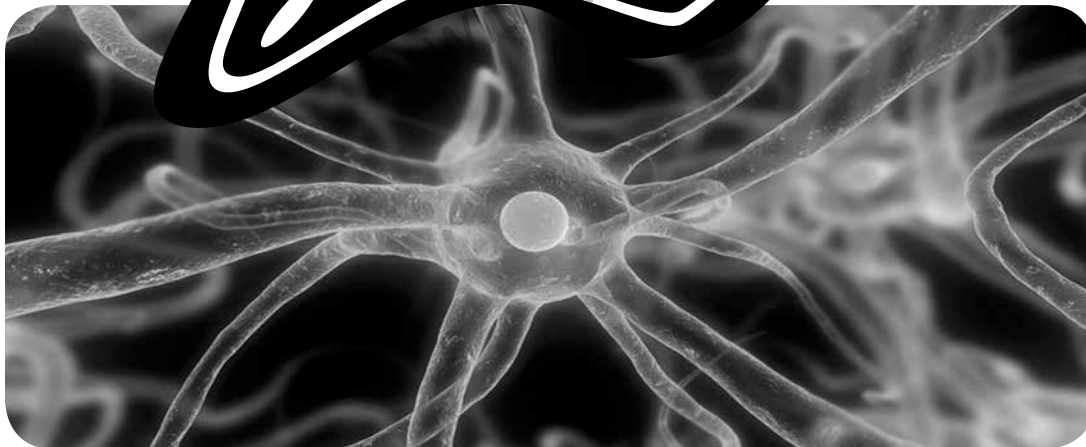


**FOCUS  
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SCIENCE**

# Cells Structure and Function

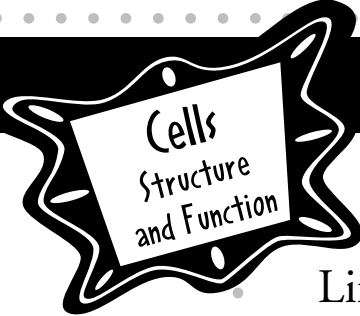
Basic Level



Life Science  
Dynamic Equilibrium

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## Cells Structure and Function

### Scientific Inquiry

**The central purpose of scientific inquiry is to develop explanations of natural phenomena in a continuing, creative process.**

Construct explanations independently for natural phenomena, especially by proposing preliminary visual models of phenomena.

**The observations made while testing proposed explanations, when analyzed using conventional and invented methods, provide new insights into phenomena.**

Design charts, tables, graphs, and other representations of observations in conventional and creative ways to help them address their research question or hypothesis.

Organize results, using appropriate graphs, diagrams, data tables, and other models to show relationships.

### Life Science

**Living things are both similar to and different from each other and from nonliving things.**

Living things are composed of cells. Cells provide structure and carry on major functions to sustain life. Cells are usually microscopic in size.

The way in which cells function is similar in all living things. Cells grow and divide, producing more cells. Cells take in nutrients, which they use to provide energy for the work that cells do and to make the materials that a cell or an organism needs.

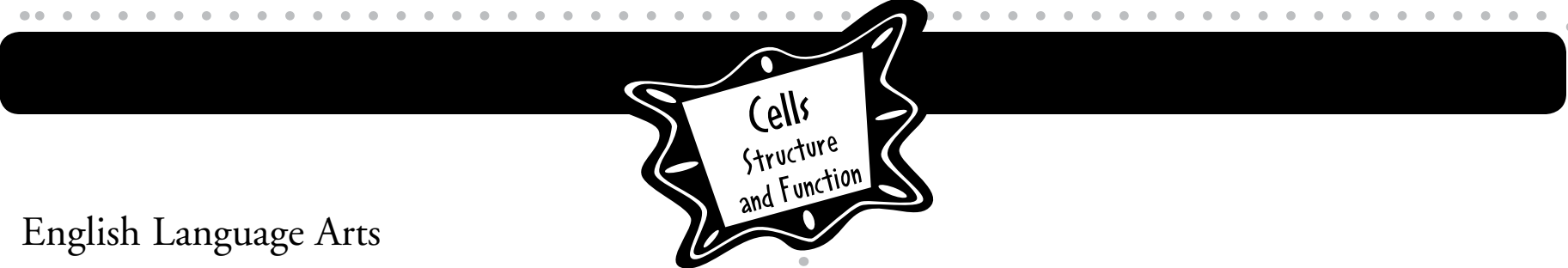
Most cells have cell membranes, genetic material, and cytoplasm. Some cells have a cell wall and/or chloroplasts. Many cells have a nucleus.

Some organisms are single cells; others, including humans, are multicellular.

Cells are organized for more effective functioning in multicellular organisms. Levels of organization for structure and function of a multicellular organism include cells, tissues, organs, and organ systems.

Many plants have roots, stems, leaves, and reproductive structures. These organized groups of tissues are responsible for a plant's life activities.

Multicellular animals often have similar organs and specialized systems for carrying out major life activities.



Cells  
Structure  
and Function

## English Language Arts

The following is a selective listing of the literacy competencies addressed in this book.

### Literacy Competencies

#### Word Recognition

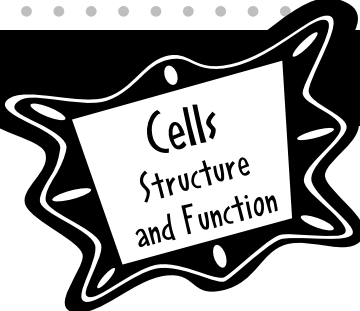
- Recognize at sight a large body of words and specialized-content vocabulary

#### Background Knowledge and Vocabulary

- Determine the meaning of unfamiliar vocabulary and idioms by using prior knowledge and context clues

#### Comprehension Strategies

- Use a variety of comprehension strategies (e.g., predicting, questioning, summarizing, visualizing, and making connections) to support understanding and response to reading



Cells  
Structure  
and Function

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## How to Help Your Students Make the Best Use of This Book

Encourage students to develop nonfiction literacy skills by completing the Active Reader activities. Also encourage them to . . .

- Underline main ideas in paragraphs.
- Circle details that support the main ideas.
- Write down questions as they read.
- Circle key words as well as unfamiliar words.

## Printing Instructions

Student Book: print pages 5–42

Assessments: print pages 43–46

Answer Key: print pages 47–50

**FOCUS  
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SCIENCE**

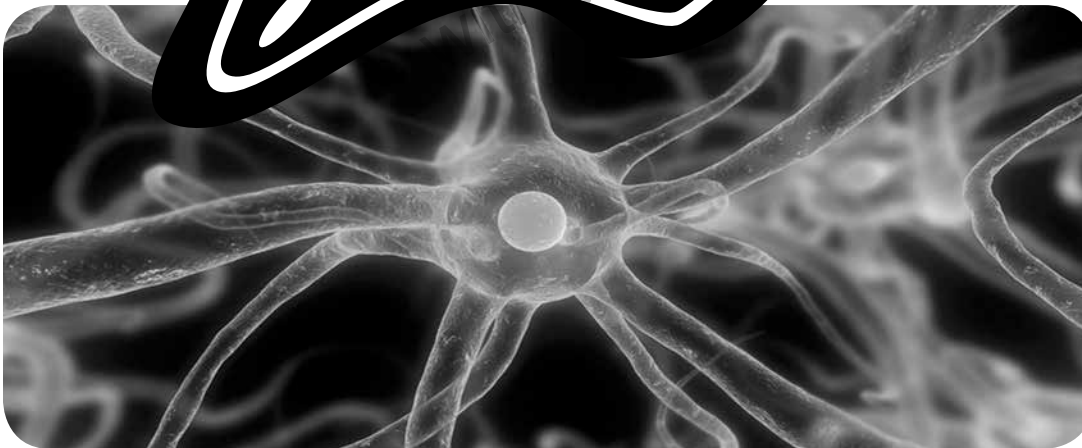
# Cells Structure and Function

**How do human body systems function to maintain homeostasis?**

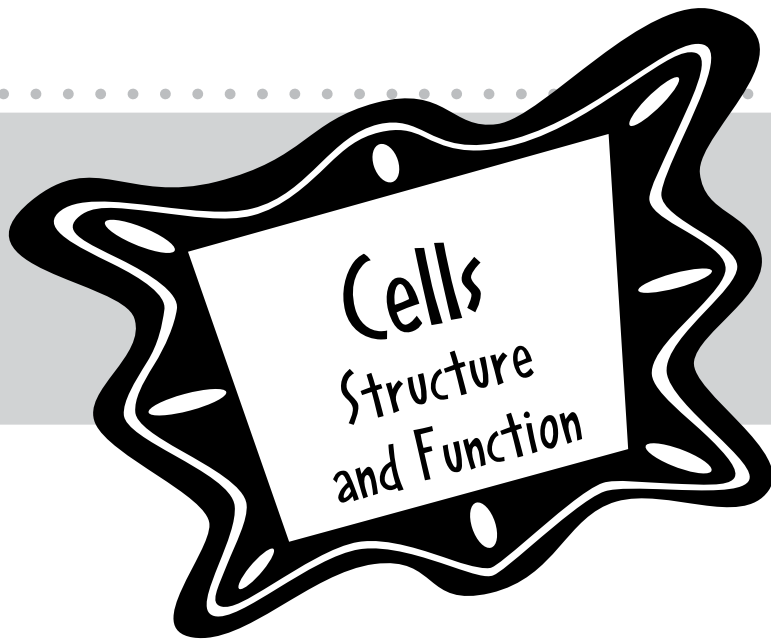
A baseball player. A muscle. A rosebud. What do they have in common? They are all alive. And, they are all made up of cells.

Cells are the basic unit of life. Cells have structures, or parts. They have functions, or jobs. Your body has cells. Read on to learn more about them.

Cells can keep everything inside of themselves in the same state. In other words, they can stay in balance. For instance, they don't become too hot or too cold. They can take in food. They can get rid of wastes. In this way, they can do their jobs over and over again. This balance is called homeostasis.



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# Table of Contents

## Starting Points

Starting Points: Build Background . . . . .	8
<i>Think Like a Scientist: Five Minute Cell Hunt</i> . . . . .	10
Key Vocabulary . . . . .	11
Key Concepts . . . . .	12

## Chapter 1 The Basic Unit of Life

Microscopes Make a Tiny World Visible . . . . .	13
<i>Hands On Science: Learn the Parts of a Microscope</i> . . . . .	15
<i>Hands On Science: Microscope Investigations</i> . . . . .	16
The Cell Theory . . . . .	17
Types of Organisms . . . . .	19
Stop and Think . . . . .	21

## Chapter 2 Inside a Cell

Cell Structures . . . . .	23
Plant and Animal Cells . . . . .	25
Stop and Think . . . . .	29
<i>Hands On Science: Make a Cell Model</i> . . . . .	30
<i>Hands On Science: Investigate Plant and Animal Cells</i> . . . . .	31

## Chapter 3 Cell Work

Transporting Materials . . . . .	34
<i>Hands On Science: Egg Osmosis</i> . . . . .	36
Photosynthesis and Cellular Respiration . . . . .	37
Protein Building . . . . .	39
Stop and Think . . . . .	41

<b>Glossary</b> . . . . .	42
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<b>Assessments</b> . . . . .	43
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<b>Answer Key</b> . . . . .	47
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# Build Background

## Use Your Knowledge

Stories about cells are often in the news. There are stories about scientists developing medicines that fight cancer cells. There are discoveries of how special cells help salamanders regrow limbs. What news stories have you heard that involve cells? Write two or three sentences about what you have heard.

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## Think About It

What do you already know about cells? What do you want to find out? Fill in the chart below. One example has been done for you. When you complete this book, come back to this page and list more things you would like to find out.

What I Know	What I Want to Find Out
1. People are made up of cells.	1. How many cells are in a person?
2.	2.
3.	3.





# Build Background

## Sort It

The words in the box name living things that are made up of cells. Use the words to complete the chart below. One of your entries will be a heading. Add more words to complete the lists.

corn      pine tree      multi-celled organisms  
elephant      human      amoeba

		Single-celled organisms
Plants	Animals	
rosebush	cat	bacteria



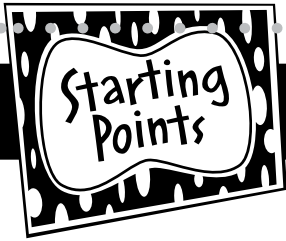
**Five Minute Cell Hunt** It's a contest! Grab a friend or some classmates and see who can find the most things made of cells in five minutes. Hint: cells are found in living things.

1. Gather a pencil or pen and a timer, such as a stopwatch.
2. Decide where to conduct your "cell hunt." Will you and your fellow contestants hunt in the same place or in separate locations? Where will you go to find the greatest variety of living things? Should you stay in one place or hurry from one place to another?
3. Set the timer for five minutes, and START the hunt! Use the chart below to write down everything you see that has cells.
4. When the timer goes off, STOP! Compare your results by discussing the questions.

Name of Plant, Animal, or Other Living Thing	How Many Did You Find?	Where Found?

**Discussion Questions:**

1. Who found the most living things? \_\_\_\_\_
2. Where were the most living things found? Why was that a good place to find cells? \_\_\_\_\_  
\_\_\_\_\_
3. Did the person who found the most living things also find the most cells? Explain. \_\_\_\_\_  
\_\_\_\_\_



# Key Vocabulary

## Rate Your Knowledge

The words listed below have to do with cells. Each word is important, but some of them may be new. Read each word. Rate your knowledge of each by putting a check or a few words in the appropriate column. After completing this book, come back to this page and write the definitions of words you did not know.

	I don't know it.	I've seen it and I think it means . . .	I know it well. It means . . .
cell			
tissue			
organ			
organelle			
nucleus			
membrane			
photosynthesis			
osmosis			
cellular respiration			

## Use Word Parts to Unlock Meaning

Read the prefixes and their meanings in the box. Then draw lines to match the terms to their definitions.

Prefix	Meaning
<i>extra-</i>	outside
<i>uni-</i>	one
<i>multi-</i>	many
<i>chlor-</i>	green
<i>cyto-</i>	cell

### Terms

1. extracellular
2. multicellular
3. chloroplast
4. cytoplasm
5. unicellular

### Definitions

- unicellular green structure in plant where photosynthesis takes place
- having one cell
- contents of a cell within the plasma membrane (except the nucleus)
- having many cells
- outside of the cell



# Key Concepts

## The Characteristics of Organisms

**Organisms** are living things. Plants, animals, bacteria, and fungi are organisms. You are an organism, too. Mountains, air, and water are not organisms. Why? They are not living things. It's not always easy to tell the difference between living and nonliving things, but there are characteristics that all living things have in common:

- Living things are made of one or more cells.
- Living things get and use energy.
- Living things grow and develop.
- Living things reproduce.
- Living things respond to their environment.
- Living things adapt to their environment.

Every living thing is made up of **cells**; but it only takes one cell to be a living thing.



**Make Estimates** Organisms can have as little as one or as many as trillions of cells. You can't count the exact number. But, scientists make estimates based on the type of organism. List some organisms in the first column. Then, fill in the second column with your guess about how many cells it has. Next, do research to find out about how many cells the organism really has. You might be surprised!

Organism	Number of Cells I Think It Has	Number of Cells It Really Has

### ACTIVE READER

**1 Reflect** *How do humans adapt to their environment when it is cold outside?*

---



---

### Good to Know

Long ago, many people thought nonliving things could suddenly turn into living things. For example, people thought piles of hay could turn into mice! Today, people know that nonliving things can't come to life.

# Chapter 1 The Basic Unit of Life

## FOCUS

Cells are the basic unit of life. As you read this section, find out how the world of cells was discovered and who discovered it.

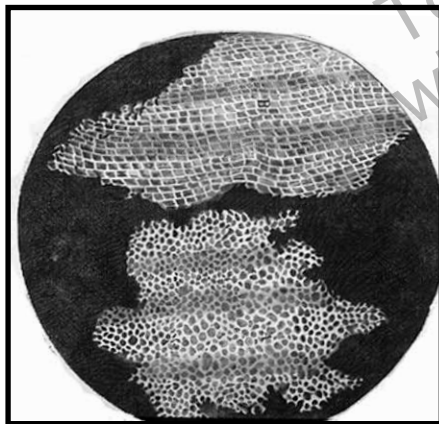
## Microscopes Make a Tiny World Visible

People didn't know about cells before the 1600s. That's because they couldn't see them. They couldn't see them because they didn't have the technology.

The first microscope was invented around 1595. It allowed scientists to study very small objects. As better microscopes were built, scientists could see even smaller objects. It wasn't long before scientists discovered cells.

## Robert Hooke

Robert Hooke was an English scientist and inventor. He designed a crude microscope. In 1663 he used it to study thin slices of a woody plant called cork. Hooke thought it looked like a honeycomb. It was full of boxlike pores. Robert Hooke had discovered plant cells!



*This is how cork looks through a microscope. Note the cells.*



*This is the type of microscope Robert Hooke used in his study of plant cells.*

## ACTIVE READER

**1 Monitor** Underline the two sentences that explain why people didn't know about cells before the 1600s.

**2 Identify** Circle the name of the scientist who discovered plant cells. What country did he live in?

## Good to Know

Robert Hooke thought the pores in the cork looked like the small rooms, or cells, in which monks at a monastery lived. That's why he named them cells.

## Anton van Leeuwenhoek

Anton van Leeuwenhoek was a Dutch businessman who lived at the same time as Robert Hooke. Leeuwenhoek also invented a microscope using one lens. In fact, he made over 500 of them during his lifetime. His microscopes could magnify objects over 200 times.

Leeuwenhoek was curious. He examined many kinds of specimens under his microscopes. He studied bits of plants and animals, and discovered blood cells. He studied drops of lake water and discovered tiny organisms inside.

He even took samples from old men whose teeth had never been brushed! In them, he found swimming “animalcules,” or “little animals.” What Leeuwenhoek saw were bacteria.



*Anton van Leeuwenhoek invented a microscope that looked like this one.*

### FOCUS QUESTIONS

1. Why is our knowledge of cells tied to the history of the microscope?

---



---

2. What scientific discoveries did Robert Hooke and Anton van Leeuwenhoek make?

---



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### ACTIVE READER

**1 Monitor** What kind of cells did Leeuwenhoek discover?

**2 Extend** If “animalcules” means “little animals,” what does the root *cule* mean?



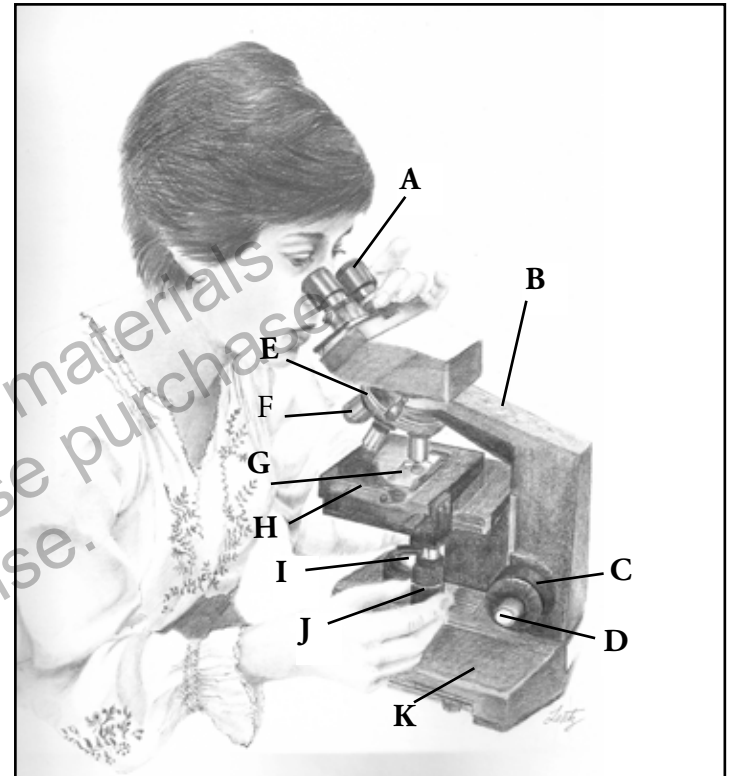
Find out about two types of microscopes: the simple microscope and the compound microscope.

How are they different from each other? Which one did Robert Hooke use? Which one did Anton van Leeuwenhoek use?



**Learn the Parts of a Microscope** The illustration at the right shows the type of microscope used in most science labs today. Study the diagram and answer the questions below.

- A. **Ocular Lens (Eyepiece)** (lens that magnifies the image of the specimen, brings light rays into focus)
- B. **Arm**
- C. **Coarse Adjustment Knob** (makes large changes in focus)
- D. **Fine Adjustment Knob** (makes tiny changes in focus)
- E. **Revolving Nosepiece**
- F. **Objectives** (three lenses that each magnify the image of the specimen to a different size)
- G. **Slide** (contains the specimen)
- H. **Stage** (where the slide specimen is placed)
- I. **Light Source/Condenser** (provides light to illuminate the specimen)
- J. **Stage Control** (adjusts the position of the stage)
- K. **Base**



Use the diagram above to answer the following questions.

1. What is the name of the part you look through? \_\_\_\_\_
2. Where do you place the slide with the specimen? \_\_\_\_\_
3. Which two parts magnify the image of the specimen? \_\_\_\_\_
4. Which part provides light to make the image brighter? \_\_\_\_\_
5. Which part is used to make tiny changes in focus? \_\_\_\_\_
6. Why do you think a microscope would have lenses that show different magnifications, instead of one lens with only the most powerful magnification?

---



---



**Microscope Investigations** Investigate what everyday objects look like under a microscope. Prepare slide specimens of the objects listed below. Look at each specimen under a microscope. Observe things at different magnifications with the different objects. Make notes about the interesting and surprising things you discover.

### Tips for Using a Microscope

- Make sure the microscope is placed with the arm facing you.
- Click the low-power objective lens into place by revolving the nosepiece.
- Put a slide on the stage and use the stage clips to secure it.
- Turn the coarse adjustment knob or stage control until the lens is very close to the slide.
- Look through the eyepiece and turn the fine adjustment knob to bring the specimen into focus.



*A printed letter e as observed through a microscope*

The letter *e* cut out from a newspaper \_\_\_\_\_

\_\_\_\_\_

A strand of your hair \_\_\_\_\_

\_\_\_\_\_

Small pieces of cloth, with threads showing \_\_\_\_\_

\_\_\_\_\_

Grains of sugar \_\_\_\_\_

\_\_\_\_\_

Your choice! \_\_\_\_\_

\_\_\_\_\_



**FOCUS**

The next part of the chapter explains the development of the cell theory. Read to learn about the scientists who made important contributions to our knowledge about cells.

**The Cell Theory**

During the 1600s and 1700s, microscopes became more powerful. Scientists observed specimens in greater detail. Over time, microscopes allowed scientists to see the smaller parts of cells. In the 1800s, three Germans drew important conclusions about cells.

**Matthias Schleiden, Theodor Schwann, and Rudolf Virchow**

Matthias Schleiden studied plants. In 1838, he concluded that all plants are made of cells. Theodor Schwann studied animals. Not long after Schleiden made his discovery, Schwann concluded that all animals are made of cells.

Now scientists knew that all living things were made of cells. But, they still didn't know where cells came from. In 1855, a German physician named Rudolf Virchow discovered the answer. He said that all cells were formed from cells that already exist.



*Schwann would say that this rabbit is made of cells. What would Schleiden say about the carrot?*

**ACTIVE READER**

**1 Identify** Circle Schleiden's conclusion. Underline Schwann's conclusion. Put parentheses around Virchow's conclusion.

**2 Extend** Which scientist would you like to have been? Why does that kind of science interest you? Do more research on the scientist and share what you find out.

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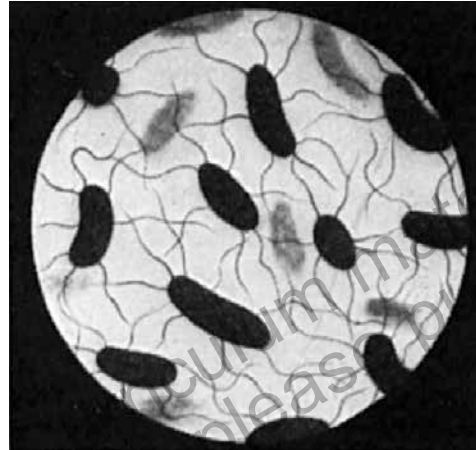


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## The Three Parts of the Cell Theory

The work of Schleiden, Schwann, and Virchow was combined into what is known as the cell theory. The three parts of the cell theory are:

- All living things are made of one or more cells.
- The cell is the basic unit of life. It is the smallest living thing that can perform all the functions of life.
- All cells come from cells that already exist.



Bacterial cells

### FOCUS QUESTIONS

1. Explain what the cell theory is in your own words.

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### ACTIVE READER

**1 Analyze** Can you connect each scientist to only one part of the cell theory? Why or why not?

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**2 Question** A question I still have about cells is...

---



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### Good to Know

Cells are living things. Like other living things, they die. Did you know that about 75 percent of dust is made up of dead skin cells? Every minute, you shed between 30,000 and 40,000 skin cells!

## FOCUS

The last part of this chapter gives an overview of types of cells. It also discusses how cells can be organized into tissues, organs, and organ systems.

## Types of Organisms

There are two types of organisms: **unicellular** and **multicellular**. Unicellular organisms have only one cell. Multicellular organisms have many cells—sometimes trillions, as in humans.

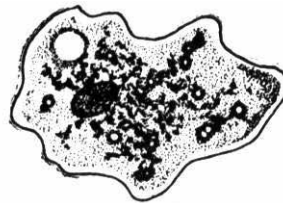
## Unicellular and Multicellular Organisms

Unicellular organisms include bacteria. There are more bacteria on the planet than any other organism. Bacteria are everywhere. They are on land and in water. They live in and on plants. They live in and on animals.

Bacteria are a type of organism called **prokaryotes**. Most prokaryotes are simple, single-celled organisms. The cells of prokaryotes do not have a distinct nucleus, or “control center.”

Most visible organisms are **eukaryotes**. Animals and plants are eukaryotes. The cells of eukaryotes have a distinct nucleus and many other structures. Eukaryotic cells are more complex than prokaryotic cells. Eukaryotes can be unicellular or multicellular organisms, though most are multicellular.

*An amoeba is a eukaryote—  
a unicellular organism.*



## ACTIVE READER

**1 Identify** Name one unicellular organism and one multicellular organism.

**2 List** List the adjective forms of the nouns *eukaryote* and *prokaryote*, as used in paragraph 4.

## Good to Know

The prefix *pro-* means “early.”  
The prefix *eu-* means “true.”  
The word part *karyote* means “nucleus.” Prokaryotes evolved without a distinct nucleus before the eukaryotes, which have one.

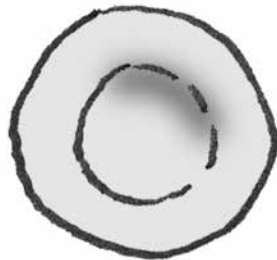
## Cell Specialization

Different multicellular organisms have different cells. For example, the human body has skin cells, blood cells, muscle cells, nerve cells, and many other kinds of cells. The different kinds of cells are different shapes and sizes. They do different jobs. They all play a part in keeping you alive and healthy.

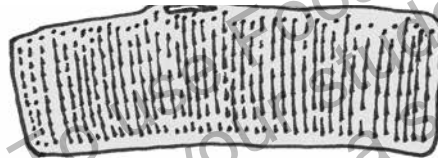
The cells in multicellular organisms are often organized into tissues, organs, and organ systems. **Tissues** are a collection of cells that work together to do a job. Bone tissue is made up of bone cells. Nerve tissue is made up of nerve cells.

**Organs** are made up of different types of tissues working together. For example, the stomach is an organ. It includes muscle tissue, nerve tissue, and blood tissue.

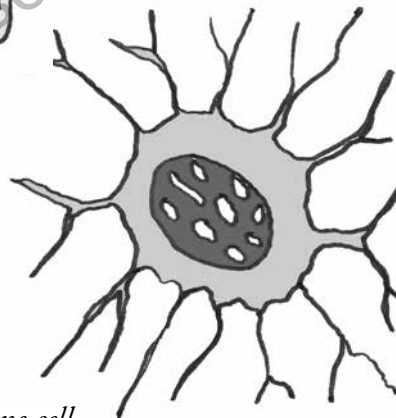
*These are illustration of only a few of the types of cells in your body.*



*Blood cell*



*Muscle cell*



*Bone cell*

### ACTIVE READER

**1 Identify** *Underline four types of cells. Circle one type of tissue. Put parentheses around the name of one organ.*

**2 List** *List the following items from smallest to largest: tissue, cell, organ system, organ.*

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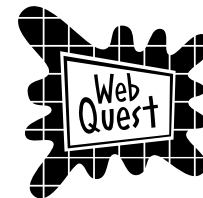
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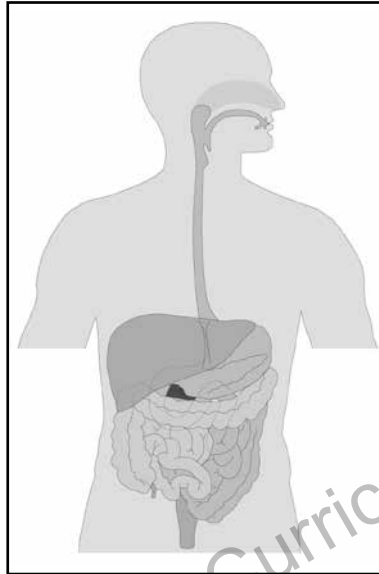


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Use the Internet to research more types of cells found in your body.

An **organ system** is a group of organs that work together to perform a job. For example, the stomach is part of the digestive system. So is the liver, intestines, and other organs. Other organ systems include the nervous system, the respiratory system, the muscular system, and the skeletal system.



*The organs of the digestive system include the esophagus, the liver, the stomach, and the intestines.*



*A runner's organ systems work together to support the demands of physical activity.*

**FOCUS QUESTIONS**

1. What is the main difference between prokaryotes and eukaryotes?

---



---

2. How are tissues and organs different from each other?

---



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**ACTIVE READER**

**1 Identify** Name three organs in the human digestive system.

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**2 Extend** Think about what you know about other organs in the human body. What is one organ in the respiratory system? What does this organ do?

---



---



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Do research to find out more about one of the organ systems in the human body. What organs are in the system? What is the system's function, and why is it important? Draw a diagram or write a report to show what you learned.

## Stop and Think

This page will help sum up what you have read so far.  
Use the tip to help you answer the questions.

### 1. Which part of the cell theory explains why a pile of straw cannot change into a mouse?

- (1) The cell is the basic unit of life.
- (2) All cells come from cells that already exist.
- (3) All living things are made of one or more cells.
- (4) All cells work with other cells in an organ system.

### 2. Which two scientists are associated with plant cells?

- (1) Anton van Leeuwenhoek and Theodor
- (2) Robert Hooke and Matthias Schleiden
- (3) Theodor Schwann and Rudolf Virchow
- (4) Rudolf Virchow and Anton van Leeuwenhoek

Base your answers to questions 3 and 4 on the statement below and on your knowledge of science.

The cells in multicellular organisms are often organized into tissues, organs, and organ systems.

### 3. How are tissues related to organs? \_\_\_\_\_

---



---

### 4. How are how organs related to organ systems? \_\_\_\_\_

---



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**Tip:**  
Read all the answer choices  
before making your  
final decision.

### Dear Ms. Understanding,

Microscopes confuse me! Here's an example. I'm looking at this microscopic critter, and he's swimming to the right of the slide. When I move the slide to follow him, he disappears! What's happening?



*Microscope Mike*

### Dear Mike,

Good question, and here's the answer. Your problem happens because of how microscope lenses work. The glass lenses make everything look reversed. If you want to look to the right, then move the slide to the left. And if you want to know 'what's up?' then move the slide down!



*Ms. Understanding*

# Chapter 1 Inside a Cell

## FOCUS

This chapter focuses on cell structures and functions in eukaryotes, in particular, plants and animals. Read this section to find out about the parts that make up a cell.

## Cell Structures

You learned that organisms are unicellular or multicellular. They are prokaryotes or eukaryotes. They can be smaller than a speck of dust or as big as a whale. But all organisms are made up of cells. And, each cell is made up of smaller parts called *structures*.

Some of the structures in cells are the same. Other structures are different, depending on whether the organism is a plant, animal, or something else. Each of the structures within a cell has a job, or function. Some structures produce food. Others store materials like water and waste. Still others release materials to parts of the cell and beyond. By working together, the parts of a cell keep organisms alive and healthy.



*The cells of these two organisms have more in common than you might think.*

## ACTIVE READER

**1 Recall** *How are prokaryotes different from eukaryotes?*

---

---

---

**2 Restate** *Organisms are made of cells. What are cells made of?*

---

## Entering a Cell

Imagine that you are taking a journey into a cell. How will you get in?

To get inside a plant cell, you'll have to go through the **cell wall** first. The cell wall is a tough, rigid structure. The cell wall protects the cell and gives it shape. Once you get through the cell wall, you have another barrier: the **cell membrane**. The cell membrane is a thin layer made up mostly of protein and fat. Every living cell has a cell membrane. A cell membrane is like a plastic bag with tiny holes in it. It keeps harmful things out of the cell, while allowing useful substances in and out.

Animal cells don't have a cell wall. Instead, they have a **cytoskeleton**. This "framework" gives the cell its shape. The cell membrane in animal cells serves the same purpose as the cell membrane in plant cells.

Once inside a plant or animal cell, you will see an entire world of **organelles**! Organelles are the structures that have specific roles in eukaryotic cells.

### FOCUS QUESTIONS

1. What structures do all eukaryotic cells have?

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2. How is entering an animal cell different from entering a plant cell?

---



---

### ACTIVE READER

**1 Identify** *What does a cell wall do?*

---



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**2 Compare** *How are a cell wall and cytoskeleton alike?*

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### Good to Know

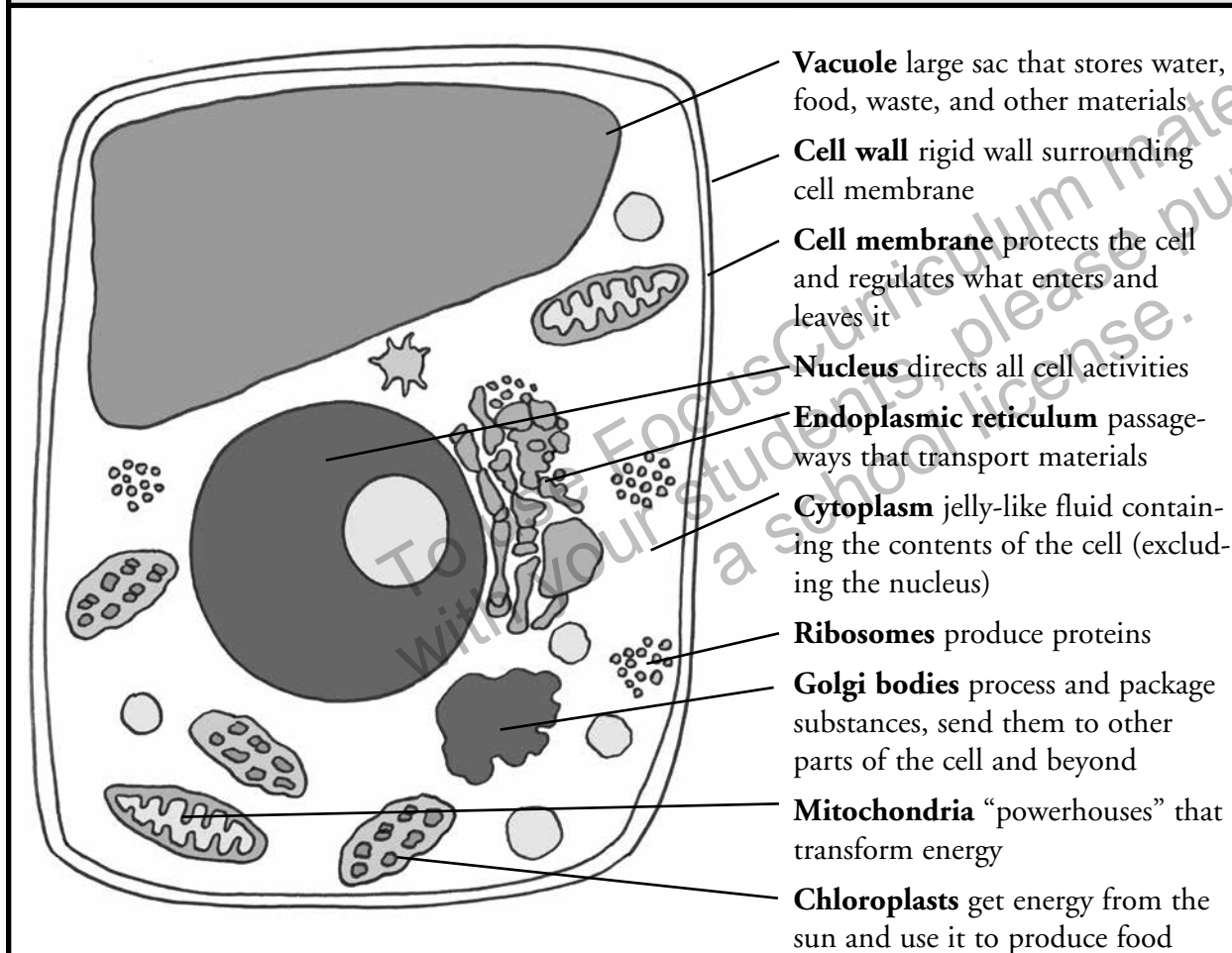
The cell membrane is also known as the plasma membrane. Organelles means "little organs." That's because they work like organs to help the body function as a whole.



## FOCUS

The diagrams in this section show the structures in a plant and animal cell. The captions explain the function of each structure. Compare the diagrams and then read to learn more.

## Plant Cell



**Vacuole** large sac that stores water, food, waste, and other materials

**Cell wall** rigid wall surrounding cell membrane

**Cell membrane** protects the cell and regulates what enters and leaves it

**Nucleus** directs all cell activities

**Endoplasmic reticulum** passageways that transport materials

**Cytoplasm** jelly-like fluid containing the contents of the cell (excluding the nucleus)

**Ribosomes** produce proteins

**Golgi bodies** process and package substances, send them to other parts of the cell and beyond

**Mitochondria** “powerhouses” that transform energy

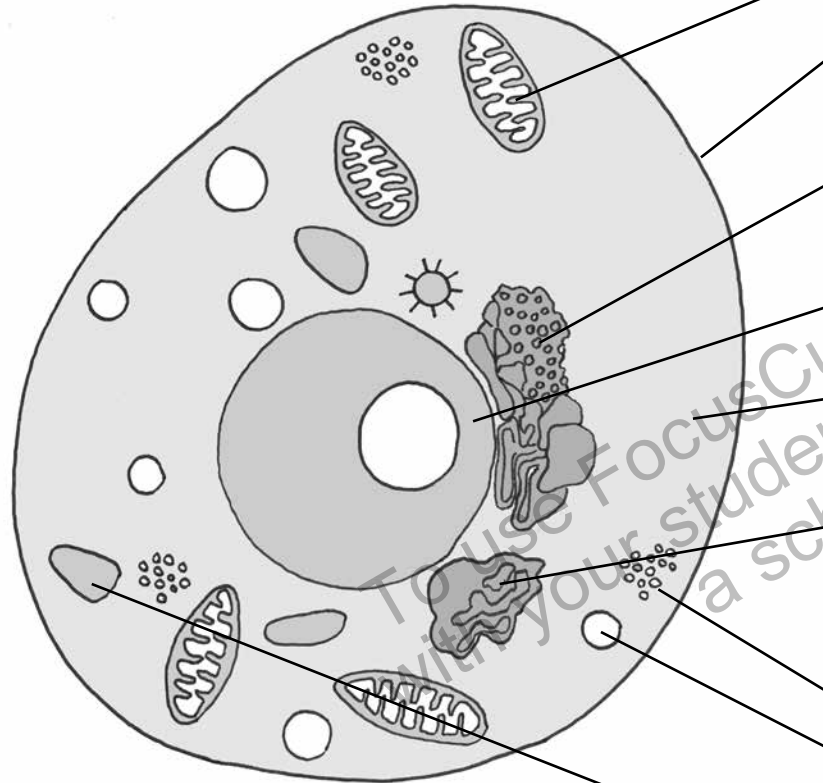
**Chloroplasts** get energy from the sun and use it to produce food

## ACTIVE READER

**1 Identify** Which organelle is the “control center” of the cell?

**2 Analyze** Why do you think Golgi bodies have been called the cell’s “post office”?

## Animal Cell



**Mitochondria** “powerhouses” that transform energy

**Cell membrane** protects the cell and regulates what enters and leaves it

**Endoplasmic reticulum** passageways that transport materials

**Nucleus** directs all cell activities

**Cytoplasm** jelly-like fluid containing the contents of the cell (excluding the nucleus)

**Golgi bodies** process and package substances, send them to other parts of the cell and beyond

**Ribosomes** produce proteins

**Lysosomes** chemically break down food particles, waste, and unneeded cell parts

**Vacuole** sac that stores water, food, waste, and other materials

### ACTIVE READER

#### 1 Compare/Contrast

*How is the vacuole in the animal cell different from the vacuole in the plant cell?*

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**2 Analyze** *Why do you think lysosomes have been called the cell’s “garbage disposal”?*

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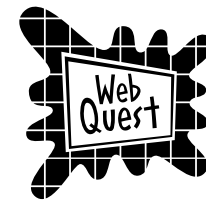
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Use the Internet to research why vacuoles are different in plant and animal cells.

## Continuing the Journey

You have passed through the cell membrane. Now you are inside the **cytoplasm**. The cytoplasm is a jelly-like fluid that is always moving. The organelles “drift around” in the cytoplasm.

The diagrams on preceding pages describe the organelles. Here are a few more details.

The nucleus is the “brains” of the cell. It directs the cell’s activities. The nucleus contains smaller parts, including a nucleolus. The nucleolus makes the **ribosomes**. These are organelles that produce proteins. You can find ribosomes in many parts of the cell.

The mitochondria change the energy in food into the energy a cell needs to carry out its functions. You will find out more about **mitochondria** and the work they do in the next chapter.



Cell nucleus  
with nucleolus

### ACTIVE READER

**1 Identify** *Underline the sentence that tells what a nucleolus does.*

**2 Reflect** *Which gives you more information about the nucleus, the photograph on this page or the diagrams on the previous pages? Explain your answer.*

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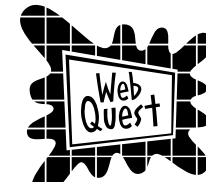
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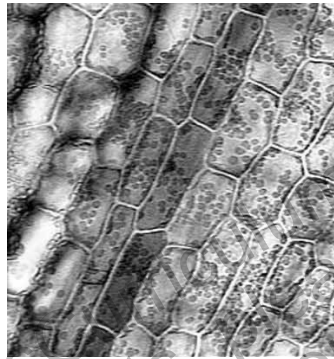
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The nucleus of a cell contains parts such as the nucleolus, chromatin, and more. Research the nucleus of a cell. Draw a diagram of a nucleus and label its parts. For each part, write a brief description of its function.

## The Chloroplasts

In a plant cell there are large green structures floating in the cytoplasm. These green structures are **chloroplasts**. Only plant cells have them. Chloroplasts are what make plant leaves green. These organelles take light energy and use it to make food. You will learn more about that process in the next chapter.



*The cells in this plant contain chloroplasts, which can be seen under a microscope.*

### FOCUS QUESTIONS

1. Explain two ways in which plant and animal cells are different from each other.

---



---

2. Explain two ways in which plant and animal cells are alike.

---



---

### ACTIVE READER

**1 Extend** *What is the name of the process in which plants use light energy to make food?*

---

### Good to Know

Not all plant cells have chloroplasts. Most underground plant cells lack chloroplasts because chloroplasts need light for their development. For example, both potato and onion plants contain parts with cells that grow underground. Can you think of others?

Stop and Think

This page will help sum up what you have read so far. Use the tip to help you answer the questions.

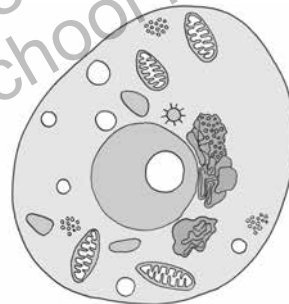
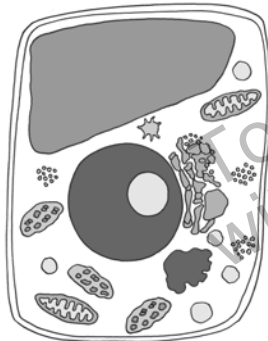
1. If you think of a cell as a city, the endoplasmic reticulum is the

- (1) mayor's office.
- (2) city streets.
- (3) library.
- (4) grocery stores.

2. A cell membrane is important because it

- (1) directs the operation of the cell.
- (2) controls what comes into and goes out of the cell.
- (3) contains the cell organelles except for the nucleus.
- (4) stores water, food, waste, and other cellular materials.

The diagrams below show two types of cells. Use them and your knowledge of science to answer questions 3 and 4.



3. What type of cell is shown at the left? What is one feature that helped you identify it?

---

4. What type of cell is shown at the right? What is one feature that helped you identify it?

---

**Tip:**  
To answer question 1, look at the diagrams of cells in this chapter and read the description of the endoplasmic reticulum. Then compare its function with the functions described in the answer choices.

Dear Ms. Understanding,

I've heard that the nucleus contains all the hereditary materials for a cell. What does this mean?



*Baffled in Brooklyn*

Dear Baffled,

Great question! This means that the nucleus holds all the information needed to make every cell in that organism. The nucleus of every cell contains the exact same hereditary materials.



*Ms. Understanding*



**Make a Cell Model** Research and create a model of a plant or animal cell. Your cell model should include examples of all the main organelles. It should also include a key that explains what each organelle does.

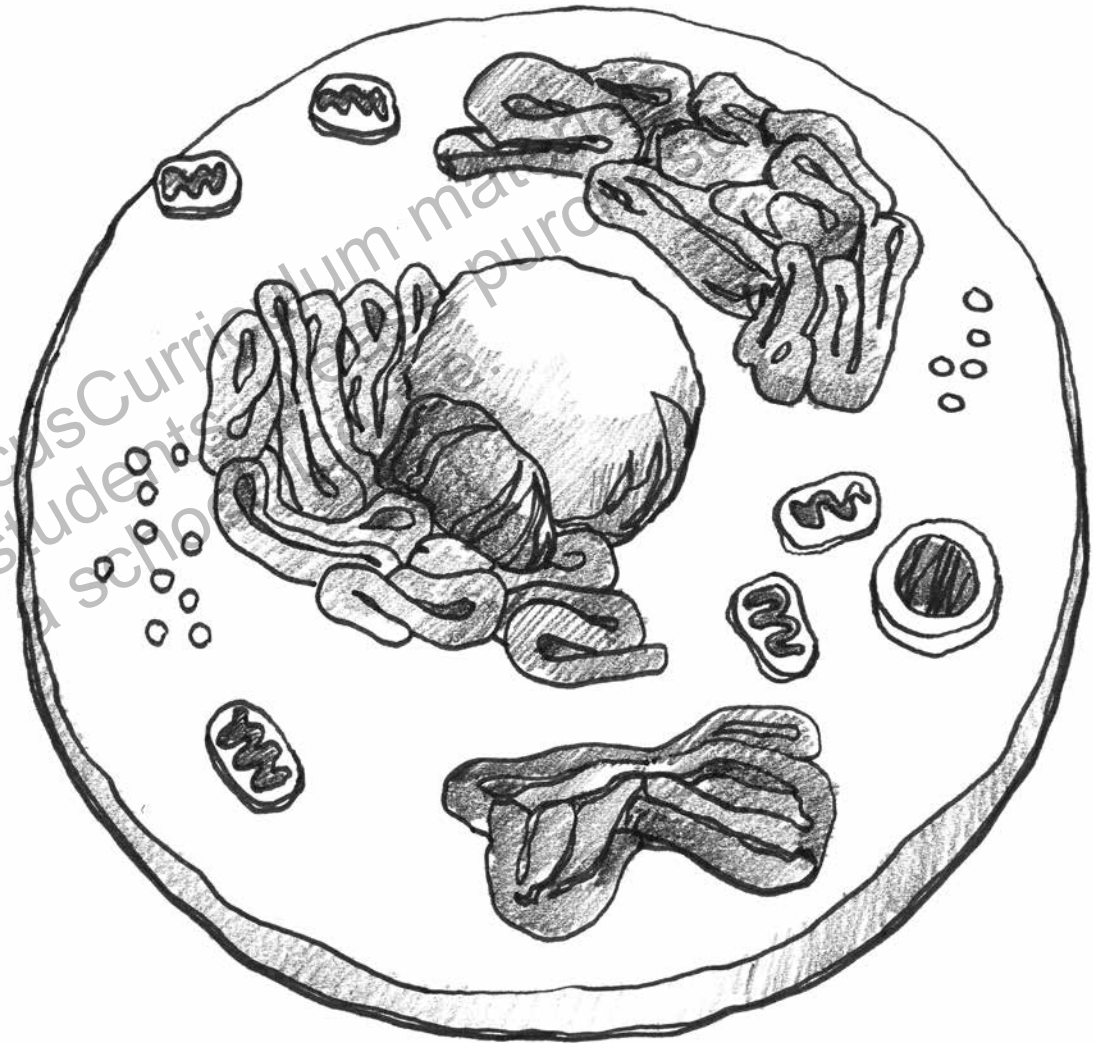
### Materials

scissors, tape, glue, construction paper, coloring pencils or markers, your information about cells (notes or this book).

To make a more elaborate model, use strange or unusual objects for organelles, such as food or other interesting items.

### Procedure

1. Review this book to decide whether you want to build an animal or plant cell.
2. Draw a rough draft of what your cell model will look like.
3. List all the materials you will use to make your model.
4. Gather the materials.
5. Create a key that identifies and tells the function for each organelle or cell part.
6. Build your model. Use it to explain the cell's structures and functions to a friend or family member.



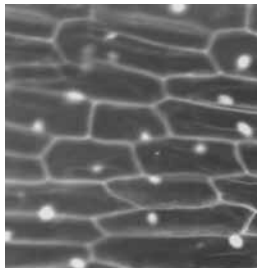


## Investigate Plant and Animal Cells

Do these microscope labs to compare and contrast plant and animal cells.

### Materials

microscope, clean slides and cover slips, pipettes, iodine solution for staining cells, paper towels, toothpicks, onion pieces, elodea leaves (a simple water plant), forceps (tweezers), labsheet for drawings and answering questions

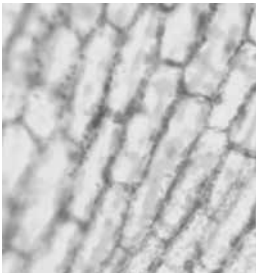


### Part A: Onion Cells

1. Use a prepared onion cell slide or make your own slide of the onion tissue, or “skin.” If you make your own slide, use the iodine solution to stain the tissue so that you can see it better under the microscope.
2. Find the stained onion cells under your “search” objective lens, and then change focus to low power. Draw at least 5 cells on your labsheet in the correct circle.
3. Change your magnification to high power and draw at least 2 good cells. In the high power drawing, label the following on one cell: cell wall, cytoplasm, nucleus.

### Answer these questions on the back of the labsheet.

1. What is the general shape of the onion cell? Is it more round shaped or more square shaped?
2. How can you tell you are looking at a plant cell as opposed to an animal cell?
3. Describe the cell nucleus.



### Part B: Elodea Cells

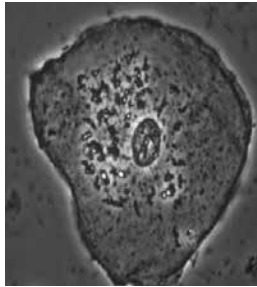
1. Use a prepared elodea cell slide or make your own slide of an elodea leaf.
2. Find the elodea cells under your “search” objective lens, and then change focus to low power. Draw 7–10 cells on your Labsheet in the correct circle.
3. Change your magnification to high power, and look for cells that have actively moving green chloroplasts. You may have to look carefully for this movement. Draw at least 5 of these cells on your labsheet. In the high power drawing, label the following on one cell: cell wall, cytoplasm, green chloroplasts.

### Answer these questions on the back of the labsheet.

1. What is the general shape of the elodea cell?
2. What is the function of the chloroplasts?
3. Why were no chloroplasts found in the onion cell?



## Investigate Plant and Animal Cells *(continued)*



### Part C: Human Cheek Cells

1. Make a slide of the tissue cells of your cheek. To do this, put a drop of iodine solution on a slide. Gently scrape the inside of your cheek with the flat side of a toothpick. Stir the toothpick in the iodine stain and throw the toothpick away. Put a coverslip onto the slide.
2. Find the stained cheek cells under your “search” objective lens, and then change focus to low power. Find a set of cells that are not clumped together. Draw at least 5 cells on your lab sheet in the correct circle.
3. Change your magnification to high power and draw at least 2 separate cells. In the high power drawing, label the following on one cell: cell membrane, cytoplasm, nucleus.

**Answer these questions on the back of the lab sheet.**

1. What is the general shape of the human cheek cell?
2. What organelles can be seen in the cheek cell?
3. What are 3 organelles that are not visible, but should be present in the cheek cell?



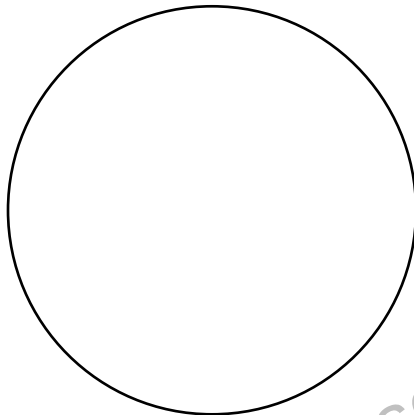


# Investigate Plant and Animal Cells

## Labsheet

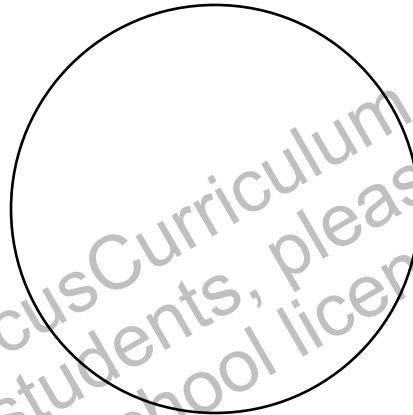
Use the circles below on this lab sheet to draw what you see.

Part A: Onion Cells



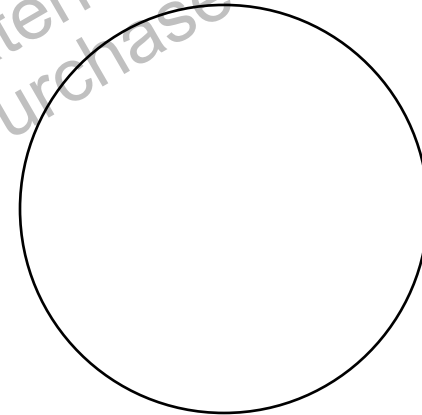
*Low power*

Part B: Elodea Cells

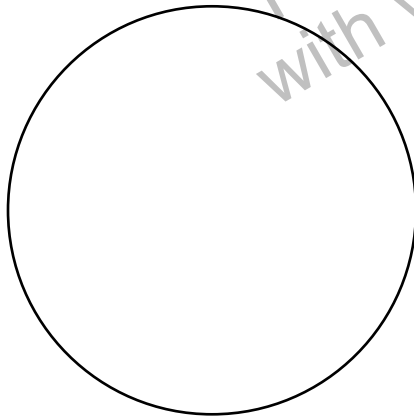


*Low power*

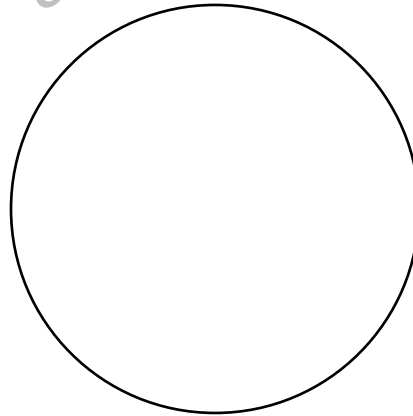
Part C: Human Cheek Cells



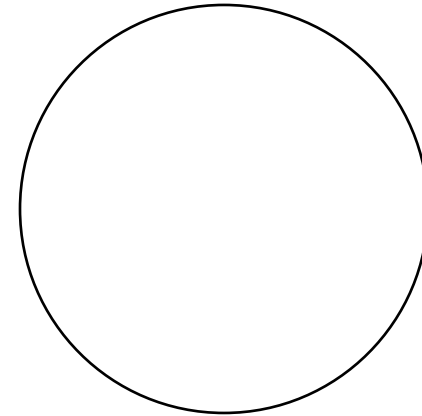
*Low power*



*High power*



*High power*



*High power*

# Chapter 3 Cell Work

## FOCUS

This chapter is about the work cells do to keep organisms healthy and functioning. In the first section, read to find out how cells transport materials.

Cells have important jobs to do. They get food, create fuel, build proteins, transport materials, and get rid of wastes. Much of the work requires moving materials in and out of the cells by crossing cell membranes.

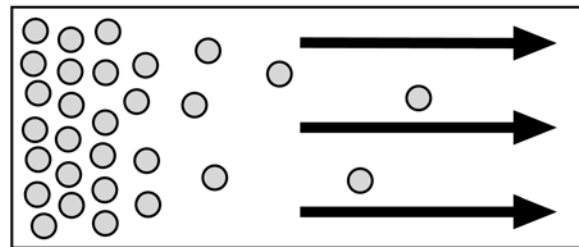
## Transporting Materials

Materials can be transported across cell membranes in two different ways: **active transport** or **passive transport**. In active transport, the cell uses energy to move the materials. In passive transport, the cell does not use energy. Think of it like this: active transport is like climbing UP a playground slide. Passive transport is like sliding DOWN it.

## Passive Transport

**Diffusion** and **osmosis** are types of passive transport. In both, small molecules move from an area of high concentration to an area of lower concentration.

Have you ever sprayed air freshener into the air? The scent spread outward from the point where you sprayed it. Soon, the entire room was filled with odor. The molecules in the air freshener were concentrated in one spot. Then they spread outward.



High Concentration → Low Concentration

*This diagram shows how molecules move from areas of high concentration to areas of lower concentration.*

## ACTIVE READER

**1 Identify** Underline the sentence that names two types of passive transport.

**2 Analyze** Use what you learned about diffusion to give another real-life example of it.

## Good to Know

Molecules in a substance are always moving. As they move, they bump into each other. The more molecules there are in one area, the more they bump into each other. The collisions make them bounce away from each other. These collisions gradually cause the molecules of a substance to spread out further and further. Finally they reach equilibrium, the point at which they are evenly spaced.

Diffusion occurs in cells through cell membranes. Remember, the cell membrane lets some things through and keeps other things out. It allows small molecules like water and oxygen to pass through. Cells need both water and oxygen to survive.

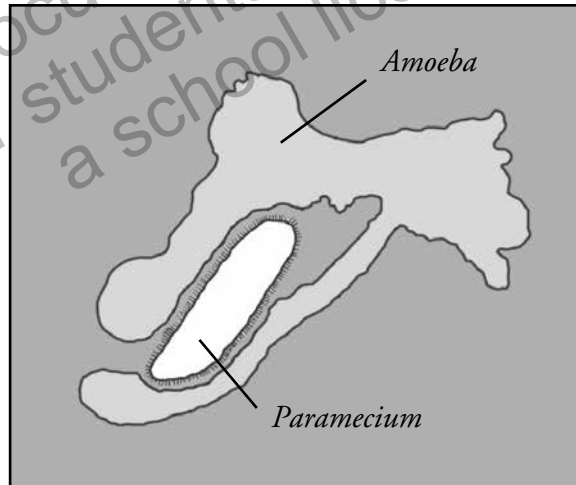
Osmosis is a special type of diffusion. It is the diffusion of water. Since many cellular processes depend on water, osmosis is a very important form of passive transport.

## Active Transport

Sometimes cells need to take in substances that already exist in higher concentrations inside the cell. In this case, cells need to use energy. So, they use active transport.

Active transport works in different ways. One way involves *transport proteins*. These “energetic” proteins pick up needed molecules outside of the cell and carry them inside.

Another type of active transport is known as *transport by engulfing*. Single-celled amoebas use this process. They simply surround, or engulf, a smaller organism. Then the cell membrane encloses the organism and devours it. The same process happens inside the human body when a white blood cell devours a bacterium.



*This illustration shows an amoeba engulfing a paramecium—a form of active transport.*

### ACTIVE READER

- 1 *Identify* Underline the two forms of active transport.
- 2 *Connect* Circle a synonym for engulf in the last paragraph.

**FOCUS** QUESTIONS

1. How are active transport and passive transport different from each other?

---

---

2. Explain how the two forms of active transport work.

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---



**Egg Osmosis** In this experiment, an egg represents a cell. Follow the procedure below to watch osmosis in action.

**Materials:** two raw eggs, clear containers large enough to hold them, vinegar, corn syrup, water (distilled water works best)

**Procedure:**

1. Carefully place each egg into a container filled with vinegar. The vinegar must cover the egg.
2. After 24 hours, look at your eggs. What has happened?

3. Dump the vinegar and very gently rinse the eggs. Return them to their containers.
4. Fill one container with corn syrup. Fill the other with water.
5. Wait 24 hours again. Look at your eggs. What has happened to each egg? Using the term osmosis, explain why they are different.

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## FOCUS

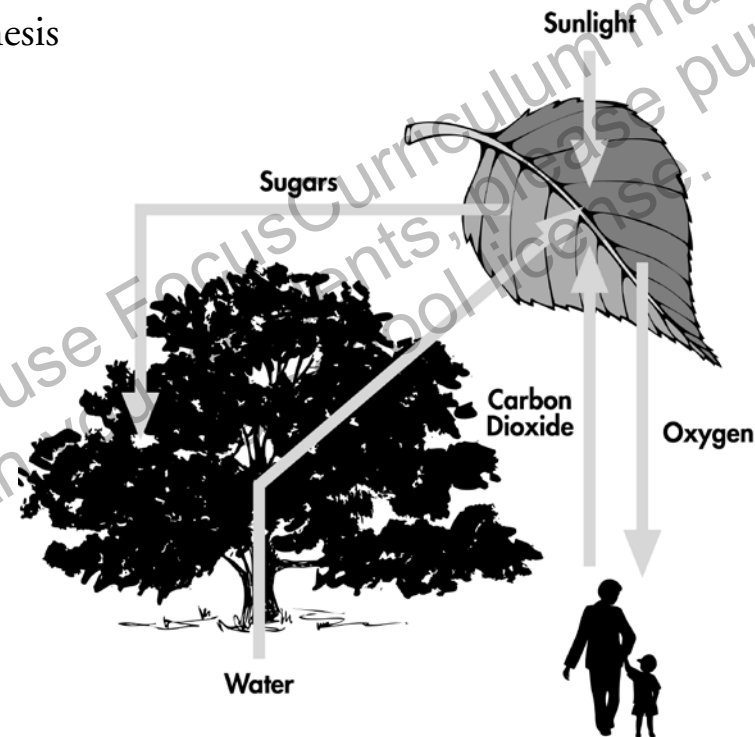
Read the next section to find out how cells convert light into food, and food into fuel.

## Photosynthesis and Cellular Respiration

Cells need energy. During **photosynthesis**, plants get energy from the sun and use it to make food. Plants and animals use the energy stored in food to make a form of energy the cell can use. The process of creating cell energy is called **cellular respiration**.

### Light into Food: Photosynthesis

In Chapter 2 you learned about chloroplasts. These organelles exist in plant cells. They help in the process of photosynthesis. Chloroplasts use energy from sunlight to combine carbon dioxide (from the air) with water to make food. The food takes the form of simple sugars like glucose.



*This diagram shows how plants use the energy from sunlight as well as carbon dioxide and water to make food and create oxygen.*

### ACTIVE READER

**1 Identify** *Underline the sentence that defines cellular respiration.*

**2 Review** *Chloroplasts are organelles. What are some other organelles found in a cell?*

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### Good to Know

The word *photosynthesis* can be divided into two parts: photo and synthesis. *Photo* comes from the Greek *phos* meaning “light;” *synthesis* comes from the Greek *sunthesis* meaning “to put together.” Photosynthesis puts together, or creates, new substances in the presence of light energy. What other words do you know that begin with the word part *photo*?

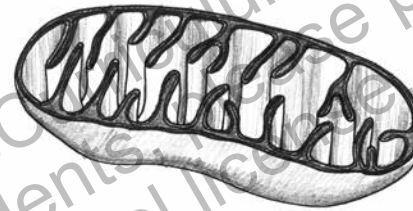
## Food into Fuel: Cellular Respiration

Energy is stored in food. But, cells can't use food as fuel. First, they need to convert the energy in food into a form they can use. They do this through cellular respiration.

In Chapter 2 you learned about mitochondria. These organelles are used during cellular respiration. Mitochondria are the “powerhouses” that produce energy. Plants and animals both have mitochondria.

How does cellular respiration work? It involves chemical reactions. Most of these reactions happen in the mitochondria. When oxygen is present, glucose is broken down into carbon dioxide and water. In the process, the energy that was stored in the glucose is released. The cell uses this energy to do work.

In a way, cellular respiration is the reverse reaction of photosynthesis. Photosynthesis uses carbon dioxide and water to produce glucose and oxygen.



*Cutaway diagram of a mitochondrion, an organelle used in cellular respiration*

### FOCUS QUESTIONS

1. In your own words, explain what photosynthesis is.

---



---

2. What two cell organelles are discussed in this section? What process is each involved in?

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### ACTIVE READER

**1 Identify** What is another word for glucose?

---

**2 Analyze** Why do you think mitochondria are known as “powerhouses”?

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## FOCUS

The underlined sentences tell why proteins are important in the body. Read this section to find out how the body creates proteins.

## Protein Building

Protein building is one of the most important functions of the cell. In the human body, proteins carry oxygen in the blood. They digest food and fight bacteria and viruses. Proteins also speed up chemical reactions.

## Structures of Proteins

Proteins are large molecules. They are made up of smaller “building block” molecules called **amino acids**. There are only twenty common amino acids. But, they can be combined in thousands of ways to make different kinds of proteins.

People eat food to get protein. Many animal and plant foods contain proteins or amino acids. Animal protein sources include fish, chicken, beef, pork, dairy products, and eggs. Plant protein sources include beans, peas, soy, nuts, seeds, and grains such as rice.



*Proteins come in many different forms. Spider webs and bird feathers are both made of proteins.*

## ACTIVE READER

**1 Analyze** Scientists have compared the 20 common amino acids to the 26 letters of the alphabet. Why is this a good comparison?

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## Good to Know

People get protein from food, but the protein in food isn't used directly. During digestion, the food proteins are broken down into amino acids. Ribosomes then assemble the amino acids into proteins the body can use.

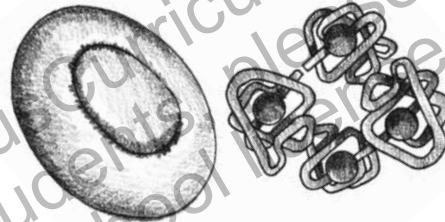
## Functions of Proteins

Proteins are the “worker molecules” of the body. They play a part in almost every activity that takes place in the body. Different proteins have different jobs. Some proteins are used to build the structures in an organism. For example, proteins such as collagen and keratin form bones, teeth, and hair. Proteins also help maintain the structure of blood vessels and other tissues.

**Antibodies** are immune system proteins. They fight invaders in the body, such as viruses. **Hemoglobin** is the protein that carries oxygen in your blood to all the parts of your body.

**Enzymes** are proteins that speed up chemical reactions. We could not live without enzymes. They speed up processes that would otherwise take a long time, such as food digestion and breathing.

*Red blood cells are saucer-shaped cells that contain hemoglobin, which is shown at the right. Hemoglobin is the protein that carries oxygen to the other cells in your body.*



### FOCUS QUESTIONS

1. What are amino acids, and what are they used for?

---



---

2. Why are enzymes important?

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---

### ACTIVE READER

**1 Identify** Underline the name of each specific protein described on this page.

**2 Describe** In your own words, describe the work of two of the proteins you underlined.

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### Conclusion

In this book you learned that cells are the basic unit of life. You discovered how plant cells and animal cells are alike and different. You learned about the structures that make up cells and the functions that cells perform. So the next time you eat a slice of pizza or take a run, think about the amazing work every cell in your body is doing.



Stop and Think

This page will help sum up what you have learned in Chapter 3. Use the tip to help you answer the questions.

1. Which of these is an example of diffusion?

- (1) a plant getting energy from sunlight
- (2) hair growing up through the scalp
- (3) an amoeba devouring a paramecium
- (4) the smell of perfume spreading through air

2. Which type of protein is responsible for speeding up chemical reactions?

- (1) hemoglobin
- (2) bacteria
- (3) enzymes
- (4) antibodies

Use the statement below and your knowledge of science to answer questions 3 and 4.

**Material can be transported across cell membranes by way of passive or active transport.**

3. How does passive transport work?

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---

4. How does active transport work?

---



---



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Dear Ms. Understanding,

Why is it called cellular respiration? Are the cells breathing or something?



*Respiring in Ronkonkoma*

Dear Respiring,

In a way, the cells are breathing! They are taking in oxygen and giving off carbon dioxide—like we do with our lungs when we breathe.



*Ms. Understanding*

**Tip:** If you can't remember the meaning of a new word, check the glossary.

# Glossary

**active transport** – the process by which the cell uses energy to move materials through the cell membrane

**amino acids** – building block molecules that make up proteins

**antibodies** – immune system proteins that fight bacteria and viruses

**cells** – basic structural and functional units of all living organisms

**cell membrane** – the thin layer that encloses the cytoplasm and controls the movement of substances into and out of the cell

**cell wall** – a tough, rigid layer that envelopes most plant cells and is located outside the cell membrane

**cellular respiration** – the process by which the energy stored in food is converted into a form of energy the cell can use

**chloroplasts** – organelles in plant cells that are used during photosynthesis

**cytoplasm** – the jelly-like fluid containing the contents of the cell (excluding the nucleus)

**cytoskeleton** – the framework in animal cells that gives the cell its structure

**diffusion** – the main form of passive transport, in which molecules move from a region of high concentration to a region of lower concentration

**enzymes** – proteins that speed up chemical reactions

**eukaryotes** – complex organisms whose cells contain a distinct nucleus and many other structures

**hemoglobin** – proteins in the red blood cells that carry oxygen to all the parts of the body

**mitochondria** – the “powerhouse” organelles that produce energy

**multicellular** – organisms that have many cells

**nucleus** – the part of the cell that directs the cell’s activities

**organs** – parts of the body made up of different types of tissues working together to perform a function

**organ system** – a group of organs that works together to perform a function

**organelles** – structures within a cell that perform certain functions

**organisms** – living things including plants, animals, bacteria, and fungi

**osmosis** – the diffusion of water molecules across a semipermeable membrane

**passive transport** – the process by which the cell transports materials through the cell membrane without using energy

**photosynthesis** – the process in which plants convert sunlight into food energy

**prokaryotes** – simple organisms that lack a cell nucleus and have very few organelles

**ribosomes** – organelles that produce proteins

**semipermeable** – allowing only certain substances to pass through

**tissues** – collections of cells with a common structure and function

**unicellular** – organisms that have only one cell

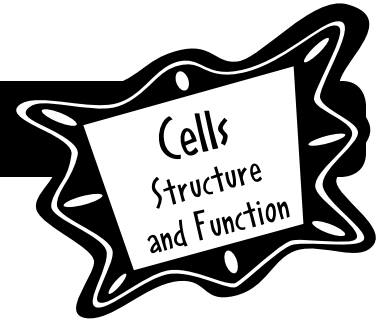
**FOCUS  
ON  
SCIENCE**

# Cells Structure and Function

Assessments

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# Check Understanding



In the Answer Document on this page, mark your answer in the row of circles for each question by filling in the circle that has the same number as the answer you have chosen.

1. How is active transport different from passive transport?

- (1) Active transport requires energy
- (2) Passive transport requires energy.
- (3) Active transport carries materials into cells.
- (4) Passive transport carries materials out of cells.

2. Which cell structure performs a function for a cell that is similar to the function that the brain carries out for a body?

- (1) vacuole
- (2) nucleus
- (3) chloroplast
- (4) Golgi body

3. What happens during cellular respiration?

- (1) Plants make energy from sunlight.
- (2) Wastes are transported out of the cell.
- (3) Water crosses a semipermeable membrane.
- (4) Food energy is converted into energy cells can use.

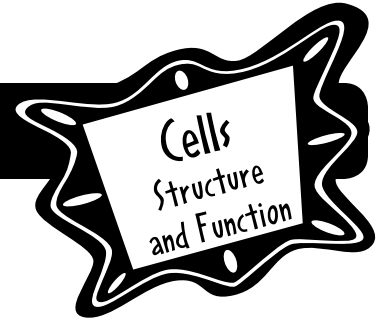
4. Which of the following organs is part of the digestive system?

- (1) liver
- (2) heart
- (3) lungs
- (4) brain

## Answer Document

- |    |   |   |   |   |    |   |   |   |   |
|----|---|---|---|---|----|---|---|---|---|
| 1. | ① | ② | ③ | ④ | 3. | ① | ② | ③ | ④ |
| 2. | ① | ② | ③ | ④ | 4. | ① | ② | ③ | ④ |

# Check Understanding



Base your answers to questions 5 and 6 on the photographs below.



Photograph A



Photograph B

5. What process is shown in the photographs?

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6. What happened to make the liquid in Photograph A become the liquid in Photograph B?

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**FOCUS  
ON  
SCIENCE**

# Cells Structure and Function

**Answer Key**

# Answer Key

Page 8: Starting Points  
Build Background

Use Your Knowledge: Answers will vary according to the student's prior knowledge.  
Think About It: Answers will vary according to the student's knowledge and questions.

Page 9: Starting Points  
Build Background  
Sort It:

Multi-celled organisms		Single-celled organisms
Plants	Animals	
rosebush	cat	bacteria
corn	elephant	amoeba
pine tree	human	

Page 10: Think Like a Scientist  
Five Minute Cell Hunt: Answers will vary.

Page 11: Starting Points  
Key Vocabulary

Rate Your Knowledge: Answers will vary depending on each student's knowledge.  
Use Word Parts to Unlock Meaning: extra-cellular – outside of the cell; multicellular – having many cells; chloroplast – green structure in plant cells where photosynthesis takes place; cytoplasm – contents of a cell within the plasma membrane (except the nucleus); unicellular – having one cell

Page 12: Starting Points  
Key Concepts

Active Reader: 1. They wear warmer clothes like coats, hats, and gloves.  
Hands On Science: Make Estimates: Answers will vary depending on the organisms students choose.

Page 13: Chapter 1

Active Reader: 1. Underline: That's because they couldn't see them. They couldn't see them because they didn't have the technology. 2. Circle: Robert Hooke; England

Page 14: Chapter 1

Active Reader: 1. blood cells; 2. little  
Focus Questions: 1. We could neither see nor study cells before the invention of the microscope. 2. Hooke: microscope, plant cells; Leeuwenhoek: blood cells, bacteria

Page 15: Chapter 1

Hands On Science: Learn the Parts of the Microscope: 1. ocular lens; 2. stage; 3. objectives; 4. light source/condenser; 5. fine adjustment knob; 6. Some detail is better viewed at a less powerful magnification.

Page 16: Chapter 1

Hands On Science: Microscope Investigations: Answers will vary.

Page 17: Chapter 1

Active Reader: 1. Circle: all plants are made of cells; Underline: all animals are made of cells; Put parentheses around: all cells were formed from cells that already exist.  
2. Answers will vary depending on the scientists chosen.

Page 18: Chapter 1

Active Reader: 1. No. Each scientist built on the work of the others.  
Focus Questions: 1. Answers will vary but students' responses should mention the three aspects of the cell theory—all living things are made of cells, single cells are the smallest form of a living thing, and all cells come from other cells.

Page 19: Chapter 1

Active Reader: 1. A bacteria is unicellular. A human is multicellular. 2. eukaryotic, prokaryotic

Page 20: Chapter 1

Active Reader: 1. Underline: skin cells, blood cells, muscle cells, bone cells, nerve cells; Circle: bone tissue, nerve tissue; Put parentheses around: stomach; 2. cell, tissue, organ, organ system



# Answer Key

Page 21: Chapter 1

Active Reader: 1. esophagus, liver, stomach, intestines; 2. Sample answer: lungs. They transfer oxygen to the blood.

Focus Questions: 1. Prokaryotes do not contain a nucleus; eukaryotes do. 2. Tissues are a collection of cells that perform a specific job. Organs are a collection of various types of tissues that work together.

Page 22: Chapter 1

Stop and Think: 1. (2); 2. (2); 3. Organs are made up of different types of tissues working together.; 4. An organ system is a group of organs that work together to perform a job.

Page 23: Chapter 2

Active Reader: 1. Prokaryotes have no nucleus. 2. Answers will vary but might include similar structures such as a nucleus, ribosomes, mitochondria, and different structures such as the cell wall that is present in plant cells, but not animal cells.

Page 24: Chapter 2

Active Reader: 1. A cell wall protects the cell and gives it shape. 2. A cytoskeleton in animal cells and a cell wall in plant cells both give the cell its shape.

Focus Questions: 1. All eukaryotic cells have a cell membrane, cytoskeleton, nucleus, and organelles. 2. To enter an animal cell, a substance has to pass through a cell membrane. To enter a plant cell, a substance must pass through a cell wall before reaching the cell membrane.

Page 25: Chapter 2

Active Reader: 1. nucleus; 2. Golgi bodies send substances to other parts of the cell.

Page 26: Chapter 2

Active Reader: 1. The vacuole in the animal cell is much smaller than the vacuole in the plant cell. 2. Lysosomes break down food particles and waste.

Page 27: Chapter 2

Active Reader: 1. Underline: The nucleolus makes the ribosomes. These are organelles that produce proteins. 2. Answers will vary, but the students may point out that the diagram has more explanatory information.

Page 28: Chapter 2

Active Reader: 1. photosynthesis  
Focus Questions: 1. Plant cells have a cell wall, which is missing in animal cells. They also have chloroplasts for photosynthesis, which animal cells do not. 2. Both plant and animal cells have structures such as a nucleus, nucleolus, and mitochondria. They also both have cytoplasm.

Page 29: Chapter 2

Stop and Think: 1. (2); 2. (2); 3. Sample answers: plant cell: A plant cell has a large vacuole.; 4. Sample answers: animal cell: An animal cell has a very small vacuole.

Page 30: Chapter 2

Hands On Science: Make a Cell Model: Responses will vary.

Page 31: Chapter 2

Hands On Science: Investigate Plant and Animal Cells: Responses will vary.

Page 34: Chapter 3

Active Reader: 1. Underline: Diffusion and osmosis are types of passive transport. 2. Examples will vary, but could include smoke from a chimney or dish soap in a sink full of water.

Page 35: Chapter 3

Active Reader: 1. Underline: transport proteins, transport by engulfing. 2. Circle: surround

Page 36: Chapter 3

Focus Questions: 1. Active transport requires energy on the part of the cell. Passive transport does not require the cell to use any energy. 2. In one form of active transport, proteins carry needed molecules into the cell. In transport by engulfing, the cell surrounds the molecule or single-celled organism and devours it.

Page 36: Chapter 3

Hands On Science: Egg Osmosis: Responses will vary.

# Answer Key

Page 37: Chapter 3

Active Reader: 1. Underline: The process of creating cell energy is called cellular respiration. 2. Answers will vary, but students may list lysosomes, ribosomes, mitochondria, golgi bodies, vacuoles, and others.

Page 38: Chapter 3

Active Reader: 1. sugar; 2. They are powerhouses because they produce the power, or energy.

Focus Questions: 1. Answers will vary depending on the student's knowledge of photosynthesis. 2. Chloroplasts are involved in photosynthesis. Mitochondria are involved in cellular respiration.

Page 39: Chapter 3

Active Reader: 1. The comparison is good because the twenty amino acids can be combined in many ways to create different proteins just as letters can be combined in many ways to create words.

Page 40: Chapter 3

Active Reader: 1. Underline: collagen, keratin, antibodies, hemoglobin, enzymes; 2. Answers will vary.

Focus Questions: 1. Amino acids are used in combination to create proteins. 2. Enzymes are important because they speed up processes within the body.

Page 41: Chapter 3

Stop and Think: 1. (4); 2. (3); 3. Passive transport. Small molecules move from an area of high concentration to an area of lower concentration.; 4. Active transport: When transport proteins pick up needed molecules outside the cell or by engulfing a smaller organism and devouring it.

Page 45: Assessments

Check Understanding: 1. (1); 2. (2); 3. (3); 4. (1)

Page 46: Assessments

Check Understanding: 5. diffusion; 6. The molecules in the dark liquid moved from an area of high concentration to nearby areas of lower concentration until the dark liquid was diffused throughout the clear liquid.