Lesson 1

The Characteristics of Cells

ESSENTIAL QUESTION

What are living things made of?

By the end of this lesson, you should be able to explain the components of the scientific theory of cells.

People communicate to others through talking, signing, body language, and other methods. Inside your body, cells communicate too. Brain cells, like the ones shown here, control balance, posture, and muscle coordination.

Lesson Labs

Quick Labs

- How Do Tools that Magnify Help Us Study Cells?
- Investigating Cell Size

Exploration Lab

- Using a Microscope to Explore Cells

Engage Your Brain

1 Predict Check T or F to show whether you think each statement is true or false.

T	F	
☐	☐	All living things are made up of one or more cells.
☐	☐	Rocks are made up of cells.
☐	☐	All cells are the same size.
☐	☐	Cells perform life functions for living things.

2 Describe Sketch your idea of what a cell looks like. Label any parts you include in your sketch.

Active Reading

3 Synthesize Many English words have their roots in other languages. Use the Greek words below to make an educated guess about the meanings of the words *prokaryote* and *eukaryote*. Here *kernel* refers to the nucleus, where genetic material is contained in some cells.

Word part	Meaning
pro-	before
eu-	true
karyon	kernel

Vocabulary Terms

- **cell**
- **organism**
- **cell membrane**
- **cytoplasm**
- **organelle**
- **nucleus**
- **prokaryote**
- **eukaryote**

4 Apply As you learn the definition of each vocabulary term in this lesson, create your own sketches of a prokaryotic cell and a eukaryotic cell and label the parts in each cell.

prokaryote:

eukaryote:

Cell-ebrate!

What is a cell?

Like all living things, you are made up of cells. A **cell** is the smallest functional and structural unit of all living organisms. An **organism** is any living thing. All organisms are made up of cells. Some organisms are just one cell. Others, like humans, contain trillions of cells. An organism carries out all of its own life processes.

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 thin slice of cork from the bark of a cork tree. The cork looked as if it was made of little boxes. Hooke named these boxes *cells*, which means "little rooms" in Latin.

Active Reading

5 Identify As you read, underline the reasons why cells are important.

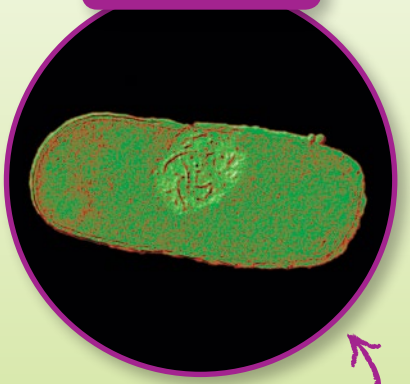
Visualize It!

6 Claims • Evidence • Reasoning Look at the photos of the three different cells. Do the cells have any common features? Give examples to explain your reasoning.

Plant cell

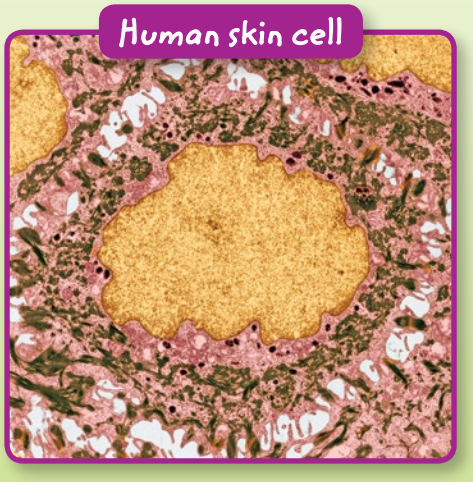
Plant cells range in size from 10 µm to 100 µm. They can be much larger than animal cells.

Bacterial cell



Bacterial cells are up to 1000 times smaller than human cells.

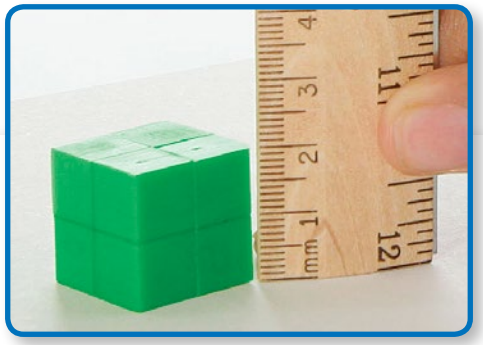
Human skin cell



The average size of a human cell is 10 µm. It would take about 50 average human cells to cover the dot on this letter i.

Why are most cells small?

Most cells are too small to be seen without a microscope. Cells are small because their size is limited by their outer surface area. Cells take in food and get rid of wastes through their outer surface. As a cell grows, it needs more food and produces more waste. Therefore, more materials pass through its outer surface. However, as a cell grows, the cell's volume increases faster than the surface area. If a cell gets too large, the cell's surface area will not be large enough to take in enough nutrients or pump out enough wastes. The ratio of the cell's outer surface area to the cell's volume is called the *surface area-to-volume ratio*. Smaller cells have a greater surface area-to-volume ratio than larger cells.



Do the Math

Here's an example of how to calculate the surface area-to-volume ratio of the cube shown at the right.

Sample Problem

A Calculate the surface area.

surface area of cube =

number of faces × area of one face

surface area of cube = $6(2\ cm \times 2\ cm)$

surface area of cube = $24\ cm^2$

B Calculate the volume.

volume of cube = side × side × side

volume of cube = $2\ cm \times 2\ cm \times 2\ cm$

volume of cube = $8\ cm^3$

C Calculate the surface area-to-volume ratio. A ratio is a comparison between numbers. It can be written by placing a colon between the numbers being compared.

surface area : volume = $24\ cm^2 : 8\ cm^3$

surface area : volume = $3\ cm^2 : 1\ cm^3$

You Try It

7 Calculate What is the surface area-to-volume ratio of a cube whose sides are 3 cm long?

A Calculate the surface area.

B Calculate the volume.

C Calculate the surface area-to-volume ratio.

Cell *Hall of Fame*

What is the cell theory?

Scientific knowledge often results from combining the work of several scientists. For example, the discoveries of Matthias Schleiden (muh•THY•uhs SHLY•duhn), Theodor Schwann (THEE•oh•dohr SHVAHN), and Rudolf Virchow (ROO•dawlf VIR•koh) led to one very important theory called the *cell theory*. The cell theory lists three basic characteristics of all cells and organisms:

- All organisms are made up of one or more cells.
- The cell is the basic unit of all organisms.
- All cells come from existing cells.

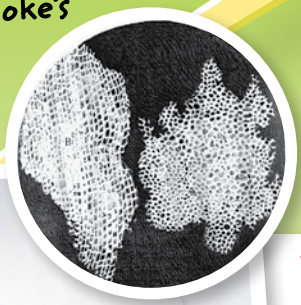
The cell theory is fundamental to the study of organisms, medicine, heredity, evolution, and all other aspects of life science.

Visualize It!

8 Provide As you read, fill in the missing events on the timeline.

1673
Anton van Leeuwenhoek made careful drawings of the organisms he observed.

Model of Hooke's microscope

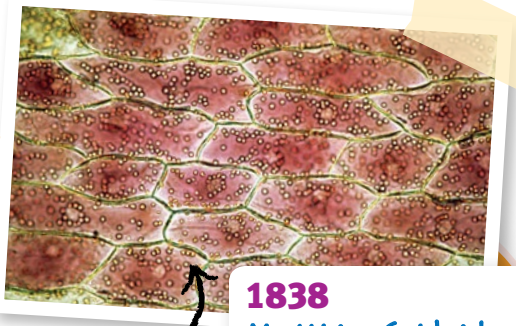


1665
Robert Hooke sees tiny, box-like spaces when using a microscope like this to observe thin slices of cork. He calls these spaces cells.

1858
Rudolf Virchow _____
_____
_____
_____.

Think Outside the Book Inquiry

9 Explain How can microscopes help you see cells? First, think of a good place to collect a sample of cells. Then, in a paragraph, describe how to prepare a microscope slide to observe those cells.



Cells of an iris petal

1838
Matthias Schleiden _____

_____

_____.

1839
Theodor Schwann _____

_____

_____

_____

_____

_____.

Butterfly wing cells

This iris and butterfly are multicellular organisms made up of many cells.

All Organisms Are Made Up of One or More Cells

Anton van Leeuwenhoek (AN•tahn VAN LAY•vuhn•huk) was the first person to describe actual living cells when he looked at a drop of pond water under a microscope. These studies made other scientists wonder if all living things were made up of cells. In 1838, Matthias Schleiden concluded that plants are made of cells. Then in 1839, Theodor Schwann determined that all animal tissues are made of cells. He concluded that all organisms are made up of one or more cells.

Organisms that are made up of just one cell are called *unicellular organisms*. The single cell of a unicellular organism must carry out all of the functions for life. Organisms that are made up of more than one cell are called *multicellular organisms*. The cells of multicellular organism often have specialized functions.

The Cell Is the Basic Unit of All Organisms

Based on his observations about the cellular make up of organisms, Schwann made another conclusion. He determined that the cell is the basic unit of all living things. Thus, Schwann wrote the first two parts of the cell theory.

All Cells Come from Existing Cells

In 1858, Rudolf Virchow, a doctor, proposed that cells could form only from the division of other cells. Virchow then added the third part of the cell theory that all cells come from existing cells.

Active Reading

10 Summarize What is the cell theory?

_____

_____

_____

_____

_____

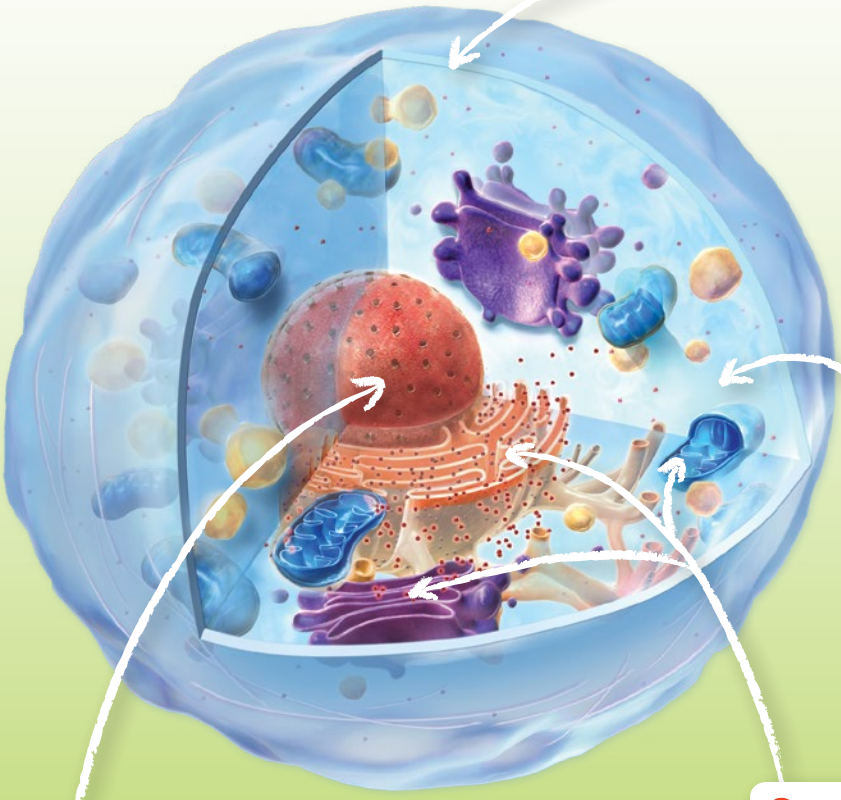
On the Cellular

What parts do all cells have in common?

Different cells vary in size and shape. However, all cells have some parts in common, including cell membranes, cytoplasm, organelles, and DNA. These different parts help the cell to carry out all the tasks needed for life.

Active Reading

11 Identify As you read, underline the function of cell membranes, organelles, and DNA.



Cell Membrane

A **cell membrane** is a protective layer that covers a cell's surface and acts as a barrier between the inside of a cell and the cell's environment. It also controls materials, such as water and oxygen, that move into and out of a cell.

Cytoplasm

The region enclosed by the cell membrane that includes the fluid and all of the *organelles* of the cell is called the **cytoplasm** (SY•tuh•plaz•uhm).

Organelles

An **organelle** is a small body in a cell's cytoplasm that is specialized to perform a specific function. Cells can have one or more types of organelles. Most, but not all, organelles have a membrane.

DNA

Deoxyribonucleic acid, or DNA, is genetic material that provides instructions for all cell processes. Organisms inherit DNA from their parent or parents. In some cells, the DNA is contained in a membrane-bound organelle called the **nucleus**. In other types of cells, the DNA is not contained in a nucleus.

What are the two types of cells?

Although cells have some basic parts in common, there are some important differences. The way that cells store their DNA is the main difference between the two cell types.

Active Reading

12 Identify As you read, underline the differences between prokaryotes and eukaryotes.

Prokaryotic

A **prokaryote** (proh•KAIR•ee•oht) is a single-celled organism that does not have a nucleus or membrane-bound organelles. Its DNA is located in the cytoplasm. Prokaryotic cells contain organelles called *ribosomes* that do not have a membrane. Some prokaryotic cells have hairlike structures called *flagella* that help them move. Prokaryotes, which include all bacteria and archaea, are smaller than eukaryotes.

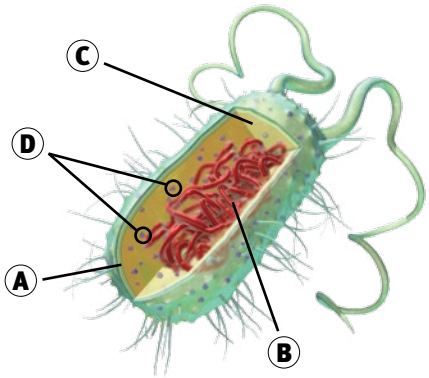
Eukaryotic

A **eukaryote** (yoo•KAIR•ee•oht) is an organism made up of cells that contain their DNA in a nucleus. Eukaryotic cells contain membrane-bound organelles, as well as ribosomes. Not all eukaryotic cells are the same. Animals, plants, protists, and fungi are eukaryotes. All multicellular organisms are eukaryotes. Most eukaryotes are multicellular. Some eukaryotes, such as amoebas and yeasts, are unicellular.

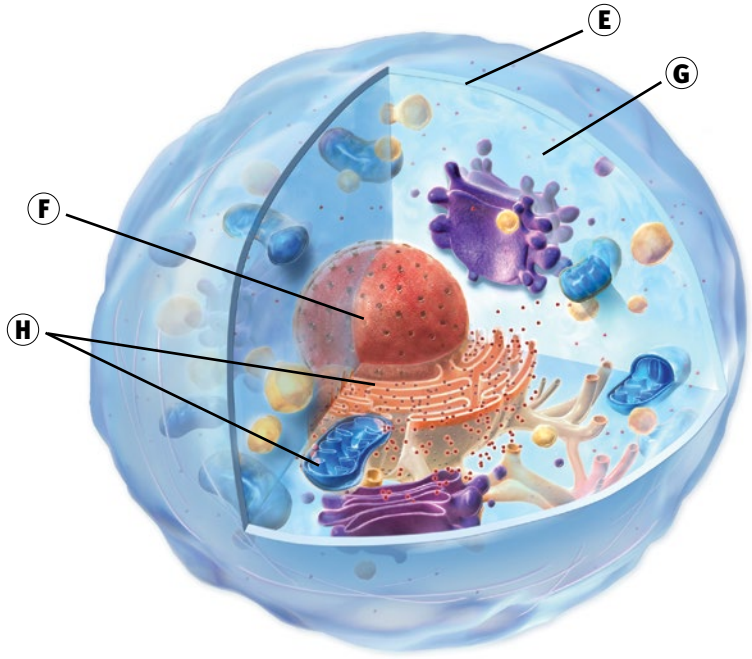
Visualize It!

13 Identify Use the list of terms below to fill in the blanks with the matching cell parts in each cell. Some terms are used twice.

DNA in cytoplasm
DNA in nucleus
Cytoplasm
Cell membrane
Organelles



Prokaryotic



Eukaryotic

A _____
B _____
C _____
D _____

E _____
F DNA in nucleus
G _____
H _____

Visual Summary

To complete this summary, fill in the blanks with the correct word or phrase. Then use the key below to check your answers. You can use this page to review the main concepts of the lesson.

Cells and Cell Theory

A cell is the smallest unit that can perform all the processes necessary for life.

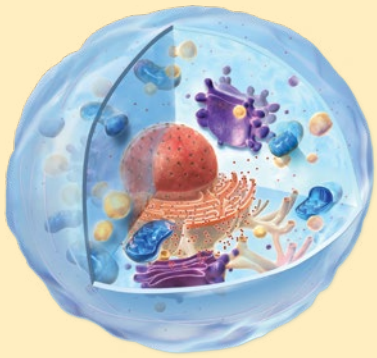
14 The cell of a(n) _____ organism must carry out all of its life functions; an organism made up of more than one cell is called a _____ organism.

The cell theory lists three basic principles of all cells and organisms.

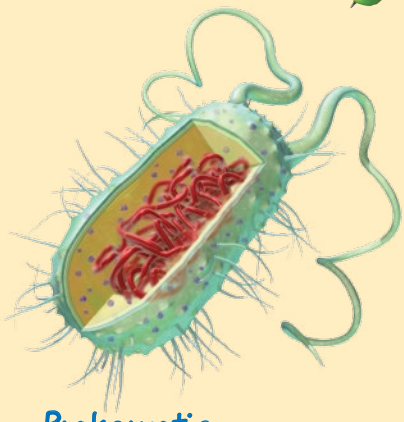
15 All cells come from existing _____.

All cells have a cell membrane, cytoplasm, organelles, and DNA.

16 The organelle that contains DNA in eukaryotic cells is called a(n) _____.



Eukaryotic



Prokaryotic

Answers: 14 unicellular, multicellular; 15 cells; 16 nucleus

17 Relate Choose an organism that you are familiar with. Do the three parts of the cell theory relate to that organism? Use evidence to support your claim.

Lesson Review

Vocabulary

Fill in the blank with the term that best completes the following sentences.

1 The _____ is the smallest functional and structural unit of all living things.

2 All cells are surrounded by a(n) _____.

3 A living thing is called a(n) _____.

Key Concepts

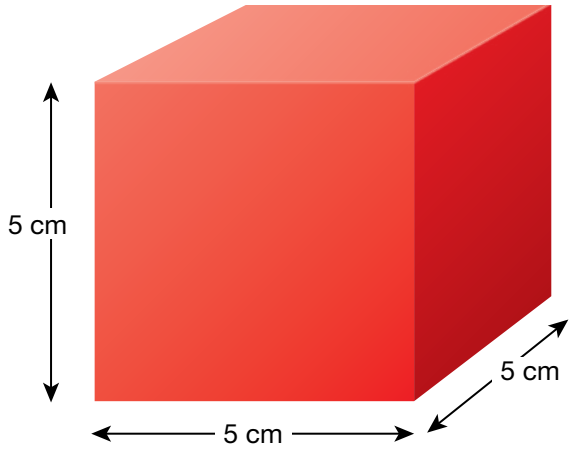
4 Describe Do all cells share any common features? Explain your reasoning and support your claim by giving two examples.

5 List What are the main ideas of the cell theory?

6 Compare How do prokaryotes differ from eukaryotes? How are they similar? Use evidence to support your claim.

Critical Thinking

Use this figure to answer the following questions.



7 Apply What is the surface area-to-volume ratio of this cube?

8 Apply Cells are not as large as this cube. Explain why in terms of a cell's surface area-to-volume ratio.

9 Compare How is the structure of a unicellular organism different than the structure of a multicellular organism? How does this affect function?

My Notes