Chapter 6

Cell Processes

How many cells are in the human body? Cells are so small that you can only see them with a microscope; this means that the average human body must contain billions of cells. Old cells are constantly being replaced with new cells. Every minute you lose 30,000 to 40,000 worn-out skin cells. If you live to be 80 years old, you have grown about 1000 skins in a lifetime! You can see how challenging it is to estimate the number of cells. Most scientists agree that the human body contains trillions of cells. If you had to individually count the cells in your body, it would take over 2000 years! It is hard to imagine how many cells there must be in a giant redwood tree. There is a redwood tree in California that measures over 360 feet tall (110 meters). How can a massive tree like that come from a tiny seed? Read this chapter on how cells work to satisfy your curiosity.

Key Questions

1. ***How do things move in and out of cells?***
2. ***How do cells get energy?***
3. ***Why are plants green?***

6.1 The Structure and Function of the Cell Membrane

The cell membrane is kind of like a soap bubble (Figure 6.1). A soap bubble consists of a thin, flexible membrane. The soapy membrane seals the inside air from the outside. Likewise the cell membrane is a thin, flexible layer that seals the inside of the cell from its outside environment. In this section, you'll learn about the structure and function of the cell membrane.

Figure 6.1: *Soap bubbles are similar to cell membranes.*

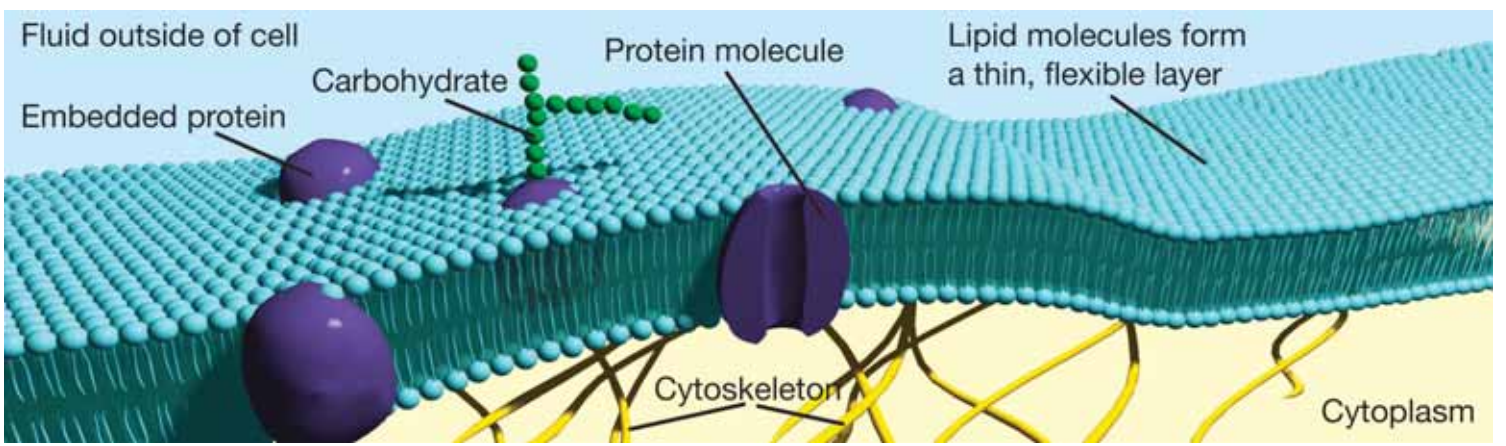
A closer look at the cell membrane

The functions of the cell membrane

The cell membrane has many functions. It protects the cell from its environment and takes in food and other compounds that the cell needs. It also gets rid of waste from inside of the cell. The cell membrane even allows cells to communicate and interact.

The structure of the cell membrane

The cell membrane is made of several types of molecules. Lipid molecules form a double layer. This creates a thin, fluid layer like a soap bubble. Embedded protein molecules can move around within this layer. Carbohydrates attached to some proteins face outward. Some of these serve as "identification cards" so cells can recognize each other.



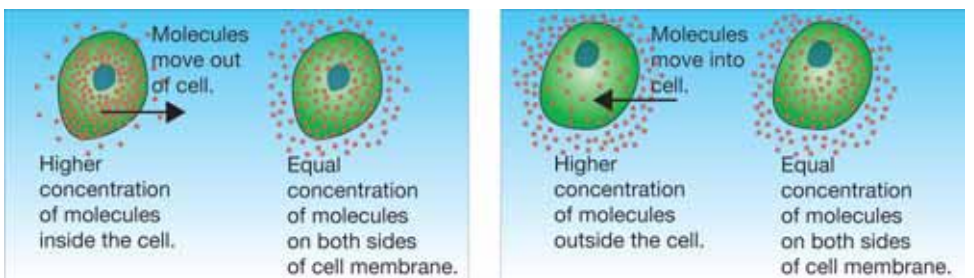
Diffusion

What is diffusion?

Cells live in a watery environment. The cytoplasm is 80% water. Every cell in your body is also surrounded by a watery solution. Solutions make it easier for molecules to move into or out of the cell. Molecules move across the cell membrane by a process called diffusion. **Diffusion** is the movement of molecules from areas of greater concentration to areas of lesser concentration.

How diffusion works in a cell

In order for diffusion to occur, there must be an unequal number of molecules on each side of the cell membrane. If there are more molecules on the outside of the membrane compared to the inside, the molecules will move to the inside of the cell until there is an equal number of molecules on both sides. Can you predict what will happen if there are more molecules on the *inside* of the cell?



Molecules move into or out of the cell until there is an equal number on both sides of the cell membrane.

Not all molecules can pass through by diffusion

Not all molecules can move across the cell membrane by diffusion. You can compare the cell membrane to a tea bag. Only smaller particles can pass through the tea bag. Larger particles are left inside of the bag. The same is true of the cell membrane. Small molecules like oxygen and carbon dioxide can pass through. You'll learn how larger molecules diffuse later in this chapter.

VOCABULARY

diffusion - the movement of molecules from areas of greater concentration to areas of lesser concentration.

MY JOURNAL

Observing diffusion

1. Fill a clear glass with water.
2. Carefully add a drop of food coloring to the water.
3. Observe the glass every 2 minutes and record your observations in your journal.

4. What happens to the food coloring? Explain what is happening at the molecular level.
5. You observed a process called *diffusion*. How might the cell membrane use diffusion to move molecules in or out?

Osmosis

What is osmosis? Water molecules are small enough to pass through the cell membrane by diffusion. **Osmosis** is the diffusion of water across the cell membrane. Like other molecules, water moves from areas of greater concentration of water molecules to areas of lesser concentration.

Cells take in water by osmosis When you put a cell into a solution, it will either take in water, stay the same, or lose water. What happens depends on the amount of water in the solution. For example, a sugar solution (sugar dissolved in water) contains fewer water molecules than the same amount of pure water.

More water molecules outside If the solution outside the cell has more water molecules than inside the cell, the cell gains water. Water molecules are free to pass across the cell membrane in both directions, but more water comes into the cell than leaves. The cell swells up (Figure 6.2, top).

Water molecules equal on both sides If the solution outside the cell has the same amount of water molecules as inside the cell, the amount of water inside the cell stays the same. Water crosses the membrane in both directions, but the amount going in is the same as the amount going out. Thus, the cell stays the same size (Figure 6.2, middle).

Fewer water molecules outside If the solution outside the cell has fewer water molecules than inside the cell, the cell loses water. Again, water crosses the cell membrane in both directions, but this time more water leaves the cell than enters it. The cell shrinks (Figure 6.2, bottom).

Animal and plant cells If animal cells take in too much water they can burst. That's why your cells are surrounded by a solution that has the same amount of water as inside the cell membrane. Plant cells can take in more water than animal cells because of their strong cell walls.

VOCABULARY

osmosis - the diffusion of water across the cell membrane.

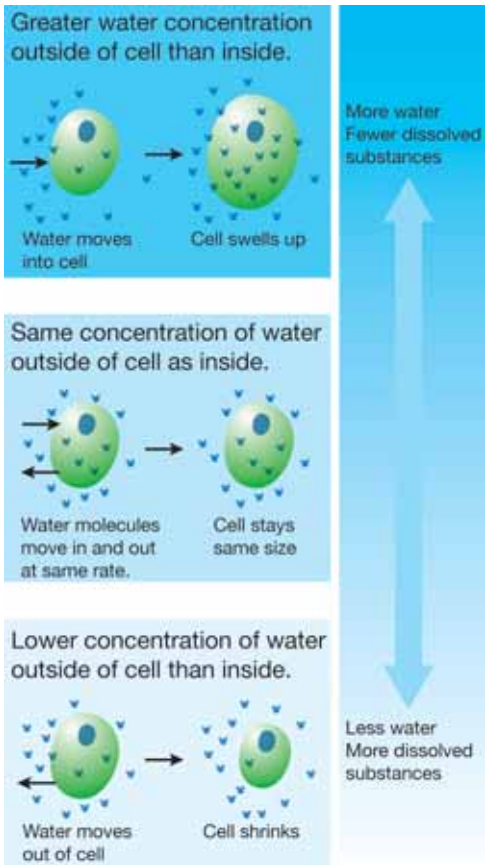


Figure 6.2: *When you put a cell into a solution, one of three things can happen.*

Other types of transport

Protein channels

Diffusion and osmosis do not require energy from the cell. This is because the molecules move *with* a concentration difference (from higher to lower). Larger molecules like sugars, starches, and proteins sometimes diffuse through *protein channels* (Figure 6.3). Because the molecules move from greater to lesser concentration through the channels, this process also does not require energy.

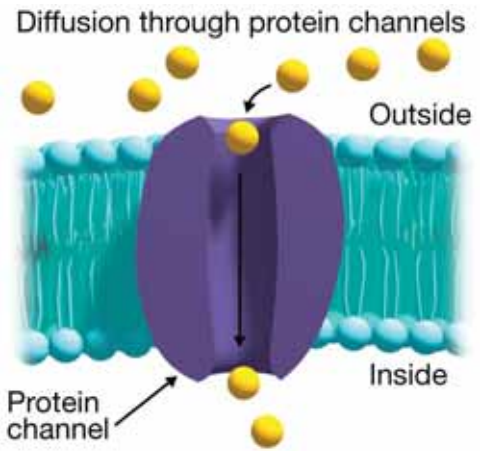
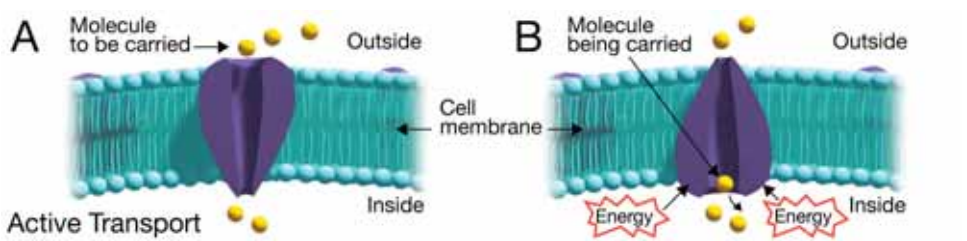


Figure 6.3: *Larger molecules can diffuse through protein channels.*

Active transport

Sometimes a cell needs to move molecules *against* a concentration difference (from lower to higher concentration). **Active transport** is a process that allows molecules to move across the cell membrane from lower to higher concentrations. Active transport requires energy. Protein molecules act as "pumps" to move the molecules across the cell membrane as shown below. Your nerve cells have lots of protein pumps to move ions across the cell membrane. This is how signals travel through your nervous system.



Other types of active transport

A cell can take in larger particles of food by "engulfing" them. The cell membrane forms a pocket around the particle. Once inside the cell, the pocket breaks loose from the cell membrane. It forms a vacuole within the cytoplasm (Figure 6.4). Cells also send material out of the cell in the same way. When this happens, a vacuole fuses with the cell membrane and the contents are forced outside of the cell. Both of these processes are types of active transport because they require energy.

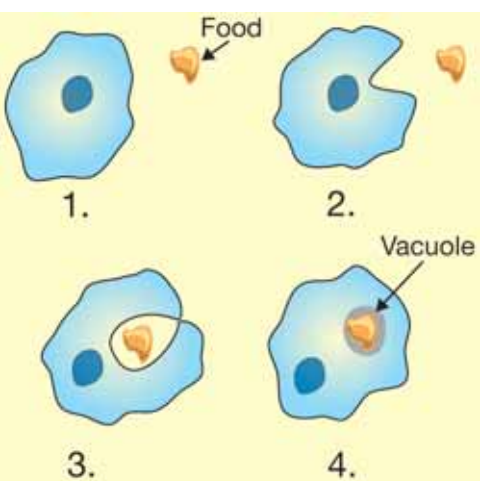


Figure 6.4: *A cell can also take in larger amounts of material by engulfing them.*

Why are cells so small?

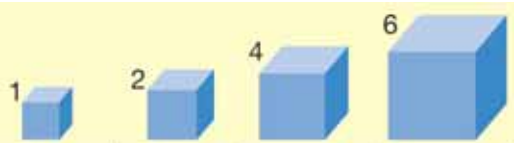
One characteristic of cells is that they are very small. Why are cells so small? The answer has to do with the cell membrane.

Cells need a large surface area

Everything the cell needs to take in or has to get rid of has to go through the cell membrane. Therefore the cell membrane needs to have a large surface area in relation to the volume of the cell. As a cell gets bigger, so does its surface area. However, the volume of a cell increases at a faster rate than the surface area of its cell membrane. If a cell gets too large, its cell membrane will not have enough openings to meet the demands of its volume. This limits the size of cells.

The volume of a cell increases faster than its surface area

To understand why the volume of a cell increases faster than its surface area, let's imagine a perfectly square cell. The *surface-area-to-volume ratio* is the area of the cell's outer surface in relationship to its volume.



Surface area (cm²)	6	24	96	216
Surface area (cm³)	1	8	64	216
Surface area: Volume	6:1	3:1	1.5:1	1:1

Long and thin cells

One way to increase surface area is to make the cell long and thin or skinny and flat. The nerve cells in your body are very long and thin. A thin, flat cell has a volume of: $16 \times 4 \times 0.125 = 8$. The cell's surface area is: $2(16 \times 0.125) + 2(16 \times 4) + 2(4 \times 0.125) = 133$. The surface-area-to-volume ratio is 133:8 (Figure 6.5).

VOCABULARY

(Discussed on previous page.)

active transport - a process that allows molecules to move across the cell membrane from lower to higher concentrations.

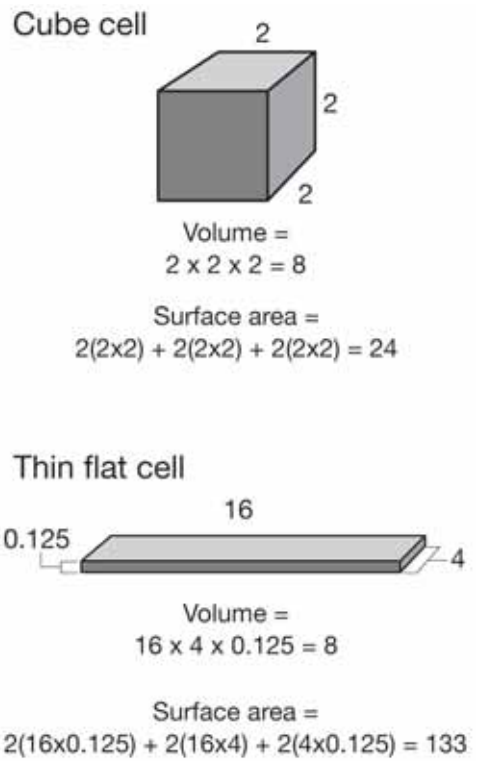
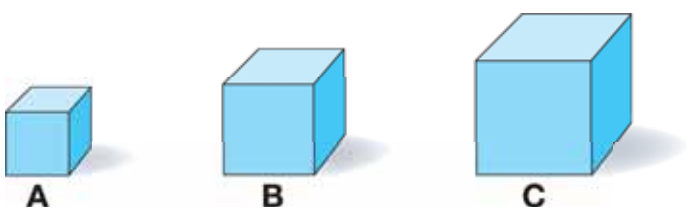


Figure 6.5: *A thin, flat cell has a higher surface-area-to-volume ratio than a square cell of the same volume.*

6.1 Section Review

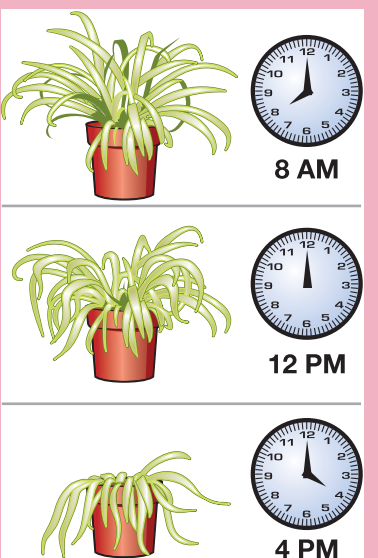
1. List four functions of the cell membrane.
2. How is the cell membrane like a soap bubble?
3. What is diffusion? Name one example of diffusion.
4. What is osmosis? What structure in a plant cell helps protect it from osmosis?
5. For each situation below, state whether water will move into the cell, move out of the cell, or stay the same.

6. How is active transport different from diffusion?
7. Name two situations in which a cell would need to use active transport instead of diffusion.
8. Explain why cells are so small.
9. Which figure below has the highest surface-area-to-volume ratio? Explain your reasoning.



CHALLENGE

The owner of this plant watered it with salt water by mistake. The pictures below show what happened to the plant at 8:00 a.m., 12:00 p.m., and 4:00 p.m.



1. Describe what happened to the plant and its cells over time.
2. Explain why you think these things happened. State your explanation as a hypothesis.
3. Design an experiment to test if your hypothesis is correct.

6.2 Cells and Energy

To stay alive, you need a constant supply of energy. You need energy to move, think, grow, and even sleep. Where does that energy come from? It all starts with the sun. Plant cells store energy from the sun in the form of molecules. In this section you'll learn about how cells store and release energy.

What is photosynthesis?

Solar cells and chloroplasts

A solar calculator has *solar cells* that convert light energy into electrical energy. The electrical energy powers the calculator. A plant cell has chloroplasts that also convert energy. *Chloroplasts* are where photosynthesis occurs. **Photosynthesis** is a process where plants use the energy of sunlight to produce energy-rich molecules (carbohydrates).

Photosynthesis takes place in the chloroplasts.

How does a tiny seed grow into a massive tree?

Before our knowledge of photosynthesis, gardeners wondered how a tiny seed could grow into a massive tree. Where did all of that mass come from? In the 1600s, a Flemish scientist named Jan Van Helmont (1580–1644) conducted an important experiment. He grew a willow tree in a carefully weighed amount of soil. He noticed that the mass of the soil barely changed while the mass of the tree greatly increased. He concluded that the extra mass came from water, not from the soil.

Photosynthesis is a chemical reaction

Later experiments carried out by other scientists showed that plants use carbon dioxide (from the air) and water to make a simple carbohydrate (*glucose*) and oxygen. This chemical reaction (photosynthesis) takes place only in the presence of light (Figure 6.6).

VOCABULARY

photosynthesis - a process where plants use the energy of sunlight to produce carbohydrates.

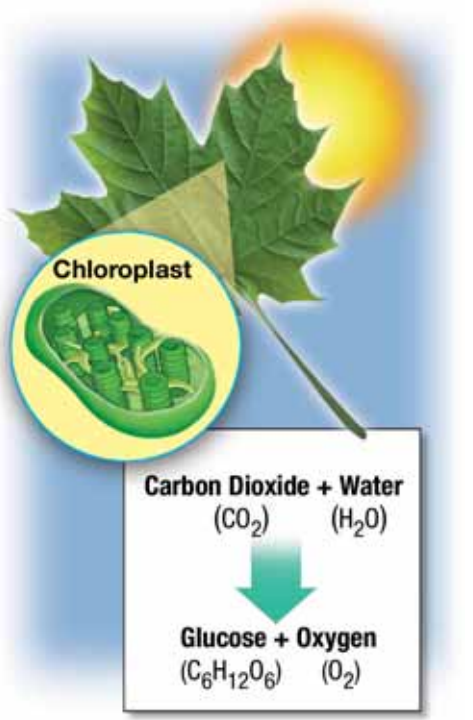
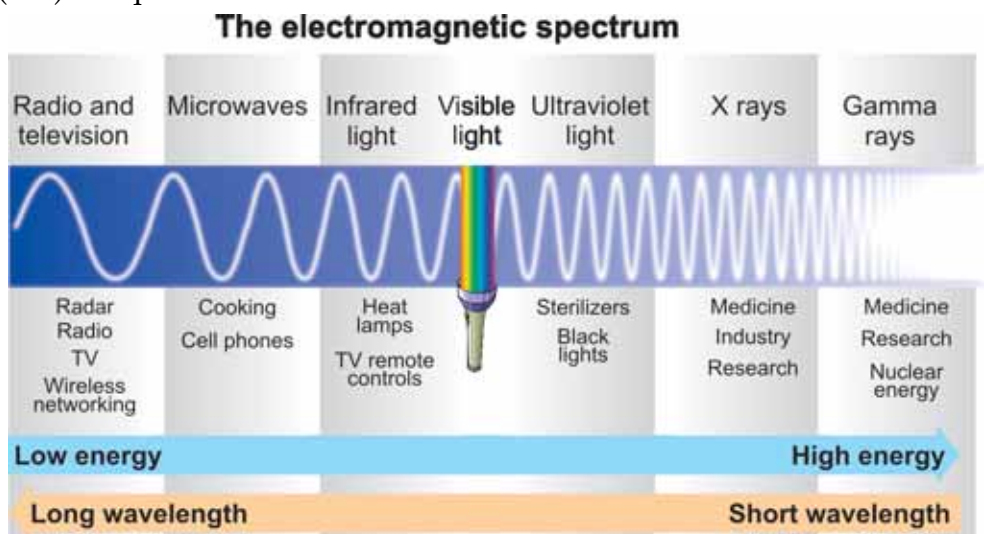


Figure 6.6: *The chemical reaction of photosynthesis. What are the reactants of the reaction? What are the products?*

Light and color

Visible light The Sun provides Earth with a steady source of light. Your eyes perceive sunlight as *white light*. However, it is really made up of different colors of light. The colors that make up sunlight are called *visible light*. There are other forms of light we cannot see such as *ultraviolet* and *infrared light*.

Light is a wave Light is a wave, like a ripple on a pond. Waves can be described by their *wavelength* (the length from peak to peak), and *energy*. Light is part of a continuum of waves known as the **electromagnetic spectrum**. Light waves have very short wavelengths. They range from 800 nm (red light) to 400 nm (violet light). One *nanometer* (nm) is equal to one-*billionth* of a meter!



Color A prism splits white light into all of its colors. **Color** is how we perceive the energy of light. All of the colors of visible light have different energies. Red light has the lowest energy and violet light has the highest energy. As we move through the rainbow from red to violet, the energy of the light increases (Figure 6.7).

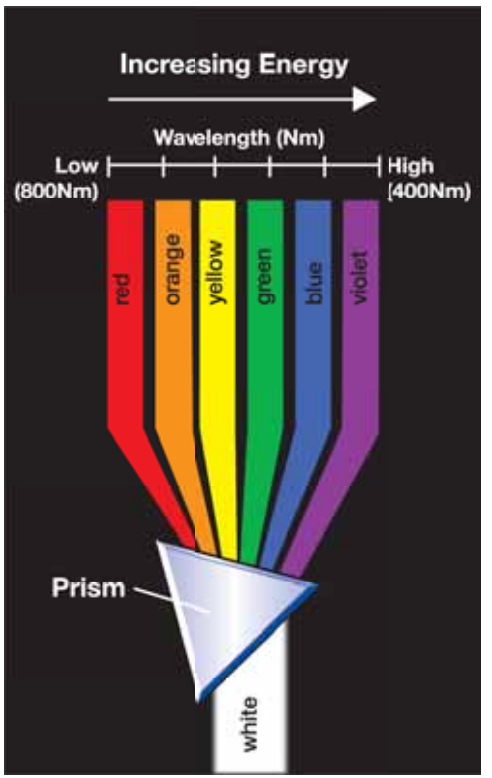


Figure 6.7: *A prism splits light into all of its colors. All of the colors of light have different energies and wavelengths.*

VOCABULARY

color - how we perceive the energy of light.

Chlorophyll

Why most plants are green

A **pigment** is a molecule that absorbs some colors of light and reflects others. **Chlorophyll** is the main pigment used in photosynthesis. It is found inside the chloroplasts of plant cells. Chlorophyll absorbs mostly blue and red light, and reflects green light. This is why most plants look green.

Light is necessary for photosynthesis

The vertical (*y*) axis of the graph in Figure 6.8 shows the percentage of light absorbed by a plant. The horizontal (*x*) axis shows the colors of light. The curve shows how much and which colors of visible light are absorbed by plants. The graph shows that plants need red and blue light to grow. Based on this graph, can you explain why plants look green? Do you think a plant would grow if it were placed under only green light?

Plants reflect some light to keep cool

Why don't plants absorb all colors of light? The reason is the same reason you wear light-colored clothes when it's hot outside. Like you, plants must reflect some light to avoid absorbing too much energy and overheating. Also, certain colors of visible light have just the right amount of energy to make photosynthesis occur. Ultraviolet light has more energy but would cause other chemical reactions. Infrared light has too little energy to make photosynthesis occur.

Why leaves change color

In some parts of the world, the leaves of some plants, such as sugar maple trees, turn brilliant red or gold in the autumn. Chlorophyll masks other plant pigments during the spring and summer. In the autumn photosynthesis slows down. Chlorophyll breaks down and red, orange, and yellow pigments in the leaves are revealed!

VOCABULARY

pigment - a molecule that absorbs some colors of light and reflects others.

chlorophyll - the main pigment used in photosynthesis that absorbs blue and red light and reflects green light.

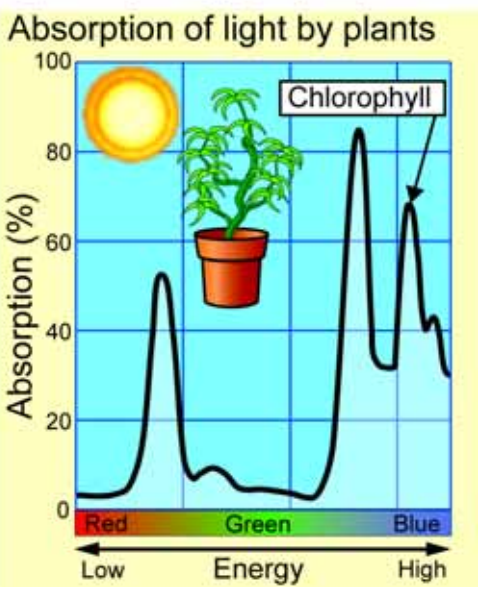


Figure 6.8: *Plants need to absorb light to grow. The plant pigment chlorophyll absorbs red and blue light, and reflects green light. This is why plants look green!*

Cellular respiration

What is cellular respiration?

Your cells get the energy they need from the food you eat. Your digestive system breaks down food into molecules. Your cells convert those molecules into a form of energy they can use. **Cellular respiration** is the process in which the chemical bonds of energy-rich molecules (like glucose) are converted into a form of energy that cells can use. In eukaryotic (including animal *and* plant) cells, cellular respiration takes place in the mitochondria.

Cellular respiration takes place in the mitochondria.

The reactants and products of cellular respiration

Respiration is the process of breathing. Cellular respiration is not the same thing as breathing but they are closely related. You breathe in to get oxygen. You breathe out to get rid of carbon dioxide. Cellular respiration is a chemical reaction that uses oxygen and glucose to produce carbon dioxide, water, and energy (Figure 6.9). When you breathe in, you take in the oxygen your cells need for cellular respiration. When you breathe out, you get rid of the carbon dioxide that your cells produce during cellular respiration. Try breathing onto a mirror or glass surface. Can you see evidence of another product of cellular respiration?

Cellular respiration and energy

During cellular respiration, some energy is stored and some is released. Energy is stored in a molecule called ATP. **ATP** is a molecule that stores and transfers chemical energy within cells. It is used to power cell functions such as muscle contractions, nerve impulses, and molecule-building. Energy released from cellular respiration is often given off in the form of heat. Your body is warm because of the released energy from cellular respiration.

VOCABULARY

cellular respiration - the process in which the chemical bonds of energy-rich molecules are converted into a form of energy that cells can use.

ATP - a molecule that stores and transfers energy within cells.

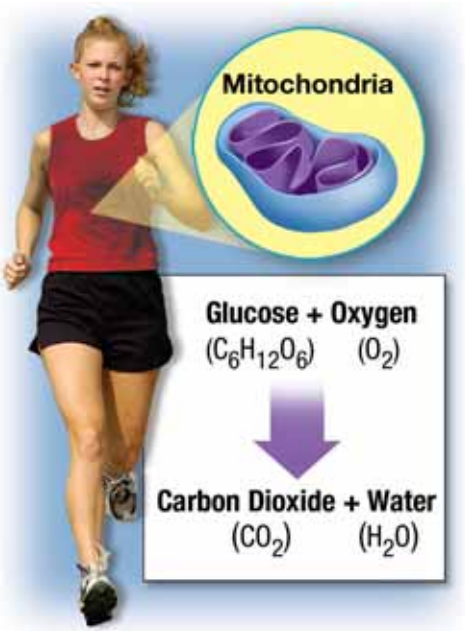
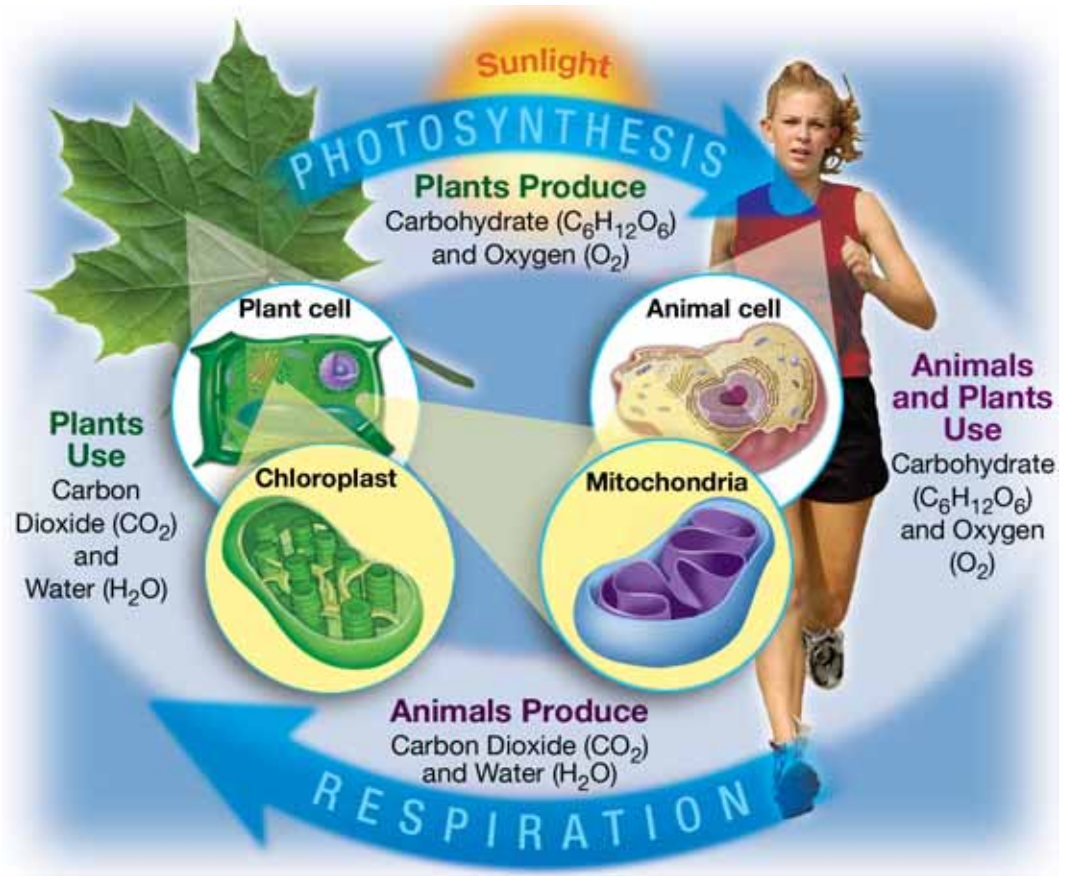


Figure 6.9: *The chemical reaction for cellular respiration. What are the reactants? What are the products?*

Comparing photosynthesis and cellular respiration

Comparing the reactions for photosynthesis and cellular respiration shows how living things on Earth are connected. The reactants in photosynthesis are the products in cellular respiration. The reactants in cellular respiration are the products in photosynthesis. The elements involved are carbon, hydrogen, and oxygen.



MY JOURNAL

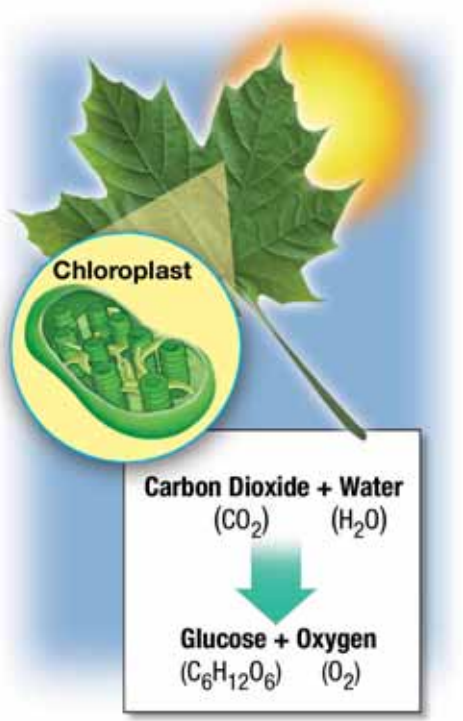
Write the story of a carbon atom as it travels through photosynthesis and cellular respiration. Include the following information in your story:

- the molecules in which the carbon atom is found.
- the organisms, cells, and organelles through which it travels.

Be creative!

6.2 Section Review

1. How are solar cells and chloroplasts similar?
2. What is the electromagnetic spectrum? Which part of the electromagnetic spectrum do plants use for photosynthesis?
3. When white light is passed through a prism, what happens?
4. The chemical reaction for photosynthesis is shown to the right. Use it to answer questions a through d.
   a. Name the reactants in the reaction.
   b. Name the products in the reaction.
   c. What is the function of sunlight in the reaction?
   d. What is the function of chlorophyll?
5. Where does cellular respiration take place?
6. What are the similarities between cellular respiration and respiration (breathing)? What are the differences?
7. What is the function of ATP in cellular respiration?
8. How are photosynthesis and cellular respiration related?
9. Do you think animals could survive without plants? Explain your answer.



CHALLENGE

All plants that use sunlight to grow have chlorophyll, but some do not look green. Come up with a hypothesis to explain this observation.

SOLVE IT!

1. Arrange the following colors from highest to lowest energy:

   green, yellow, red, blue, orange, violet

2. Arrange the following types of electromagnetic waves from longest to shortest wavelength:

   visible light, radio waves, ultraviolet light, microwaves, gamma rays, infrared waves

RESEARCH CONNECTION

Amazing Cells!

Did you know your body is made of trillions of cells? There are millions of different types. Where did all of these different types come from? Part of the answer is a special type of cell called *stem cells*.

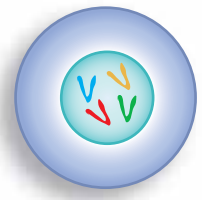
Many living things need stem cells including animals and plants. An organism that is not fully developed is called an *embryo*. In animal embryos, stem cells can develop into different types of cells. Your body has over 200,000 different types of cells. It has blood cells, muscle cells, skin cells, and stomach cells just to name a few. Each type of cell has its own structure and function.

The process of differentiation

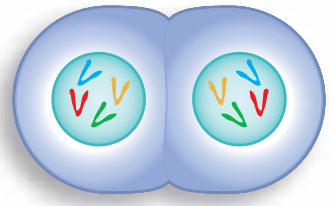
All stem cells have some certain properties:

- Stem cells divide to make more stem cells.
- Stem cells also have the ability to develop into different types of cells.

A stem cell divides into two daughter cells. Each daughter cell is identical to the original parent cell. When mature, these cells also divide. This is how embryos get a supply of stem cells. A growing embryo needs a lot of stem cells to develop tissues and organs. In the laboratory, starting with a few stem cells, scientists have grown millions in a few months.



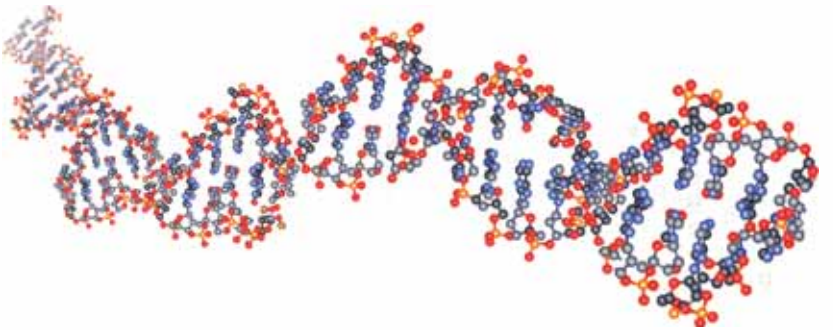
Parent cell



Two daughter cells

So how do stem cells change into other types of cells? Scientists are studying this problem.

Something called a signal tells stem cells to become different types of cells. Genes are pieces of DNA that carry information from the parent cell to the offspring cells. The genes inside stem cells provide internal signals. The environment outside of the cell provides external signals. The cell's environment includes chemicals from other cells.



Different types of specialized animal cells

There are two main types of animal stem cells. More than twenty years ago, scientists extracted stem cells from the embryos of mice. These stem cells are described as embryonic. The other main type of stem cells is described as adult. Embryonic stem cells and adult stem cells are very different.

Embryonic stem cells can divide to make more stem cells. They wait for a signal. Then they start producing specialized cells. These specialized cells form the tissues, which in turn form the organs.

Embryonic stems cells are like new players on a soccer team. Until the players are trained, they are reserves. They have the potential to do a lot of different things. Once they are trained, they become specialized in a position. The players might be defenders or forwards. They might play goalie or mid field. Similarly, embryonic stem cells are generic cells at first. They get "training" from a signal. Then they develop tissue for the kidneys, liver, or other organs.

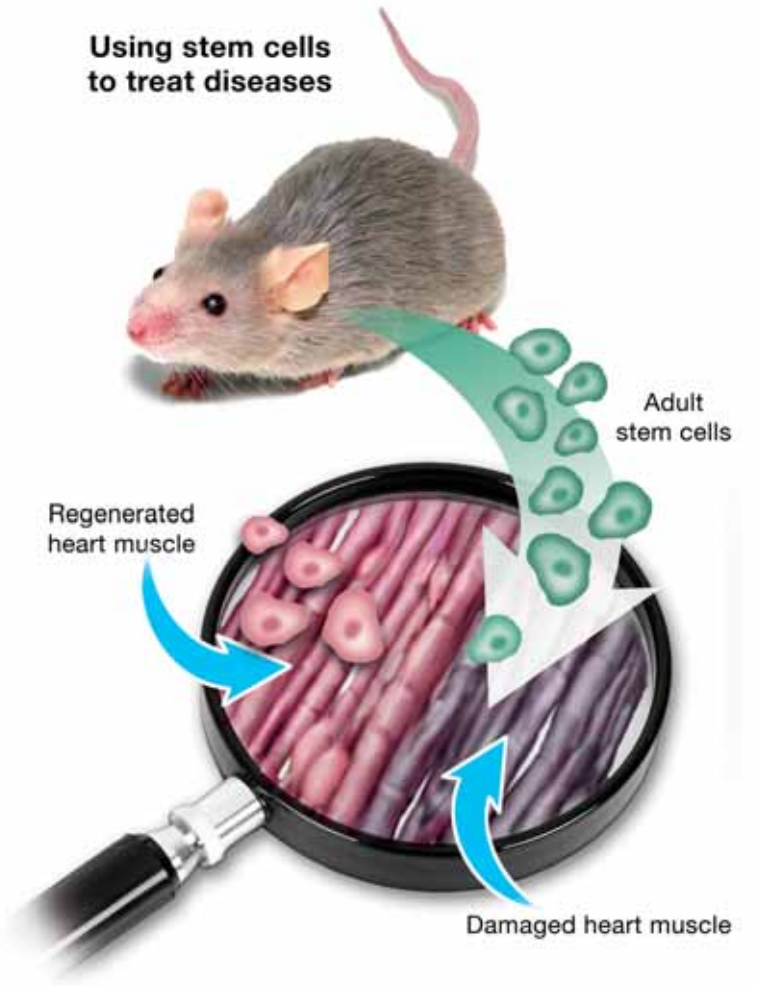
While the main job of embryonic stem cells is growth, the main job of adult stem cells is repair. They do not have as much potential as embryonic stem cells. They seem to already carry genetic information that determines which type of cells they can become. They exist alongside the types of cells they can produce. Adult stem cells in the skin, for example, develop into skin cells to help new skin grow after an injury.

The potential for treating diseases

Scientists think stem cells may help treat diseases. Can you think how this might work? Embryonic stem cells can develop into many other types of cells. If the right signals can be discovered, these cells might be able to replace or repair diseased tissue. Scientist's hope that diseases such as diabetes and heart disease may be treated this way someday.

Adult stem cells are already used in medicine. For 30 years, adult stem cells have been used in bone marrow transplants. The potential of adult stem cells is more limited, but scientists hope to use them to fight diseases. For example, research in mice indicates that putting adult stem cells into a damaged heart may help repair heart tissue.

Scientists are trying to better understand what triggers the differentiation of stem cells. As knowledge and understanding of stem cells increase, so does the potential for many new disease therapies.

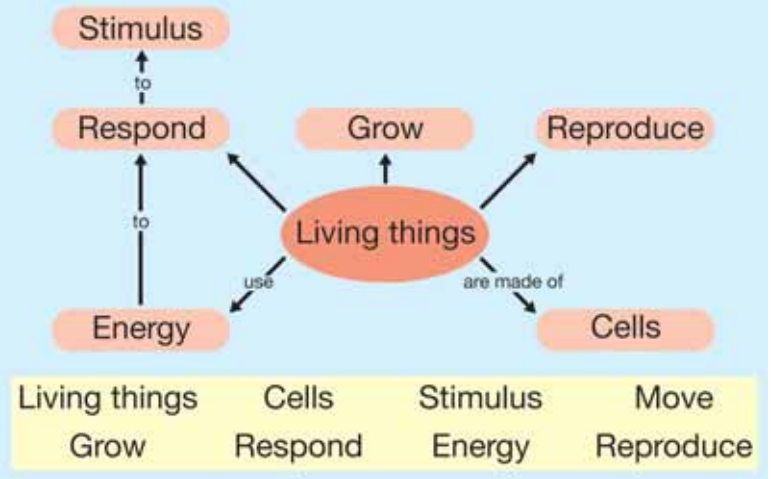


Questions:

1. What are the properties of stem cells?
2. Explain how stem cells change into different cell types.
3. What is the major difference between embryonic stem cells and adult stem cells?
4. How are adult stem cells used in medicine today?

CHAPTER ACTIVITY Making a Concept Map

A concept map is a way to represent information visually. A concept map consists of nodes that contain written concepts. The nodes are connected with lines to to show relationships. The lines are labeled with an arrowhead to describe the direction of the information.



In this activity you will create a concept map that explains how cells get and use energy. Your concept map should address the following question: **How do animal and plant cells use energy for life's processes?**

What you will do

1. Write the concepts below on separate index cards or sticky notes so they can be moved around.

mitochondria	growth	ATP	energy
chloroplasts	plant cell	food	carbon dioxide
oxygen	carbohydrates	energy	pigments
photosynthesis	carbon	sunlight	plants
animals	air	cellular respiration	chlorophyll

2. Obtain a large sheet of paper or poster board from your teacher.
3. Rank the concepts in order by placing the most general concepts at the top to the most specific term at the bottom. Think about the focus question to help rank the question. Begin with only one to three of the most general concepts at the top of the map.
4. Choose two to four sub concepts to place under each general concept.
5. Connect the concepts by lines. Label the lines with one or a few linking words that define the relationship between the two concepts. These should read as a statement. Draw arrow heads to show the direction of the information.
6. Look at your map and revise any part if necessary.
7. Look for cross links between concepts in different sections of the map. Draw and label these lines.
8. Present your concept map to the class and compare it to others.

Applying your knowledge

a. Explain the relationship between photosynthesis and growth.
b. Do plants take in organic food substances such as starch, sugar or protein from the soil?
c. As a plant grows it gains weight (mass). Where does this weight come from?
d. Where is carbon dioxide and water absorbed by most plants?
e. What is the role of chlorophyll in a plant cell?
f. How does the food you eat aid in cellular respiration?
g. How did your concept map change as you made it?
h. Revise your concept map again if you wish, after your class discussion.

Chapter 6 Assessment

Vocabulary

Select the correct term to complete the sentences.

chlorophyll	photosynthesis	active transport
pigment	ATP	osmosis
cellular respiration		diffusion

Section 6.1

1. Movement of molecules that requires energy is called ____.
2. ____ is a kind of diffusion that involves water moving across the cell membrane.
3. Osmosis and ____ are two types of passive transport because they do not require energy.

Section 6.2

4. ____ stores and transfers chemical energy in cells.
5. Plant cells perform ____ to store energy from the sun in the form of molecules.
6. When ____ breaks down in the autumn, leaves change color as red, orange, and yellow pigments become visible.
7. ____ uses oxygen and glucose to produce carbon dioxide, water, and energy.
8. Chlorophyll is a ____, which is a molecule that absorbs some colors of light and reflects others.

Concepts

Section 6.1

1. Draw and label a diagram of the cell membrane.
2. How do different cells recognize each other?
3. Distinguish between diffusion and osmosis.
4. Identify each situation as an example of diffusion, osmosis, or active transport.
   a. making a cup of tea
   b. leftover salad wilting in the refrigerator
   c. smoke escaping from the chimney
   d. pumping up a tire with air
   e. stained cotton t shirt soaking in sink
   f. smell of perfume spreading through the room

Section 6.2

5. Why do plants look green?
6. How are breathing and cellular respiration related?
7. Do plant cells need to carry out respiration? Explain.
8. Create a table that compares photosynthesis and cellular respiration including: definitions, reactants, products, what organisms perform the process, and where it occurs in the cell.

Math and Writing Skills

Section 6.1

1. The concentration of a solution can be expressed as a *ratio* - a comparison of two numbers. For example if you dissolved 10 grams of sugar in one liter of water, you could say the concentration as a ratio - 10 g: 1L or 10g/L. Calculate these concentrations and ratios.
   a. You dissolve 120 g of sugar in 2 L of water. What is the concentration per liter? State the concentration as a ratio.
   b. You dissolve 50 g of salt in 3 L of water. What is the concentration per liter? State the concentration as a ratio.

2. Helium balloons float because helium is lighter than the mixture of gases in the surrounding air. Use what you learned about diffusion to explain why helium balloons deflate after a few days. How is the balloon like the cell membrane?

3. This chart shows the time (minutes) that it took for a substance to diffuse completely in a liquid of increasing temperature. (degrees Celsius). Use the data to help answer the questions and predict the affect of temperature on the rate of diffusion.

Temperature (degrees Celsius)	Time for diffusion (minutes)
10	8
20	4
30	2
40	1.8
50	1.6
60	1.4
70	1.2
80	1
90	.8
100	.5

   a. At what temperature was the rate of diffusion the fastest?
   b. At what temperature was the rate of diffusion the slowest?
   c. How does temperature affect the rate of diffusion?

Section 6.2

4. Fill in the greater than (>) or less than (<) symbol as appropriate to complete these statements about energy and wavelengths.
   a. the energy used in x rays ____ the energy used in microwaves
   b. the wavelengths of gamma rays ____ the wavelengths of radar
   c. the energy of blue visible light ____ the energy of orange visible light
   d. the wavelength of tv remote controls ____ the wavelengths of black lights

5. The word “photosynthesis” means “putting together with light.” Explain how the meaning of the word photosynthesis is related to the process.

6. Why are mitochondria sometimes called the powerhouses of cells? Explain.

Chapter Project

Potato experiment

Try this easy experiment, and then complete the project by answering the questions. Carefully slice a potato into thin round or oval pieces so that each slice has two flat, cut sides. USE EXTREME CARE WHEN USING A SHARP KNIFE! Place potatoes on a proper cutting surface such as a cutting board, and be sure the potato can't roll and move around while you cut it. It is best to have an adult do the cutting. Place a couple of potato slices in a bowl filled with plain water. Place some different potato slices in a second bowl of water to which 2 spoonfuls of salt has been added and dissolved. Wait about 15 minutes, and compare the potato slices. Pick them up out of the water and see if they feel different. Try bending the slices.

1. Describe the differences you noticed in the potatoes after they soaked for 15 minutes. Explain, using the terms cells and osmosis, what happened to cause these results.

2. Draw a labeled "before and after" diagram that can explain to someone who did not do the experiment exactly what happened and what the science is that explains the results. Use arrows to show movement of molecules.