Amazon rain forest.

In 2000, a scientist from Brazil's Amazon National Research Institute came across two squirrel-sized monkeys in a remote and isolated corner of the rain forest, about 2,575 km from Rio de Janeiro. It turns out that the monkeys had never been seen before, or even known to exist.

The new species were spotted by a scientist who named them after two nearby rivers the Manicore and the Acari, where the animals were discovered. Both animals are marmosets, which is a type of monkey found only in Central and South America. Marmosets have claws instead of nails, live in trees, and use their extraordinarily long tail like an extra arm or leg. Small and light, both marmosets measure about 23 cm in length with a 38 cm tail, and weigh no more than 0.4 kg.

The Manicore marmoset has a silvery-white upper body, a light-gray cap on its head, a yellow-orange underbody, and a black tail.



Acari marmoset

key BUSINESS

The Amazon rain forest is home to animals waiting to be discovered

The Acari marmoset's upper body is snowy white, its gray back sports a stripe running to the knee, and its black tail flashes a bright-orange tip.

Amazin' Amazon

The Amazon Basin is a treasure trove of unique species. The Amazon River is Earth's largest body of freshwater, with 1,100 smaller tributaries. And more than half of the world's plant and animal species live in its rain forest ecosystems. Many of these species are found nowhere else on Earth. Scientists believe that some animals, like the newly discovered marmosets, evolved differently from other marmosets because the rivers create natural barriers that separated the animals.

The discovery reminds people of how much we have to learn about Earth's diversity of life. Even among humans' closest relatives, the primates, there are still new species to be discovered.

CLICK HERE

CONNECTIONS Research and Report Working in small groups, find out more about the Amazon rain forest. Which plants and animals live there? What products come from the rain forest? How does what happens in the Amazon rain forest affect you? Prepare a multimedia presentation.

SCIENCE Online
For more information, visit science.glencoe.com

CONTENTS

Chapter 1 Study Guide

Reviewing Main Ideas

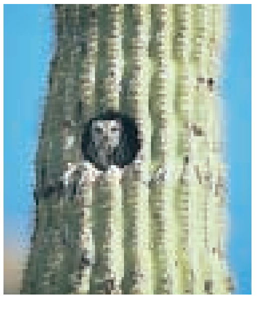
Section 1 What is science?

1. Scientists investigate observations about living and nonliving things with the help of problem-solving techniques. *What problem-solving methods would this scientist use to find out how dolphins learn?*

2. Scientists use SI measurements to gather measurable data.
3. Safe laboratory practices help you learn more about science.

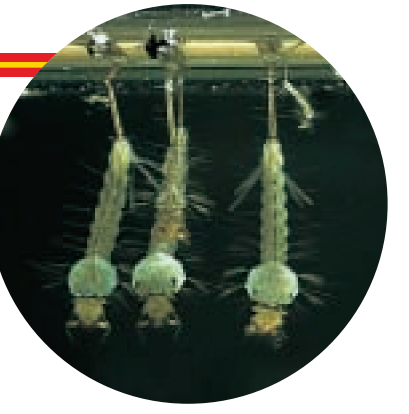
Section 2 Living Things

1. Organisms are made of cells, use energy, reproduce, respond, grow, and develop.
2. Organisms need energy, water, food, and a place to live. *What raw material is limited for organisms living in a desert?*



Section 3 Where does life come from?

1. Controlled experiments over many years finally disproved the theory of spontaneous generation.
2. Pasteur's experiment proved biogenesis, which is the theory that life comes from life. *Where did the mosquito larvae in this pond come from?*



3. Oparin's hypothesis is one explanation of how life began on Earth.

Section 4 How are living things classified?

1. Classification is the grouping of ideas, information, or objects based on their similar characteristics.
2. Scientists today use phylogeny to group organisms into six kingdoms.
3. All organisms are given a two word scientific name using binomial nomenclature. *How would binomial nomenclature keep scientists from confusing these two beetles?*

4. Dichotomous keys are used to identify specific organisms.

After You Read

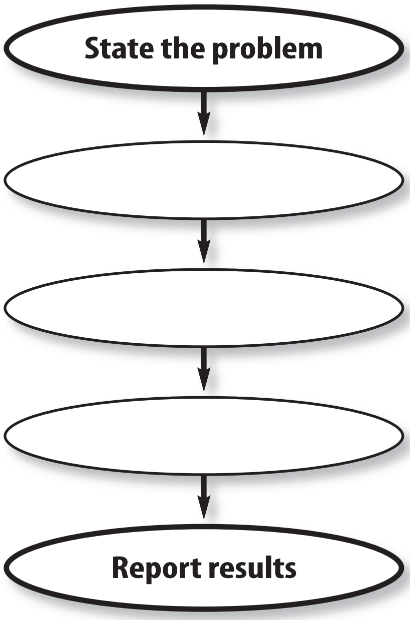
FOLDABLES Reading & Study Skills

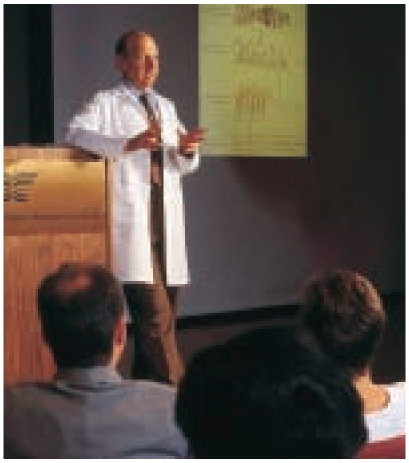
Trade vocabulary study Foldables with a classmate and quiz each other to see how many words you can define without looking under the tabs.

Chapter 1 Study Guide

Visualizing Main Ideas

Use the following terms to complete an events chain concept map showing the order in which you might use a scientific method: analyze data, perform an experiment, *and* form a hypothesis.





Vocabulary Review

Vocabulary Words

a. binomial nomenclature
b. biogenesis
c. cell
d. control
e. genus
f. homeostasis
g. hypothesis
h. kingdom
i. law
j. organism
k. phylogeny
l. scientific methods
m. spontaneous generation
n. theory
o. variable

THE PRINCETON REVIEW Study Tip

If you're not sure how terms in a question are related, try making a concept map of the terms. Ask your teacher to check your map.

Using Vocabulary

Explain the differences in the vocabulary words in each pair below. Then explain how they are related.

1. control, variable
2. law, theory
3. biogenesis, spontaneous generation
4. binomial nomenclature, phylogeny
5. organism, cell
6. kingdom, phylogeny
7. hypothesis, scientific methods
8. organism, homeostasis
9. kingdom, genus
10. theory, hypothesis

Chapter 1 Assessment

Checking Concepts

Choose the word or phrase that best answers the question.

1. What category of organisms can mate and produce fertile offspring?
   - **A)** family
   - **B)** class
   - **C)** genus
   - **D)** species

2. What is the closest relative of *Canis lupus?*
   - **A)** *Quercus alba*
   - **B)** *Equus zebra*
   - **C)** *Felis tigris*
   - **D)** *Canis familiaris*

3. What is the source of energy for plants?
   - **A)** the Sun
   - **B)** carbon dioxide
   - **C)** water
   - **D)** oxygen

4. What makes up more than 50 percent of all living things?
   - **A)** oxygen
   - **B)** carbon dioxide
   - **C)** minerals
   - **D)** water

5. Who finally disproved the theory of spontaneous generation?
   - **A)** Oparin
   - **B)** Aristotle
   - **C)** Pasteur
   - **D)** Miller

6. What gas do some scientists think was missing from Earth's early atmosphere?
   - **A)** ammonia
   - **B)** hydrogen
   - **C)** methane
   - **D)** oxygen

7. What is the length of time an organism is expected to live?
   - **A)** life span
   - **B)** stimulus
   - **C)** homeostasis
   - **D)** theory

8. What is the part of an experiment that can be changed called?
   - **A)** conclusion
   - **B)** variable
   - **C)** control
   - **D)** data

9. What does the first word in a two-word name of an organism identify?
   - **A)** kingdom
   - **B)** species
   - **C)** phylum
   - **D)** genus

10. What SI unit is used to measure the volume of liquids?
    - **A)** meter
    - **B)** liter
    - **C)** gram
    - **D)** degree

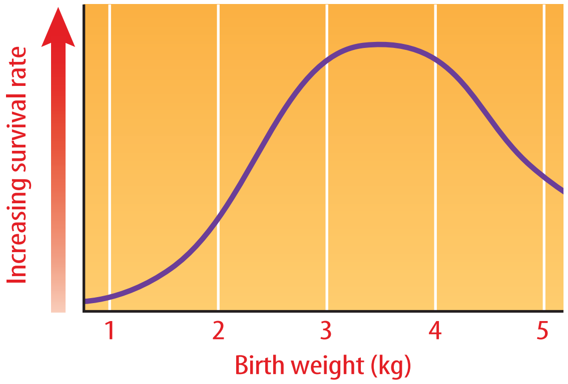
Thinking Critically

11. How does SI help scientists in different parts of the world?
12. Using a bird as an example, explain how it has all the traits of living things.
13. Explain what binomial nomenclature is and why it is important.
14. Explain how the experiment of 1668 correctly used scientific methods to test the theory of spontaneous generation.
15. What does *Lathyrus odoratus,* the name for a sweet pea, tell you about one of its characteristics?

Developing Skills

16. **Identifying and Manipulating Variables and Controls** Design an experiment to test the effects of fertilizer on growing plants. Identify scientific methods used in your experiment.
17. **Forming Hypotheses** A lima bean plant is placed under a green light, another is placed under a red light, and a third under a blue light. Their growth is measured for four weeks to determine which light is best for plant growth. What are the variables in this experiment? State a hypothesis for this experiment.
18. **Comparing and Contrasting** What characteristics do an icicle and a plant share? How can you tell that the plant is a living thing and the icicle is not?

19. Interpreting Data Read the following hypothesis: Babies with a birth weight of 2.5 kg have the best chance of survival. Do the data in the following graph support this hypothesis? Explain.



20. Classifying Which of these metric units—meter, kilometer, kilogram, or liter—is the best one to use when measuring each of the following?

A) your height
B) distance between two cities
C) how much juice is in a pitcher
D) your mass

Performance Assessment

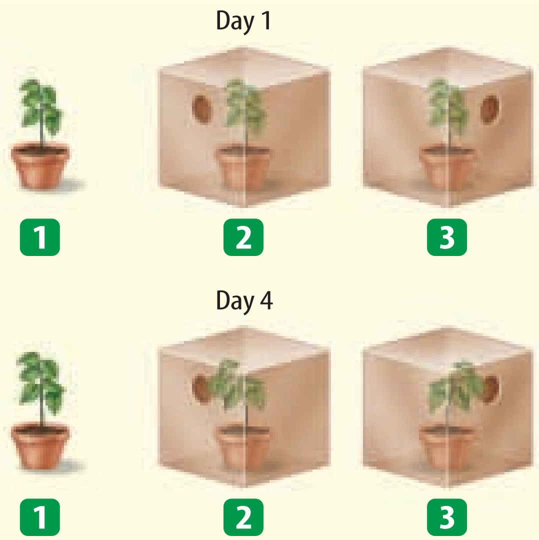
21. Bulletin Board Interview people in your community whose jobs require a knowledge of life science. Make a Life Science Careers bulletin board. Summarize each person's job and what he or she had to study to prepare for that job.

Technology

Go to the Glencoe Science Web site at **science.glencoe.com** or use the **Glencoe Science CD-ROM** for additional chapter assessment.

THE PRINCETON REVIEW Test Practice

A science class was learning about how living things respond to stimuli. Their experiment about the response of plants to light is shown below.



Study the experiment and answer the following questions.

1. Which hypothesis is probably being tested by this experiment?

A) Plants grow better in full light.
B) Plants prefer to grow in a box with one hole.
C) Plants can grow in any direction.
D) Plants grow toward the light.

2. After day 4, Fatima wanted to find out how plant 2 and plant 3 would grow in normal light. To do this, she would have to _____.

F) use all new plants and boxes without holes
G) add water to all of the pots
H) remove the boxes over plant 2 and plant 3
J) put holes on all sides of the boxes