KEY CONCEPT

1.1

The cell is the basic unit of living things.

BEFORE, you learned

- Living things have common characteristics
- Living things have common needs
- A theory is something that explains what is observed in nature

NOW, you will learn

- How living things are different from nonliving things
- How the microscope led to the discovery of cells
- About the cell theory

/OCABULARY

ınicellular p. 11
ıulticellular p. 11
ıicroscope p. 12
ıacteria p. 14

EXPLORE Activity and Life

Does a candle show signs of life?

PROCEDURE

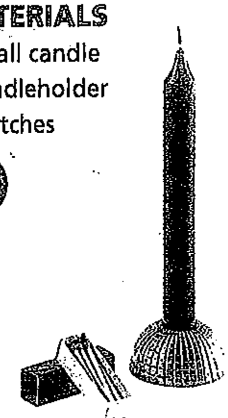
1. Carefully light one candle.
2. Sit quietly and observe the candle. Note its behavior. What does the flame do? What happens to the wax?

WHAT DO YOU THINK?

- How does a lit candle seem alive?
- How do you know for sure that it is not?

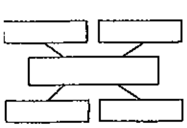
MATERIALS

- small candle
- candleholder
- matches



Living things are different from nonliving things.

ΜAIN IDEA WEB
Vıake a main idea web ɜbout living things, including how they differ from ıonliving things.



You know life when you see it. Perhaps your class takes a field trip to a local state park to collect water samples. You are surrounded by trees. There is a stream, with rocks covered with moss and green algae. There are fish and frogs; there are birds and insects. You are surrounded by life. But how would you define it?

One way to answer the question is to think about what makes a living thing different from a nonliving thing. You might ask if a thing uses energy. Or maybe you would observe it to see if it moves. You could investigate whether it consumes food and water. These are characteristics of living things, or organisms. Any individual form of life that is capable of growing and reproducing is an organism. All organisms get water and other materials from the environment.

Characteristics of Life

Living things have these characteristics:

- organization
- the ability to develop and grow
- the ability to respond to the environment
- the ability to reproduce

An organism's body must be organized in a way that enables it to meet its needs. Some organisms, like bacteria, are very simple. A more complex organism, such as the kingfisher shown in the photograph below, is organized so that different parts of its body perform different jobs, called functions. For example, a kingfisher has wings for flying, a heart for pumping blood, and eyes for seeing.

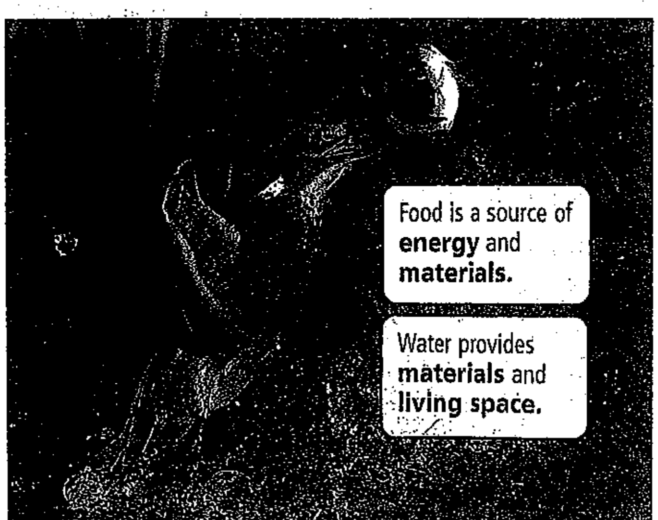
Another characteristic of organisms is that they grow and, in most cases, develop into adult forms. Some organisms change a great deal in size and appearance throughout their lifetimes, whereas others grow and change very little. Organisms also respond to the world outside them. Think of how the pupils of your eyes get smaller in bright light. Finally, organisms can reproduce, producing new organisms that are similar to themselves.

CHECK YOUR READING What four characteristics are common to all living things?

Needs of Life

Organisms cannot carry out the activities that characterize life without a few necessities: energy, materials, and living space. What does it mean to need energy? You know that if you want to run a race, you need energy. But did you know that your body also needs energy to sleep or to breathe or even to think? All organisms require a steady supply of energy to stay alive. Where does this energy come from, and how does an organism get it?

APPLY Identify three living things in this photograph. How do they meet their needs?



The energy used by almost all forms of life on Earth comes from the Sun. Some organisms, like plants and some bacteria, are able to capture this energy directly. Your body, like the bodies of other animals, uses food as a source of energy. The food animals eat comes from plants or from organisms that eat plants. Food also provides the materials necessary for growth and reproduction. These materials include substances such as carbon dioxide, nitrogen, oxygen, and water. Finally, all organisms need space to live and grow. If any one of these requirements is missing, an organism will die.

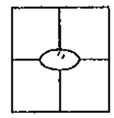
All living things are made of cells.

The cell is the smallest unit of a living thing. Some organisms are made of a single cell. These organisms are **unicellular** and usually too small for you to see directly. Pond water is full of tiny unicellular organisms. Most of the organisms you can see, such as a frog or a water lily, are made up of many cells. Organisms made up of many cells are called **multicellular** organisms.

The needs and characteristics of a single cell in a unicellular organism are the same as those for any organism. Each of the tiny single-celled organisms found in a drop of pond water performs all the activities that characterize life. Multicellular organisms, like a frog or a water lily, have bodies that are more complex. Different parts of the body of a multicellular organism perform different functions. A water lily's roots hold it in the soil and its leaves capture energy from the Sun. A frog moves with its arms and legs and eats with its mouth.

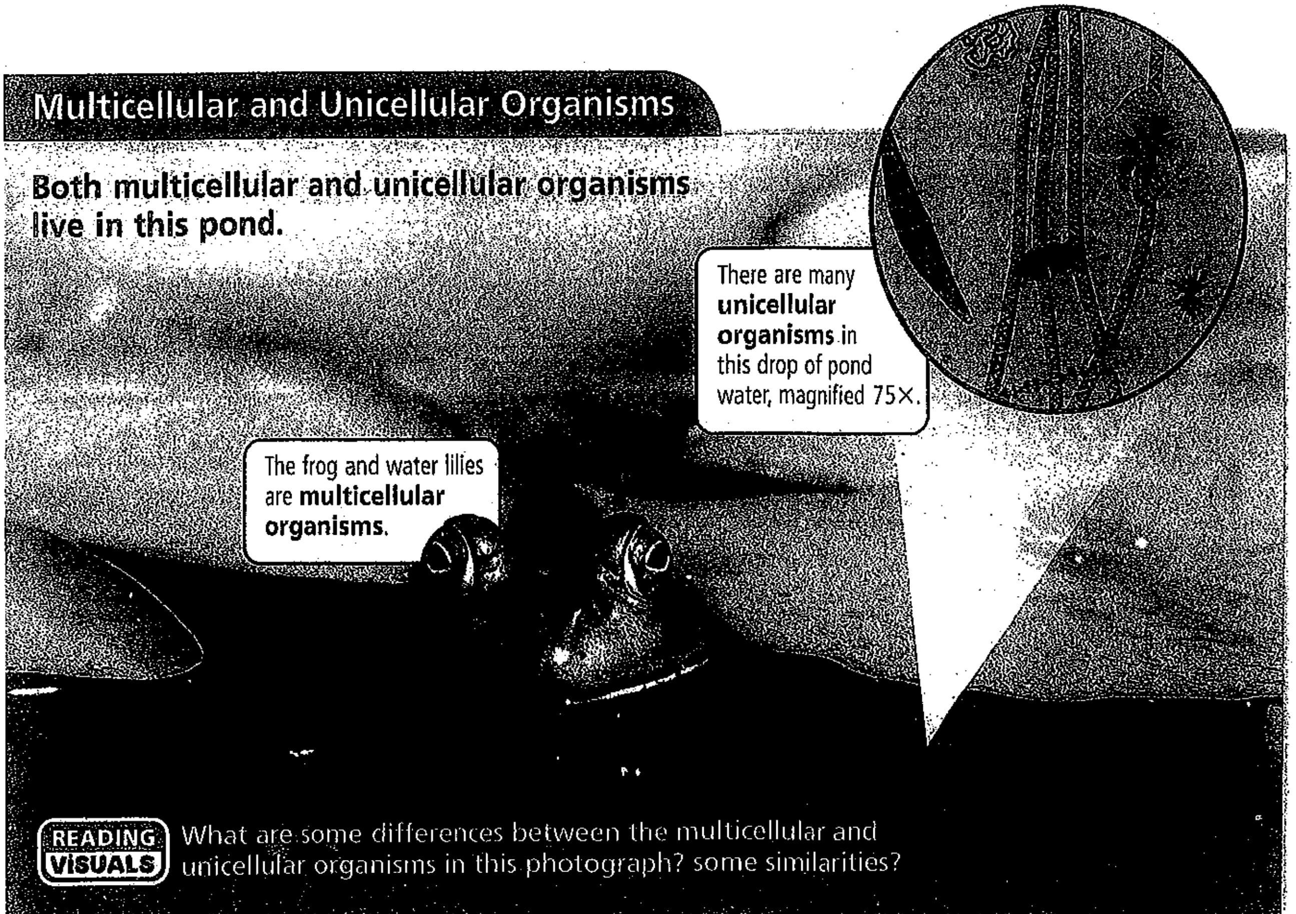
Multicellular organisms have different types of cells that make up their body parts and help the organisms meet their needs. Roots are made of root cells, which are different from leaf cells. Muscle cells have special parts that allow them to move. In a multicellular organism, many cells work together to carry out the basic activities of life.

VOCABULARY
Add four squares for *unicellular* and *multicellular* to your notebook. You may want to add to your lists of characteristics and examples as you read through the chapter.



Multicellular and Unicellular Organisms

Both multicellular and unicellular organisms live in this pond.



READING VISUALS What are some differences between the multicellular and unicellular organisms in this photograph? some similarities?

The microscope led to the discovery of cells.

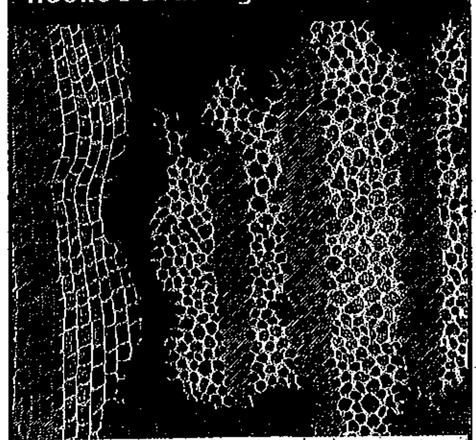
READING TIP

The word *microscopic* is an adjective made from the noun *microscope*. Things that are microscopic are too small to see without the use of a microscope.

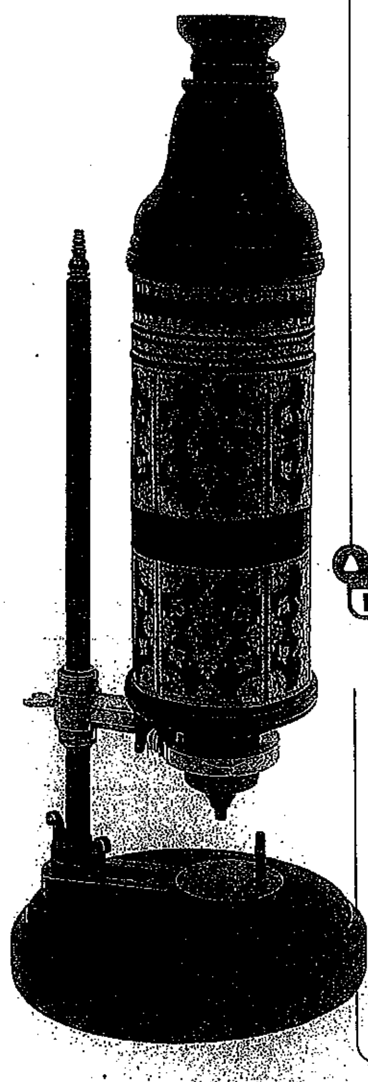
Most cells are microscopic, too small to see without the aid of a microscope. A **microscope** is an instrument which makes an object appear bigger than it is. It took the invention of this relatively simple tool to lead to the discovery of cells. In the 1660s, Robert Hooke began using microscopes to look at all sorts of materials. Anton van Leeuwenhoek took up similar work in the 1670s. They were among the first people to describe cells.

Robert Hooke gave the cell its name. While looking at a sample of cork, a layer of bark taken from an oak tree, he saw a group of similarly shaped compartments that looked to him like tiny empty rooms, or cells. You can see from his drawing, shown at right, how well these cells fit Hooke's description. Hooke used a microscope that magnified objects 30 times (30 ×). In other words, objects appeared thirty times larger than their actual size.

Hooke's Drawing of Cells



Robert Hooke published this drawing of dead cork cells in 1665. The microscope he used, shown at left, has two lenses.



The bark cells Hooke saw were actually dead cells, which is why they appeared empty. Anton van Leeuwenhoek was one of the first people to describe living cells. He looked at a drop of pond water under a microscope. Imagine his surprise when he saw that a drop of water was full of living things! Using lenses that could magnify an object almost 300 ×, he observed tiny unicellular organisms like those shown on page 11.

CHECK YOUR READING How did the invention of the microscope change the study of biology?

You can understand how powerful a microscope is if you think of how big a penny would be if it were increased in size 30 ×. It would be a little bigger than the tire of a ten-speed bicycle. Enlarged 300 ×, that penny would be so big that you would need a tractor-trailer to move it. Magnify your best friend 30 × (supposing a height of 1.5 meters, or almost 5 ft), and your friend would appear to be 45 meters (147 ft) tall. That's almost the height of Niagara Falls. Change the magnification to 300 ×, and your friend would appear to be 450 meters (1470 ft) tall—taller than the Empire State Building.

Cells come from other cells.

The studies of Hooke and Leeuwenhoek made people ask if all living things have cells. People continued to observe samples taken from all sorts of living matter. They continued to find cells, although often these cells looked very different from one another. Still, it was clear that all living matter was made of cells.

There was another important question scientists were trying to answer: Where do cells come from? The answer to this question was settled by the 1850s. People studying all types of living cells observed the same thing—that cells divide. One living cell divides into two living cells. Here, under the microscope, was evidence of where cells come from. Life comes from life—that is, one cell comes from another cell.

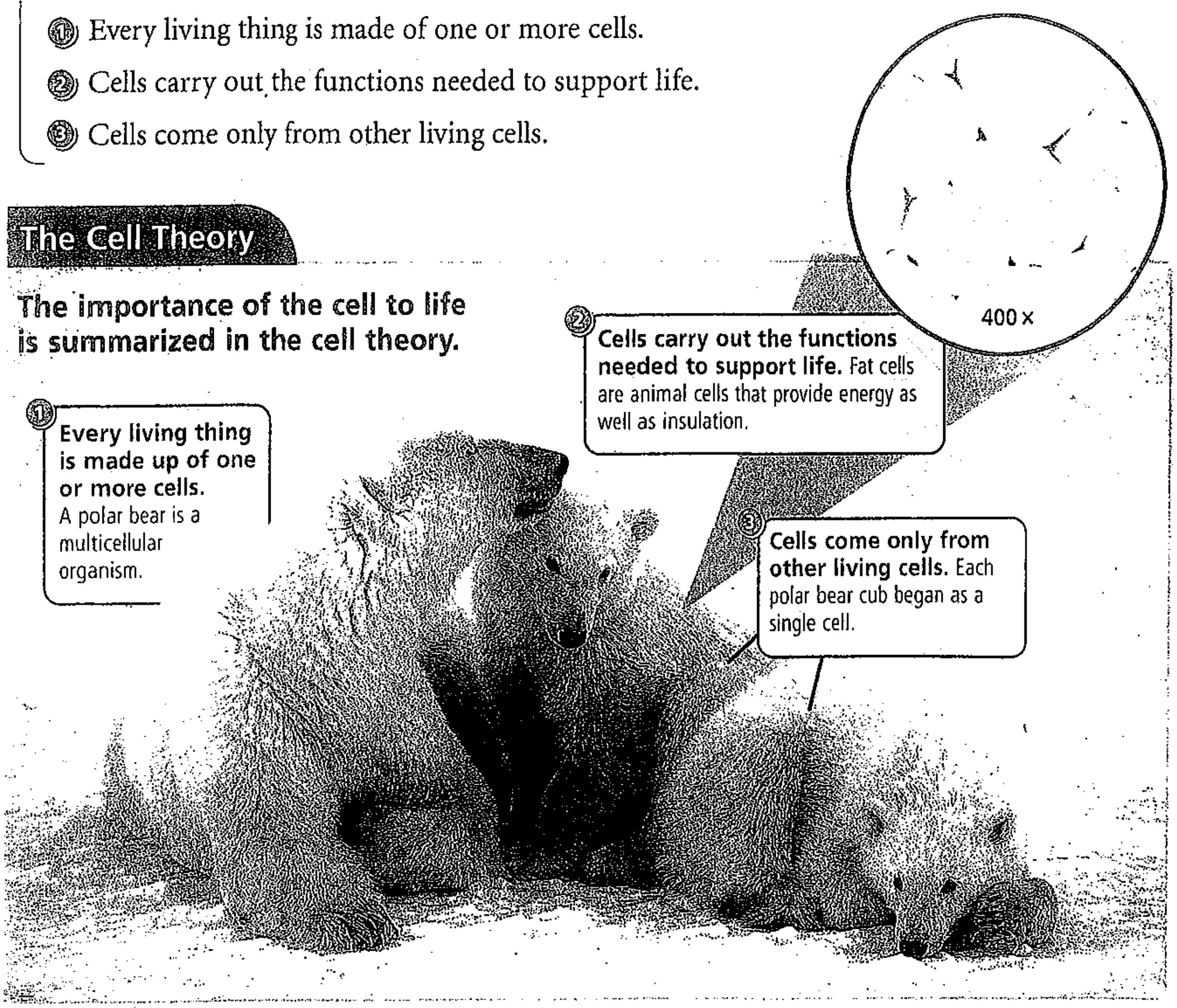
CHECK YOUR READING What do scientists mean when they say that life comes from life? Your answer should include the word *cells*.

The observations and evidence gathered over a long time by many scientists are summarized in the three concepts of the cell theory:

1. Every living thing is made of one or more cells.
2. Cells carry out the functions needed to support life.
3. Cells come only from other living cells.

The Cell Theory

The importance of the cell to life is summarized in the cell theory.



The cell theory is important to the study of biology.

The three ideas on page 13 are so important that they are grouped together using the word *theory*. A scientific theory is a widely accepted explanation of things observed in nature. A theory must be supported by evidence, including experimental evidence and observations. A theory proves its value when it explains new discoveries and observations.

CHECK YOUR READING What are two characteristics of a scientific theory?

Theories are important for a number of reasons. Certainly they satisfy scientists' desire to understand the natural world, and they serve as foundations for further research and study. Theories can also lead to research that has some practical benefit for society.

Louis Pasteur

The work of the French scientist Louis Pasteur shows how an understanding of cell theory can have practical uses. Pasteur lived in the 1800s, when there was no mechanical refrigeration in homes. People were used to having foods spoil, like milk going sour. During this time, many people died from diseases such as typhoid fever, tuberculosis, and diphtheria. Pasteur's work showed that microscopic organisms were involved both in the spoilage of food and in disease.

The milk that you get from the school cafeteria has been pasteurized so that it will stay fresh longer.

Pasteur observed that milk that turned sour contained large numbers of tiny single-celled organisms called **bacteria** (bak-TEER-ee-uh). He developed a process, now known as pasteurization, in which heat is used to kill the bacteria. Killing the bacteria keeps milk fresh longer. The fact that bacteria cause milk to sour or "sicken" made Pasteur wonder whether microscopic organisms could also be the cause of sickness in humans and animals.

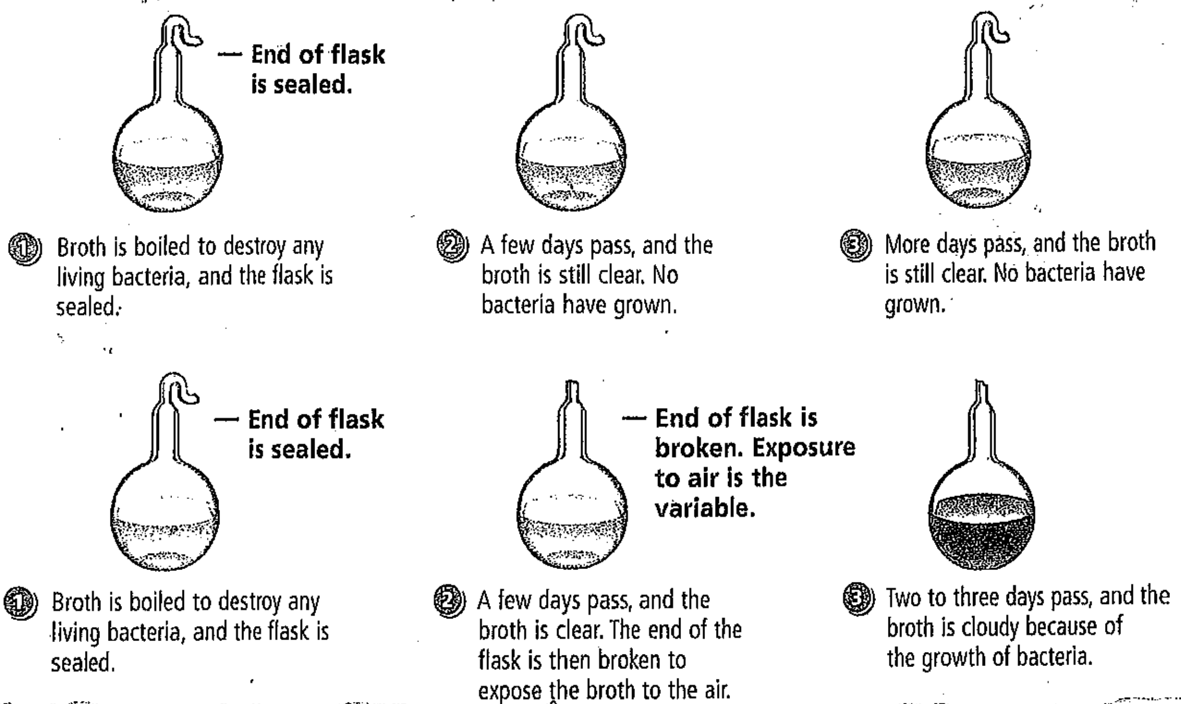
Bacteria and Spontaneous Generation

Using a microscope to study air, water, and soil, Pasteur found microorganisms everywhere. He found bacteria in the blood of animals, including people who were sick. Pasteur referred to the microorganisms he observed as "germs." He realized that an understanding of germs might help prevent disease. Pasteur's work led to the first animal vaccinations for cholera and anthrax and to a treatment for rabies in humans.

At the time that Pasteur was doing his research, there were scientists who thought that bacteria grew from nonliving materials, an idea called spontaneous generation. Pasteur conducted a now-

Pasteur's Experiments

Pasteur's experiments showed that bacteria are present in the air. They do not appear spontaneously.



famous series of experiments that did not support the idea of spontaneous generation and confirmed the cell theory. He showed that cells come only from other cells. Two of Pasteur's experiments are shown above. Both began with a sealed flask containing boiled broth. In the first experiment, the flask remained sealed, while in the second experiment, the top of the flask was broken to expose the contents to air. Bacteria grew only in the second flask.

1 Review

:EY CONCEPTS

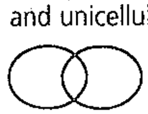
. Name four characteristics of living things.

!. How did the microscope change human understanding of life?

!. Explain the three concepts that make up the cell theory.

CRITICAL THINKING

4. **Analyze** Relate the characteristics of a scientific theory to the cell theory.
5. **Compare and Contrast** Draw a Venn diagram to compare and contrast multicellular and unicellular organisms.



CHALLENGE

6. **Synthesize** Explain how Pasteur's experiment supported the cell theory and failed to support the theory of spontaneous generation.