

Chapter 5

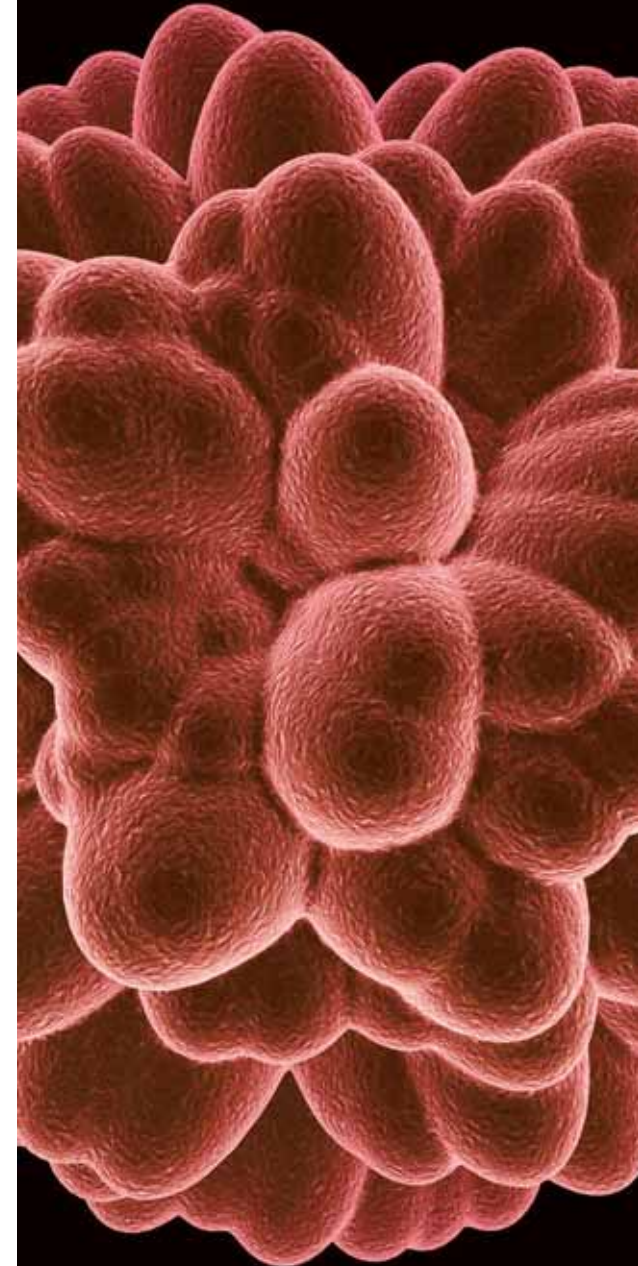
Cell Structure and Function

Can you name something that you know exists even though you can't see it with your eyes? A drop of pond water has tiny swimming organisms and small bits of plant material, but we can't always see them with our eyes. How do we know there are tiny things in a drop of pond water? We can use a microscope to view the pond water. There are instruments people use every day to help them see things they wouldn't usually be able to see. Have you ever used a pair of binoculars or a magnifying glass? Have you ever had an X-ray taken of an injury? Do you need to wear glasses or contact lenses to see clearly? Vision systems are even being developed to restore vision to blind people. In this chapter, you will take a journey into a small world that was discovered when the microscope was invented—the world of the cell. Imagine you could shrink yourself and walk into a tiny cell. What is it like inside a cell? It's a fascinating journey!



Key Questions

1. *What is a cell and how do we know cells exist?*
2. *Are human cells, animal cells, and plant cells all the same?*
3. *What is inside a cell, and how is a cell like a cookie factory?*



5.1 What Are Cells?

Look closely at the skin on your arm. Can you see that it is made of cells? Of course not! Your skin cells are much too small to see with your eyes. Now look at one square centimeter of your arm. That square centimeter contains about 100,000 skin cells. Cells are so small that they weren't even discovered until the invention of the microscope. What are cells and how were they discovered?

You are made of cells

A cell is the smallest unit of a living thing

A cell is the basic unit of structure and function in a living thing. Your body is composed of billions of cells. You have skin cells, muscle cells, nerve cells, blood cells, and many other types as well. Each type of cell has a unique structure and function, but they all share similarities. Figure 5.1 shows pictures of different types of cells found in your body.

A cell is the basic unit of structure and function in a living thing.

Each cell carries out the living functions

Each cell in your body shares the characteristics of all living things. Each cell can respond, grow, reproduce, and use energy. Like larger organisms, cells respond to changes in their surroundings in ways that keep them alive. In Chapter 2 we learned that this process is called *homeostasis*.

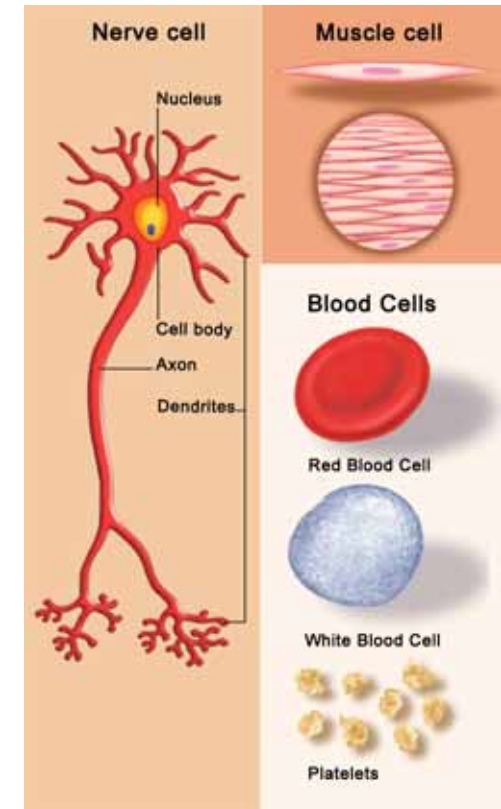
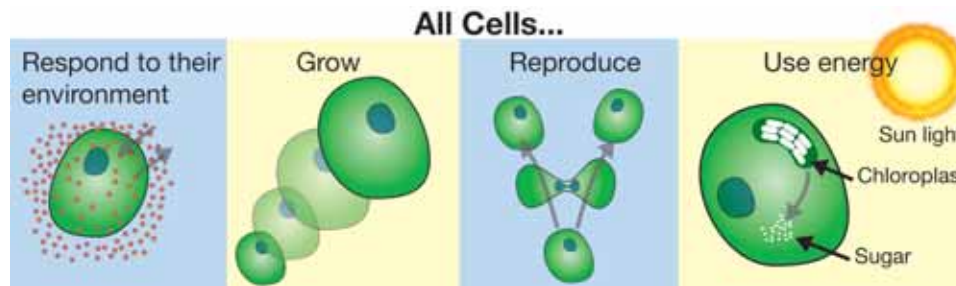
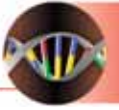


Figure 5.1: Different types of cells found in your body. Platelets are found in your blood but are particles, not cells.



Finding out about cells

- Robert Hooke discovered cells** How did we learn about cells? It all started with the invention of the microscope in the late 1500s. English scientist Robert Hooke (1635–1703) was the first to record his observations of cells. In 1663, he took a thin slice of cork and placed it under a microscope that he built. *Cork* is made from the bark of the cork oak tree, but its cells are no longer alive. Hooke made detailed sketches of his observations. An artist's version of one of his sketches is shown in Figure 5.2. Hooke called each of the square structures a *cell* because they reminded him of tiny rooms.
- Some organisms are made of a single cell** Anton van Leeuwenhoek (1632–1723) was not a scientist. He was a Dutch craftsman who made lenses. Yet with skill and curiosity, Leeuwenhoek made some of the most important discoveries in biology. He used his lenses to build a simple microscope. With his microscope, he looked at pond water, blood, and scrapings from his teeth. He was the first to observe single-celled protists, blood cells, and bacteria.
- All living things are made from cells** As microscopes improved, scientists made more discoveries. In 1839, two German scientists, Matthais Schleiden and Theodore Schwann, viewed plant and animal tissues under a microscope. They concluded that all plants and animals were made up of cells.
- Fluorescent microscopy** A new technique is called a fluorescent microscope. Cells usually do not glow. Scientists use fluorescent proteins to make cells glow. The cells absorb these proteins like stains. The fluorescent microscope uses filters that only let in light that matches the fluorescing material being studied. All other types of light are blocked out. The fluorescing areas shine out against a dark background, making certain cell structures glow. The mouse egg cells in Figure 5.3 have been treated to show DNA as a glowing blue.



Figure 5.2: Robert Hooke's sketch of cork cells looked like this.

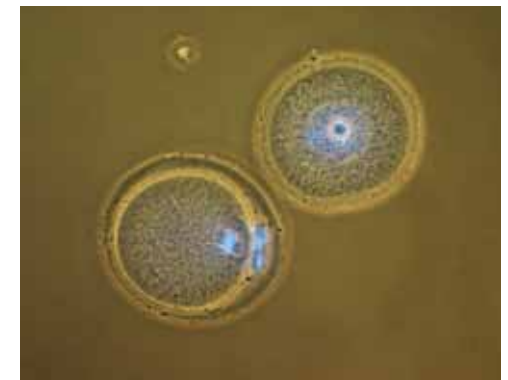


Figure 5.3: Mouse egg cells. The DNA is the glowing blue.

The cell theory

Cells only come from other cells

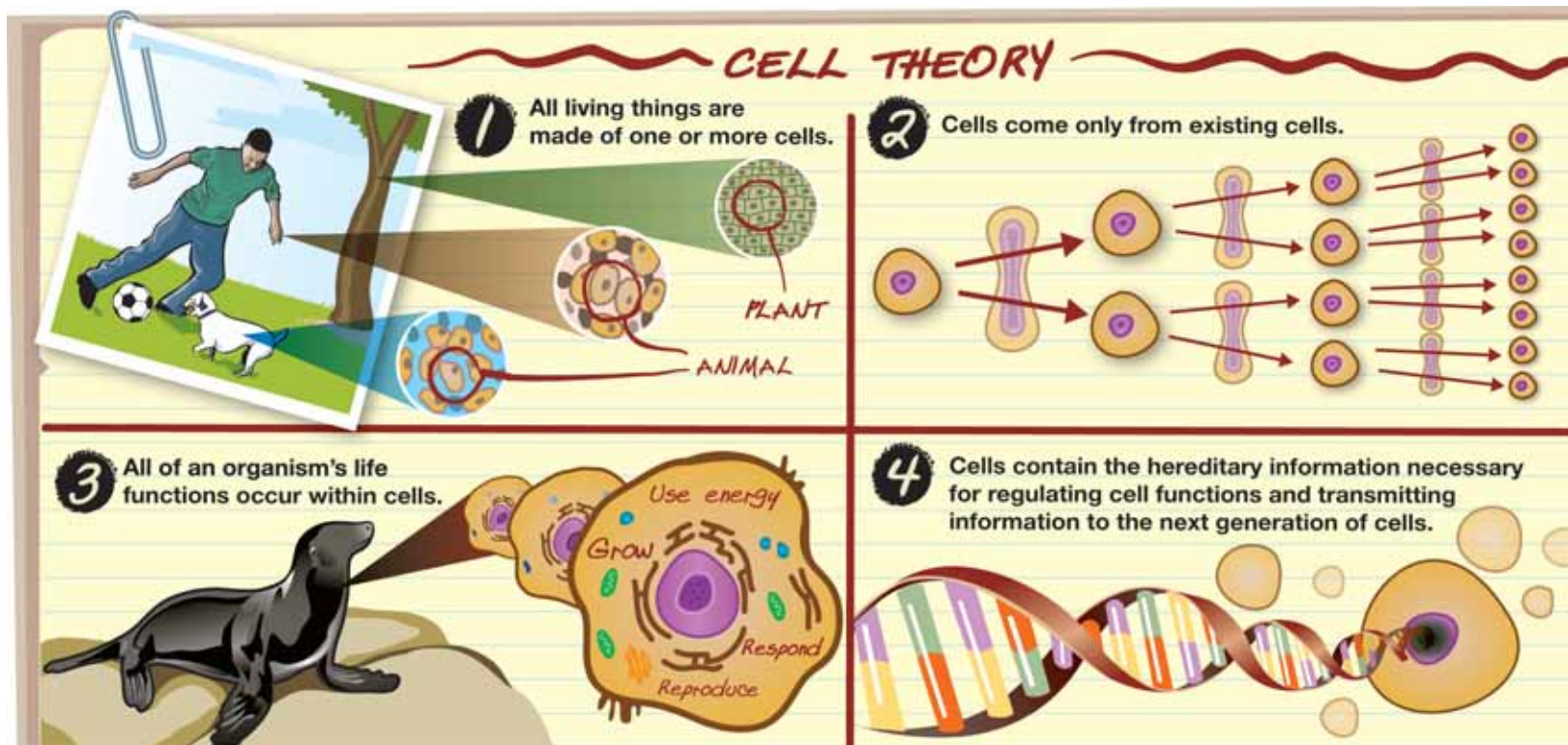
Schleiden and Schwann's theory was widely accepted by other scientists. But where did cells come from? In the 1800s it was believed that living things came from nonliving objects. Did cells come from some tiny, nonliving objects? In 1855, a German physician named Rudolf Virchow (1821–1902) proposed that cells can only come from other cells.

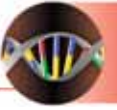
Statements of the cell theory

The work of Hooke, Leeuwenhoek, Schleiden, Schwann, Virchow, and others led to an important theory in life science. The **cell theory** explains the relationship between cells and living things.

VOCABULARY

cell theory - a theory that explains the relationship between cells and living things.





Similarities among cells

There are many different types of cells Some organisms are made of only a single cell. You are made of billions of cells. In multicellular organisms like you, there are many different types of *specialized* cells. For example, the cells that line the retina of your eye have a structure and function that is very different from your skin cells. About 200 different types of specialized cells make up the tissues and organs of your body.

There are different types of cells but all cells share similar characteristics.

All cells share some similarities Even though there are many different types of cells, they all share similar characteristics (Figure 5.4). These include:

1. **All cells are surrounded by a cell membrane.** The **cell membrane** is a barrier between the inside of the cell and its environment. It also controls the movement of materials into and out of the cell.
2. **All cells contain organelles.** An **organelle** is a structure inside of a cell that helps the cell perform its functions. Although all cells contain organelles, they don't all contain the same kinds. You'll learn more about the organelles in the next section.
3. **All cells contain cytoplasm.** The **cytoplasm** is a fluid mixture that contains the organelles. It also contains the compounds cells need to survive such as water, salts, enzymes, and other carbon compounds.
4. **All cells contain DNA.** The cell theory states that all cells come from other cells. When cells reproduce, they make copies of their DNA and pass it on to the new cells. DNA contains the instructions for making new cells and controls all cell functions.

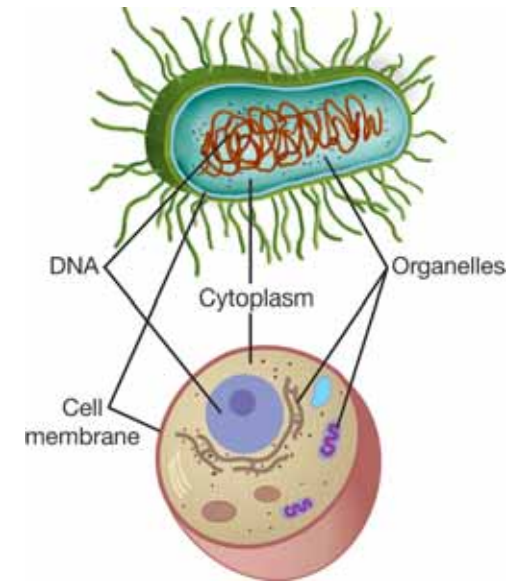


Figure 5.4: All cells have a cell membrane, organelles, cytoplasm, and DNA.

VOCABULARY

cell membrane - a separating barrier that controls movement of materials into and out of the cell.

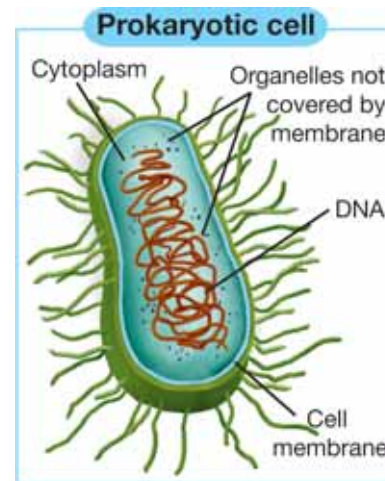
organelle - a structure inside of a cell that helps it perform its functions.

cytoplasm - a fluid mixture that contains the organelles and the compounds the cell needs.

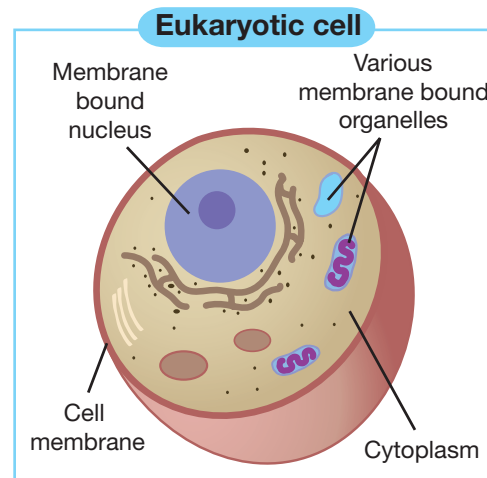
Classifying cells

Two types of cells Based on the organization of their structures, all living cells can be classified into two groups: prokaryotic and eukaryotic (Figure 5.5). Animals, plants, fungi, and protozoans all have eukaryotic cells. Only bacteria have prokaryotic cells.

Prokaryotic cells **Prokaryotic cells** do not have a nucleus. The word *prokaryotic* means “before nucleus” in Greek. Scientists believe that all life on Earth came from these cells. The oldest fossils of bacteria are estimated to be 3.5 billion years old. The DNA in a prokaryotic cell is bunched up in the center of the cell. The organelles are not covered with a membrane. All prokaryotic cells are much smaller than eukaryotic cells.



Eukaryotic cells **Eukaryotic cells** have a nucleus and membrane-covered organelles. The word *eukaryotic* means “true nucleus” in Greek. The oldest fossils of eukaryotic cells are about 2 billion years old. There is more DNA in these types of cells and it is found in the nucleus. These cells have membrane-covered organelles. They tend to be about ten times larger than prokaryotic cells.



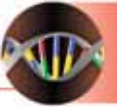
VOCABULARY

prokaryotic cell - a cell that does not have a nucleus or membrane-covered organelles.

eukaryotic cell - a cell that has a nucleus and membrane-covered organelles.

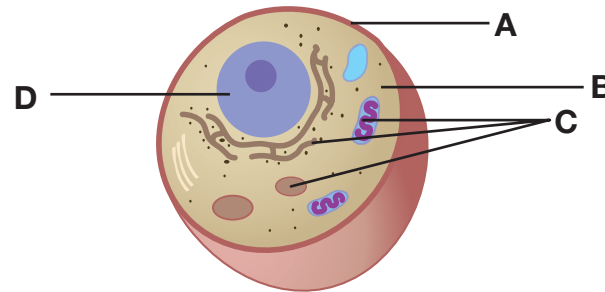
Prokaryotic cells	Eukaryotic cells
Bacteria	All other cells
No nucleus	Nucleus
Organelles not membrane-covered	Membrane-covered organelles
DNA is bunched up in the center of the cell	DNA is found in the nucleus

Figure 5.5: Comparing prokaryotic and eukaryotic cells.



5.1 Section Review

1. What is the basic unit of structure and function in a living thing called?
2. How did the invention of the microscope help scientists learn more about living things?
3. Who was the first to discover cells?
4. Draw a timeline that shows the dates, discoveries, and scientists involved in the development of the cell theory.
5. What are the four statements of the cell theory?
6. What are specialized cells? List three examples.
7. What are four similarities that all cells share?
8. List the cell part for each letter on the diagram below. What is the function of each part?



9. Classify each item below as having prokaryotic or eukaryotic cells.
 - a. *Streptococcus*, a bacteria that causes strep throat.
 - b. Yeast, a type of fungi use to make bread.
 - c. A euglena, a one-celled protozoan that uses a whip to move around.
 - d. *Acidophilus*, a bacteria used to make yogurt.

! CHALLENGE

1. Write a paragraph that agrees or disagrees with the following statement: "Muscle cells are completely different than nerve cells." Give the reasons for why you agree or disagree in your answer.
2. Explain three differences between molecules and cells.
3. Conduct Internet research to find out about the largest cell in the world.

5.2 Cells: A Look Inside

Imagine a factory that makes thousands of cookies a day. Ingredients come into the factory, get mixed and baked, then the cookies are packaged. The factory has many parts that contribute to the process. Can you name some of those parts and their functions? A cell is a lot like a cookie factory. It too has many parts that contribute to its processes. Let's compare a cell to a cookie factory.

Comparing a cell to a cookie factory

Parts and functions A cookie factory has many parts. The cytoplasm of a cell has many *organelles*. Figure 5.6 shows a fictional cookie factory. A typical animal cell and its parts are shown on the next page. Table 5.1 compares a cookie factory to an animal cell. As you read this section, refer to the table to help you remember the cell parts and their functions.

Table 5.1: Comparing a cell and a cookie factory

Process	Cookie factory part	Cell part
Ingredients in/products out	Factory gate and doors	Cell membrane
Control center	Manager's office	Nucleus
Energy	Power plant	Mitochondria
Storage	Storage room	Vacuole
Making the product	Mixing/baking room	Ribosome
Transport of materials	Conveyer belts	Endoplasmic reticulum
Packaging and distribution	Shipping room	Golgi body
Clean up and recycling	Custodial staff	Lysosome
Structure/support	Walls and studs	Cytoskeleton

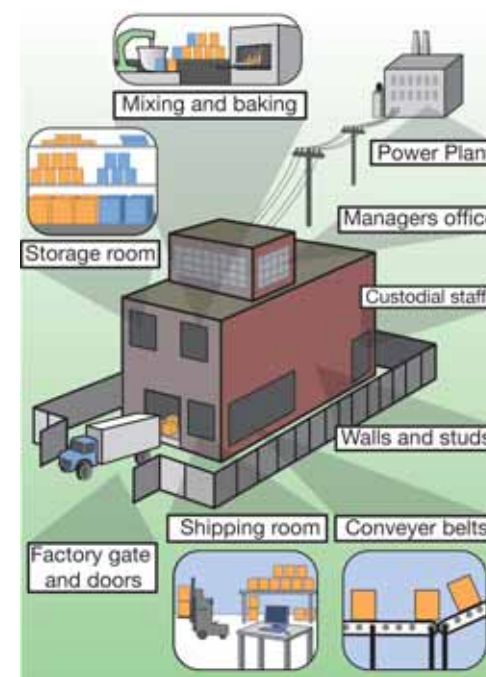


Figure 5.6: The parts of a cookie factory.



An **analogy** is a comparison of one thing to another different thing. The cookie factory is a good analogy for remembering cell parts and their functions. After reading this section, make another analogy comparing your school to a cell.

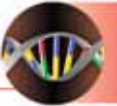
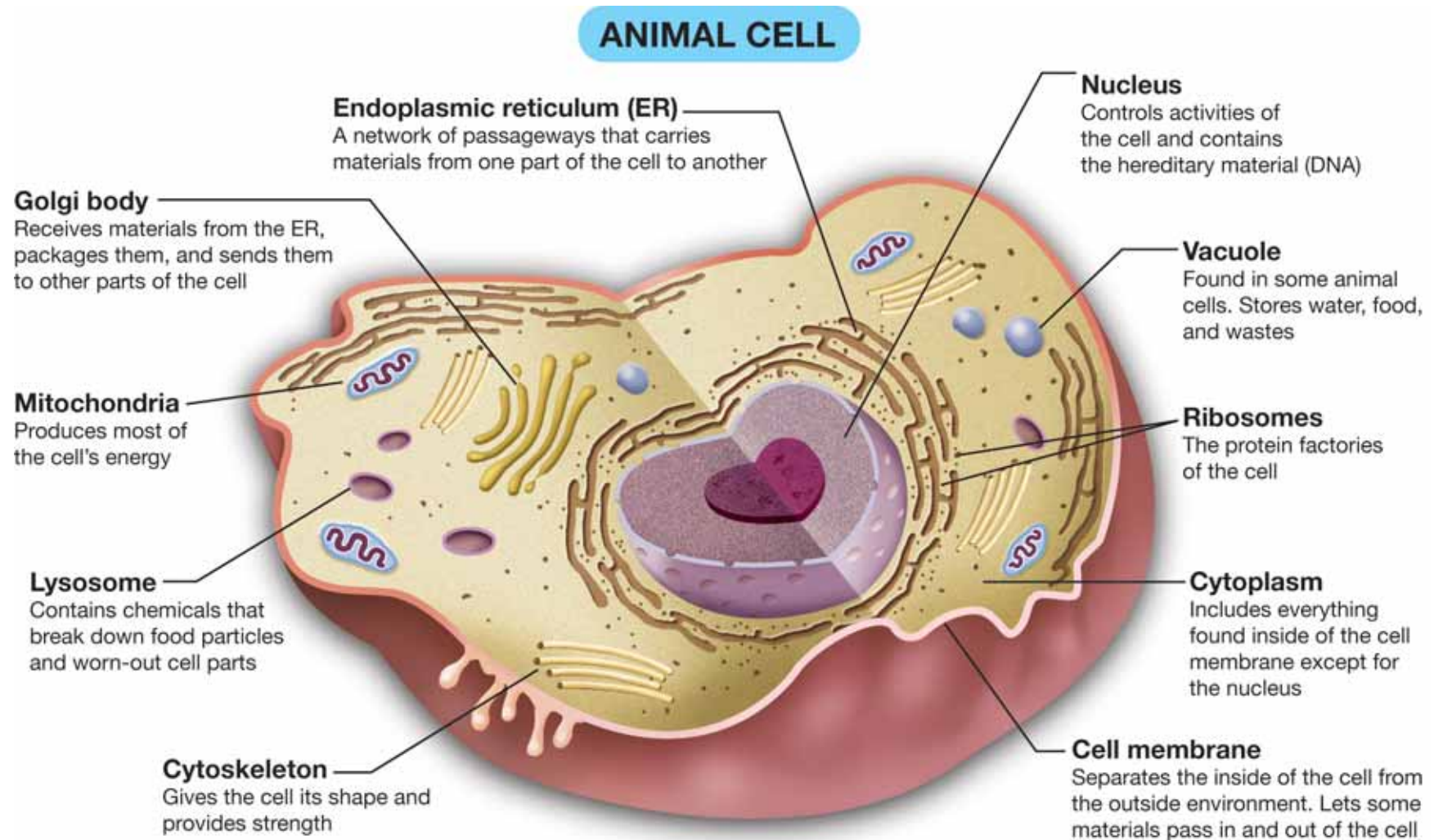


Diagram of an animal cell

The picture below is a schematic drawing of an animal cell. Under a microscope, you would not be able to see many of the organelles.

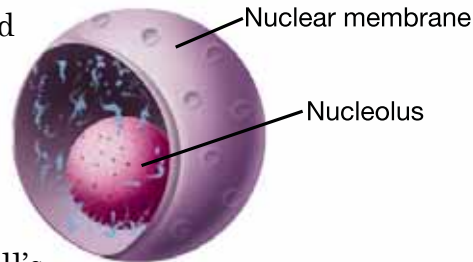


The cell membrane and nucleus

Looking at cells under a microscope To make cell parts visible under a microscope, you can apply a stain to the cells. A *stain* is a dye that binds to certain compounds in cells. Some stains bind to proteins while others bind to carbohydrates. Methylene blue is a stain often used to look at animal cells. It binds to proteins and makes the nucleus of the cell stand out. It also makes individual cells stand out by staining the cell membrane (Figure 5.7).

The cell membrane The cell membrane is a thin layer that separates the inside of the cell from its outside environment. It keeps the cytoplasm inside while letting waste products out. It also lets nutrients into the cell. It is made out of lipids and proteins. A cell membrane is kind of like your skin. Your skin lets water and other materials pass through and separates your internal parts from the outside.

The nucleus is the control center The most visible organelle in a eukaryotic cell is the nucleus. The nucleus is covered with a membrane that allows materials to pass in and out. It's often called the “control center” of the cell because it contains DNA. As you have learned, DNA is the hereditary material that carries all of the information on how to make the cell's proteins. You might say it's kind of like a recipe book.



The nucleolus If you look closely at the nucleus of a cell under a microscope, you may see an even darker spot. This spot is called the *nucleolus*. It acts as a storage area for materials that are used by other organelles.

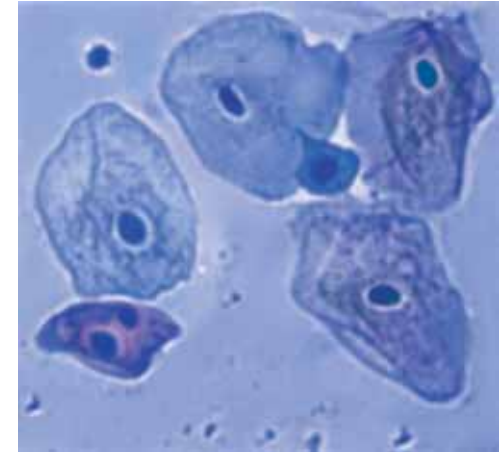
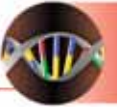


Figure 5.7: These human cheek cells have been stained with methylene blue. How many cells do you see? Can you identify the nucleus in each cell?



Cells are not flat objects like they appear in this text. They are three-dimensional just like you are. A cell that appears circular on paper is really shaped like a ball.

Find everyday objects that remind you of the different organelles inside of a cell. Collect those objects and make a table listing the object and the organelle it reminds you of.



Organelles and their functions

Seeing the other organelles Even with a powerful microscope, it's difficult to see organelles other than the nucleus. Scientists use different techniques like fluorescent microscopy to make organelles stand out. Figure 5.8 shows cells that have been treated to make the mitochondria stand out (the red dots).

Many discoveries about organelles were made using an *electron microscope*. This type of microscope uses tiny particles called *electrons*, instead of reflected light, to form images.

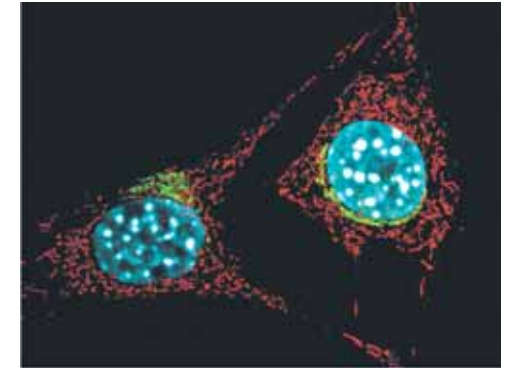
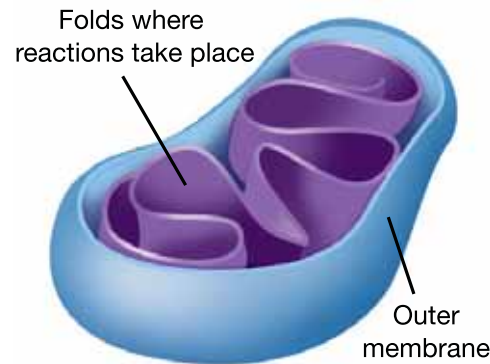


Figure 5.8: These mouse cells have been prepared to show mitochondria and the nucleus. The mitochondria appear as glowing red structures.

Mitochondria: the powerhouse of the cell **Mitochondria** are called the “powerhouses” of cells because they produce much of the energy a cell needs to carry out its functions. They are rod-shaped organelles surrounded by two membranes. The inner membrane contains many folds, where chemical reactions take place. Mitochondria can only work if they have oxygen. The reason you breathe air is to get enough oxygen for your mitochondria. Cells in active tissues—like muscle and liver cells—have the most mitochondria.



Mitochondria produce much of the energy a cell needs to carry out its functions.

Vacuoles: storage areas of the cell In some animal cells, you will find small, fluid-filled sacs called vacuoles. A **vacuole** is the storage area of the cell. Vacuoles store water, food, and waste. Plant cells usually have one large vacuole that stores most of the water they need.

VOCABULARY

mitochondria - an organelle that produces much of the energy a cell needs to carry out its functions.

vacuole - an organelle that stores food, water, and other materials needed by the cell.

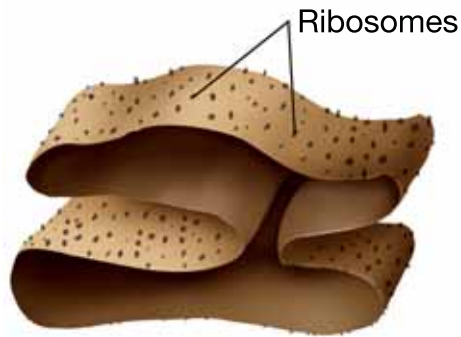
Endoplasmic reticulum The **endoplasmic reticulum** (ER) is a series of tunnels throughout the cytoplasm. They transport proteins from one part of the cell to another. You can think of the ER as a series of folded and connected tubes. There are different places to enter and exit in various locations.

Ribosomes If you look closely at the ER, you can sometimes see little round grains all around it. Each of those tiny grains is an individual ribosome. **Ribosomes** are the protein factories of the cell. When ribosomes make proteins, they release them into the ER. Some ribosomes are not attached to the ER, but float in the cytoplasm.

Golgi bodies **Golgi bodies** receive proteins and other compounds from the ER. They package these materials and distribute them to other parts of the cell. They also release materials outside of the cell. The number and size of Golgi bodies found in a cell depends on the quantity of compounds produced in the cell. The more compounds produced, the more and larger Golgi bodies there are. For example, a large number of Golgi bodies are found in cells that produce digestive enzymes.

Lysosomes **Lysosomes** contain enzymes that can break things down. Lysosomes pick up foreign invaders such as bacteria, food, and old organelles and break them into small pieces that can be reused.

Cytoskeleton The **cytoskeleton** is a series of fibers made from proteins. It provides structure to the cell and gives it its shape. Figure 5.9 shows a cell that has been treated so the cytoskeleton stands out.



VOCABULARY

endoplasmic reticulum - an organelle that transports proteins inside of the cell.

ribosome - an organelle that makes proteins.

Golgi body - an organelle that receives proteins, packages them, and distributes them.

lysosome - an organelle that contains enzymes that break things down to be reused by the cell.

cytoskeleton - a series of protein fibers inside of a cell that give structure and shape to the cell.

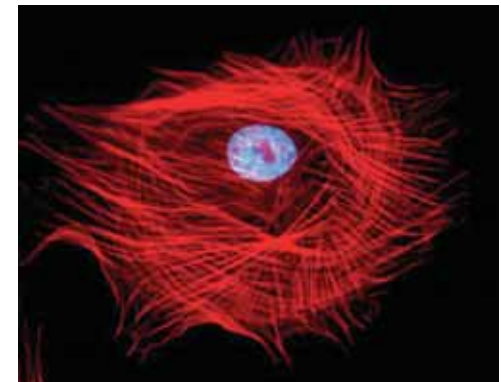


Figure 5.9: This cell was treated to make the cytoskeleton stand out.

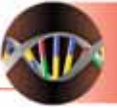
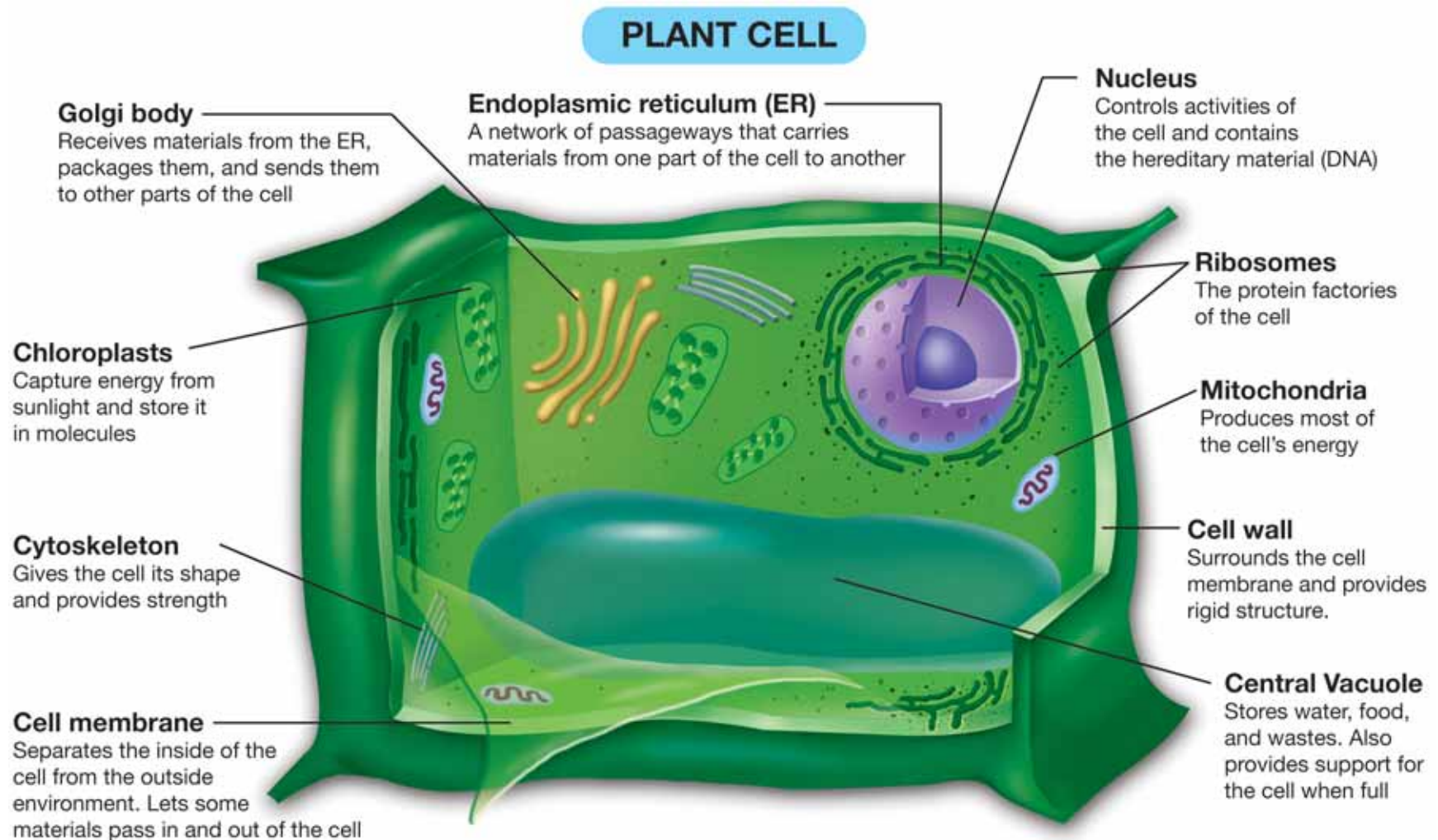


Diagram of a plant cell

Plant cells are different from animal cells. Here is a diagram of a typical plant cell.



How plant cells are different from animal cells

Figure 5.10 shows that plant and animal cells look very different. Their differences are described below.

Plant cells have chloroplasts

Plant cells have chloroplasts, but animal cells do not. A **chloroplast** is an organelle that contains a pigment called *chlorophyll*. Chloroplasts are organelles that convert light energy into chemical energy in the form of molecules. This process is called *photosynthesis*.

Plant cells have a large, central vacuole

Plant cells have a large central vacuole that stores *cell sap*. The major component of cell sap is water. Cell sap also consists of sugars, amino acids, and ions. When these vacuoles are full of cell sap, they help give plant cells their structure and rigidity.

Plant cells have a cell wall

Plant cells have a cell wall, but animal cells do not. The **cell wall** is made of a carbohydrate called *cellulose*. Cell walls provide structure and support for the plant. Unlike the cell membrane, the cell wall is able to withstand high internal pressure. The buildup of water inside the central vacuole provides pressure against the cell wall. When a plant needs water it wilts because the central vacuoles in its cells are empty. They no longer push against the cell walls to keep the plant upright. Watering the plant restores water in the central vacuoles.

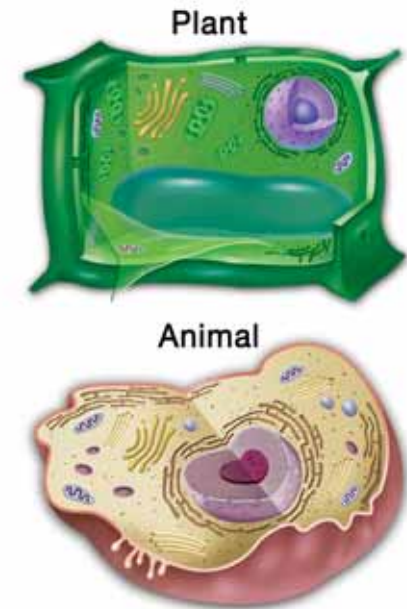
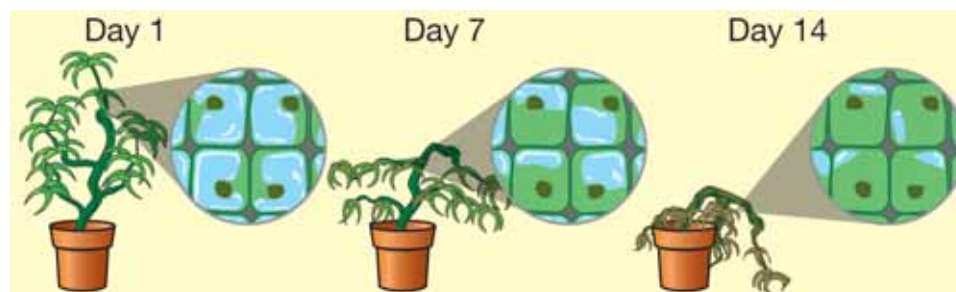
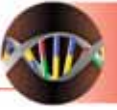


Figure 5.10: *How are plant cells different from animal cells?*

VOCABULARY

chloroplast - an organelle that converts light energy into chemical energy in the form of molecules.

cell wall - the outer layer of a plant cell that is made from cellulose and makes plant cells rigid.



5.2 Section Review

1. Name the correct organelle for each function in the table below.

Organelle	Function
	Produces much of the energy a cell needs to carry out its functions
	Makes proteins.
	Controls all activities of the cell and contains the hereditary material
	Packages proteins and distributes them to other parts of the cell
	Lets materials pass into or out of the cell
	Stores water, food, and wastes
	Transports proteins inside of the cell

2. The plant cell wall is made of:
- glucose
 - protein
 - cellulose
 - lipids
3. A *Venn diagram* shows how two or more things are similar and different. Place the organelles into the Venn diagram in Figure 5.11. What do your results tell you about the differences between plant and animal cells?
4. What is the function of the cell wall? Why do plant cells need a cell wall?



What effect on the function of a cell would occur if one of the following organelles was missing? Write a sentence for each organelle.

- ribosome
- lysosome
- vacuole
- mitochondria
- chloroplast
- cell membrane

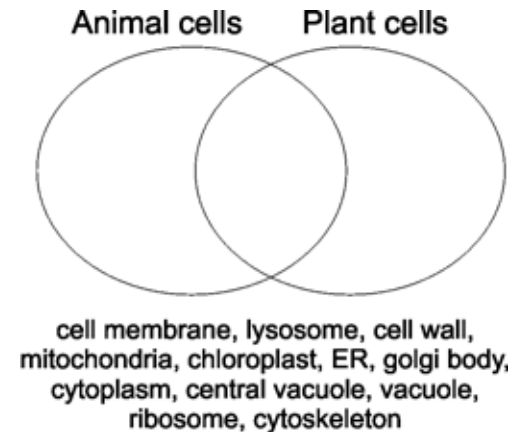


Figure 5.11: Complete the Venn diagram for question 3.



Organ Transplants

How many ways do living things protect themselves? You can probably think of dozens of examples. Roses have thorns. Rabbits are quick. Pigeons fly in flocks. Have you ever thought about this? What is the most important way that many living things, including people, protect themselves? The answer might surprise you.

All living things must protect themselves against disease. Like other living things, people are under constant assault from bacteria, viruses, and other organisms. Our immune systems fight off these organisms.

What happens when a foreign cell enters your body? It causes a quick response from your immune system. A variety of cells attack the invader. At the heart of your immune system are cells called

lymphocytes. These are a type of white blood cell. Lymphocytes can grab onto foreign cells and help remove them from your body.

For your immune system, the world divides into “us” and “them.” “Us” means every cell in your body. “Them” means almost everything else on Earth. The immune system attacks “them.” This can be a problem with organ transplants.



Photo - courtesy of CDC

The problem with transplants

Hindu doctors in South Asia may have transplanted skin 2,600 years ago. Such grafts took skin from one part of a person's body. It replaced damaged skin in another part of the same person's body. This is still done today.

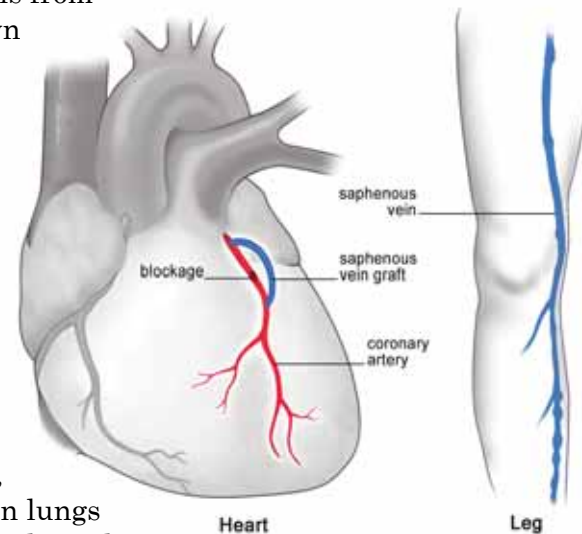
The immune system ignores this kind of transplant. The tissues “match” exactly. All of the cells came from the same body. For the same reason, heart bypass operations use blood vessels from the patient's own body to replace blocked heart arteries.

Modern medicine is able to transplant many organs besides skin and blood vessels.

Kidneys, livers, hearts, and even lungs have been transplanted.

Transplants save people's lives. In each case, the patient's immune system must be overcome. The immune system may see the transplant as an invader. This is called “rejection.”

Antigens are on the surface of cells. They tell your immune system whether a cell is “us” or “them.” Two types of antigens cause rejection. One is found on red blood cells. The other is called transplantation, or *histocompatibility*, antigens. These are found on every cell in your body except red blood cells. The main transplantation antigens are called the human leukocyte antigens, or HLA. Your genes



determine your HLA. Only identical twins have the same genes. An organ could be transplanted from one identical twin to another without rejection. In every other case, doctors need to match organs. Doctors look for as close a match as they can between the HLA of the patient and the person who donated the organ.

Tissue-matching

Matching antigens is more often called “tissue matching” or “tissue typing.” Both blood type and HLA are matched as closely as possible.

Lymphocytes are used for HLA matching. Blood typing is simple. But there are many more HLA antigens. Tissue matching is more complicated than blood typing. In simple terms, lymphocytes from the donor and the patient are tested. The same chemicals are used on each set of cells. A certain chemical may kill both. Then the donor and patient have that one antigen in common. The lymphocytes may both survive. Then the donor and patient both lack that antigen. The lymphocytes of just the donor may be affected, but not the patient. The HLA does not match.

This process is repeated many times to test for different antigens. Even when the donor and patient seem to match well, there is a final test. Lymphocytes from the donor are tested against blood serum from the patient. If this test fails, the transplant is usually not done.

These tests are done in a laboratory. Trained technicians do the tests under the direction of a pathologist. This medical doctor specializes in body tissues and fluids.



Photo - courtesy of CDC

The future of transplants

A transplant has the best chance of success when the donor and the patient are related. The chance of a complete match is best between siblings. Brothers and sisters may donate bone marrow or a kidney to one another. Most other transplants, however, come from people who donate their organs when they die.

An exact tissue match can only happen with identical twins.

Most transplant patients must take drugs to stop their immune systems from rejecting the new tissue. There are side effects with this approach.

Many more people could be helped if organs could be transplanted as easily as blood. One idea is to change a patient's immune system so that it would still fight infections but not attack a donated organ.

Scientists have made this work in laboratory mice. In 2005, Navy doctors made it work with monkeys. If it can work safely in people, organ transplants might become the easiest way to treat many diseases in the future.

Questions:

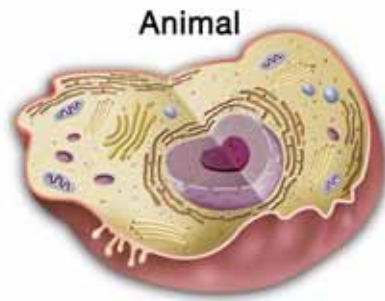
1. What specialized cells are the “heart” of your immune system?
2. What doctors are believed to have done the first organ transplants, and when did they do them?
3. Why do you think a living thing's immune response is called its “most important” way of protecting itself?
4. How might organ transplants in the future be done as easily as blood is transfused today?



CHAPTER ACTIVITY

Building a Scale Model of a Cell

Cells appear in all shapes and sizes. In animals, cells can be long like the motor neurons that run from the tips of your toes to the base of the neck. Other cells in your body can be small like the red blood cells. Cell models are a good way to help you identify cell structures. Often it is not clear how the size of the cell is related to the size of the organelles. In this activity, you will explore the relationship of cell size to organelle size by creating a scale model.



What you will do

1. Complete the table (right). Use a scale factor of 1 micrometer = 1 centimeter. The calculation for the diameter of the cell is completed for you.
2. Obtain a large sheet of paper from your teacher.
3. Measure the diameter of the cell (35 centimeters) and draw a circle on your paper. This will be the outline of your animal cell. Cut out the circle out of the paper.
4. Using your calculation, make a nucleus to scale using the colored-construction paper your teacher has provided.
5. Make and add the rest of the organelles. Be sure to use the animal cell diagram on page 99 as a guide in making your organelles. For example, you could make a golgi body that consists of 5 separate parts, 7×2 micrometers each.

6. Once the model is complete, label the organelles. Or you may wish to make a key that identifies each organelle.

Organelle	Average Size (μm)	Scaling Factor ($1 \mu\text{m} = 1 \text{ cm}$)	Model Size (cm)
Cell Diameter	35	$35 \mu\text{m} \times 1 \text{ cm}/\mu\text{m}$	35
Nucleus	5		
Mitochondria	6×2		
Lysosome	2		
Endoplasmic Reticulum	5×10		
Golgi Body	7×2		
Vacuole	2		
Ribosome	.02		

Applying your knowledge

- a. What is the smallest organelle in a typical animal cell?
- b. What is the largest organelle in a typical animal cell?
- c. How is your model of the cell different than models the teacher used in class, or models you may see in a text book?
- d. This method does not apply only to cells. Can you think of other examples where scale models are used?
- e. How might you build a 3-dimensional scale model of a cell? With a classmate, propose a method for creating a scaled 3-dimensional model of a cell with all the organelles. What types of things could one use to represent the cell boundaries? What things might one use to represent the organelles? Begin by writing up your ideas in a proposal. Your teacher may ask you to build your model as a project.

Chapter 5 Assessment

Vocabulary

Select the correct term to complete the sentences.

cell membrane	cytoskeleton	mitochondria
cell wall	endoplasmic reticulum	organelle
nucleus	golgi body	prokaryotic
cytoplasm	lysosome	ribosome

Section 5.1

1. Bacteria are _____ cells.
2. The _____ controls what enters and exits the cell.
3. A structure inside a cell that does a certain job is called an _____.
4. The fluid mixture with organelles and other vital compounds in cells is the _____.
5. Eukaryotic cells all have a _____ that contains DNA.

Section 5.2

6. The _____ is the organelle that transports materials like proteins around the cell.
7. Fibers inside the cell that give structure and shape are called the _____.
8. Muscle cells have a lot of _____ to produce the large amounts of energy necessary to do their work.
9. A _____ is a protein factory in the cell.
10. Enzymes found in a _____ are used to break down old cell parts that are then recycled by the cell.
11. Proteins move from the ribosome to the _____ for packaging before distribution around the cell.
12. Animal cells can change shape to move because they don't have a _____, which is what makes plant cells rigid.

Concepts

Section 5.1

1. Which of the following is not part of the cell theory?
 - a. Cells only come from existing cells.
 - b. All of an organism's life functions occur within cells.
 - c. The two major types of cells are prokaryotic cells and eukaryotic cells.
 - d. All living things are made of one or more cells.
2. Identify each characteristic as either a feature of prokaryotic cells (P) or as a feature of eukaryotic cells (E).
 - a. _____ name means “before nucleus” in Greek
 - b. _____ believed to have originated 2 billion years ago
 - c. _____ DNA is contained in nucleus
 - d. _____ larger of the two types - 10 times the size of the other
 - e. _____ have organelles without membrane covers

Section 5.2

Match the organelles to the most appropriate item that performs the same function to complete these analogies.

- | | |
|------------------------|--------------|
| _____ 3. ER | a. nutshell |
| _____ 4. cell wall | b. warehouse |
| _____ 5. vacuole | c. brain |
| _____ 6. cell membrane | d. highway |
| _____ 7. nucleus | e. skin |
8. Which part of the cell is like a recipe book?
 - a. nucleolus
 - b. DNA
 - c. cell membrane
 - d. none of the above
 9. The _____ is the largest organelle in the cell.

10. Cells can only have one of certain organelles like the nucleus. Which organelles can a cell have many of the same kind? Explain your answer.
11. Which organelle would cause a lot of damage to the cell if it were to break open? Why?
12. Potato cells don't have chloroplasts. If you saw these cells under the microscope, how could you tell that they were plant cells?

Math and Writing Skills

Section 5.1

1. Imagine that you are Anton van Leeuwenhoek and you have just observed the first blood cells, bacteria, and single-celled protists. Write a letter to a friend describing your amazing discoveries.
2. Write an imaginary dialogue that could have taken place between Matthais Schleiden and Theodore Schwann after they observed plant and animal tissue under a microscope.
3. Many of the cells in your body are 0.01 mm long. Use that measurement to complete these calculations.
 - a. An amoeba - a unicellular protist - is 1 mm long. How many body cells would you have to stack end to end to equal the size of an amoeba?
 - b. Figure out what your height is in millimeters by multiplying your height in meters by 1000. How many body cells would you have to stack end to end to equal your height?
 - c. The length of a swimming pool is 25,000 mm. How many body cells would you have to stack end to end to equal the length of the pool?
 - d. Prokaryotic cells are approximately 1/10 the size of eukaryotic cells. How big are prokaryotic cells?

4. If you were trying to classify an unknown organism by looking at its cells, what could its cells tell you?

Section 5.2

5. Describe what goes on in a typical animal cell. Be sure to mention all the organelles listed in the text.
6. Which organelles does a spinach cell have that a rabbit cell does not? Explain your answer.
7. Explain the connection between a wilted plant and cell parts like the vacuole and the cell wall.

Chapter Project

Cellular song

Cells have organelles with weird names like golgi body and endoplasmic reticulum. It is often helpful to invent a way to help you remember the names of the structures and their functions. Create a song or poem about cell structure, using the guidelines below. Record the song or poem and play it back for the class, or perform it live. If you don't like solo work, join some classmates and do this as a group project. Make sure everyone contributes verses to the song or poem!

1. Choose one type of cell, either a plant cell or an animal cell.
2. Choose a popular song for the melody or rap. If you create a poem, make the verses rhyme.
3. The song or poem must include each structure listed on the animal or plant cell diagram in your book. In addition to naming the structures, you must use the song or poem to help you remember the function of each structure.
4. Submit your creation for approval, memorize it, and then share the song or poem with your classmates. When it comes time for a written test on cell structure, you might be humming a tune to help you remember the answers!