

SECTION

1

The Diversity of Cells

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

- What is a cell?
- What do all cells have in common?
- What are the two kinds of cells?

National Science Education Standards

LS 1a, 1b, 1c, 2c, 3b, 5a

What Is a Cell?

Most cells are so small that they cannot be seen by the naked eye. So how did scientists find cells? By accident! The first person to see cells wasn't even looking for them.

A **cell** is the smallest unit that can perform all the functions necessary for life. All living things are made of cells. Some living things are made of only one cell. Others are made of millions of cells.

Robert Hooke was the first person to describe cells. In 1665, he built a microscope to look at tiny objects. One day he looked at a piece of cork. Cork is found in the bark of cork trees. Hooke thought the cork looked like it was made of little boxes. He named these boxes *cells*, which means "little rooms" in Latin.



The first cells that Hooke saw were from cork. These cells were easy to see because plant cells have cell walls. At first, Hooke didn't think animals had cells because he couldn't see them. Today we know that all living things are made of cells.

STUDY TIP

Organize As you read this section, make lists of things that are found in prokaryotic cells, things that are found in eukaryotic cells, and things that are found in both kinds of cells.

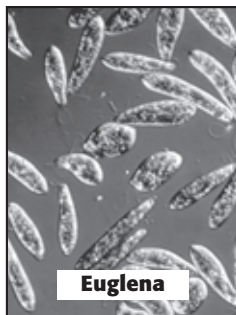
STANDARDS CHECK

LS 1b All organisms are composed of cells—the fundamental unit of life. Most organisms are single cells; other organisms, including humans, are multicellular.

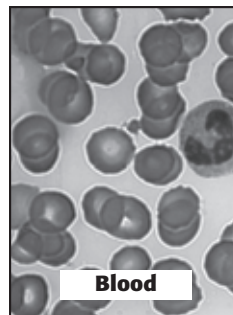
1. Identify What is the basic unit of all living things?

In the late 1600s, a Dutch merchant named Anton van Leeuwenhoek studied many different kinds of cells. He made his own microscopes. With them, he looked at tiny pond organisms called protists. He also looked at blood cells, yeasts, and bacteria.

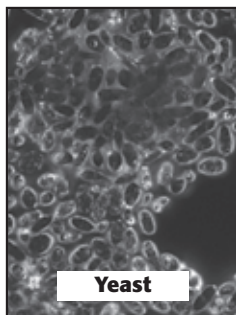
SECTION 1 The Diversity of Cells *continued*



Euglena



Blood



Yeast



Bacteria

TAKE A LOOK

2. Identify Which of these cells is probably the smallest? Explain your answer.

Leeuwenhoek looked at many different kinds of cells with his microscope. He was the first person to see bacteria. Bacterial cells are usually much smaller than most other types of cells.

What Is the Cell Theory?

Since Hooke first saw cork cells, many discoveries have been made about cells. Cells from different organisms can be very different from one another. Even cells from different parts of the same organism can be very different. However, all cells have several important things in common. These observations are known as the *cell theory*. The cell theory has three parts:

1. All organisms are made of one or more cells.
2. The cell is the basic unit of all living things.
3. All cells come from existing cells.

What Are the Parts of a Cell?

Cells come in many shapes and sizes and can have different functions. However, all cells have three parts in common: a cell membrane, genetic material, and organelles. ✓

READING CHECK

3. List What three parts do all cells have in common?

CELL MEMBRANE

All cells are surrounded by a cell membrane. The **cell membrane** is a layer that covers and protects the cell. The membrane separates the cell from its surroundings. The cell membrane also controls all material going in and out of the cell. Inside the cell is a fluid called *cytoplasm*.

SECTION 1 The Diversity of Cells *continued*

GENETIC MATERIAL

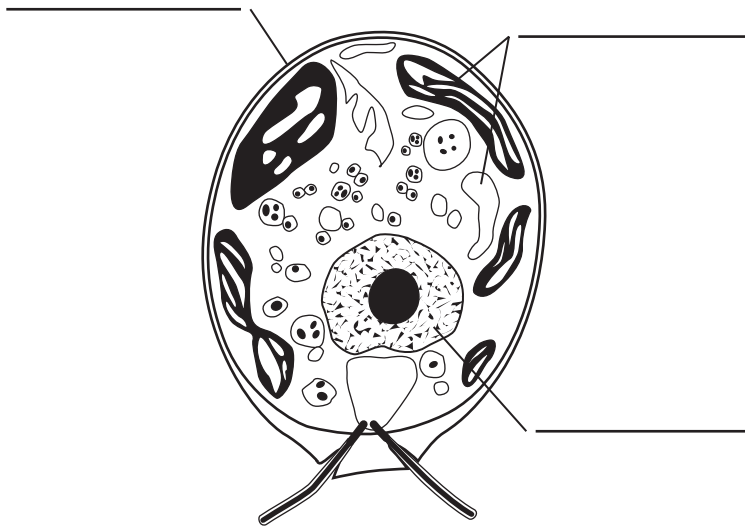
All cells contain DNA (deoxyribonucleic acid) at some point in their lives. *DNA* is the genetic material that carries information needed to make proteins, new cells, and new organisms. DNA is passed from parent cells to new cells and it controls the activities of the cell.

The DNA in some cells is found inside a structure called the **nucleus**. Most of your cells have a nucleus.

ORGANELLES

Cells have structures called **organelles** that do different jobs for the cell. Most organelles have a membrane covering them. Different types of cells can have different organelles.

Parts of a Cell



STANDARDS CHECK

LS 2c Every organism requires a set of instructions for **specifying** its traits. Heredity is the passage of these instructions from one generation to another.

Word Help: **specify** to describe or define in detail

4. Explain What is the function of DNA?

TAKE A LOOK

5. Identify Use the following words to fill in the blank labels on the figure: DNA, cell membrane, organelles.

What Are the Two Kinds of Cells?

There are two basic kinds of cells—cells with a nucleus and cells without a nucleus. Those without a nucleus are called *prokaryotic cells*. Those with a nucleus are called *eukaryotic cells*. ✓

What Are Prokaryotes?

A **prokaryote** is an organism made of one cell that does not have a nucleus or other organelles covered by a membrane. Prokaryotes are made of prokaryotic cells. There are two types of prokaryotes: bacteria and archaea.

READING CHECK

6. Compare What is one way prokaryotic and eukaryotic cells differ?

SECTION 1 The Diversity of Cells *continued*

Critical Thinking

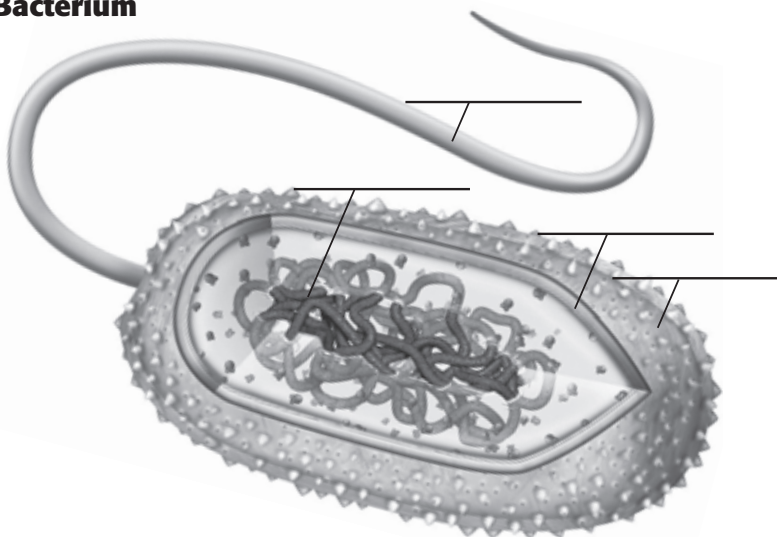
7. Make Inferences Why do you think bacteria can live in your digestive system without making you sick?

BACTERIA

The most common prokaryotes are bacteria (singular, *bacterium*). Bacteria are the smallest known cells. These tiny organisms live almost everywhere. Some bacteria live in the soil and water. Others live on or inside other organisms. You have bacteria living on your skin and teeth and in your digestive system. The following are some characteristics of bacteria:

- no nucleus
- circular DNA shaped like a twisted rubber band
- no membrane-covered (or *membrane-bound*) organelles
- a cell wall outside the cell membrane
- a *flagellum* (plural, *flagella*), a tail-like structure that some bacteria use to help them move

A Bacterium



TAKE A LOOK

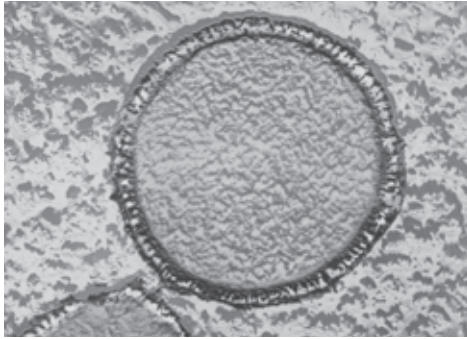
8. Identify Label the parts of the bacterium using the following terms: DNA, flagellum, cell membrane, cell wall.

ARCHAEA

Archaea (singular, *archaeon*) and bacteria share the following characteristics:

- no nucleus
- no membrane-bound organelles
- circular DNA
- a cell wall

SECTION 1 The Diversity of Cells *continued*



This photograph was taken with an electron microscope. This archaeon lives in volcanic vents deep in the ocean. Temperatures at these vents are very high. Most other living things could not survive there.

Archaea have some other features that no other cells have. For example, the cell wall and cell membrane of archaea are made of different substances from those of bacteria. Some archaea live in places where no other organisms could live. For example, some can live in the boiling water of hot springs. Others can live in toxic places such as volcanic vents filled with sulfur. Still others can live in very salty water in places such as the Dead Sea. ✓

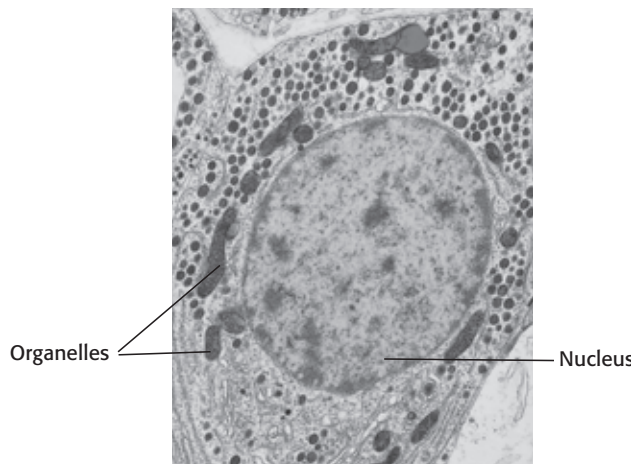
What Are Eukaryotes?

Eukaryotic cells are the largest cells. They are about 10 times larger than bacteria cells. However, you still need a microscope to see most eukaryotic cells.

Eukaryotes are organisms made of eukaryotic cells. These organisms can have one cell or many cells. Yeast, which makes bread rise, is an example of a eukaryote with one cell. Multicellular organisms, or those made of many cells, include plants and animals.

Unlike prokaryotic cells, eukaryotic cells have a nucleus that holds their DNA. Eukaryotic cells also have membrane-bound organelles. ✓

Eukaryotic Cell



READING CHECK

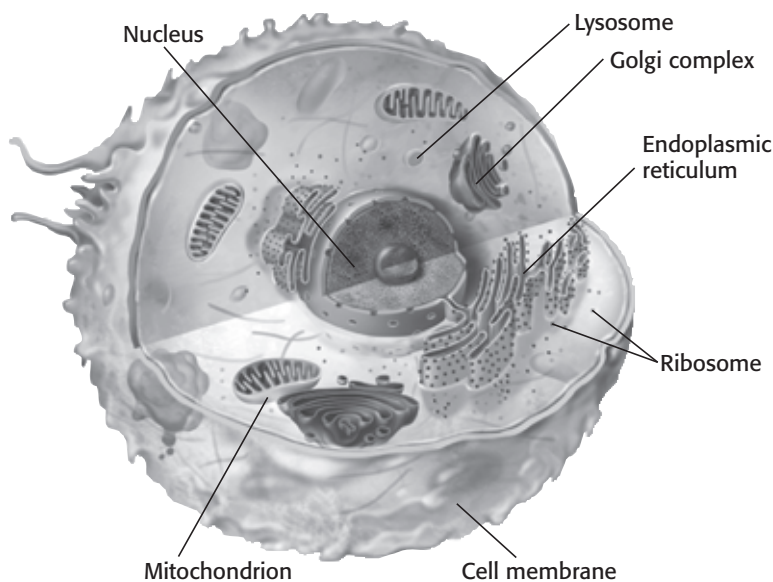
9. Compare Name two ways that archaea differ from bacteria.

READING CHECK

10. Identify Name two things eukaryotic cells have that prokaryotic cells do not.

SECTION 1 The Diversity of Cells *continued*

Organelles in a Typical Eukaryotic Cell



TAKE A LOOK

11. Identify Where is the genetic material found in this cell?

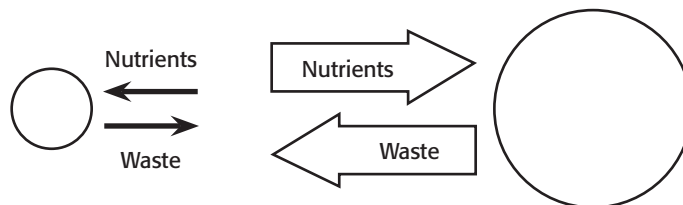
Critical Thinking

12. Apply Concepts The yolk of a chicken egg is a very large cell. Unlike most cells, egg yolks do not have to take in any nutrients. Why does this allow the cell to be so big?

Why Are Cells So Small?

Your body is made of trillions of cells. Most cells are so small you need a microscope to see them. More than 50 human cells can fit on the dot of this letter *i*. However, some cells are big. For example, the yolk of a chicken egg is one big cell! Why, then, are most cells small?

Cells take in food and get rid of waste through their outer surfaces. As a cell gets larger, it needs more food to survive. It also produces more waste. This means that more materials have to pass through the surface of a large cell than a small cell.



Large cells have to take in more nutrients and get rid of more wastes than small cells.

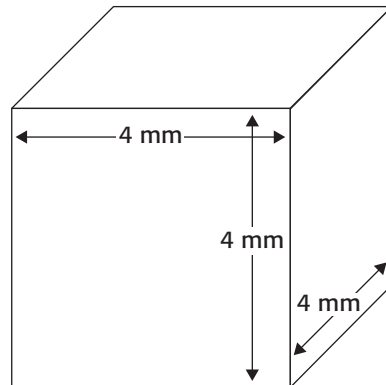
As a cell's volume increases, its outside surface area grows too. However, volume always grows faster than surface area. If the cell volume gets too big, the surface area will not be large enough for the cell to survive. The cell will not be able to take in enough nutrients or get rid of all its wastes. This means that surface area limits the size of most cells.

SECTION 1 The Diversity of Cells *continued***SURFACE AREA AND VOLUME OF CELLS**

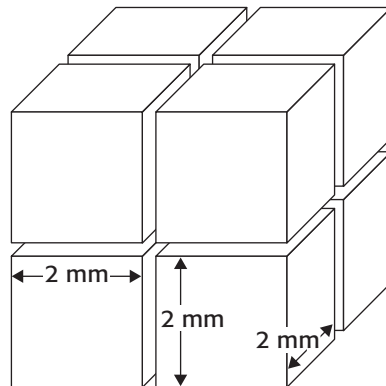
To understand how surface area limits the size of a cell, study the figures below. Imagine that the cubes are cells. You can calculate the surface areas and volumes of the cells using these equations:

$$\text{volume of cube} = \text{side} \times \text{side} \times \text{side}$$

$$\text{surface area of cube} = \text{number of sides} \times \text{area of side}$$



The volume of this cell is 64 mm^3 . Its surface area is 96 mm^2 .



When the large cell is broken up into 8 smaller cells, the total volume stays the same. However, all of the small cells together have more surface area than the large cell. The total surface area of the small cells is 192 mm^2 .

The large cell takes in and gets rid of the same amount of material as all of the smaller cells. However, the large cell does not have as much surface area as the smaller cells. Therefore, it cannot take in nutrients or get rid of wastes as easily as each of the smaller cells.

Math Focus**13. Calculate Ratios**

Scientists say that most cells are small because of the surface area-to-volume ratio. What is this ratio for the large cell?

TAKE A LOOK

14. Compare Which cell has a greater surface area compared to its volume—the large cell or one of the smaller cells?

Section 1 Review

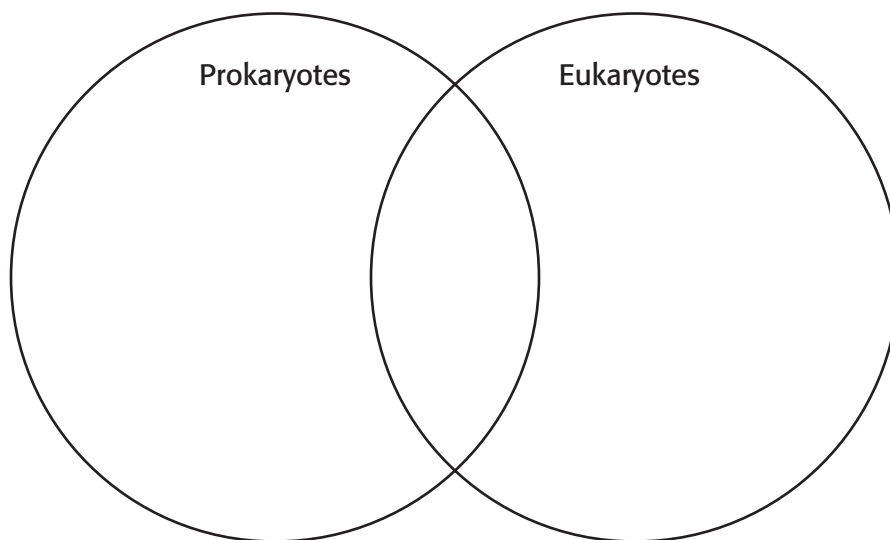
NSES LS 1a, 1b, 1c, 2c, 3b, 5a

SECTION VOCABULARY

<p>cell in biology, the smallest unit that can perform all life processes; cells are covered by a membrane and have DNA and cytoplasm</p> <p>cell membrane a phospholipid layer that covers a cell's surface; acts as a barrier between the inside of a cell and the cell's environment</p> <p>eukaryote an organism made up of cells that have a nucleus enclosed by a membrane; eukaryotes include animals, plants, and fungi, but not archaea or bacteria</p>	<p>nucleus in a eukaryotic cell, a membrane-bound organelle that contains the cell's DNA and that has a role in processes such as growth, metabolism, and reproduction</p> <p>organelle one of the small bodies in a cell's cytoplasm that are specialized to perform a specific function</p> <p>prokaryote an organism that consists of a single cell that does not have a nucleus</p>
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1. Identify What are the three parts of the cell theory?

2. Compare Fill in the Venn Diagram below to compare prokaryotes and eukaryotes. Be sure to label the circles.



3. Apply Concepts You have just discovered a new organism. It has only one cell and was found on the ocean floor, at a vent of boiling hot water. The organism has a cell wall but no nucleus. Explain how you would classify this organism.
