FIGURE 2.9 Lysosomes digest and recycle foreign materials or worn-out parts. (colored TEM; magnification 21,000×)

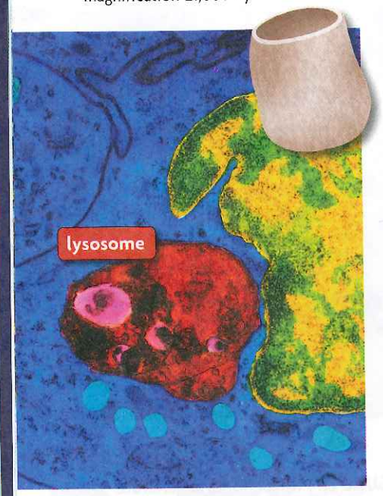
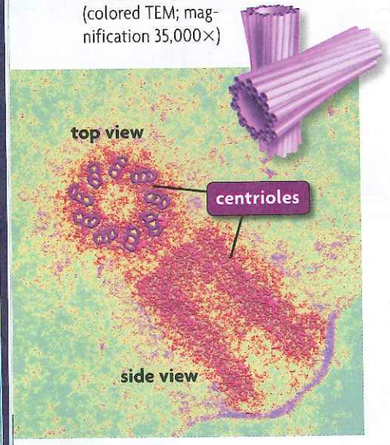


FIGURE 2.10 Centrioles divide DNA during cell division. (colored TEM; magnification 35,000×)



Lysosomes

Lysosomes (LY-suh-SOHMZ), shown in **FIGURE 2.9,** are membrane-bound organelles that contain enzymes. They defend a cell from invading bacteria and viruses. They also break down damaged or worn-out cell parts. Lysosomes tend to be numerous in animal cells. Their presence in plant cells is still questioned by some scientists, but others assert that plant cells do have lysosomes, though fewer than are found in animal cells.

Recall that all enzymes are proteins. Initially, lysosomal enzymes are made in the rough ER in an inactive form. Vesicles pinch off from the ER membrane, carry the enzymes, and then fuse with the Golgi apparatus. There, the enzymes are activated and packaged as lysosomes that pinch off from the Golgi membrane. The lysosomes can then engulf and digest targeted molecules. When a molecule is broken down, the products pass through the lysosomal membrane and into the cytoplasm, where they are used again.

Lysosomes provide an example of the importance of membrane-bound structures in the eukaryotic cell. Because lysosomal enzymes can destroy cell components, they must be surrounded by a membrane that prevents them from destroying necessary structures. However, the cell also uses other methods to protect itself from these destructive enzymes. For example, the enzymes do not work as well in the cytoplasm as they do inside the lysosome.

Centrosome and Centrioles

The centrosome is a small region of cytoplasm that produces microtubules. In animal cells, it contains two small structures called centrioles. **Centrioles** (SEHN-tree-OHLZ) are cylinder-shaped organelles made of short microtubules arranged in a circle. The two centrioles are perpendicular to each other, as shown in **FIGURE 2.10.** Before an animal cell divides, the centrosome, including the centrioles, doubles and the two new centrosomes move to opposite ends of the cell. Microtubules grow from each centrosome, forming spindle fibers. These fibers attach to the DNA and appear to help divide it between the two cells.

Centrioles were once thought to play a critical role in animal cell division. However, experiments have shown that animal cells can divide even if the centrioles are removed, making their role questionable. In addition, although centrioles are found in some algae, they are not found in plants.

Centrioles also organize microtubules to form cilia and flagella. Cilia look like little hairs; flagella look like a whip or a tail. Their motion forces liquids past a cell. For single cells, this movement results in swimming. For cells anchored in tissue, this motion sweeps liquid across the cell surface.

Compare In what ways are lysosomes, vesicles, and the central vacuole similar?

MAIN IDEA

Plant cells have cell walls and chloroplasts.

Plant cells have two features not shared by animal cells: cell walls and chloroplasts. Cell walls are structures that provide rigid support. Chloroplasts are organelles that help a plant convert solar energy to chemical energy.

Cell Walls

In plants, algae, fungi, and most bacteria, the cell membrane is surrounded by a strong **cell wall,** which is a rigid layer that gives protection, support, and shape to the cell. The cell walls of multiple cells, as shown in **FIGURE 2.11,** can adhere to each other to help support an entire organism. For instance, much of the wood in a tree trunk consists of dead cells whose cell walls continue to support the entire tree.

Cell wall composition varies and is related to the different needs of each type of organism. In plants and algae, the cell wall is made of cellulose, a polysaccharide. Because molecules cannot easily diffuse across cellulose, the cell walls of plants and algae have openings, or channels. Water and other molecules small enough to fit through the channels can freely pass through the cell wall. In fungi, cell walls are made of chitin, and in bacteria, they are made of peptidoglycan.

Chloroplasts

Chloroplasts (KLAWR-uh-PLASTS) are organelles that carry out photosynthesis, a series of complex chemical reactions that convert solar energy into energy-rich molecules the cell can use. Photosynthesis will be discussed more fully in Cells and Energy. Like mitochondria, chloroplasts are highly compartmentalized. They have both an outer membrane and an inner membrane. They also have stacks of disc-shaped sacs within the inner membrane, shown in **FIGURE 2.12.** These sacs, called thylakoids, contain chlorophyll, a light-absorbing molecule that gives plants their green color and plays a key role in photosynthesis. Like mitochondria, chloroplasts also have their own ribosomes and DNA. Scientists have hypothesized that they, too, were originally free-living prokaryotes that were taken in by larger cells.

Both chloroplasts and mitochondria are present in plant cells, where they work together to capture and convert energy. Chloroplasts are found in the cells of certain other organisms as well, including green algae.

Analyze Would it be accurate to say that a chloroplast makes energy for a plant cell? Explain your answer.

FIGURE 2.11 Cell walls shape and support individual cells and entire organisms. (LM; magnification 3000×)

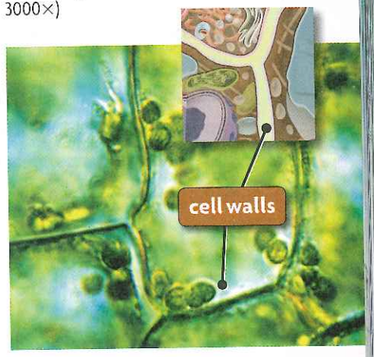
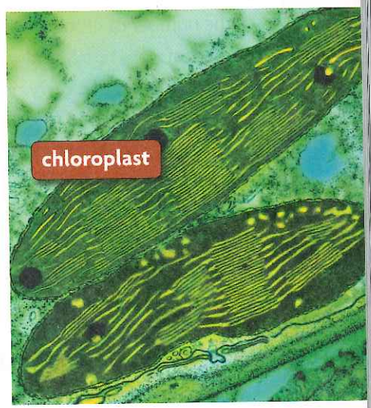


FIGURE 2.12 Chloroplasts convert solar energy into chemical energy through photosynthesis. (colored TEM; magnification 21,000×)



3.2 Formative Assessment

REVIEWING MAIN IDEAS

1. What are the functions of the **cytoskeleton**?
2. Describe the structure of the **nucleus.**
3. Explain the structure and function of the **mitochondrion.**
4. What function does the **cell wall** perform in a plant?

CRITICAL THINKING

5. **Compare** What similarities do mitochondria and **chloroplasts** share?
6. **Compare** Describe how the **endoplasmic reticulum,** mitochondrion, and **Golgi apparatus** are structurally similar.

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7. Medicine, alcohol, and many drugs are detoxified in liver cells. Why do you think the liver cells of some people who abuse alcohol and drugs have an increased amount of smooth ER?