Section 4

Looking Inside Cells

Reading Preview

Key Concepts

- What role do the cell wall and cell membrane play in the cell?
- What are the functions of cell organelles?
- How are cells organized in many-celled organisms?

Key Terms

- organelle • cell wall
- cell membrane • cytoplasm
- mitochondria
- endoplasmic reticulum
- ribosome • Golgi body
- chloroplast • vacuole
- lysosome

Target Reading Skill

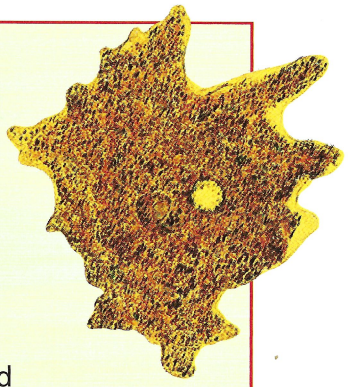
Previewing Visuals Before you read, preview Figure 24. Then write two questions that you have about the illustrations in a graphic organizer like the one below. As you read, answer your questions.

Plant and Animal Cells

Q. How are animal cells different from plant cells?
A.
Q.

Lab zone Discover Activity

How Large Are Cells?



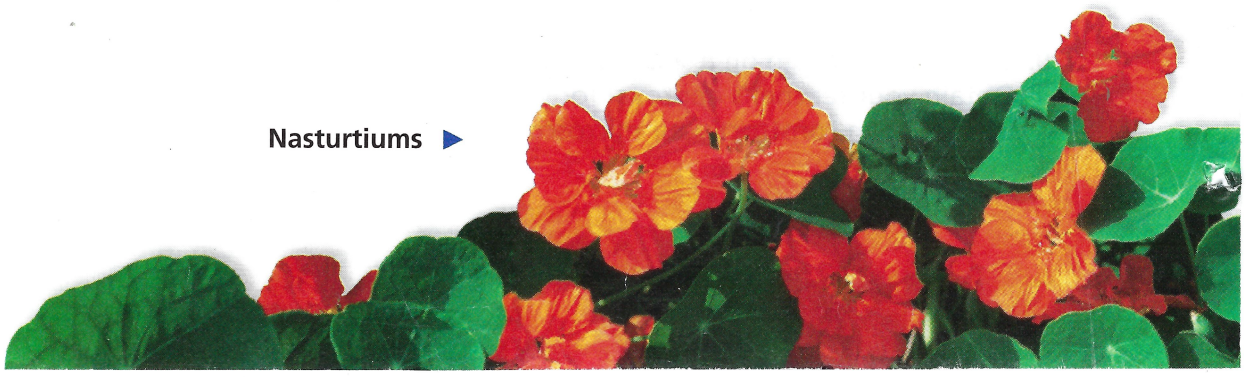
1. Look at the organism in the photo. The organism is an amoeba (uh MEE buh), a large single-celled organism. This type of amoeba is about 1 mm long.
2. Multiply your height in meters by 1,000 to get your height in millimeters. How many amoebas would you have to stack end-to-end to equal your height?
3. Many of the cells in your body are about 0.01 mm long—one hundredth the size of an amoeba. How many body cells would you have to stack end-to-end to equal your height?

Think It Over

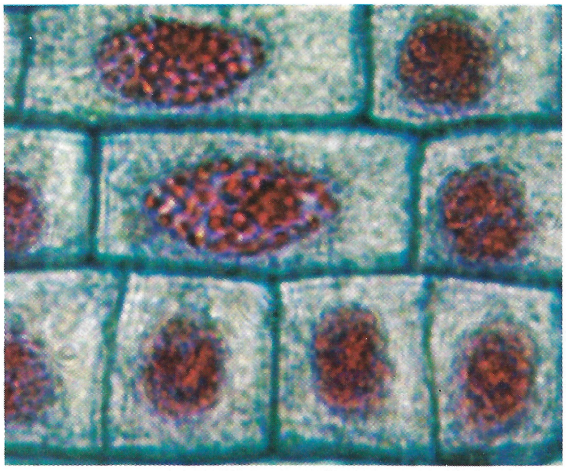
Inferring Look at a metric ruler to see how small 1 mm is. Now imagine a distance one one-hundredth as long, or 0.01 mm. Why can't you see your body's cells without the aid of a microscope?

Nasturtiums brighten up many gardens with green leaves and colorful flowers. How do nasturtiums carry out all the functions necessary to stay alive? To answer this question, you are about to take an imaginary journey. You will travel inside a nasturtium leaf, visiting its tiny cells. You will observe some of the structures found in plant cells. You will also learn some differences between plant and animal cells.

As you will discover on your journey, there are even smaller structures inside a cell. These tiny cell structures, called **organelles,** carry out specific functions within the cell. Just as your stomach, lungs, and heart have different functions in your body, each organelle has a different function within the cell. Now it's time to hop aboard your imaginary ship and sail into a typical plant cell.

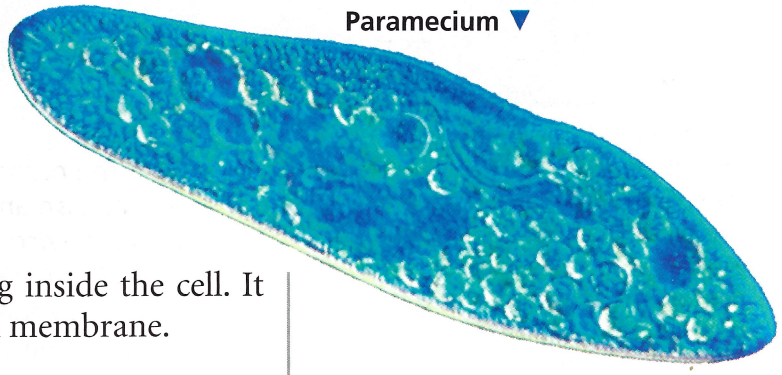


Nasturtiums ▶



◀ Onion root cells

Paramecium ▼



Enter the Cell

Your ship doesn't have an easy time getting inside the cell. It has to pass through the cell wall and the cell membrane.

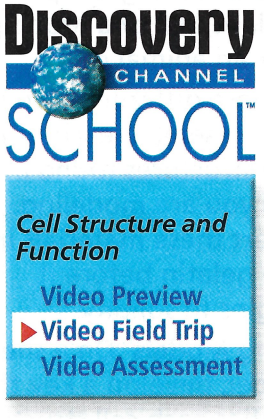
Cell Wall As you travel through the plant cell, refer to Figure 24 in this section. First, you must slip through the cell wall. The **cell wall** is a rigid layer of nonliving material that surrounds the cells of plants and some other organisms. The cells of animals, in contrast, do not have cell walls. **A plant's cell wall helps to protect and support the cell.** The cell wall is made mostly of a strong material called cellulose. Although the cell wall is tough, many materials, including water and oxygen, can pass through easily.

Cell Membrane After you sail through the cell wall, the next barrier you must cross is the **cell membrane.** All cells have cell membranes. In cells with cell walls, the cell membrane is located just inside the cell wall. In other cells, the cell membrane forms the outside boundary that separates the cell from its environment.

The cell membrane controls what substances come into and out of a cell. Everything the cell needs, from food to oxygen, enters the cell through the cell membrane. Fortunately, your ship can slip through, too. Harmful waste products leave the cell through the cell membrane. For a cell to survive, the cell membrane must allow these materials to pass in and out. In addition, the cell membrane prevents harmful materials from entering the cell. In a sense, the cell membrane is like a window screen. The screen allows air to enter and leave a room, but it keeps insects out.

Reading Checkpoint What is the function of the cell wall?

FIGURE 20
Cell Wall and Cell Membrane
The onion root cells have both a cell wall and a cell membrane. The single-celled paramecium has only a cell membrane.
Interpreting Photographs *What shape do the cell walls give to the onion root cells?*



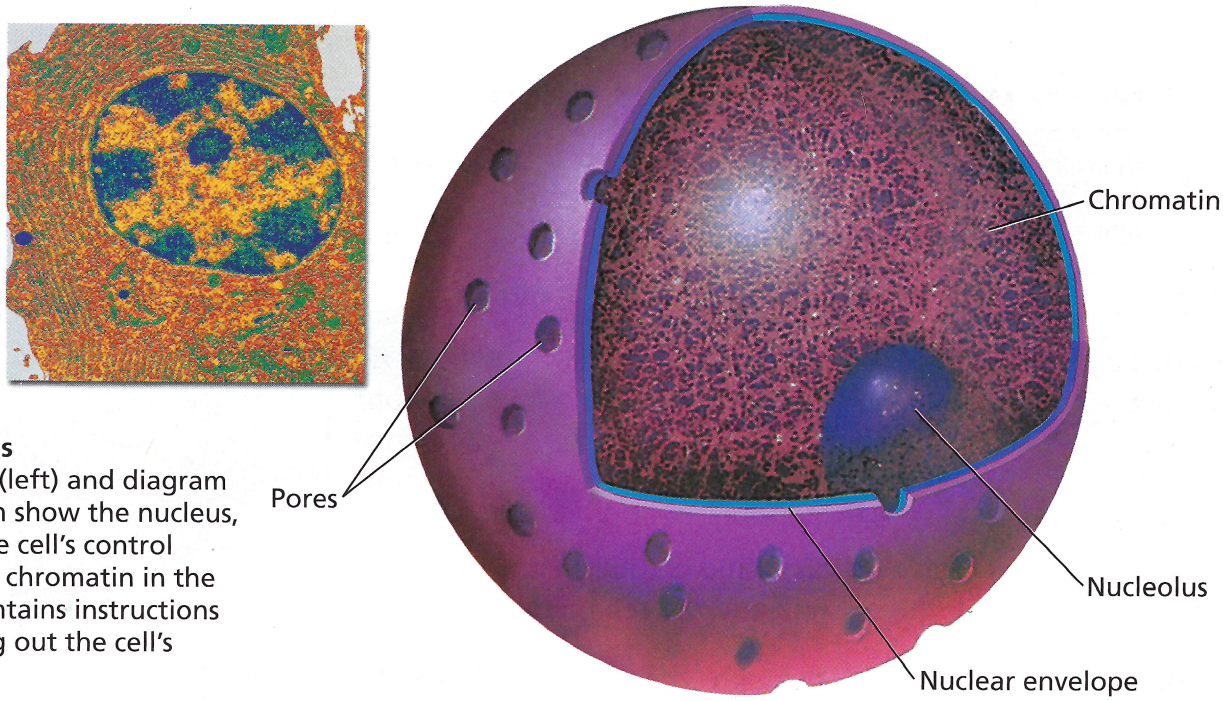


FIGURE 21
The Nucleus
The photo (left) and diagram (right) both show the nucleus, which is the cell's control center. The chromatin in the nucleus contains instructions for carrying out the cell's activities.

Sail On to the Nucleus

As you sail inside the cell, a large, oval structure comes into view. This structure, the nucleus, acts as the "brain" of the cell. **You can think of the nucleus as the cell's control center, directing all of the cell's activities.**

Nuclear Envelope Notice in Figure 21 that the nucleus is surrounded by a membrane called the nuclear envelope. Just as a mailing envelope protects the letter inside it, the nuclear envelope protects the nucleus. Materials pass in and out of the nucleus through pores in the nuclear envelope. So aim for that pore just ahead and carefully glide into the nucleus.

Chromatin You might wonder how the nucleus "knows" how to direct the cell. The answer lies in those thin strands floating directly ahead in the nucleus. These strands, called chromatin, contain genetic material, the instructions for directing the cell's functions. For example, the instructions in the chromatin ensure that leaf cells grow and divide to form more leaf cells.

Nucleolus As you prepare to leave the nucleus, you spot a small object floating by. This structure, a nucleolus, is where ribosomes are made. Ribosomes are the organelles where proteins are produced. Proteins are important chemicals in cells.

Reading Checkpoint **Where in the nucleus is genetic material found?**

Lab zone Try This Activity

Gelatin Cell

Make your own model of a cell.

1. Dissolve a packet of colorless gelatin in warm water. Pour the gelatin into a rectangular pan (for a plant cell) or a round pan (for an animal cell).
2. Choose different materials that resemble each of the cell structures found in the cell you are modeling. Insert these materials into the gelatin before it begins to solidify.

Making Models On a sheet of paper, develop a key that identifies each cell structure in your model. Describe the function of each structure.

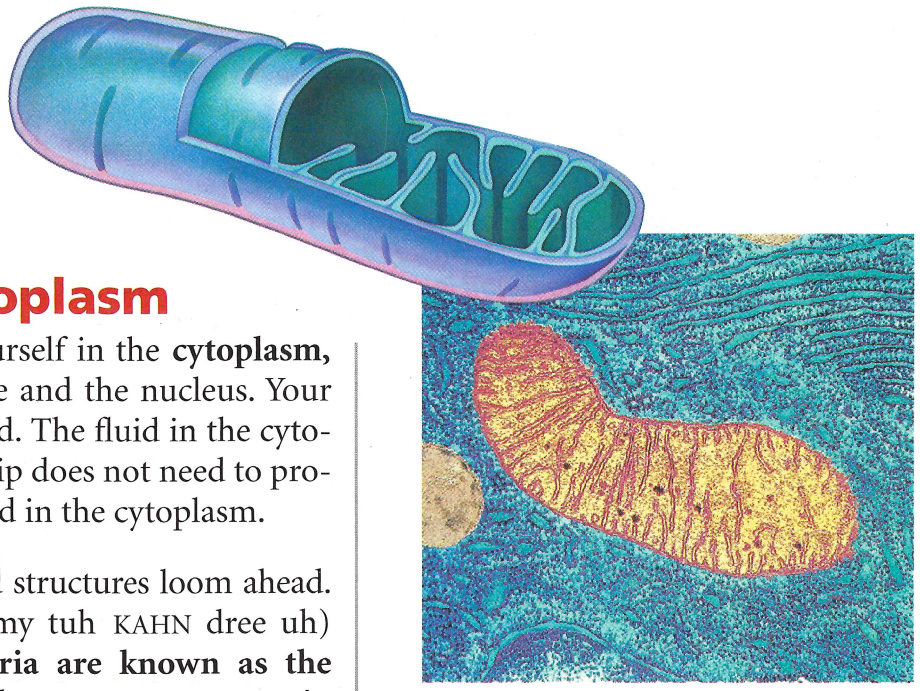


FIGURE 22 Mitochondrion
The mitochondria produce most of the cell's energy. **Inferring** *In what types of cells would you expect to find a lot of mitochondria?*

Organelles in the Cytoplasm

As you leave the nucleus, you find yourself in the **cytoplasm,** the region between the cell membrane and the nucleus. Your ship floats in a clear, thick, gel-like fluid. The fluid in the cytoplasm is constantly moving, so your ship does not need to propel itself. Many cell organelles are found in the cytoplasm.

Mitochondria Suddenly, rod-shaped structures loom ahead. These organelles are **mitochondria** (my tuh KAHN dree uh) (singular *mitochondrion*). **Mitochondria are known as the "powerhouses" of the cell because they convert energy in food molecules to energy the cell can use to carry out its functions.** Figure 22 shows a mitochondrion up close.

Endoplasmic Reticulum As you sail farther into the cytoplasm, you find yourself in a maze of passageways called the **endoplasmic reticulum** (en duh PLAZ mik rih TIK yuh lum). **The endoplasmic reticulum's passageways carry proteins and other materials from one part of the cell to another.**

Ribosomes Attached to some surfaces of the endoplasmic reticulum are small, grainlike bodies called **ribosomes.** Other ribosomes float in the cytoplasm. **Ribosomes function as factories to produce proteins.** Some newly made proteins are released through the wall of the endoplasmic reticulum. From the interior of the endoplasmic reticulum, the proteins will be transported to the Golgi bodies.

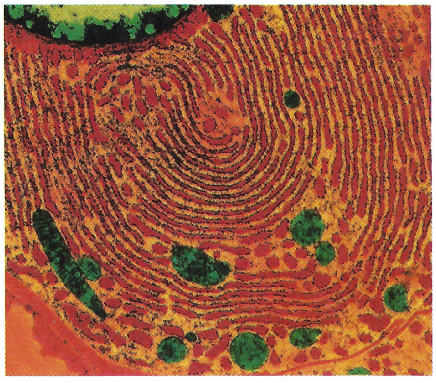


FIGURE 23
Endoplasmic Reticulum
The endoplasmic reticulum is similar to the system of hallways in a building. Proteins and other materials move throughout the cell by way of the endoplasmic reticulum. The spots on this organelle are ribosomes, which produce proteins.

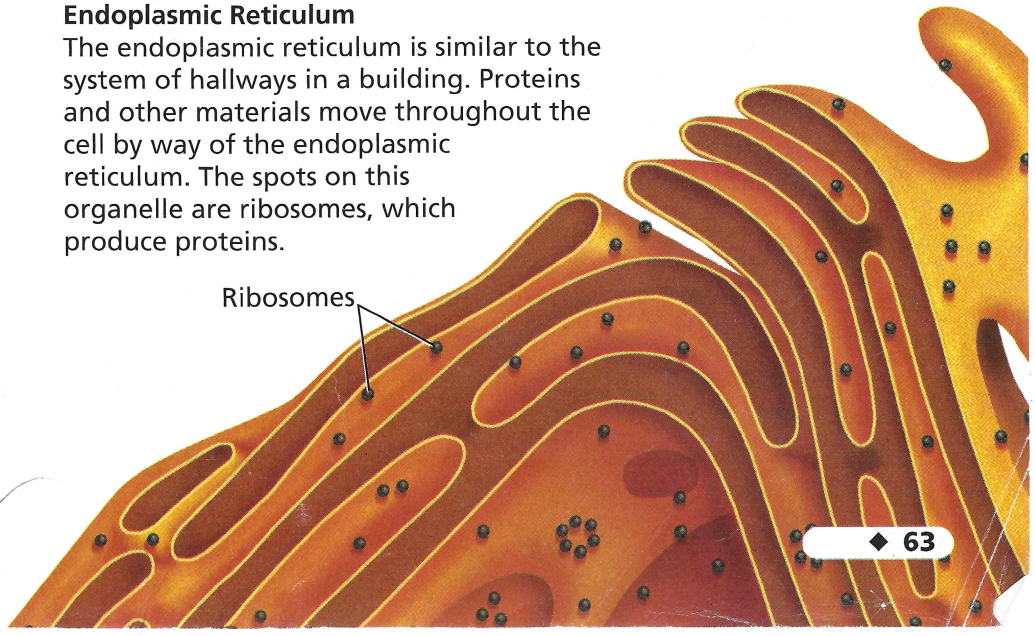
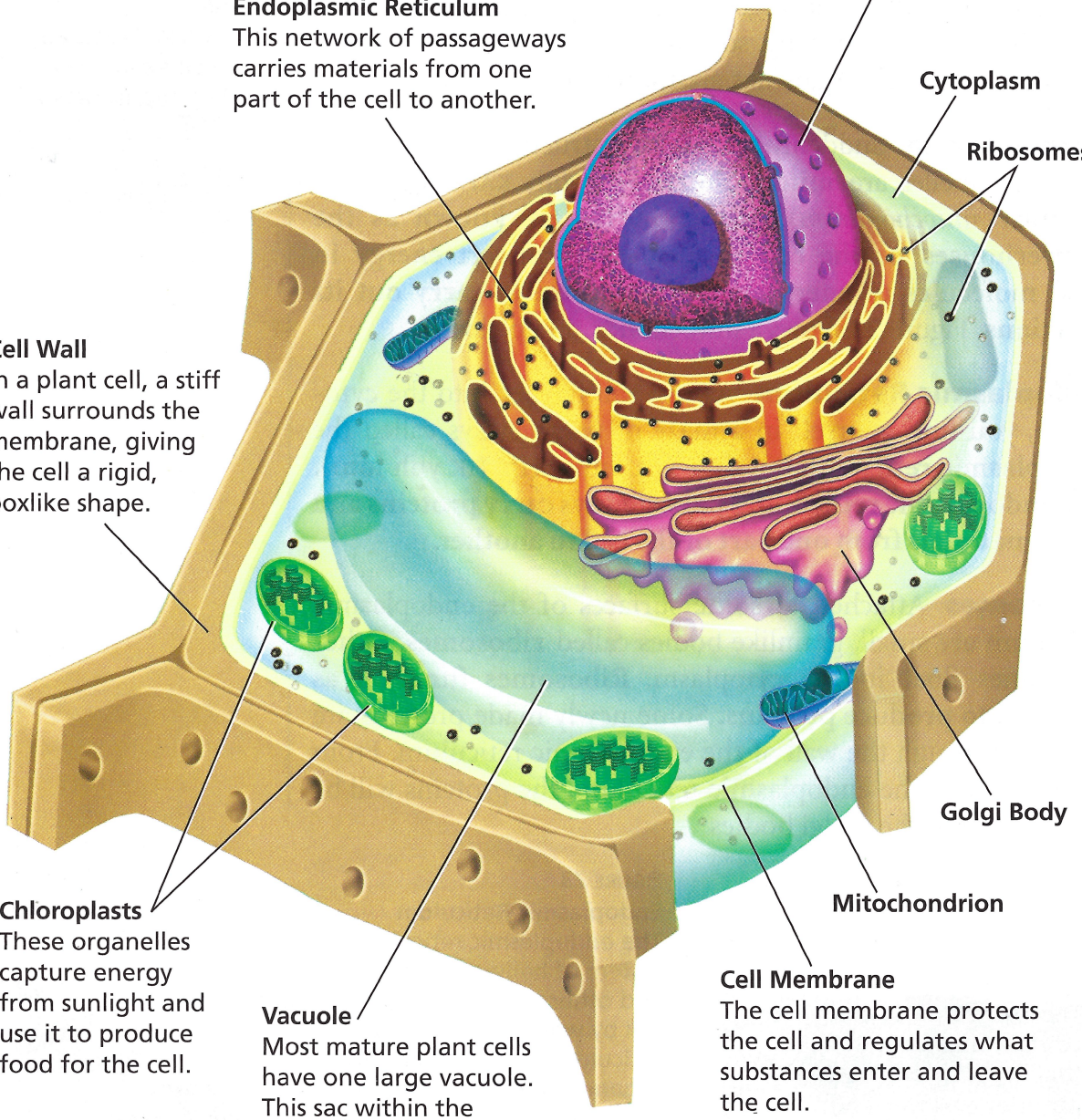


FIGURE 24

Plant and Animal Cells

These illustrations show typical structures found in plant and animal cells. **Comparing and Contrasting** *Identify one structure found in plant cells but not in animal cells.*



Plant Cell

Go Online
active art

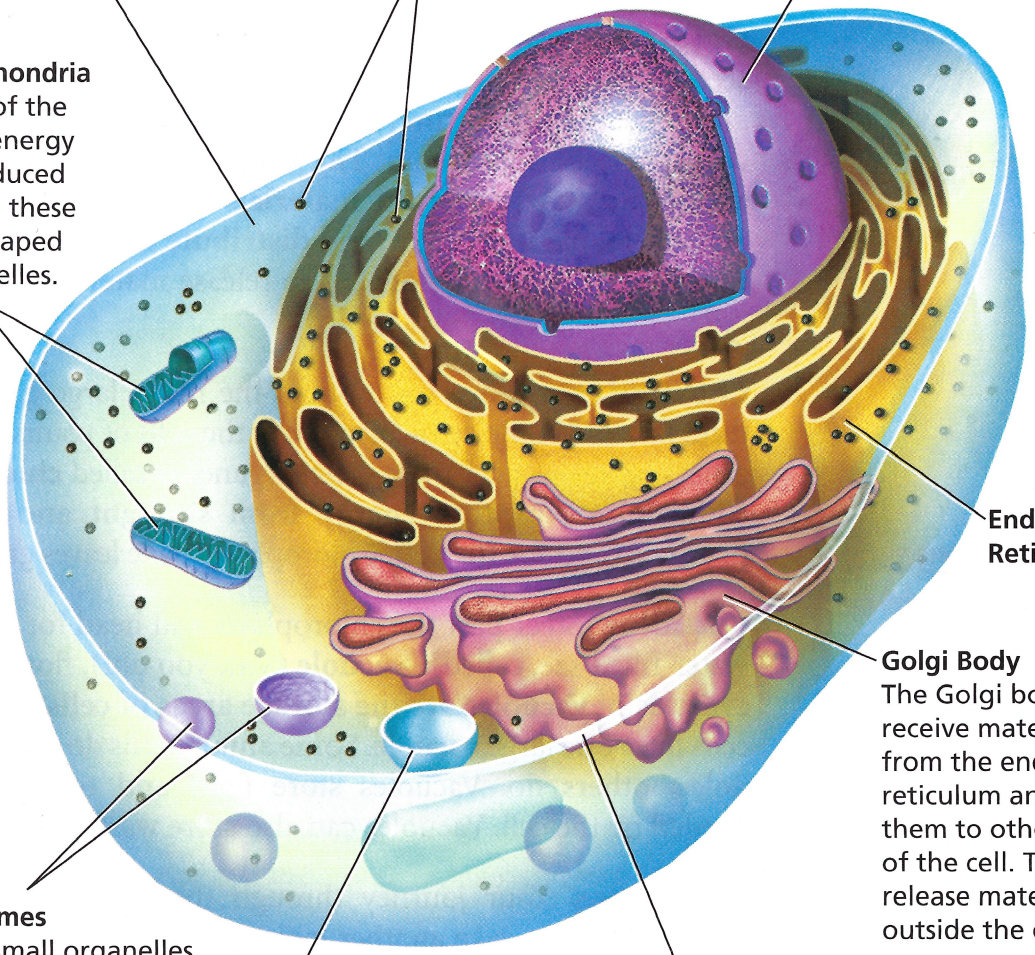
For: Plant and Animal Cells activity
Visit: PHSchool.com
Web Code: cep-3012

Cytoplasm
The cytoplasm includes a gel-like fluid in which many different organelles are found.

Ribosomes
These small structures function as factories to produce proteins. Ribosomes may be attached to the endoplasmic reticulum, or they may float in the cytoplasm.

Nucleus
The nucleus directs all of the cell's activities, including reproduction.

Mitochondria
Most of the cell's energy is produced within these rod-shaped organelles.



Endoplasmic Reticulum

Golgi Body
The Golgi bodies receive materials from the endoplasmic reticulum and send them to other parts of the cell. They also release materials outside the cell.

Lysosomes
These small organelles contain chemicals that break down food particles and worn-out cell parts.

Vacuole
Some animal cells have vacuoles that store food, water, waste, and other materials.

Cell Membrane
Since an animal cell does not have a cell wall, the cell membrane forms a barrier between the cytoplasm and the environment outside the cell.

Animal Cell

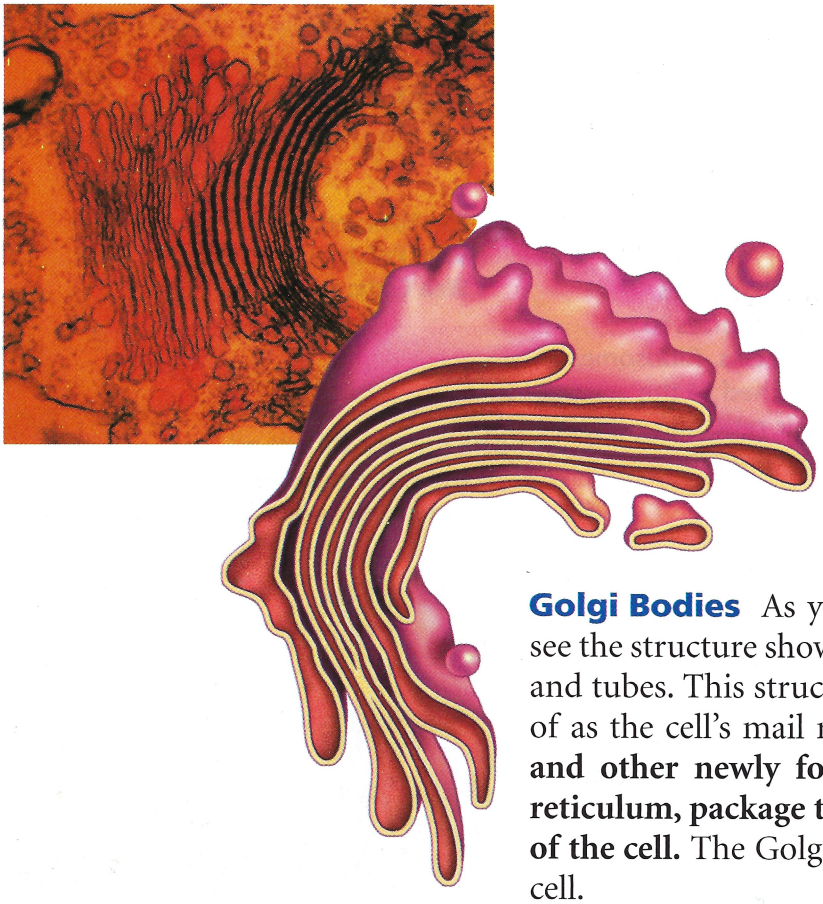


FIGURE 25
A Golgi Body
Golgi bodies are organelles that transport materials.
Applying Concepts *Why can a Golgi body be described as a cell's mail room?*

Golgi Bodies As you leave the endoplasmic reticulum, you see the structure shown in Figure 25. It looks like flattened sacs and tubes. This structure, called a **Golgi body,** can be thought of as the cell's mail room. **The Golgi bodies receive proteins and other newly formed materials from the endoplasmic reticulum, package them, and distribute them to other parts of the cell.** The Golgi bodies also release materials outside the cell.

Chloroplasts Have you noticed the many large green structures floating in the cytoplasm? Only the cells of plants and some other organisms have these green organelles called **chloroplasts. Chloroplasts capture energy from sunlight and use it to produce food for the cell.** Chloroplasts make leaves green.

Vacuoles Steer past the chloroplasts and head for that large, water-filled sac, called a **vacuole** (VAK yoo ohl), floating in the cytoplasm. **Vacuoles are the storage areas of cells.** Most plant cells have one large vacuole. Some animal cells do not have vacuoles; others do. Vacuoles store food and other materials needed by the cell. Vacuoles can also store waste products.

Lysosomes Your journey through the cell is almost over. Before you leave, take another look around you. If you carefully swing your ship around the vacuole, you may be lucky enough to see a **lysosome** (LY suh sohm). **Lysosomes are small, round structures containing chemicals that break down certain materials in the cell.** Some chemicals break down large food particles into smaller ones. Lysosomes also break down old cell parts and release the substances so they can be used again. In this sense, you can think of lysosomes as the cell's cleanup crew.

Reading Checkpoint **What organelle captures the energy of sunlight and uses it to make food for the cell?**

Lab zone Skills Activity

Observing

Observe the characteristics of plant and animal cells.

1. Obtain a prepared slide of plant cells from your teacher. Examine these cells under the low-power and high-power lenses of a microscope.
2. Draw a picture of what you see.
3. Repeat Steps 1 and 2 with a prepared slide of animal cells.

How are plant and animal cells alike? How are they different?

Specialized Cells

Plants and animals (including yourself) contain many cells. In a many-celled organism, the cells are often quite different from each other and are specialized to perform specific functions. Contrast, for example, the nerve cell and red blood cells in Figure 26. Nerve cells are specialized to transmit information from one part of your body to another, and red blood cells carry oxygen throughout your body.

In many-celled organisms, cells are often organized into tissues, organs, and organ systems. A tissue is a group of similar cells that work together to perform a specific function. For example, your brain is made mostly of nervous tissue, which consists of nerve cells. An organ, such as your brain, is made of different kinds of tissues that function together. In addition to nervous tissue, the brain contains other kinds of tissue that support and protect it. Your brain is part of your nervous system, which is an organ system that directs body activities and processes. An organ system is a group of organs that work together to perform a major function.

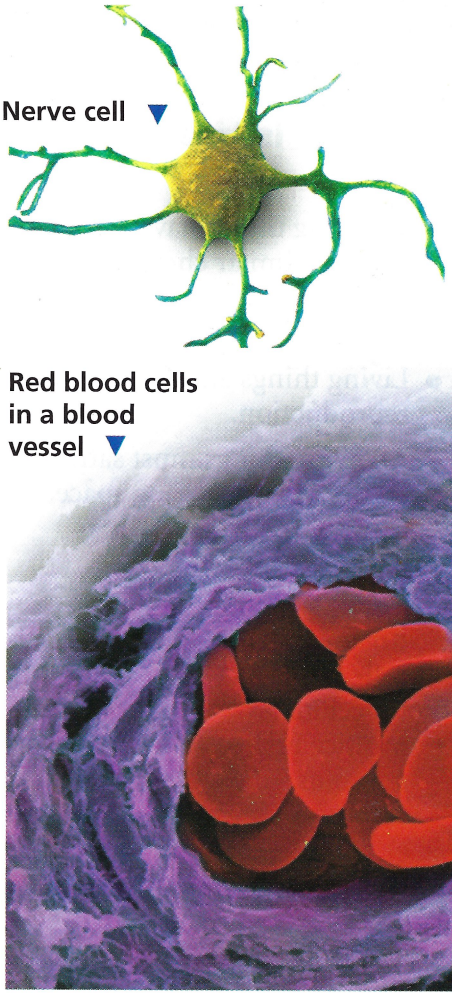


FIGURE 26 Specialized Cells Nerve cells carry information throughout the human body. Red blood cells carry oxygen.

Section 4 Assessment

Target Reading Skill **Previewing Visuals** Refer to your questions and answers about Figure 24 to help you answer the questions below.

Reviewing Key Concepts

1. a. **Comparing and Contrasting** Compare the functions of the cell wall and the cell membrane.
   b. **Inferring** How does cellulose help with one function of the cell wall?
2. a. **Identifying** Identify the functions of ribosomes and Golgi bodies.
   b. **Describing** Describe the characteristics of the endoplasmic reticulum.
   c. **Applying Concepts** How are the functions of ribosomes, Golgi bodies, and the endoplasmic reticulum related to one another?
3. a. **Reviewing** What is a tissue? What is an organ?
   b. **Explaining** What is the relationship among cells, tissues, and organs?
   c. **Inferring** Would a tissue or an organ have more kinds of specialized cells? Explain.

Writing in Science

Writing a Description Write a paragraph describing a typical animal cell. Your paragraph should include all the structures generally found in animal cells and a brief explanation of the functions of those structures.

Chapter 2 Study Guide

1 What Is Life?

Key Concepts

- All living things have a cellular organization, contain similar chemicals, use energy, respond to their surroundings, grow and develop, and reproduce.
- Living things arise from living things through reproduction.
- All living things must satisfy their basic needs for water, food, living space, and stable internal conditions.

Key Terms

organism
cell
unicellular
multicellular
stimulus
response
development
spontaneous generation
autotroph
heterotroph
homeostasis

2 Classifying Organisms

Key Concepts

- Biologists use classification to organize living things into groups so that the organisms are easier to study.
- The more classification levels that two organisms share, the more characteristics they have in common.
- Organisms are placed into domains and kingdoms based on their cell type, their ability to make food, and the number of cells in their bodies.

Key Terms

classification
taxonomy
binomial nomenclature
genus
species
prokaryote
nucleus
eukaryote

3 Discovering Cells

Key Concepts

- Cells are the basic units of structure and function in living things.
- The cell theory states the following: All living things are composed of cells. Cells are the basic units of structure and function in living things. All cells are produced from other cells.
- The invention of the microscope enabled people to learn about cells. Light microscopes magnify an object by bending light. Electron microscopes use electrons instead of light.

Key Terms

cell
microscope
cell theory

4 Looking Inside Cells

Key Concepts

- A plant's cell wall protects and supports the cell. The cell membrane controls what substances come into and out of a cell.
- The nucleus directs the cell's activities.
- Mitochondria convert energy in food molecules to energy the cell can use.
- The endoplasmic reticulum carries materials throughout the cell.
- Ribosomes produce proteins.
- The Golgi bodies receive materials, package them, and distribute them.
- Chloroplasts capture energy from sunlight and use it to produce food for the cell.
- Vacuoles are the storage areas of cells.
- Lysosomes contain chemicals that break down certain materials in the cell.
- In many-celled organisms, cells are often organized into tissues, organs, and organ systems.

Key Terms

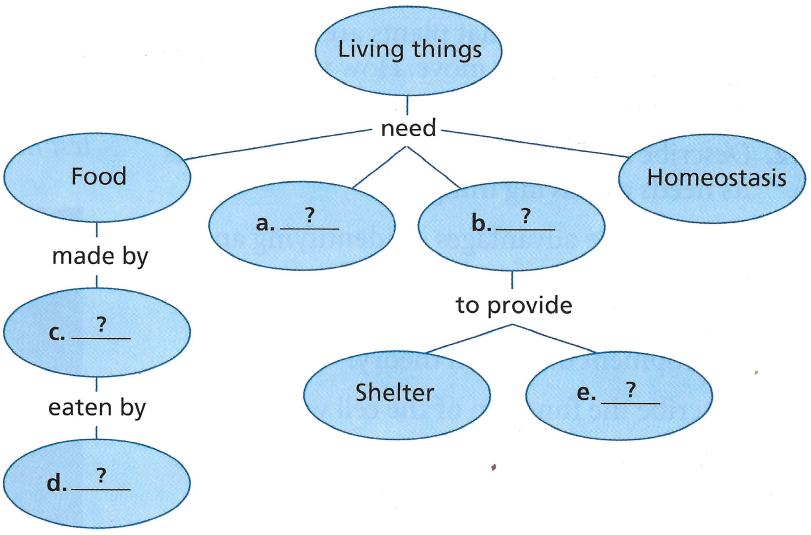
organelle
cell wall
cell membrane
cytoplasm
mitochondria
endoplasmic reticulum
ribosome
Golgi body
chloroplast
vacuole
lysosome

Review and Assessment

Go Online PHSchool.com
For: Links on proteins
Visit: www.SciLinks.org
Web Code: cha-1020

Organizing Information

Concept Mapping Copy the concept map about the needs of organisms onto a separate sheet of paper. Then complete it and add a title. (For more on Concept Mapping, see the Skills Handbook.)



Reviewing Key Terms

Choose the letter of the best answer.

1. The idea that life could spring from nonliving matter is called
   a. development.
   b. spontaneous generation.
   c. homeostasis.
   d. evolution.
2. The scientific study of how living things are classified is called
   a. development.
   b. biology.
   c. taxonomy.
   d. evolution.
3. A genus is divided into
   a. species. **b.** phyla.
   c. families. **d.** classes.
4. The basic units of structure in all living things are
   a. nuclei. **b.** organelles.
   c. tissues. **d.** cells.
5. In plant and animal cells, the control center of the cell is the
   a. chloroplast.
   b. cytoplasm.
   c. nucleus.
   d. Golgi body.

If the statement is true, write *true*. If it is false, change the underlined word or words to make the statement true.

6. Bacteria are <u>unicellular</u> organisms.
7. Linnaeus devised a system of naming organisms called <u>binomial nomenclature</u>.
8. The gray wolf, *Canis lupus*, and the red wolf, *Canis rufus*, belong to the same <u>species</u>.
9. Cells were discovered using <u>electron</u> microscopes.
10. <u>Ribosomes</u> produce proteins.

Writing in Science

Dialogue A dialogue is a conversation. Write a dialogue that might have taken place between Schleiden and Schwann. The scientists should discuss their observations and conclusions.

Discovery CHANNEL SCHOOL
Cell Structure and Function
Video Preview
Video Field Trip
Video Assessment

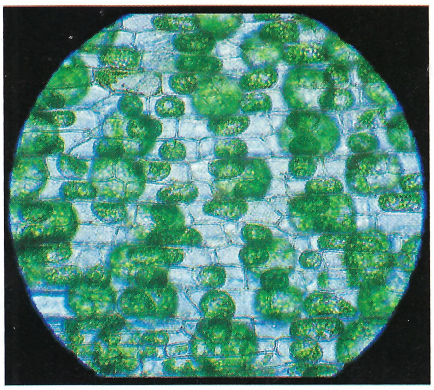
Review and Assessment

Checking Concepts

11. Your friend thinks that plants are not alive because they do not move. How would you respond to your friend?
12. Describe how your pet, or a friend's pet, meets its needs as a living thing.
13. What are the advantages of identifying an organism by its scientific name?
14. What role did the microscope play in the development of the cell theory?
15. Describe the function of the cell wall.
16. Which organelles are called the "powerhouses" of the cell? Why are they given that name?
17. How are cells usually organized in large multicellular organisms?

Thinking Critically

18. **Applying Concepts** How do you know that a robot is not alive?
19. **Inferring** Which two of the following organisms are most closely related: *Entamoeba histolytica, Escherichia coli, Entamoeba coli*? Explain your answer.
20. **Applying Concepts** The photograph below has not been artificially colored. Do the cells in the photo come from a plant or an animal? Explain your answer.

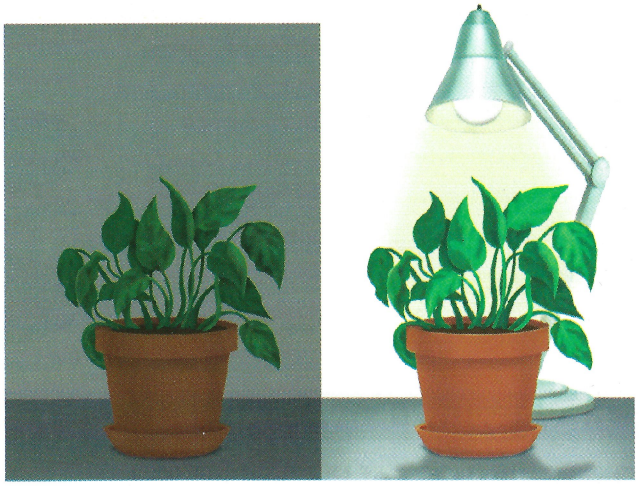


21. **Classifying** If you were trying to classify an unfamiliar organism by looking at its cells, what could the cells tell you?

Applying Skills

Refer to the illustrations below to answer Questions 22–25.

A student designed the experiment pictured below to test how light affects the growth of plants.



22. **Controlling Variables** Is this a controlled experiment? If so, identify the manipulated variable. If not, why not?
23. **Developing Hypotheses** What hypothesis might this experiment be testing?
24. **Predicting** Based on what you know about plants, predict how each plant will change in two weeks.
25. **Designing Experiments** Design a controlled experiment to determine whether the amount of water that a plant receives affects its growth.

Lab zone Chapter Project

Performance Assessment Prepare a display presenting your conclusion about your mystery object. Describe the observations that helped you to reach your conclusion. Compare your ideas with those of other students. If necessary, defend your work.