

Eukaryotic Cells:  
The Inside StoryPlease  
ReturnTerms to Learn

cell wall	chloroplast
ribosome	Golgi complex
endoplasmic reticulum	vesicle
mitochondria	vacuole
	lysosome

What You'll Do

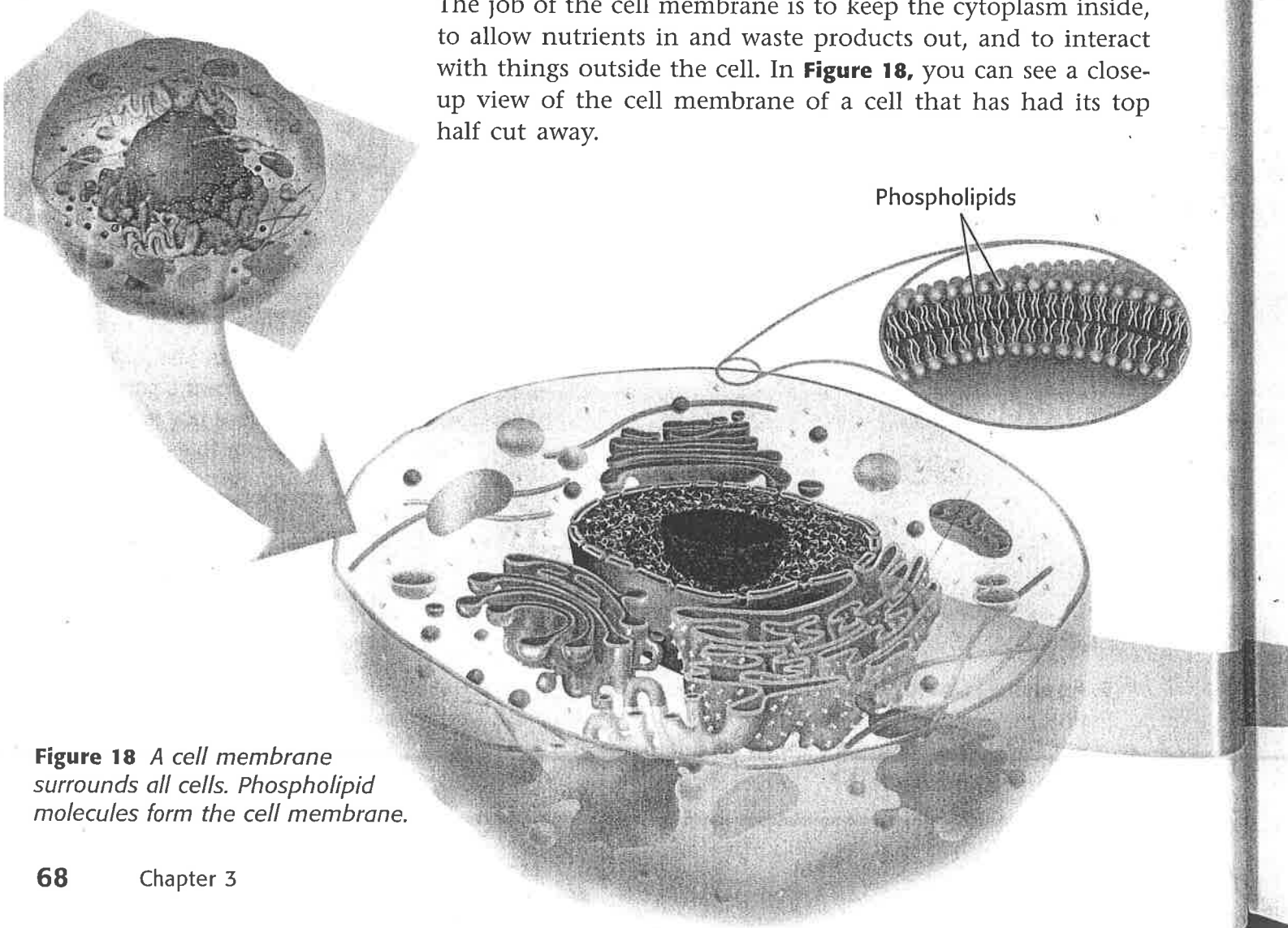
- ◆ Explain the function of each part of a eukaryotic cell.
- ◆ Describe the differences between animal cells and plant cells.

For a long time after the discovery of cells, scientists did not really know what cells were made of. Cells are so small that the details of their structure could not be seen until better methods of magnifying and staining were developed. We now know that cells are very complex, especially eukaryotic cells. Everything, from the structures covering the cells to the organelles inside them, performs a task that helps to keep the cells alive.

**Holding It All Together**

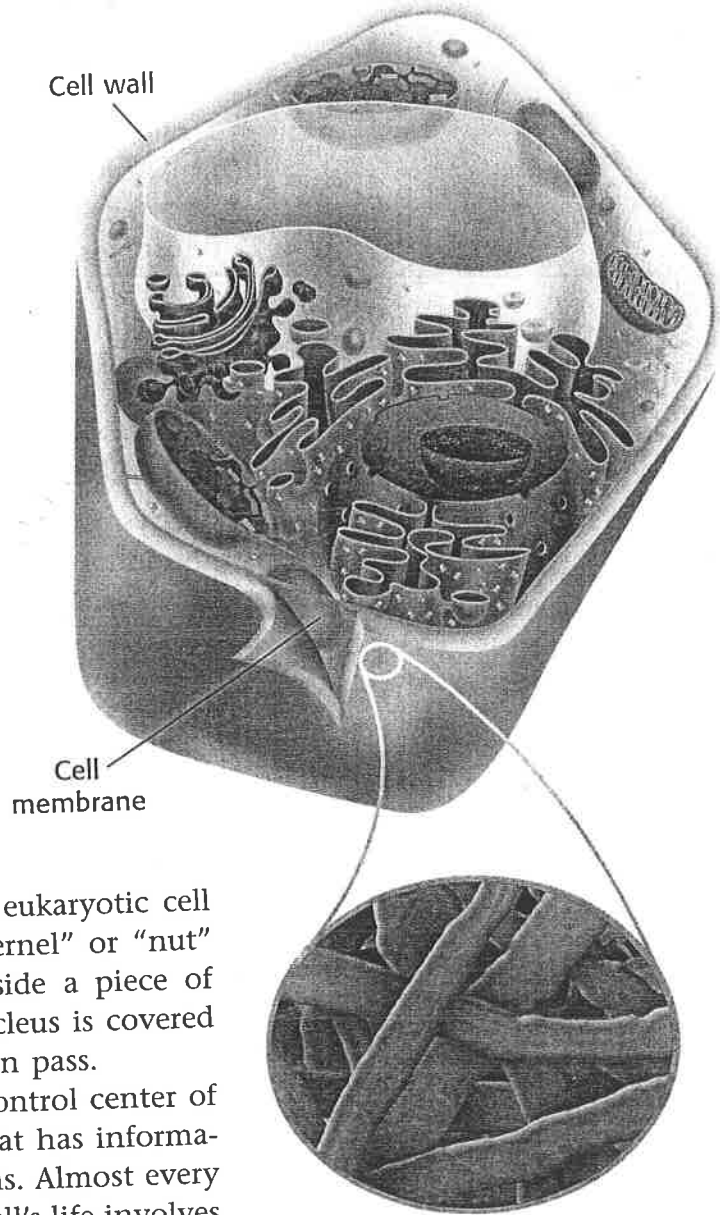
All cells have outer coverings that separate what is inside the cell from what is outside. One kind of covering, called the cell membrane, surrounds all cells. Some cells have an additional layer outside the cell membrane called the cell wall.

**Cell Membrane** All cells are covered by a cell membrane. The job of the cell membrane is to keep the cytoplasm inside, to allow nutrients in and waste products out, and to interact with things outside the cell. In **Figure 18**, you can see a close-up view of the cell membrane of a cell that has had its top half cut away.



**Figure 18** A cell membrane surrounds all cells. Phospholipid molecules form the cell membrane.

**Cell Wall** The cells of plants and algae have a hard cell wall made of cellulose. The **cell wall** provides strength and support to the cell membrane. When too much water enters or leaves a plant cell, the cell wall can prevent the membrane from tearing. The strength of billions of cell walls in plants enables a tree to stand tall and its limbs to defy gravity. When you are looking at dried hay, sticks, and wooden boards, you are seeing the cell walls of dead plant cells. The cells of fungi, such as mushrooms, toadstools, mold, and yeasts, have cell walls made of a chemical similar to that found in the hard covering of insects. **Figure 19** shows a cross section of a generalized plant cell and a close-up view of the cell wall.

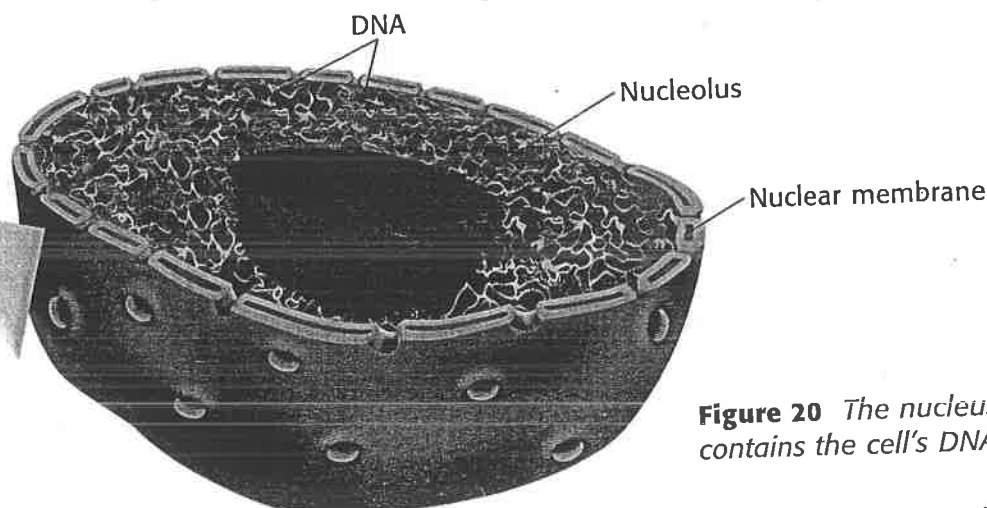


**Figure 19** The cell wall surrounds the cell membrane. In plant cells, the cell wall is made of cellulose fibers.

### The Cell's Library

The largest and most visible organelle in a eukaryotic cell is the nucleus. The word *nucleus* means "kernel" or "nut" (maybe it does look sort of like a nut inside a piece of candy). As you can see in **Figure 20**, the nucleus is covered by a membrane through which materials can pass.

The nucleus has often been called the control center of the cell. As you know, it stores the DNA that has information on how to make all of the cell's proteins. Almost every chemical reaction that is important to the cell's life involves some kind of protein. Sometimes a dark spot can be seen inside the nucleus. This spot is called a *nucleolus*, and it looks like a small nucleus inside the big nucleus. The nucleolus stores the materials that will be used later to make ribosomes in the cytoplasm.



**Figure 20** The nucleus contains the cell's DNA.

## Protein Factories

Proteins, the building blocks of all cells, are made up of chemicals known as *amino acids*. These amino acids are hooked together to make proteins at very small organelles called **ribosomes**. Ribosomes are the smallest but most abundant organelles. *All* cells have ribosomes because all cells need protein to live. Unlike most other organelles, ribosomes are not covered with a membrane.

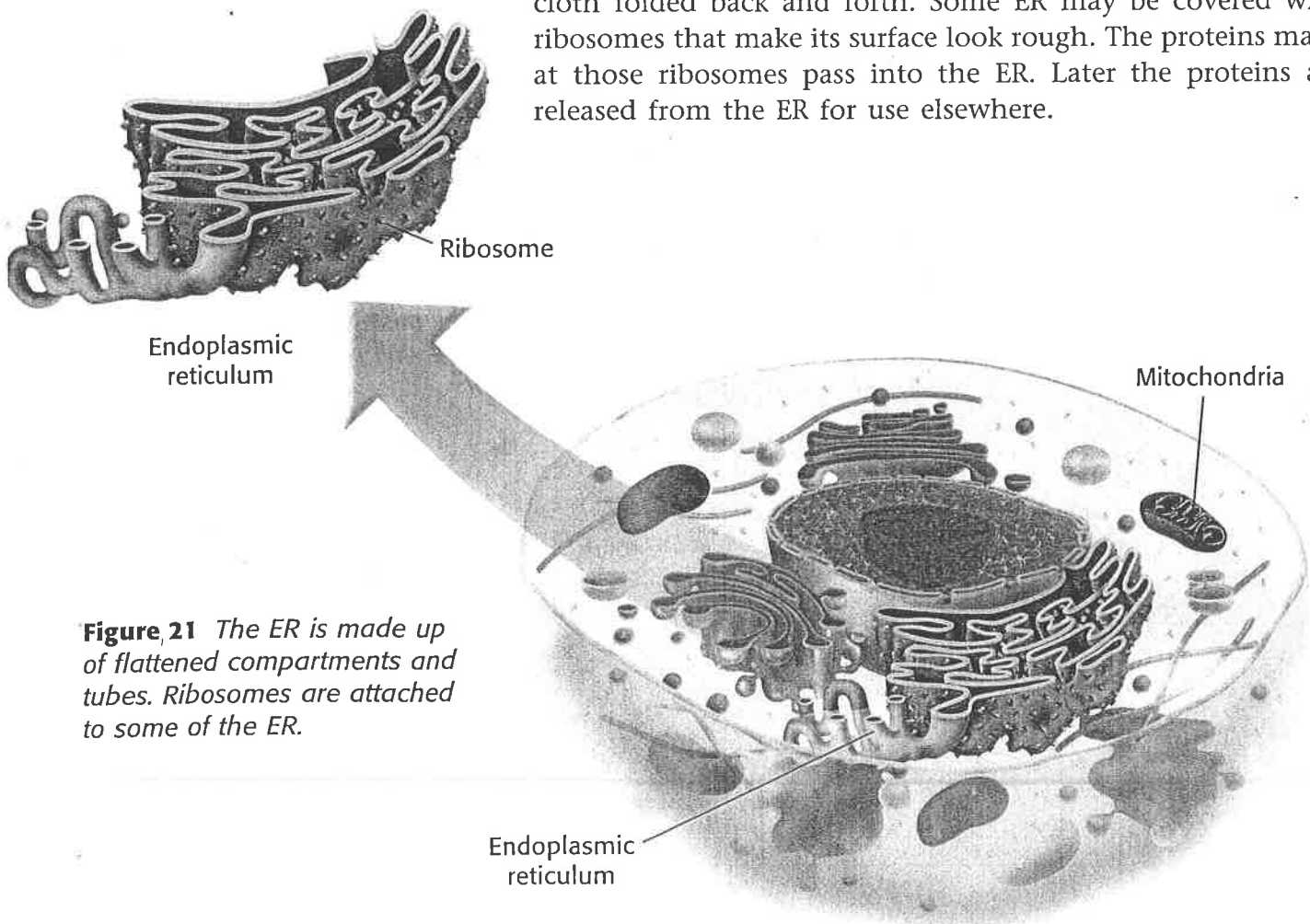
### Self-Check

What is the difference between a cell wall and a cell membrane? (See page 782 to check your answer.)

## The Cell's Delivery System

Eukaryotic cells have an organelle called the endoplasmic (EN doh PLAZ mik) reticulum (ri TIK yuh luhm), which is shown in **Figure 21**. The **endoplasmic reticulum**, or ER, is a membrane-covered compartment that makes lipids and other materials for use inside and outside the cell. It is also the organelle that breaks down drugs and certain other chemicals that could damage the cell. The ER is the internal delivery system of a cell. Substances in the ER can move from one place to another through its many tubular connections, sort of like cars moving through tunnels.

The ER looks like flattened sacks stacked side by side or a cloth folded back and forth. Some ER may be covered with ribosomes that make its surface look rough. The proteins made at those ribosomes pass into the ER. Later the proteins are released from the ER for use elsewhere.



**Figure 21** The ER is made up of flattened compartments and tubes. Ribosomes are attached to some of the ER.

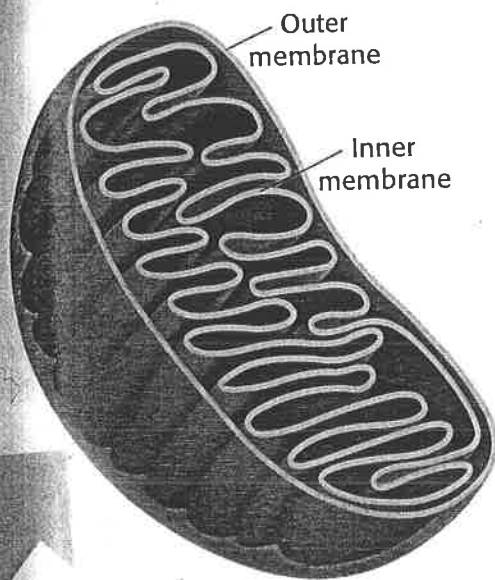
## The Cell's Power Plants

In today's world, we use many sources of energy, such as oil, gas, and nuclear power. We need this energy to heat our homes, fuel our cars, and cook our food. Cells also need energy to function. Where do they get it?

**Mitochondria** Inside all cells, food molecules are "burned" (broken down) to release energy. The energy is transferred to a special molecule that the cell uses to get work done. As you learned earlier, this molecule is called ATP.

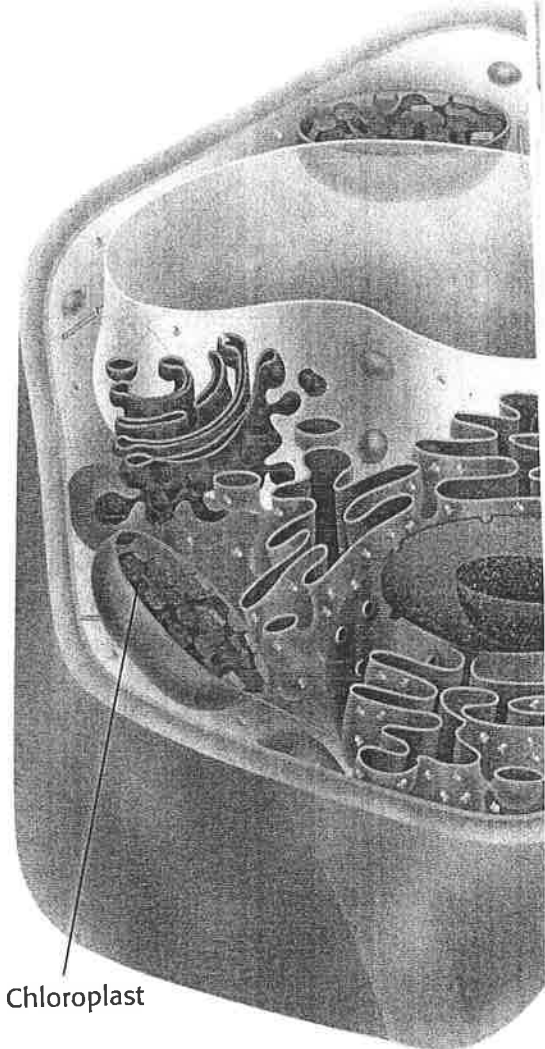
ATP can be made at several locations in eukaryotic cells, but most of it is produced at bean-shaped organelles called **mitochondria** (MIET oh KAHN drie uh), shown in **Figure 22**. These organelles are surrounded by two membranes. The inner membrane, which has many folds in it, is where most of the ATP is made.

Mitochondria can work only if they have oxygen. The reason you breathe air is to make sure your mitochondria have the oxygen they need to make ATP. Highly active cells, such as those in the heart and liver, may have thousands of mitochondria, while other cells may have only a few.

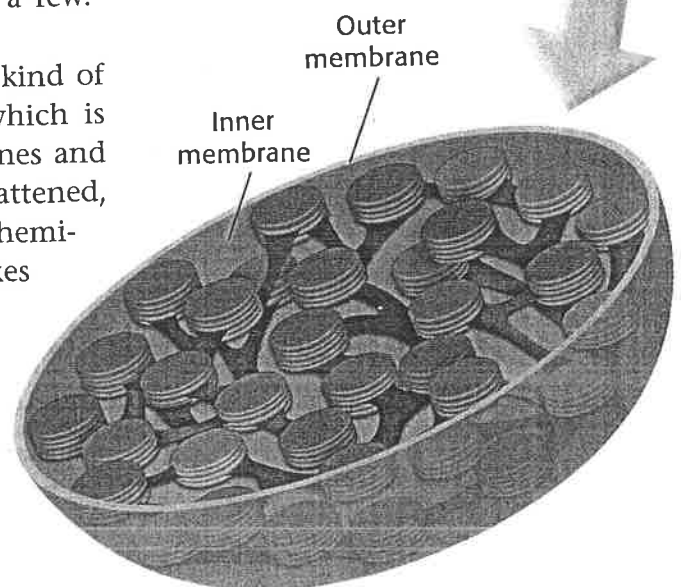


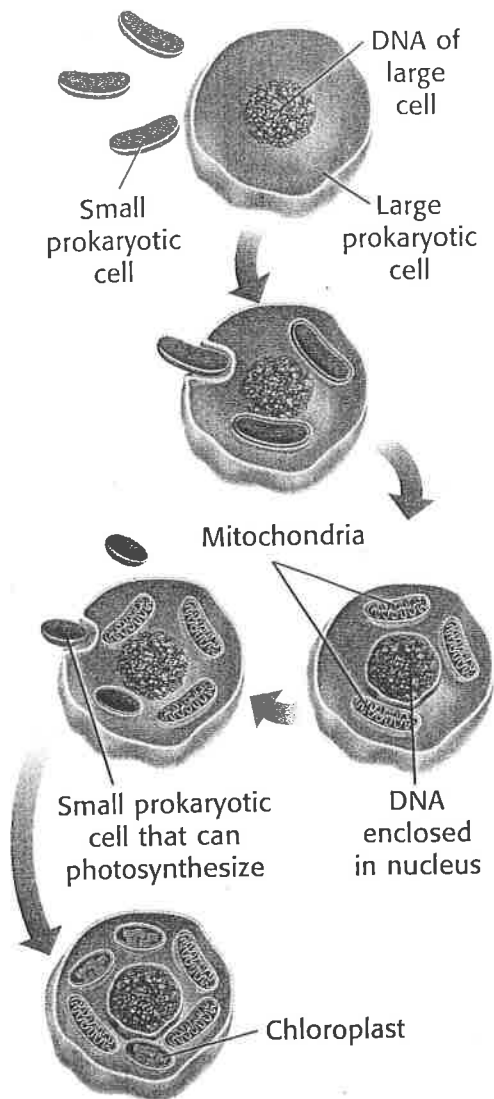
**Figure 22** Mitochondria have two membranes. The inner membrane has many folds.

**Chloroplasts** Plants and algae have an additional kind of energy-converting organelle, called a **chloroplast**, which is shown in **Figure 23**. Chloroplasts have two membranes and structures that look like stacks of coins. These are flattened, membrane-covered sacs that contain an important chemical called chlorophyll. Chlorophyll is what makes chloroplasts green. The energy of sunlight is trapped by chlorophyll and used to make sugar. This process is called *photosynthesis*. The sugar that is produced is used by mitochondria to make ATP. You will learn more about photosynthesis in a later chapter.



**Figure 23** Chloroplasts, found in plant cells, also have two membranes. The inner membrane forms stacks of flattened sacs.





**Figure 24** Mitochondria and chloroplasts may have originated from energy-producing ancestors that were engulfed by larger cells.

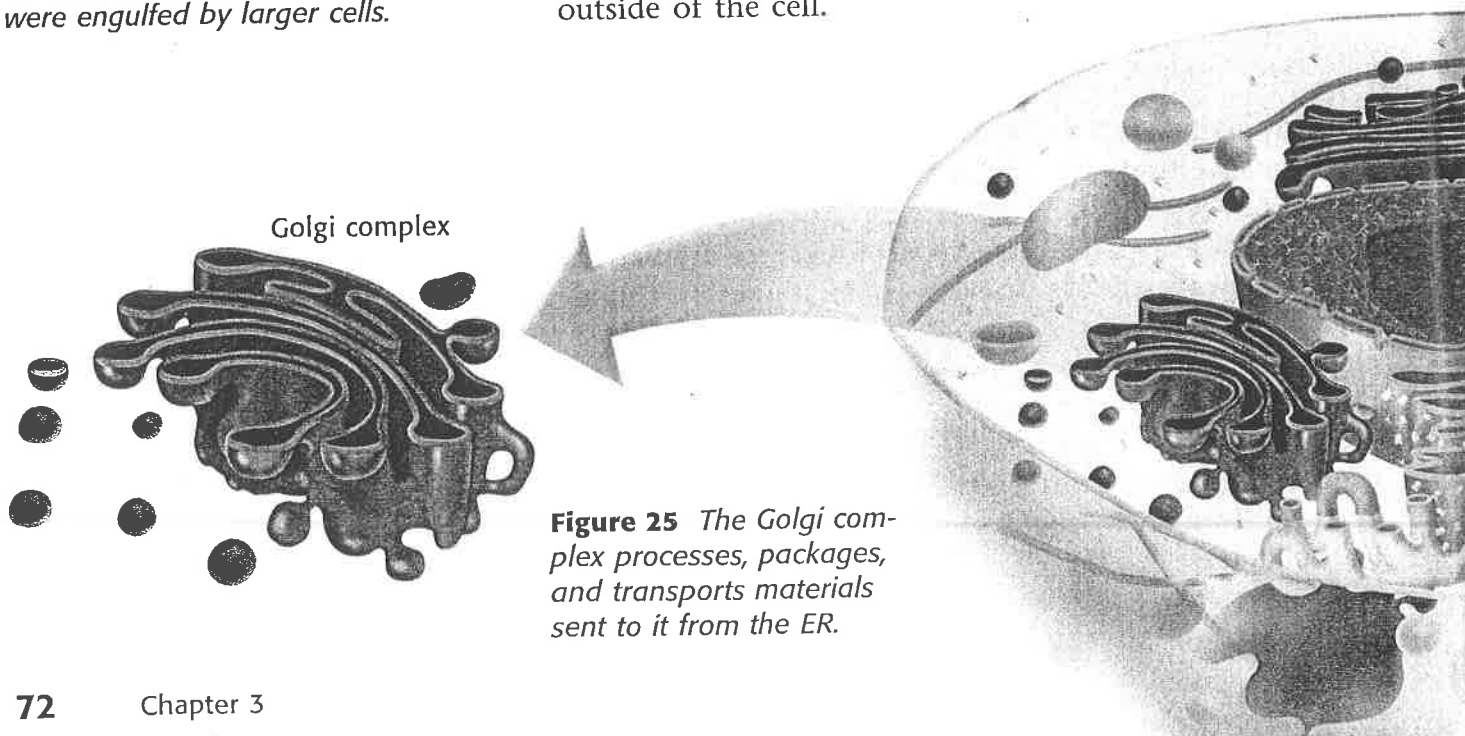
**Where Did They Come From?** Many scientists believe that mitochondria and chloroplasts originated as prokaryotic cells that were “eaten” by larger cells. Instead of being digested, the bacteria survived. **Figure 24** shows how bacteria might have become the ancestors of mitochondria and chloroplasts.

What evidence do scientists have that this theory is correct? The first piece of evidence is that mitochondria and chloroplasts are about the same size as bacteria. The second is that both are surrounded by *two membranes*. If the theory is correct, the outer membrane was created when the bacteria were engulfed by the larger cells. Other evidence supports this theory. Mitochondria and chloroplasts have the same kind of ribosomes and circular DNA as bacteria. They also divide like bacteria.

### The Cell’s Packaging Center

When proteins and other materials need to be processed and shipped out of a eukaryotic cell, the job goes to an organelle called the **Golgi complex**. This structure is named after Camillo Golgi, the Italian scientist who first identified it.

The Golgi complex looks like the ER, but it is located closer to the cell membrane. The Golgi complex of a cell is shown in **Figure 25**. Lipids and proteins from the ER are delivered to the Golgi complex, where they are modified for different functions. The final products are enclosed in a piece of the Golgi complex’s membrane that pinches off to form a small compartment. This small compartment transports its contents to other parts of the cell or outside of the cell.



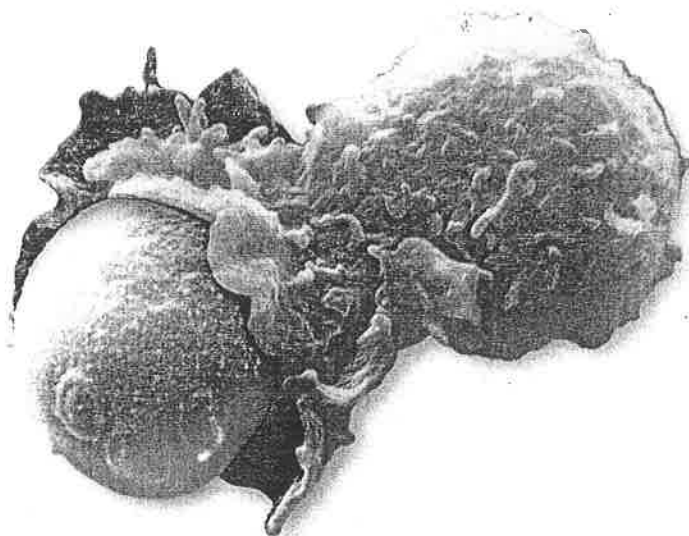
**Figure 25** The Golgi complex processes, packages, and transports materials sent to it from the ER.

## The Cell's Storage Centers

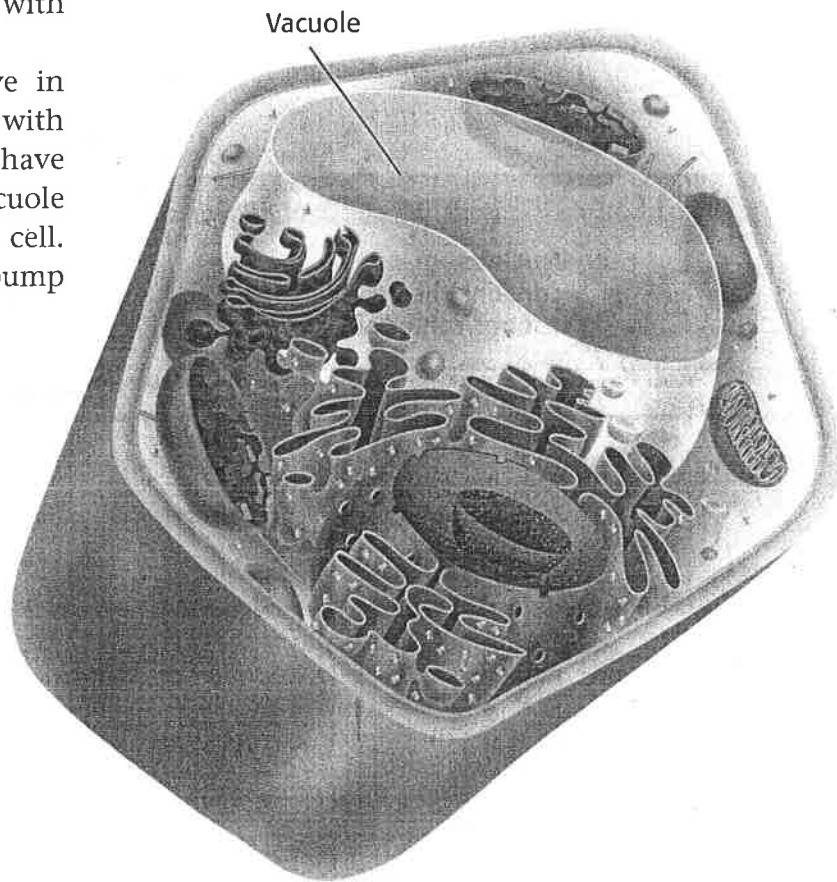
All eukaryotic cells have membrane-covered compartments called **vesicles**. Some of them form when part of the membrane pinches off the ER or Golgi complex. Others are formed when part of the cell membrane surrounds an object outside the cell. This is how white blood cells engulf other cells in your body, as shown in **Figure 26**.

**Vacuoles** Most plant cells have a very large membrane-covered chamber called a **vacuole**, as shown in **Figure 27**. Vacuoles store water and other liquids. Vacuoles that are full of water help support the cell. Some plants wilt when their cell vacuoles lose water. If you want crispy lettuce for a salad, all you need to do is fill up the vacuoles by leaving the lettuce in water overnight. Have you ever wondered what makes roses red and violets blue? It is a colorful liquid stored inside vacuoles. Vacuoles also contain the juices you associate with oranges and other fruits.

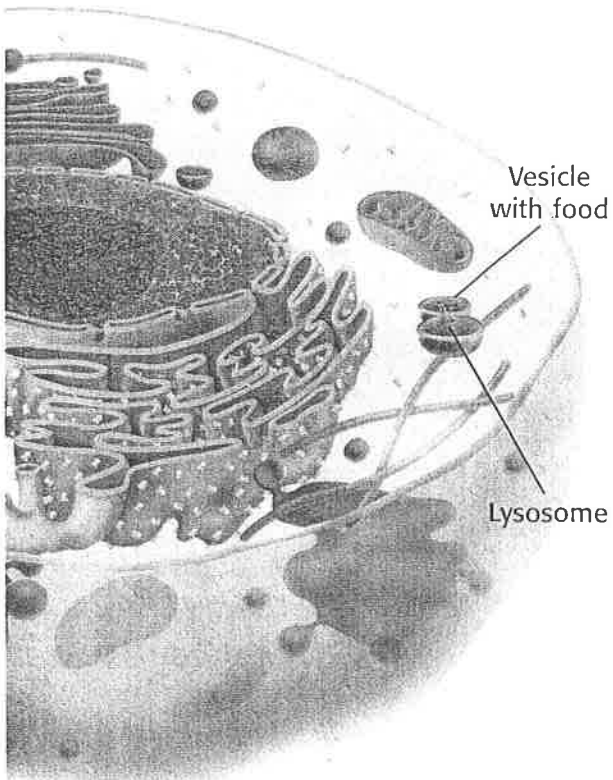
Some unicellular organisms that live in freshwater environments have a problem with too much water entering the cell. They have a special structure called a contractile vacuole that can squeeze excess water out of the cell. It works in much the same way that a pump removes water from inside a boat.



**Figure 26** The smaller cell is a yeast cell that is being engulfed by a white blood cell.



**Figure 27** This plant cell's vacuole is the large structure in the middle of the cell shown in blue. Vacuoles are usually the largest organelles in a plant cell.



**Figure 28** *This lysosome is pouring enzymes into a vesicle that contains food particles. The digested food molecules are released into the cytoplasm for use by the cell.*

## Packages of Destruction









What causes most of the cells of a caterpillar to dissolve into ooze inside a cocoon? What causes the tail of a tadpole to shrink and then disappear? Lysosomes, that's what!

**Lysosomes** are special vesicles in animal cells that contain enzymes. When a cell engulfs a particle and encloses it in a vesicle, lysosomes bump into these vesicles and pour enzymes into them. This is illustrated in **Figure 28**. The particles in the vesicles are digested by the enzymes.

Lysosomes destroy worn-out or damaged organelles. They also get rid of waste materials and protect the cell from foreign invaders.

Sometimes lysosome membranes break, and the enzymes spill into the cytoplasm, killing the cell. This is what must happen for a tadpole to become a frog. Lysosomes cause the cells in a tadpole's tail to die and dissolve as the tadpole becomes a frog. Lysosomes played a similar role in your development! Before you were born, lysosomes caused the destruction of cells that formed the webbing between your fingers. Lysosome destruction of cells may also be one of the factors that contribute to the aging process in humans.

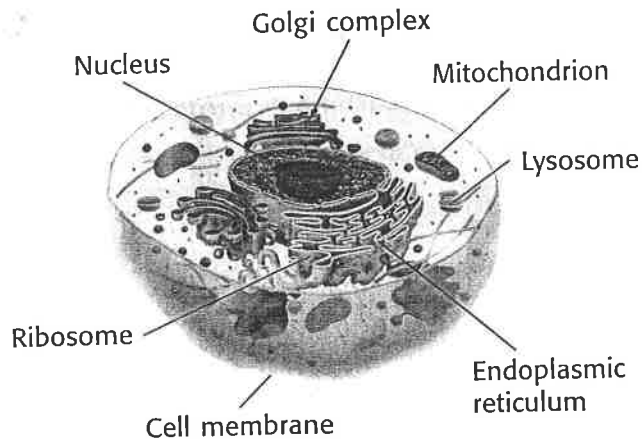
### Organelles and Their Functions

 <p><b>Nucleus</b> contains the cell's DNA and is the control center of the cell</p>	 <p><b>Chloroplasts</b> make food using the energy of sunlight</p>
 <p><b>Ribosomes</b> the site where amino acids are hooked together to make proteins</p>	 <p><b>Golgi complex</b> processes and transports materials out of the cell</p>
 <p><b>Endoplasmic reticulum</b> makes lipids, breaks down drugs and other substances, packages up proteins for release from the cell</p>	 <p><b>Vacuole</b> stores water and other materials</p>
 <p><b>Mitochondria</b> break down food molecules to make ATP</p>	 <p><b>Lysosomes</b> digest food particles, wastes, cell parts, and foreign invaders</p>

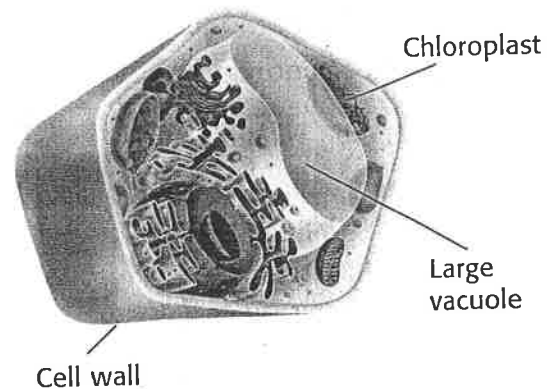
## Plant or Animal?

How can you tell the difference between a plant cell and an animal cell? They both have a cell membrane, and they both have nuclei, ribosomes, mitochondria, endoplasmic reticula, Golgi complexes, and lysosomes. But plant cells have things that animal cells do not have: a cell wall, chloroplasts, and a large vacuole. You can see the differences between plant and animal cells in **Figure 29**.

### Found in Plant and Animal Cells



### Found Only in Plant Cells



**Figure 29** Animal and plant cells have some structures in common, but they also have some that are unique.

## REVIEW

1. How does the nucleus control the cell's activities?
2. Which of the following would not be found in an animal cell: mitochondria, cell wall, chloroplast, ribosome, endoplasmic reticulum, Golgi complex, large vacuole, DNA, chlorophyll?
3. Use the following words in a sentence: oxygen, ATP, breathing, and mitochondria.
4. **Applying Concepts** You have the job of giving new names to different things in a city. The new names have to be parts of a eukaryotic cell. Write down some things you would see in a city. Assign the name of a cell part that is most appropriate to their function. Explain your choices.

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