Chapter

16

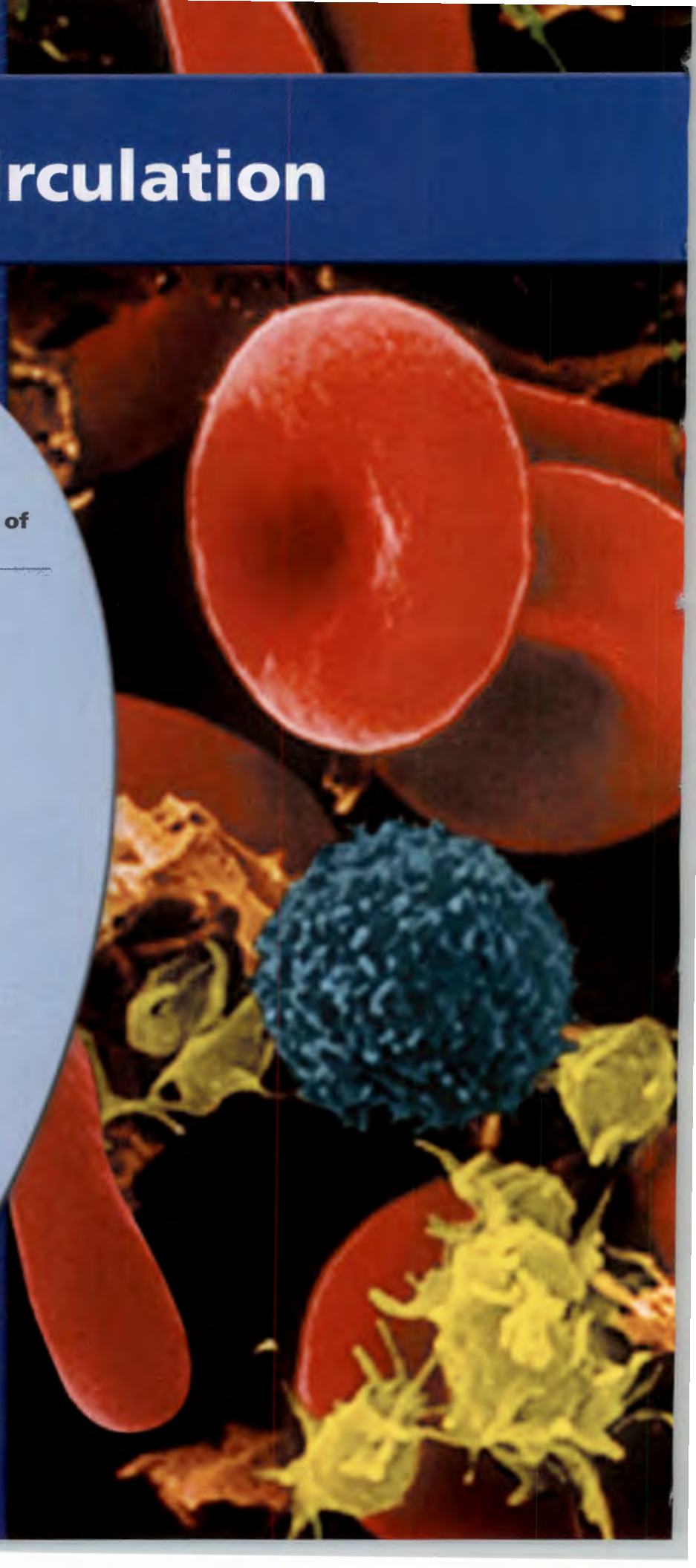
Circulation

The BIG Idea

Structure and Function

What are the major functions of the circulatory system?

Chapter Preview



Blood cells travel in blood vessels to all parts of the body.

Discovery CHANNEL SCHOOL

Circulation

- ▶ Video Preview
- Video Field Trip
- Video Assessment

Lab zone™ Chapter **Project**

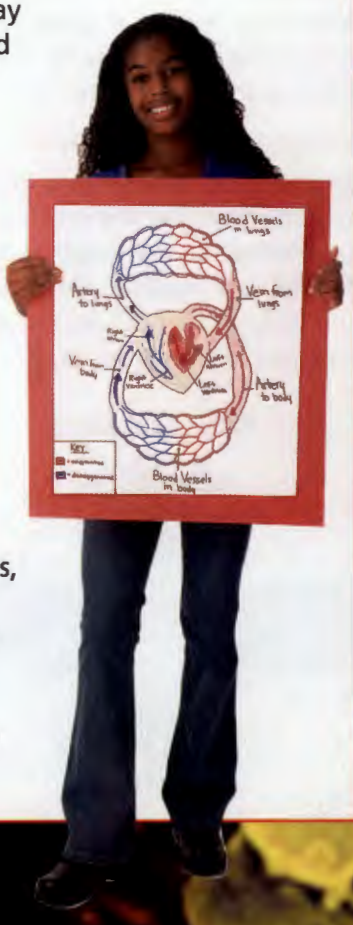
Travels of a Red Blood Cell

Every day, you travel from home to school and back home again. Your travel path makes a loop, or circuit, ending where it began. In this chapter, you'll learn how your blood also travels in circuits. In this project, you'll create a display to show how blood circulates throughout the body.

Your Goal To design and construct a display showing a complete journey of a red blood cell through the human body

Your display must

- show a red blood cell that leaves from the heart and returns to the same place
- show where the exchange of oxygen and carbon dioxide takes place
- provide written descriptions of the circuits made by the red blood cell
- be designed following the safety guidelines in Appendix A



Plan It! Preview the chapter and find diagrams that show the heart, red blood cells, and the pathway of blood throughout the body. Then discuss the kinds of displays you could use, including a three-dimensional model, posters, a series of drawings, a flip book, or a video animation. Write down any content questions you'll need to answer.

Section 1

The Body's Transport System

Reading Preview

Key Concepts

- What are the functions of the cardiovascular system?
- What is the function and structure of the heart?
- What path does blood take through the cardiovascular system?
- What are the functions and structures of arteries, capillaries, and veins?

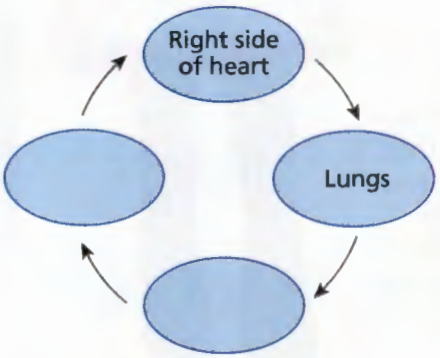
Key Terms

- cardiovascular system • heart
- atrium • pacemaker
- ventricle • valve • artery
- capillary • vein • aorta
- coronary artery • pulse
- diffusion • blood pressure

Target Reading Skill

Sequencing As you read, make a cycle diagram like the one below that shows the path that blood follows as it circulates throughout the body. Write each step of the pathway in a separate circle.

Pathway of Blood



Lab zone **Discover Activity**

How Hard Does Your Heart Work?

1. Every minute, your heart beats about 75 to 85 times. With each beat, it pumps about 60 milliliters of blood. Can you work as hard and fast as your heart does?
2. Cover a table or desk with newspapers. Place two large plastic containers side by side on the newspapers. Fill one with 2.5 liters of water, which is about the volume of blood that your heart pumps in 30 seconds. Leave the other container empty.
3. With a plastic cup that holds about 60 milliliters, transfer water as quickly as possible into the empty container, trying not to spill any. **CAUTION:** *Wipe up spills on the floor immediately.* Have a partner time you for 30 seconds. As you work, count how many transfers you make in 30 seconds.
4. Multiply your results by 2 to find the number of transfers in 1 minute.

Think It Over

Inferring Compare your performance with the number of times your heart beats every minute. What do your results tell you about the strength and speed of a heartbeat?

Late at night, a truck rolls through the darkness. Loaded with fresh fruits and vegetables, the truck is headed for a city supermarket. The driver steers off the interstate and onto a smaller highway. Finally, after driving through narrow city streets, the truck reaches its destination. As dawn breaks, store workers unload the cargo. At the same time, a garbage truck removes yesterday's trash and drives off down the road.

The Cardiovascular System

Like the roads that link all parts of the country, your body has a "highway" network, called the cardiovascular system, that links all parts of your body. The **cardiovascular system,** also called the circulatory system, consists of the heart, blood vessels, and blood. **The cardiovascular system carries needed substances to cells and carries waste products away from cells. In addition, blood contains cells that fight disease.**

Delivering Needed Materials Most substances that need to get from one part of the body to another are carried by blood. For example, blood carries oxygen from your lungs to your other body cells. Blood also transports the glucose your cells use to produce energy.

Removing Waste Products The cardiovascular system picks up wastes from cells. For example, when cells break down glucose, they produce carbon dioxide as a waste product. The carbon dioxide passes from the cells into the blood. The cardiovascular system then carries carbon dioxide to the lungs, where it is exhaled.

Fighting Disease The cardiovascular system also transports cells that attack disease-causing microorganisms. This process can help keep you from becoming sick. If you do get sick, these disease-fighting blood cells will kill the microorganisms and help you get well.

Reading Checkpoint **How does the cardiovascular system help fight disease?**

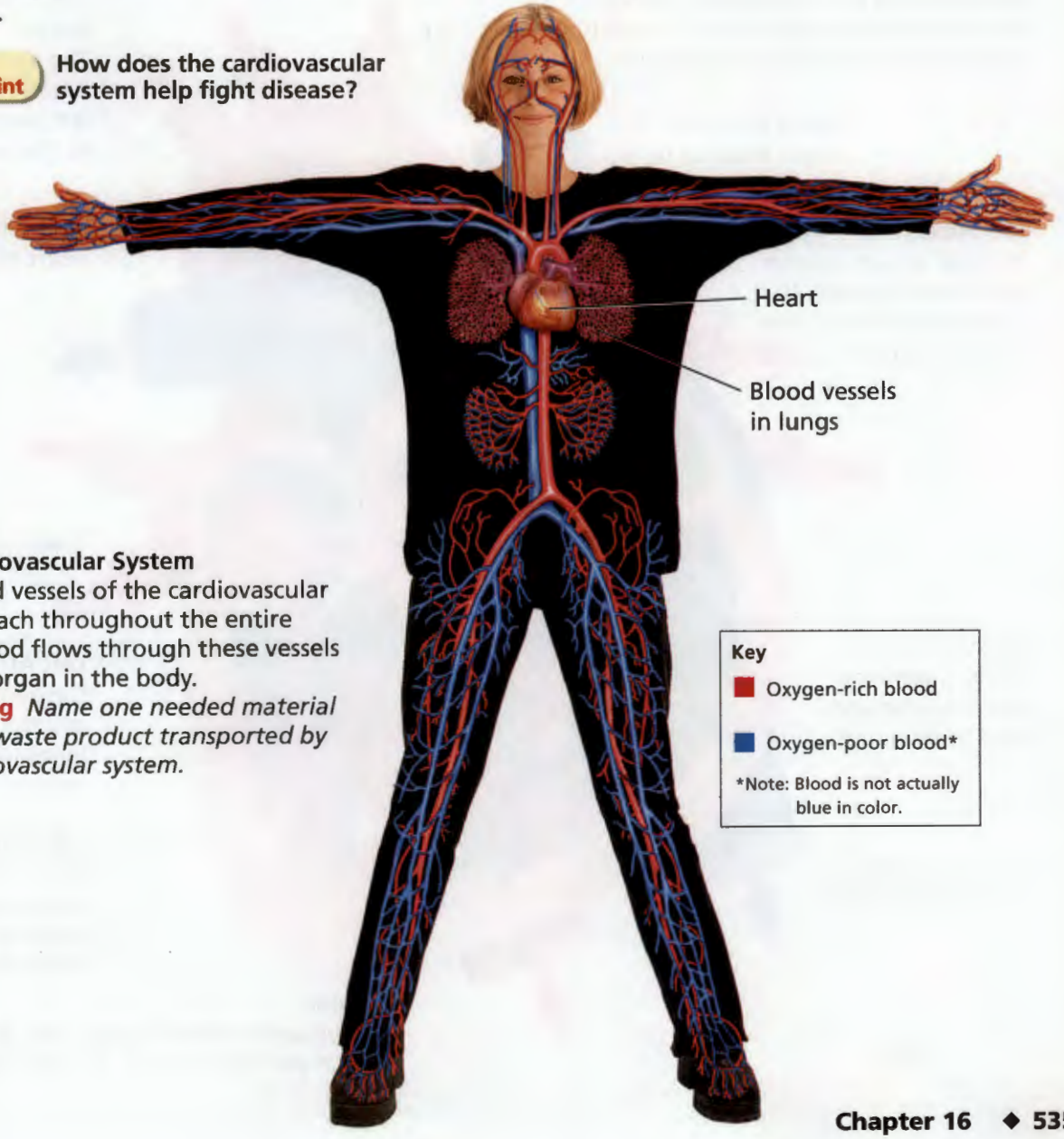


FIGURE 1
The Cardiovascular System
The blood vessels of the cardiovascular system reach throughout the entire body. Blood flows through these vessels to every organ in the body.
Classifying *Name one needed material and one waste product transported by the cardiovascular system.*

The Heart

Without the heart, blood wouldn't go anywhere. The **heart** is a hollow, muscular organ that pumps blood throughout the body. **Each time the heart beats, it pushes blood through the blood vessels of the cardiovascular system.**

Your heart, shown in Figure 2, is about the size of your fist. It is located in the center of your chest. The heart lies behind the sternum (breastbone) and inside the rib cage. It is made of cardiac muscle, which can contract over and over without getting tired.

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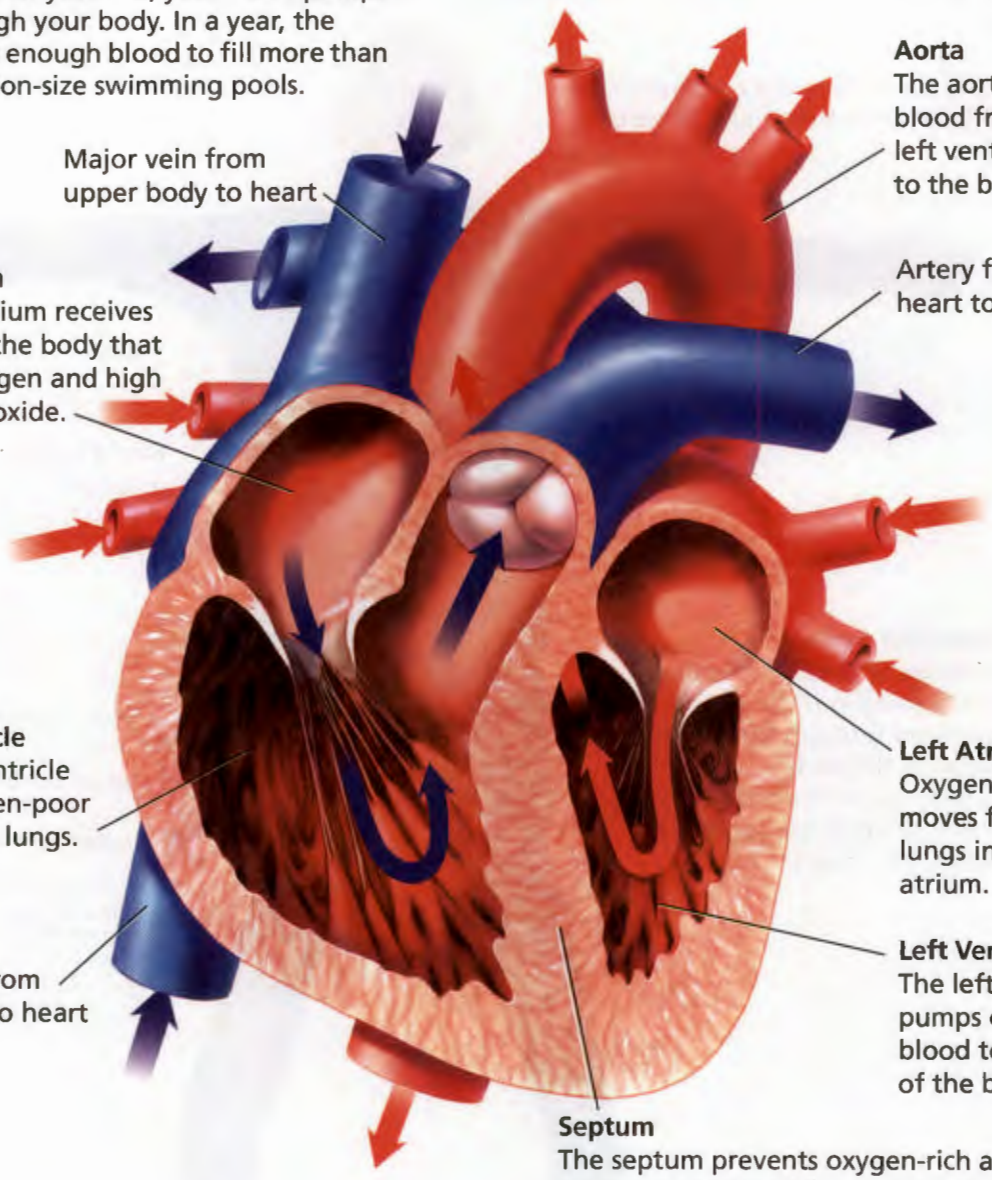
FIGURE 2
The Heart

Every second of your life, your heart pumps blood through your body. In a year, the heart pumps enough blood to fill more than 30 competition-size swimming pools.



The Heart's Structure The heart has a right side and a left side. **The right side of the heart is completely separated from the left side by a wall of tissue called the septum. Each side has two compartments, or chambers—an upper chamber and a lower chamber.** Each of the two upper chambers, called an **atrium** (AY tree um) (plural *atria*), receives blood that comes into the heart. Located in the right atrium is a group of heart cells called the **pacemaker,** which sends out signals that make the heart muscle contract.

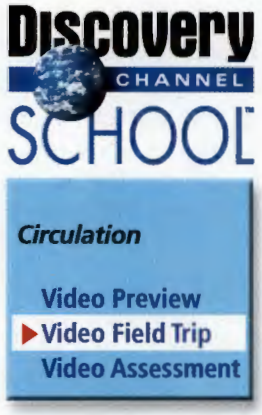
Each lower chamber, called a **ventricle,** pumps blood out of the heart. The atria are separated from the ventricles by valves. A **valve** is a flap of tissue that prevents blood from flowing backward. Valves are also located between the ventricles and the large blood vessels that carry blood away from the heart.

How the Heart Works The action of the heart has two main phases. In one phase, the heart muscle relaxes and the heart fills with blood. In the other phase, the heart muscle contracts and pumps blood forward. A heartbeat, which sounds something like *lub-dup*, can be heard during the pumping phase.

When the heart muscle relaxes, blood flows into the chambers. Then, the atria contract, squeezing blood out of the atria, through the valves, and into the ventricles. Next, the ventricles contract. This contraction closes the valves between the atria and ventricles, making the *lub* sound and squeezing blood into large blood vessels. As the valves between the ventricles and the blood vessels snap shut, they make the *dup* sound.

When muscle cells in the ventricles contract, they exert a force on the blood. A force is a push or a pull. The force exerted by the ventricles pushes blood out of your heart and into arteries. The contraction of the left ventricle exerts much more force than the contraction of the right ventricle.

Reading Checkpoint **What is the role of the pacemaker?**



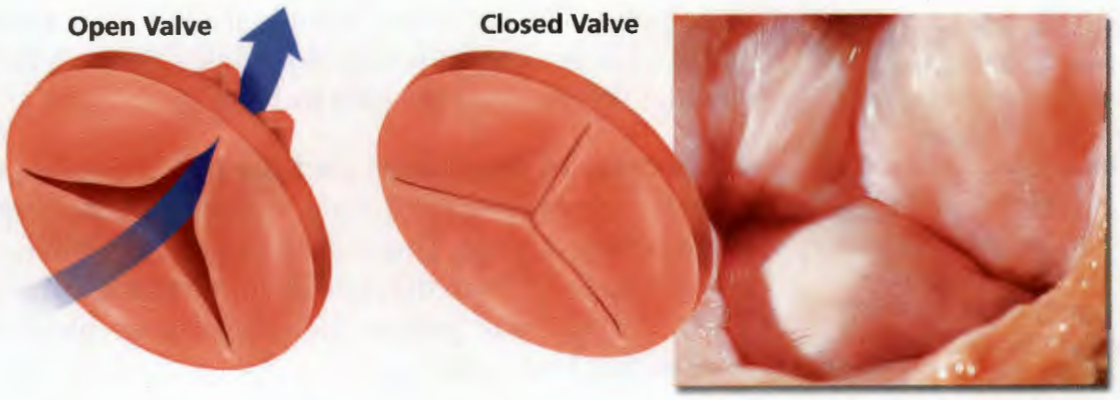


FIGURE 3
Open and Closed Heart Valves As blood flows out of the heart and toward the lungs, it passes through a valve like the one in the photograph. **Applying Concepts** *What is the function of a closed heart valve?*

FIGURE 4
Getting Blood to Body Cells
During strenuous exercise, such as swimming, the pattern of blood flow through the body ensures that body cells get the oxygen they need quickly and efficiently.

Two Loops

After leaving the heart, blood travels in blood vessels through the body. Your body has three kinds of blood vessels—arteries, capillaries, and veins. **Arteries** are blood vessels that carry blood away from the heart. From the arteries, blood flows into tiny, narrow vessels called **capillaries.** In the capillaries, substances are exchanged between the blood and body cells. From capillaries, blood flows into **veins,** blood vessels that carry blood back to the heart.

Pattern of Blood Flow The overall pattern of blood flow through the body is something like a figure eight. The heart is at the center where the two loops cross. **In the first loop, blood travels from the heart to the lungs and then back to the heart. In the second loop, blood is pumped from the heart throughout the body and then returns again to the heart.** The heart is really two pumps, one on the right and one on the left. The right side pumps blood to the lungs, and the left side pumps blood to the rest of the body.

Blood travels in only one direction. If you were a drop of blood, you could start at any point and eventually return to the same point. The entire trip would take less than a minute. As you read about the path that blood takes through the cardiovascular system, trace the path in Figure 5.

Loop One: To the Lungs and Back When blood from the body flows into the right atrium, it contains little oxygen but a lot of carbon dioxide. This oxygen-poor blood is dark red. The blood then flows from the right atrium into the right ventricle. Then, the ventricle pumps the oxygen-poor blood into the arteries that lead to the lungs.

Lab zone Skills Activity

Creating Data Tables

Scientists measured the volume of blood that different organs receive, at rest and during vigorous exercise.

- At rest, the organs of the abdomen received about 1,400 mL of blood per minute (mL/min). During vigorous exercise, they received 600 mL/min.
- At rest, skeletal muscles received 1,200 mL/min. During vigorous exercise, they received about 12,500 mL/min.
- At rest, the kidneys received 1,100 mL/min. During vigorous exercise, they received about 600 mL/min.

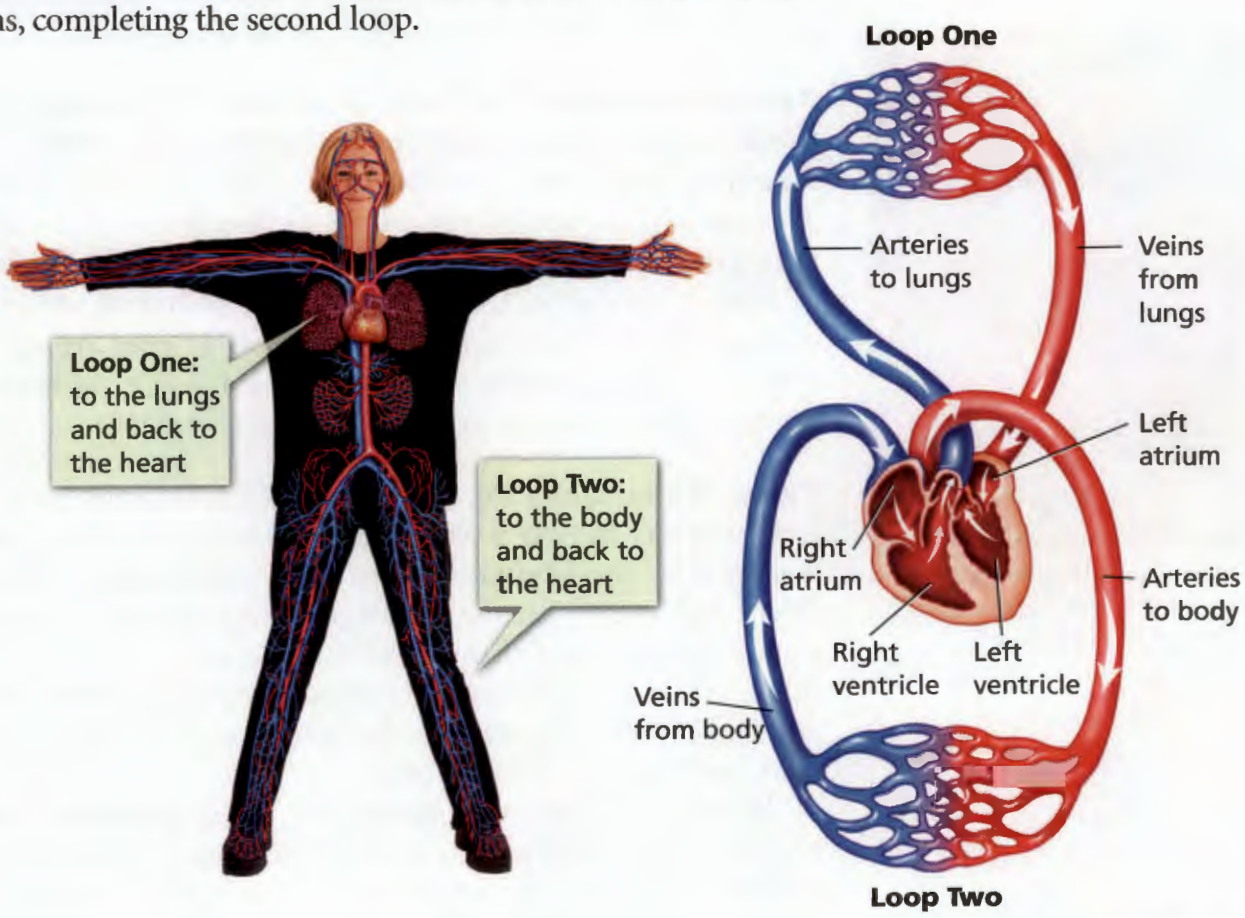
Create a table to record these data. Then, use the data to explain why some organs receive more blood during exercise than others.

As blood flows through the lungs, large blood vessels branch into smaller ones. Eventually, blood flows through tiny capillaries that are in close contact with the air that comes into the lungs. The air in the lungs has more oxygen than the blood in the capillaries, so oxygen moves from the lungs into the blood. For the same reason, carbon dioxide moves in the opposite direction—from the blood into the lungs. As the blood leaves the lungs, it is now rich in oxygen and poor in carbon dioxide. This blood, which is bright red, flows to the left side of the heart and will be pumped through the second loop.

Loop Two: To the Body and Back The second loop begins as the left atrium fills with oxygen-rich blood coming from the lungs. The blood then moves into the left ventricle. From the left ventricle, the blood is pumped into the **aorta** (ay AWR tuh), the largest artery in the body.

Eventually, after passing through branching arteries, blood flows through tiny capillaries in different parts of your body, such as your brain, liver, and legs. These vessels are in close contact with body cells. Oxygen moves out of the blood and into the body cells. At the same time, carbon dioxide passes from the body cells and into the blood. This blood, which is low in oxygen, then flows back to the right atrium of the heart through veins, completing the second loop.

FIGURE 5
Direction of Blood Flow
Blood circulates through the body in two loops, with the heart at the center. Loop one goes from the heart to the lungs and back. Loop two circulates blood throughout the rest of the body.
Interpreting Diagrams *Where does the blood that enters the left atrium come from?*



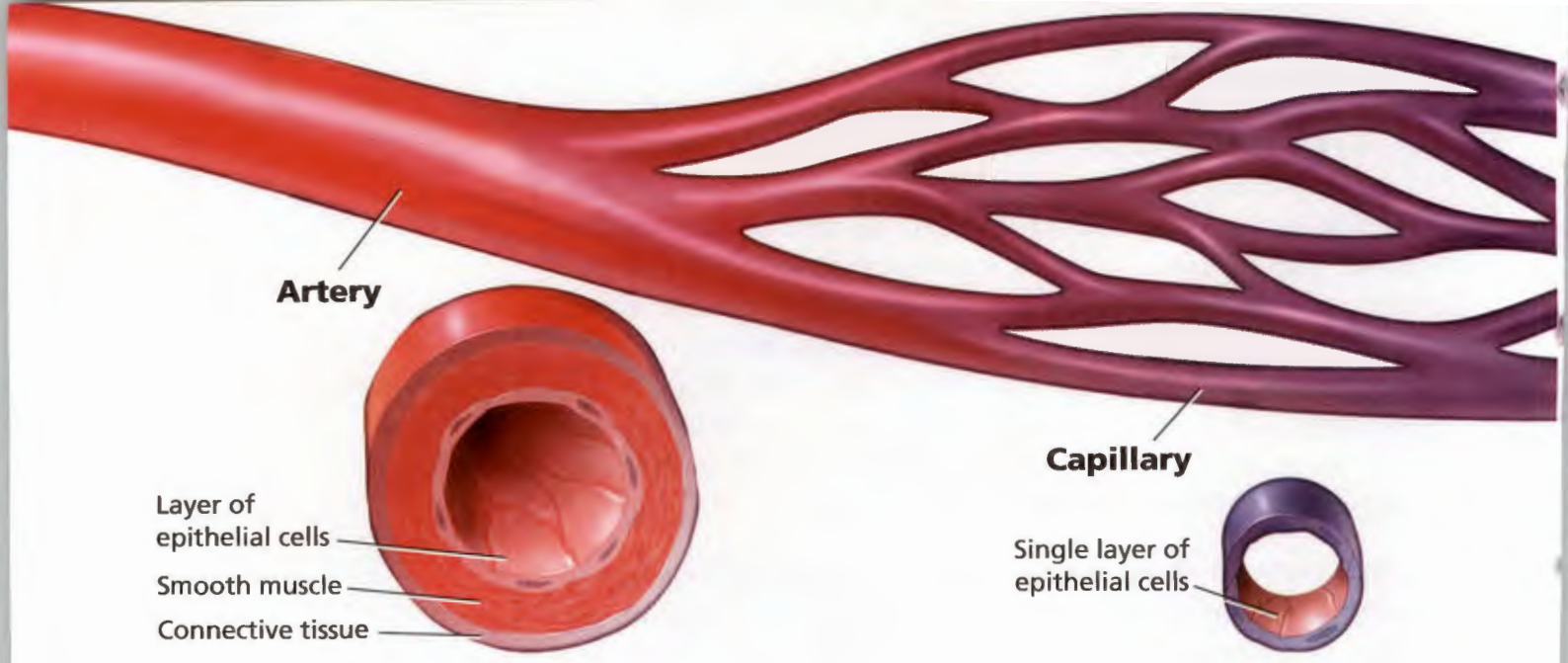
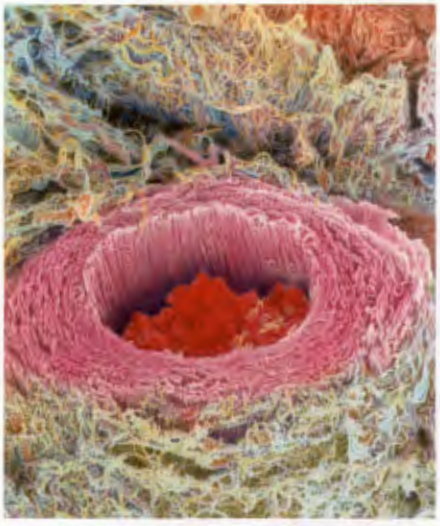


FIGURE 6
Artery, Capillary, and Vein
The walls of arteries and veins have three layers. The walls of capillaries are only one cell thick. **Relating Cause and Effect** *How does material get from inside capillaries to body cells?*



▲ The artery wall appears as a thick pink band surrounding a clump of red blood cells.

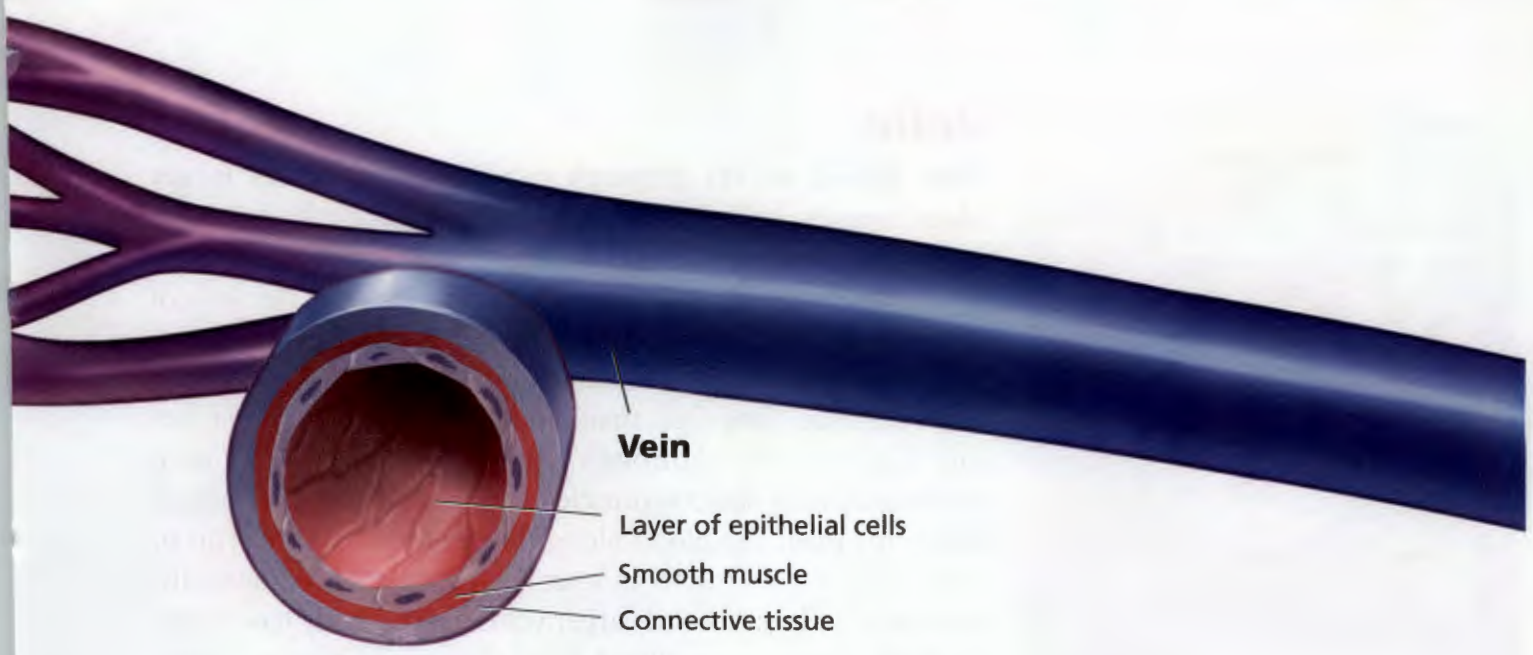
Arteries

When blood leaves the heart, it travels through arteries. The right ventricle pumps blood into the arteries that go to the lungs. The left ventricle pumps blood into the aorta. Smaller arteries branch off the aorta. The first branches, called the **coronary arteries,** carry blood to the heart itself. Other branches carry blood to the brain, intestines, and other organs. Each artery branches into smaller and smaller arteries.

Artery Structure **The walls of arteries are generally very thick. In fact, artery walls consist of three cell layers.** The innermost layer, which is made up of epithelial cells, is smooth. This smooth surface enables blood to flow freely. The middle layer consists mostly of muscle tissue. The outer wall is made up of flexible connective tissue. Because of this layered structure, arteries have both strength and flexibility. Arteries are able to withstand the enormous pressure of blood as it is pumped by the heart and to expand and relax between heart beats.

Pulse If you lightly touch the inside of your wrist, you can feel the artery in your wrist rise and fall repeatedly. This **pulse** is caused by the alternating expansion and relaxation of the artery wall. Every time the heart's ventricles contract, they send a spurt of blood out through all the arteries in your body. As this spurt travels through the arteries, it pushes the artery walls and makes them expand. After the spurt passes, the artery walls relax and become narrower again.

When you count the number of times an artery pulses beneath your fingers, you are counting heartbeats. By taking your pulse rate, you can determine how fast your heart is beating.



Regulating Blood Flow The layer of muscle in an artery acts as a control gate, adjusting the amount of blood sent to different organs. When the muscle contracts, the opening in the artery becomes smaller. When the muscle relaxes, the opening becomes larger. For example, after you eat, your stomach and intestines need a greater blood supply for digestion. The arteries leading to those organs open wider, and more blood flows through them. In contrast, when you are running, your stomach and intestines need less blood than the muscles in your legs. The arteries leading to the digestive organs become narrower, decreasing the blood flow to these organs.

Reading Checkpoint **What causes your pulse?**

Capillaries

Eventually, blood flows from small arteries into the tiny capillaries. **In the capillaries, materials are exchanged between the blood and the body's cells. Capillary walls are only one cell thick.** Thus, materials can pass easily through them. Materials such as oxygen and glucose pass from the blood, through the capillary walls, to the cells. Cellular waste products travel in the opposite direction—from cells, through the capillary walls, and into the blood.

One way that materials are exchanged between the blood and body cells is by diffusion. **Diffusion** is the process by which molecules move from an area of higher concentration to an area of lower concentration. For example, glucose is more highly concentrated in the blood than it is in the body cells. Therefore, glucose diffuses from the blood into the body cells.

Math Skills

Calculating a Rate

A rate is the speed at which something happens. When you calculate a rate, you compare the number of events with the time period in which they occur. Here's how to calculate the pulse rate of a person whose heart beats 142 times in 2 minutes.

1. Write the comparison as a fraction.

$$\frac{142 \text{ heartbeats}}{2 \text{ minutes}}$$

2. Divide the numerator and the denominator by 2.

$$\frac{142 \div 2}{2 \div 2} = \frac{71}{1}$$

The person's pulse rate is 71 heartbeats per minute.

Practice Problem Calculate your pulse rate if your heart beats 170 times in 2.5 minutes.

FIGURE 7
Artery and Vein
In this photo, you can compare the wall of an artery (top) with the wall of a vein (bottom).
Comparing and Contrasting
Where is the pushing force of the heart greater—in arteries or in veins?

Veins

After blood moves through capillaries, it enters larger blood vessels called veins, which carry blood back to the heart. The walls of veins, like those of arteries, have three layers, with muscle in the middle layer. However, the walls of veins are generally much thinner than those of arteries.

By the time blood flows into veins, the pushing force of the heart has much less effect than it did in the arteries. Several factors help move blood through veins. First, because many veins are located near skeletal muscles, the contraction of the muscles helps push the blood along. For example, as you run or walk, the skeletal muscles in your legs contract and squeeze the veins in your legs. Second, larger veins in your body have valves in them that prevent blood from flowing backward. Third, breathing movements, which exert a squeezing pressure against veins in the chest, also force blood toward the heart.

Reading Checkpoint **How do skeletal muscles help move blood in veins?**

Blood Pressure

Suppose that you are washing a car. You attach the hose to the faucet and turn on the faucet. The water flows out in a slow, steady stream. Then, while your back is turned, your little brother turns the faucet on all the way. Suddenly, the water spurts out rapidly, and the hose almost jumps out of your hand.

As water flows through a hose, it pushes against the walls of the hose, creating pressure on the walls. Pressure is the force that something exerts over a given area. When your brother turned on the faucet all the way, the additional water flow increased the pressure exerted on the inside of the hose. The extra pressure made the water spurt out of the nozzle faster.

What Causes Blood Pressure? Blood traveling through blood vessels behaves in a manner similar to that of water moving through a hose. Blood exerts a force, called **blood pressure,** against the walls of blood vessels. Blood pressure is caused by the force with which the ventricles contract. In general, as blood moves away from the heart, blood pressure decreases. This change happens because the farther away from the ventricle the blood moves, the lower its force is. Blood flowing through the arteries exerts the highest pressure. Blood pressure in arteries farther from the heart is much lower.

Measuring Blood Pressure Blood pressure can be measured with an instrument called a sphygmomanometer (sfig moh muh NAHM uh tur). A cuff is wrapped around the upper arm. Air is pumped into the cuff until the blood flow through the artery is stopped. As the pressure is released, the examiner listens to the pulse and records two numbers. Blood pressure is expressed in millimeters of mercury. The first number is a measure of the blood pressure while the heart's ventricles contract and pump blood into the arteries. The second number, which is lower, measures the blood pressure while the ventricles relax. The two numbers are expressed as a fraction: the contraction pressure over the relaxation pressure.

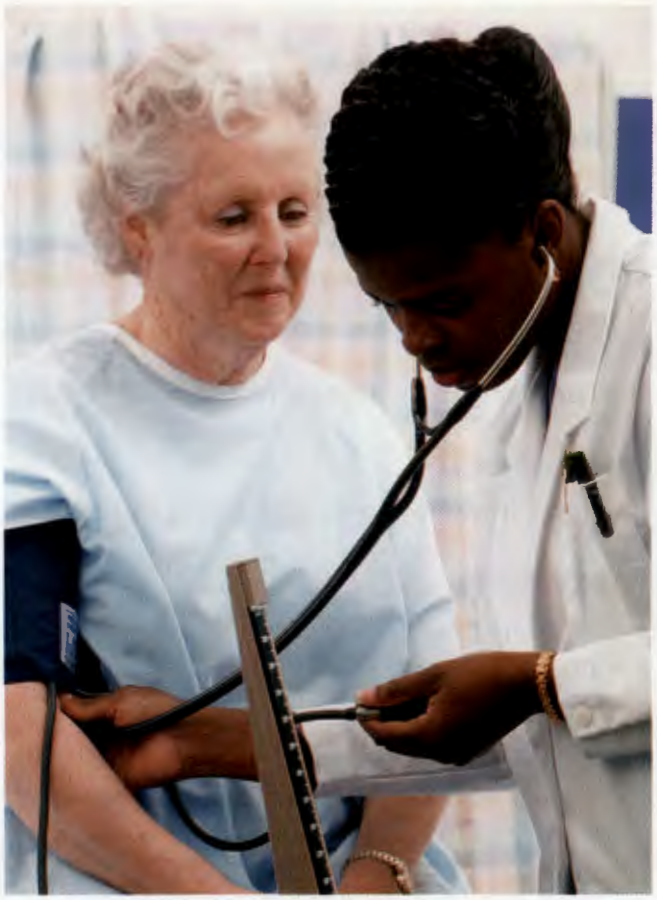


FIGURE 8
Measuring Blood Pressure
Blood pressure can be measured with a sphygmomanometer. A typical blood pressure reading for a healthy person is 120/80 or lower.

Section 1 Assessment

Target Reading Skill **Sequencing** Refer to your cycle diagram about the pathway of blood flow as you answer Question 3.

Reviewing Key Concepts

1. a. **Reviewing** What does the cardiovascular system consist of?
   b. **Classifying** What three functions does the cardiovascular system perform?
2. a. **Identifying** What function does the heart perform?
   b. **Summarizing** What are the four chambers of the heart? What structures separate one chamber from another?
   c. **Predicting** What would happen if the valve between the right atrium and the right ventricle did not work properly?
3. a. **Identifying** Where does blood returning from the body enter the heart?
   b. **Sequencing** Where does the blood move next?
4. a. **Describing** What roles do arteries, capillaries, and veins play in the cardiovascular system?
   b. **Comparing and Contrasting** How are the structures of arteries, capillaries, and veins similar? How are they different?

Math Practice

Before a run, you take your pulse rate for 30 seconds and count 29 beats. Immediately after the run, you count 63 beats in 30 seconds.

5. **Calculating a Rate** What was your pulse rate per minute before the run?
6. **Calculating a Rate** What was your pulse rate immediately after the run?

Lab zone Skills Lab

Heart Beat, Health Beat

Problem

How does physical activity affect your pulse rate?

Skills Focus

graphing, interpreting data, drawing conclusions

Materials

- graph paper
- watch with second hand or heart rate monitor

Procedure

1. Predict how your pulse rate will change as you go from resting to being active, then back to resting again. Then, copy the data table into your notebook.
2. Locate your pulse by placing the index and middle finger of one hand on your other wrist at the base of your thumb. Move the two fingers slightly until you feel your pulse. If you are using a heart rate monitor, see your teacher for instructions.
3. Work with a partner for the rest of this lab. Begin by determining your resting pulse rate. Count the number of beats in your pulse for exactly 1 minute while your partner times you. Record your resting pulse rate in your data table. **CAUTION:** *Do not complete the rest of this lab if there is any medical reason why you should avoid physical activities.*
4. Walk in place for 1 minute while your partner times you. Stop and immediately take your pulse for 1 minute. Record the number in your data table.
5. Run in place for 1 minute. Take your pulse again, and record the result.
6. Sit down right away, and have your partner time you as you rest for 1 minute. Then, take your pulse rate again.
7. Have your partner time you as you rest for 3 more minutes. Then take your pulse rate again and record it.

Data Table

Activity	Pulse Rate
Resting	
Walking	
Running	
Resting after exercise (1 min)	
Resting after exercise (3+ min)	

Analyze and Conclude

1. **Graphing** Use the data you obtained to create a bar graph of your pulse rate under the different conditions you tested.
2. **Interpreting Data** What happens to the pulse rate when the physical activity has stopped?
3. **Inferring** What can you infer about the heartbeat when the pulse rate increases?
4. **Drawing Conclusions** What conclusion can you draw about the relationship between physical activity and a person's pulse rate?
5. **Communicating** How could you improve the accuracy of your pulse measurements? Write a paragraph in which you discuss this question in relation to the steps you followed in your procedure.

Design an Experiment

Design an experiment to determine whether the resting pulse rates of adults, teens, and young children differ. *Obtain your teacher's permission before carrying out your investigation.*

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Section 2

Blood and Lymph

Reading Preview

Key Concepts

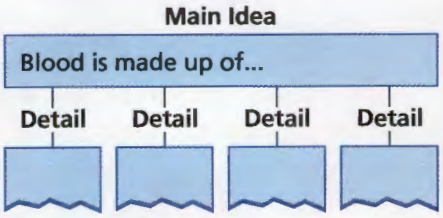
- What are the components of blood?
- What determines the type of blood that a person can receive in a transfusion?
- What are the structures and functions of the lymphatic system?

Key Terms

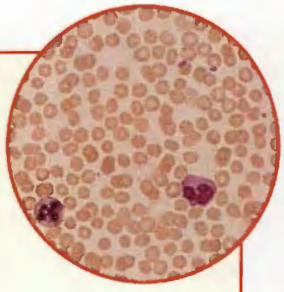
- plasma
- red blood cell
- hemoglobin
- white blood cell
- platelet
- lymphatic system
- lymph
- lymph node

Target Reading Skill

Identifying Main Ideas As you read the section titled Blood, write the main idea in a graphic organizer like the one below. Then, write four supporting details that give examples of the main idea.



Lab zone Discover Activity



What Kinds of Cells Are in Blood?

1. Obtain a microscope slide of human blood. Look at the slide under the microscope, first under low power and then under high power.
2. Look carefully at the different kinds of cells that you see.
3. Make several drawings of each kind of cell. Use red pencil for the red blood cells.

Think It Over

Observing How many kinds of cells did you see? How do they differ from one another?

While riding your bike through the neighborhood, you take a tumble and scrape your knee. Your knee begins to sting, and you notice blood oozing from the wound. You go inside to clean the wound. As you do, you wonder, "Just what is blood?"

Blood

Blood may seem like just a plain red liquid, but it is actually a complex tissue that has several parts. **Blood is made up of four components: plasma, red blood cells, white blood cells, and platelets.** About 45 percent of the volume of blood is cells. The rest is plasma.

Plasma Most of the materials transported in the blood travel in the plasma. **Plasma** is the liquid part of the blood. Water makes up 90 percent of plasma. The other 10 percent is dissolved materials. Plasma carries nutrients, such as glucose, fats, vitamins, and minerals. Plasma also carries chemical messengers that direct body activities such as the uptake of glucose by your cells. In addition, many wastes produced by cell processes are carried away by plasma.

Protein molecules give plasma its yellow color. There are three groups of plasma proteins. One group helps to regulate the amount of water in blood. The second group, which is produced by white blood cells, helps fight disease. The third group of proteins interacts with platelets to form blood clots.

Red Blood Cells Without red blood cells, your body could not use the oxygen that you breathe in. **Red blood cells** take up oxygen in the lungs and deliver it to cells elsewhere in the body. Red blood cells, like most blood cells, are produced in bone marrow. Under a microscope, these cells look like disks with pinched-in centers. Because of their pinched shape, red blood cells are thin in the middle and can bend and twist easily. This flexibility enables them to squeeze through narrow capillaries.

A red blood cell is made mostly of **hemoglobin** (HEE muh gloh bin), which is an iron-containing protein that binds chemically to oxygen molecules. When hemoglobin combines with oxygen, the cells become bright red. Without oxygen, the cells are dark red. Thus, blood leaving the heart through the aorta is bright red, whereas blood returning from the body to the heart through veins is dark red. Hemoglobin picks up oxygen in the lungs and releases it as blood travels through capillaries in the rest of the body. Hemoglobin also picks up some of the carbon dioxide produced by cells. However, most of the carbon dioxide is carried by plasma. The blood carries the carbon dioxide to the lungs, where it is released from the body.

Mature red blood cells have no nuclei. Without a nucleus, a red blood cell cannot reproduce or repair itself. Mature red blood cells live only about 120 days. Every second, about 2 million red blood cells in your body die. Fortunately, your bone marrow produces new red blood cells at the same rate.

Reading Checkpoint **What is hemoglobin?**

White Blood Cells Like red blood cells, white blood cells are produced in bone marrow. **White blood cells** are the body's disease fighters. Some white blood cells recognize disease-causing organisms, such as bacteria, and alert the body that it has been invaded. Other white blood cells produce chemicals to fight the invaders. Still others surround and kill the organisms.

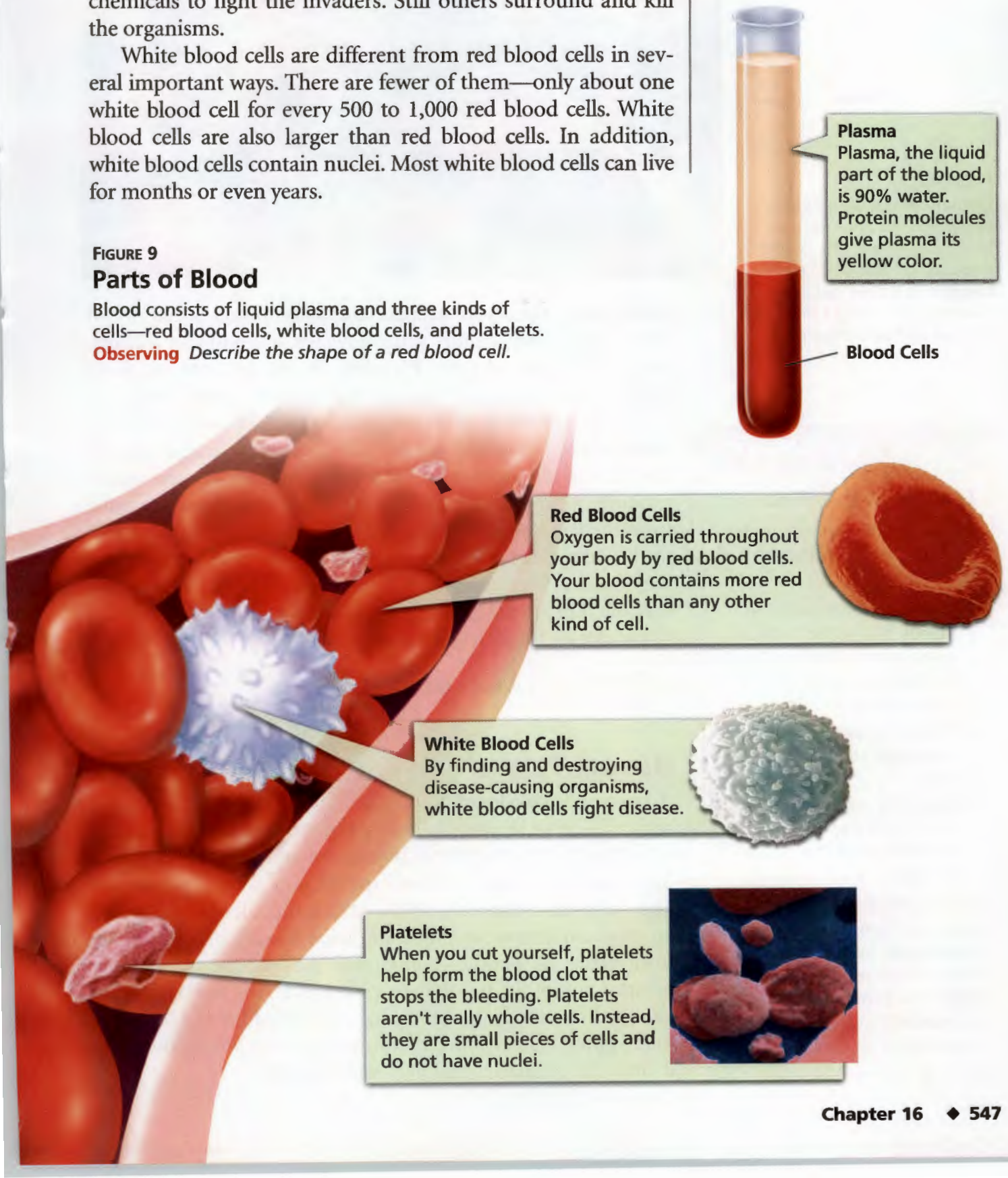
White blood cells are different from red blood cells in several important ways. There are fewer of them—only about one white blood cell for every 500 to 1,000 red blood cells. White blood cells are also larger than red blood cells. In addition, white blood cells contain nuclei. Most white blood cells can live for months or even years.

FIGURE 9

Parts of Blood

Blood consists of liquid plasma and three kinds of cells—red blood cells, white blood cells, and platelets.

Observing *Describe the shape of a red blood cell.*



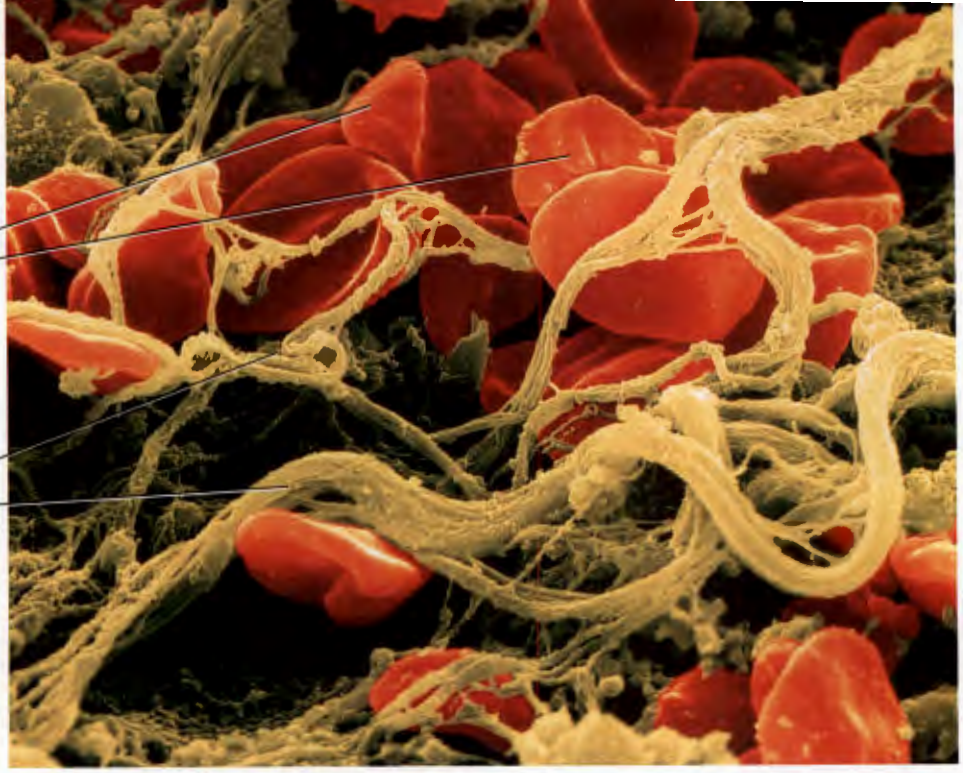


FIGURE 10
Formation of a Blood Clot
When you cut your skin, a blood clot forms. The blood clot consists of blood cells trapped in a fiber net.
Relating Cause and Effect *How is this net of fibers produced?*

Lab zone Try This Activity

Caught in the Web

In this activity, you will model part of the process by which a blood clot forms.

1. Cover the opening of a sturdy plastic cup with a piece of cheesecloth. Use a rubber band to hold the cheesecloth in place.
2. Put some water, paper clips, and coins in another cup.
3. Carefully pour the water, coins, and paper clips into the middle of the cheesecloth.

Making Models The paper clips and coins represent blood cells. What does the cheesecloth represent? What starts the production of the substance that the cheesecloth represents?

Platelets When you scraped your knee, blood oozed out of the wound. After a short time, however, a blood clot formed, stopping the blood flow. **Platelets** (PLAYT lits) are cell fragments that play an important part in forming blood clots.

When a blood vessel is cut, platelets collect and stick to the vessel at the site of the wound. The platelets release chemicals that start a chain reaction. This series of reactions eventually produces a protein called fibrin (FY brin). Fibrin gets its name from the fact that it weaves a net of tiny fibers across the cut in the blood vessel. Look at Figure 10 to see how the fiber net traps the blood cells. As more and more platelets and blood cells become trapped in the net, a blood clot forms. A scab is a dried blood clot on the skin surface.

Reading Checkpoint **What is the role of platelets?**

Blood Types

If a person loses a lot of blood—either from a wound or during surgery—he or she may be given a blood transfusion. A blood transfusion is the transfer of blood from one person to another. Most early attempts at blood transfusion failed, but no one knew why until the early 1900s. At that time, Karl Landsteiner, an Austrian American physician, tried mixing blood samples from pairs of people. Sometimes the two blood samples blended smoothly. In other cases, however, the red blood cells clumped together. This clumping accounted for the failure of many blood transfusions. If clumping occurs within the body, it clogs the capillaries and may lead to death.

Marker Molecules Landsteiner went on to discover that there are four major types of blood—A, B, AB, and O. Blood types are determined by proteins known as marker molecules that are on the red blood cells. If your blood type is A, you have the A marker. If your blood type is B, you have the B marker. People with type AB blood have both A and B markers. People with type O blood have neither A nor B markers.

Your plasma contains clumping proteins that recognize red blood cells with "foreign" markers (not yours) and make those cells clump together. For example, if you have blood type A, your blood contains clumping proteins that act against cells with B markers. So, if you receive a transfusion of type B blood, your clumping proteins will make the "foreign" type B cells clump together.

Safe Transfusions Landsteiner's work led to a better understanding of transfusions. **The marker molecules on your red blood cells determine your blood type and the type of blood that you can safely receive in transfusions.** A person with type A blood can receive transfusions of either type A or type O blood. Neither of these two blood types has B markers. Thus they would not be recognized as foreign by the clumping proteins in type A blood. A person with type AB blood can receive all blood types in transfusion because type AB blood has no clumping proteins. Figure 11 shows which transfusions are safe for each blood type.

If you ever receive a transfusion, your blood type will be checked first. Then, donated blood that you can safely receive will be found. This process is called cross matching. You may have heard a doctor on a television show give the order to "type and cross." The doctor wants to find out what blood type the patient has and then cross match it with donated blood.

Go Online
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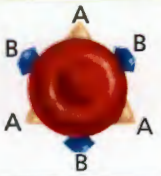
For: Links on blood
Visit: www.SciLinks.org
Web Code: scn-0433

FIGURE 11
Blood Types and Their Markers
The chemical markers on a person's red blood cells determine the types of blood he or she can safely receive in a transfusion.
Interpreting Tables *What types of blood can be given safely to a person with blood type AB?*

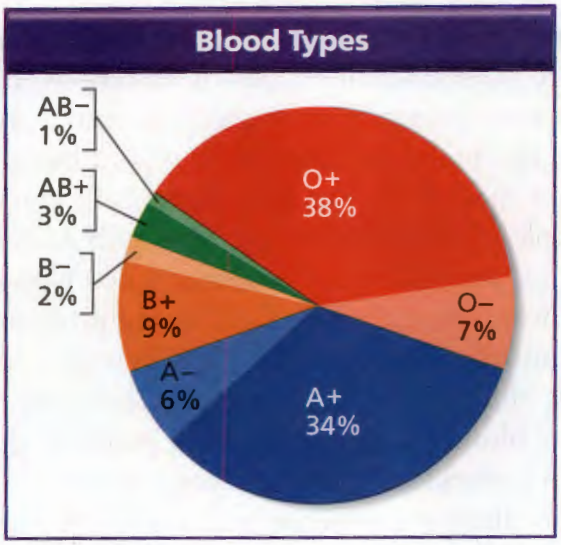
Blood Types and Their Markers

Blood Type Characteristic	Blood Type A	Blood Type B	Blood Type AB	Blood Type O
Marker Molecules on Red Blood Cells				
Clumping Proteins	anti-B	anti-A	no clumping proteins	anti-A and anti-B
Blood Types That Can Be Safely Received in a Transfusion	A and O	B and O	A, B, AB, and O	O

Math Analyzing Data

Blood Type Distribution

The circle graph shows the percentage of each blood type found in the U.S. population.



1. **Reading Graphs** What does each wedge of the graph represent?
2. **Interpreting Data** Rank the four major blood types—A, B, AB, and O—from least common to most common. What is the percentage of each type?
3. **Calculating** According to the graph, what percentage of the population is Rh positive? What percentage is Rh negative?
4. **Predicting** What type of blood can someone who is B negative (blood type B and Rh negative) receive? What percentage of the population does that represent?
5. **Creating Data Tables** Use the data to make a table of the eight possible blood types. Include columns for the A, B, AB, and O blood types and Rh factor (positive or negative), and a row for percentage of the population.

Rh Factor Landsteiner also discovered the presence of another protein on red blood cells, which he called Rh factor. About 85 percent of the people he tested had this protein, and about 15 percent lacked it. Like the A, B, AB, and O blood types, the presence of Rh factor is determined by a marker on the red blood cell. If your blood type is Rh positive, you have the Rh marker. If your blood type is Rh negative, you lack the marker on your cells. If you are Rh negative and ever received Rh positive blood, you would develop Rh clumping proteins in your plasma. This situation is potentially dangerous.

Reading Checkpoint **Where is the Rh marker found?**

The Lymphatic System

As blood travels through the capillaries in the cardiovascular system, some of the fluid leaks out. It moves through the walls of capillaries and into surrounding tissues. This fluid carries materials that the cells in the tissues need.

After bathing the cells, this fluid moves into your body's drainage system, called the **lymphatic system** (lim FAT ik). **The lymphatic system is a network of veinlike vessels that returns the fluid to the bloodstream.** The lymphatic system acts something like rain gutters after a rainstorm, carrying the excess fluid away.

Lymph Once the fluid is inside the lymphatic system, it is called **lymph.** Lymph consists of water and dissolved materials such as glucose. It also contains some white blood cells that have left the capillaries.

The lymphatic system has no pump, so lymph moves slowly. Lymphatic vessels, which are part of the cardiovascular system, connect to large veins in the chest. Lymph empties into these veins, and the fluid once again becomes part of blood plasma.

Lymph Nodes As lymph flows through the lymphatic system, it passes through small knobs of tissue called lymph nodes. The **lymph nodes** filter lymph, trapping bacteria and other disease-causing microorganisms in the fluid. When the body is fighting an infection, the lymph nodes enlarge. If you've ever had "swollen glands" when you've been sick, you've actually had swollen lymph nodes.

Reading Checkpoint **What is lymph?**

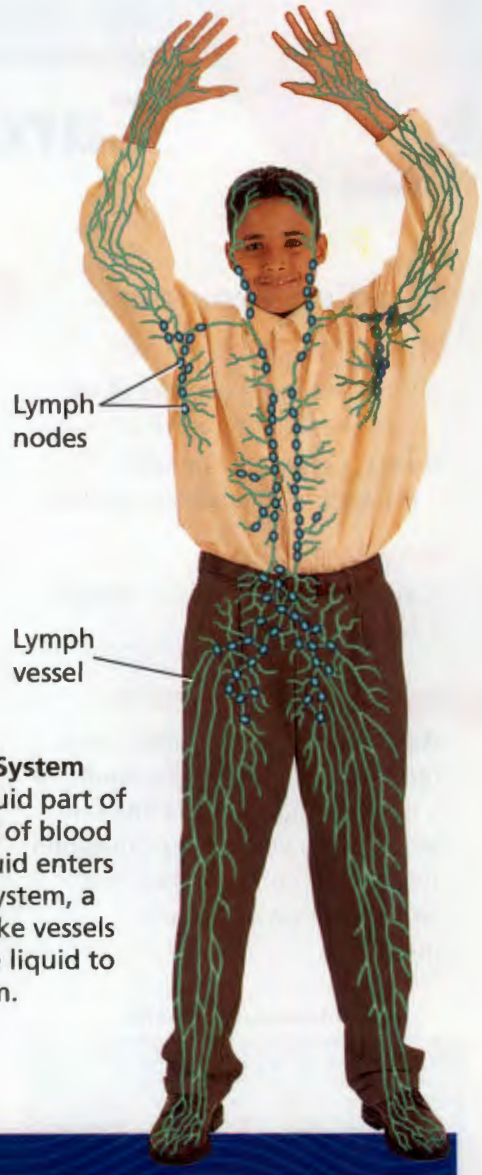


FIGURE 12
The Lymphatic System
Some of the liquid part of blood leaks out of blood vessels. This liquid enters the lymphatic system, a system of veinlike vessels that returns the liquid to the bloodstream.

Section 2 Assessment

Target Reading Skill **Identifying Main Ideas**
Use your graphic organizer to help you answer Question 1 below.

Reviewing Key Concepts

1. **a. Listing** Name the four components of blood. Identify whether each is a cell, a part of a cell, or a liquid.
   b. Summarizing Briefly describe what happens to stop the bleeding when you cut yourself.
   c. Relating Cause and Effect People with the disorder hemophilia do not produce the protein fibrin. Explain why hemophilia is a serious disorder.
2. **a. Reviewing** What is a marker molecule?
   b. Explaining Explain why a person with type O blood cannot receive a transfusion of type A blood.
   c. Predicting Can a person with type AB, Rh negative blood safely receive a transfusion of type O, Rh negative blood? Explain.
3. **a. Identifying** Where does lymph come from?
   b. Sequencing What happens to lymph after it travels through the lymphatic system?

Lab zone At-Home Activity

What's Your Blood Type? If possible, find out your blood type. Explain to family members the types of blood you can receive and to whom you can donate blood. Create a chart to help with your explanation.

Cardiovascular Health

Reading Preview

Key Concepts

- What are some diseases of the cardiovascular system?
- What behaviors can help maintain cardiovascular health?

Key Terms

- atherosclerosis
- heart attack
- hypertension
- hypertension

Target Reading Skill

Asking Questions Before you read, preview the red headings. In a graphic organizer like the one below, ask a *what* or *how* question for each heading. As you read, write the answers to your questions.

Cardiovascular Health

Question	Answer
What are some cardiovascular diseases?	Cardiovascular diseases include...

Lab zone Discover Activity

Which Foods Are "Heart Healthy"?

1. Your teacher will give you an assortment of foods. If they have nutrition labels, read the information.
2. Sort the foods into three groups. In one group, put those foods that you think are good for your cardiovascular system. In the second group, put foods that you think might damage your cardiovascular system if eaten often. Place foods you aren't sure about in the third group.

Think It Over

Forming Operational Definitions How did you define a "heart-healthy" food?

Shortly after sunrise, when most people are just waking up, a team of rowers is already out on the river. Rhythmically, with perfectly coordinated movement, the rowers pull on the oars, making the boat glide swiftly through the water. Despite the chilly morning air, sweat glistens on the rowers' faces and arms. Inside their chests, their hearts are pounding, delivering blood to the arm and chest muscles that power the oars.

FIGURE 13
Exercising for Health
Strenuous exercise, such as rowing, requires a healthy cardiovascular system. In turn, exercise keeps the cardiovascular system healthy.

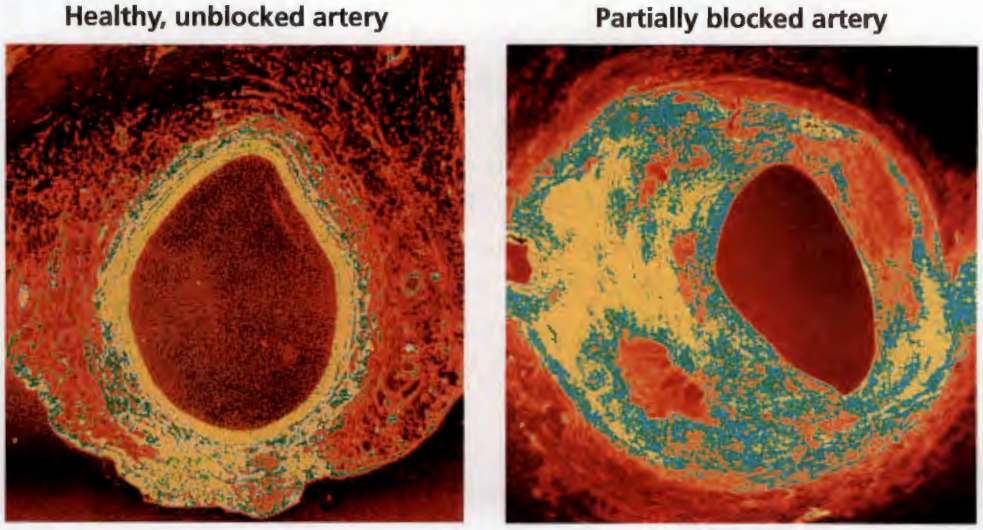


FIGURE 14
Effect of Atherosclerosis
The artery on the right shows atherosclerosis, which is caused by deposits of fat on the artery walls.
Relating Cause and Effect *What kind of diet can lead to atherosclerosis?*

Cardiovascular Diseases

Rowers cannot perform at their peaks unless their cardiovascular systems are in excellent condition. But cardiovascular health is important for all people, not just for athletes. Cardiovascular disease is the leading cause of death in the United States today. **Diseases of the cardiovascular system include atherosclerosis and hypertension.**

Atherosclerosis Compare the photos of the two arteries in Figure 14. The one on the left is a healthy artery. It has a large space in the center through which blood can flow easily. The artery on the right, in contrast, has a smaller space in the middle. This artery exhibits **atherosclerosis** (ath uh roh skluh ROH sis), a condition in which an artery wall thickens as a result of the buildup of fatty materials. One of these fatty materials is cholesterol, a waxy substance. Atherosclerosis results in a reduced flow of blood in the affected artery.

Atherosclerosis can develop in the coronary arteries, which supply the heart muscle. When that happens, the heart muscle receives less blood and therefore less oxygen. This condition may lead to a heart attack. A **heart attack** occurs when blood flow to part of the heart muscle is blocked. Cells die in the part of the heart that does not receive blood and oxygen. This permanently damages the heart.

Treatment for mild atherosclerosis usually includes a low-fat diet and a moderate exercise program. In addition, medications that lower the levels of cholesterol and fats in the blood may be prescribed. People with severe atherosclerosis may need to undergo surgery or other procedures to unclog the blocked arteries.

Lab zone Try This Activity

Blocking the Flow

Use this activity to model how fatty deposits affect the flow of blood through an artery.

1. Put a funnel in the mouth of a plastic jar. The funnel will represent an artery.
2. Slowly pour 100 mL of water into the funnel. Have your partner time how many seconds it takes for all the water to flow through the funnel. Then, discard the water.
3. Use a plastic knife to spread a small amount of paste along the bottom of the funnel's neck. Then, with a toothpick, carve out a hole in the paste so that the funnel is partly, but not completely, clogged.
4. Repeat Steps 1 and 2.

Predicting If the funnels were arteries, which one—blocked or unblocked—would do a better job of supplying blood to tissues? Explain.

Go Online
SCILINKS NSTA
For: Links on cardiovascular problems
Visit: www.SciLinks.org
Web Code: scn-0434

Hypertension High blood pressure, or **hypertension** (hy pur TEN shun), is a disorder in which a person's blood pressure is consistently higher than normal—usually defined as greater than 140/90.

Hypertension makes the heart work harder to pump blood throughout the body. It also may damage the walls of the blood vessels. Over time, both the heart and arteries can be severely harmed by hypertension. Because people with hypertension often have no obvious symptoms to warn them of the danger until damage is severe, hypertension is sometimes called the "silent killer."

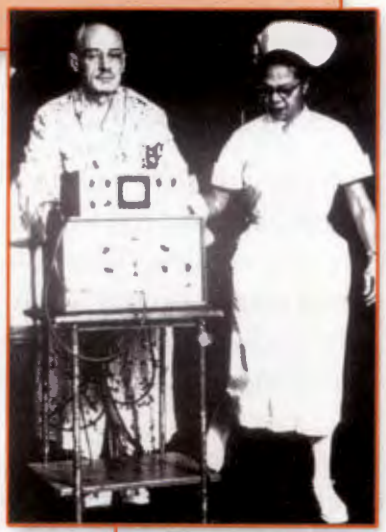
• Tech & Design in History •

Advances in Cardiovascular Medicine

Scientists today have an in-depth understanding of how the cardiovascular system works and how to treat cardiovascular problems. This timeline describes some of the advances in cardiovascular medicine.

1930s–1940s
Blood Banks
Charles Drew demonstrated that emergency blood transfusions could be done with plasma if whole blood was not available. During World War II, Drew established blood banks for storing donated blood. His work helped save millions of lives on and off the battlefield.

1958
Artificial Pacemaker
Electrical engineer Earl Baaken developed an external pacemaker to correct irregular heartbeats. A small electric generator connected to the pacemaker generated electric pulses that regulated heart rate. The first pacemakers had a fixed rate of 70 to 75 pulses per minute.



1961
Heart Valve Replacement
The first successful artificial heart valve was inserted into a patient's heart by surgeons Albert Starr and M. L. Edwards in Oregon. The valve was a rubberlike ball inside a stainless steel cage.

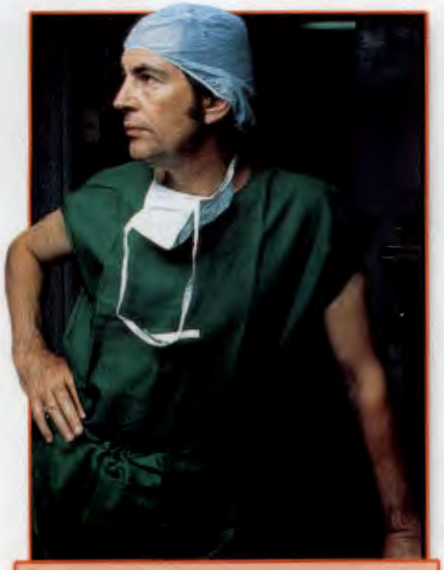
1930 | 1940 | 1950 | 1960

Hypertension and atherosclerosis are closely related. As the arteries narrow, blood pressure increases. For mild hypertension, regular exercise and careful food choices may be enough to lower blood pressure. People with hypertension may need to limit their intake of sodium, which can increase blood pressure. Sodium is found in table salt and in processed foods such as soups and packaged snack foods. For many people who have hypertension, however, medications are needed to reduce their blood pressure.

Reading Checkpoint **Why is hypertension called the "silent killer"?**

Writing in Science

Research and Write Choose one of the scientists whose work is described in the timeline. Imagine that you are on a committee that has chosen this scientist to receive an award. Write the speech you would give at the award ceremony, explaining the scientists contributions.



1967
First Heart Transplant

Christiaan Barnard, a South African surgeon, performed the first transplant of a human heart. Louis Washkansky, the man who received the heart, lived for only 18 days after the transplant. But Barnard's work paved the way for future successes in transplanting hearts and other organs.

1977
Angioplasty

The first coronary balloon angioplasty was performed by Andreas Gruentzig and a team of surgeons in San Francisco. A balloon is inserted into the coronary artery and inflated, thus opening the artery. In 2001, more than two million angioplasties were performed worldwide.

2001
Replacement Heart

The first replacement heart was implanted by a team of surgeons in Louisville, Kentucky. Unlike the first artificial heart, the Jarvik-7, the replacement heart has its own internal batteries. The patient does not have to be "plugged in" to an external power source. The first patient to receive the replacement heart lived for more than 500 days.

1970 1980 1990 2000

FIGURE 15
Eating for Health
Eating foods that are low in fat can help keep your cardiovascular system healthy.
Applying Concepts *What are some heart-healthy low-fat foods?*

Keeping Healthy

Few young people have heart attacks, but signs of atherosclerosis can be found in some people as young as 18 to 20 years old. You can establish habits now that will lessen your risk of developing atherosclerosis and hypertension. **To help maintain cardiovascular health, people should exercise regularly; eat a balanced diet that is low in saturated fats and trans fats, cholesterol, and sodium; and avoid smoking.**

Exercise and Diet Do you participate in sports, ride a bike, swim, dance, or climb stairs instead of taking the elevator? Every time you do one of those activities, you are helping to strengthen your heart muscle and prevent atherosclerosis.

Foods that are high in cholesterol, saturated fats, and trans fats can lead to atherosclerosis. Foods such as red meats, eggs, and cheese are high in cholesterol. But because they also contain substances that your body needs, a smart approach might be to eat them only in small quantities. Foods that are high in saturated fat include butter, whole milk, and ice cream. Foods high in trans fat include margarine, potato chips, and doughnuts.

Avoid Smoking Smokers are more than twice as likely to have a heart attack as are nonsmokers. Every year, about 180,000 people in the United States who were smokers die from cardiovascular disease. If smokers quit, however, their risk of death from cardiovascular disease decreases.

Reading Checkpoint **What are some foods that are high in cholesterol?**

Section 3 Assessment

Target Reading Skill **Asking Questions** Use the answers to the questions you wrote about the headings to help you answer the questions below.

Reviewing Key Concepts

1. a. **Defining** What is atherosclerosis? What is hypertension?
   b. **Relating Cause and Effect** How do these two diseases affect the heart?
2. a. **Listing** List three things you can do to help your cardiovascular system stay healthy.
   b. **Explaining** Why it is important to exercise?
   c. **Inferring** Coronary heart disease is less common in some countries than in the United States. What factors might account for this difference?

Lab zone At-Home Activity

Heart-Healthy Activities With your family, discuss things you all can do to maintain heart health. Make a list of activities that you can enjoy together. You might also work with your family to cook and serve a "heart-healthy" meal. List the foods you would serve at the meal.

Lab zone Skills Lab

Do You Know Your A-B-O's?

Problem

Which blood types can safely receive transfusions of type A blood? Which can receive type O blood?

Skills Focus

interpreting data, drawing conclusions

Materials

- 4 paper cups
- 8 plastic petri dishes
- marking pen
- 4 plastic droppers
- white paper
- toothpicks
- four model "blood" types

Procedure

1. Write down your ideas about why type O blood might be in higher demand than other blood types. Then, make two copies of the data table in your notebook.
2. Label four paper cups A, B, AB, and O. Fill each cup about one-third full with the model "blood" supplied by your teacher. Place one clean plastic dropper into each cup. Use each dropper to transfer only that one type of blood.
3. Label the side of each of four petri dishes with a blood type: A, B, AB, or O. Place the petri dishes on a sheet of white paper.
4. Use the plastic droppers to place 10 drops of each type of blood in its labeled petri dish. Each sample represents the blood of a potential receiver of a blood transfusion. Record the original color of each sample in your data table as yellow, blue, green, or colorless.
5. Label your first data table Donor: Type A. To test whether each potential receiver can safely receive type A blood, add 10 drops of type A blood to each sample. Stir each mixture with a separate, clean toothpick.
6. Record the final color of each mixture in the data table. If the color stayed the same, write "safe" in the last column. If the color of the mixture changed, write "unsafe."
7. Label your second data table Donor: Type O. Obtain four clean petri dishes, and repeat Steps 3 through 6 to determine who could safely receive type O blood.

Data Table

Donor: Type _____

Potential Receiver	Original Color	Final Color of Mixture	Safe or Unsafe?
A			
B			
AB			
O			

Analyze and Conclude

1. **Interpreting Data** Which blood types can safely receive a transfusion of type A blood? Type O blood?
2. **Inferring** Use what you know about marker molecules to explain why some transfusions of type A blood are safe while others are unsafe.
3. **Drawing Conclusions** If some blood types are not available, how might type O blood be useful?
4. **Communicating** Write a paragraph in which you discuss why it is important for hospitals to have an adequate supply of different types of blood.

More to Explore

Repeat this activity to find out which blood types can safely receive donations of type B and type AB blood.

Chapter 16 Study Guide

The BIG Idea **Structure and Function** The circulatory system moves blood through the body, transports food, and enables the exchange of gases.

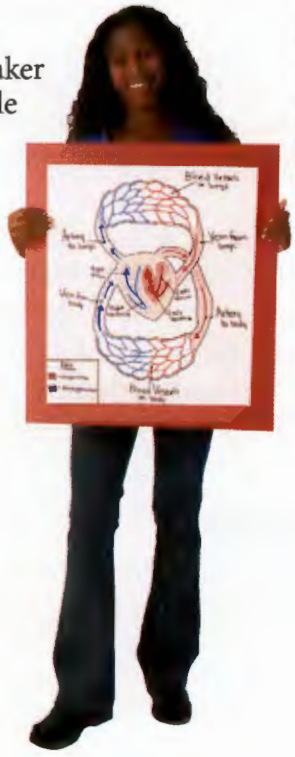
1 The Body's Transport System

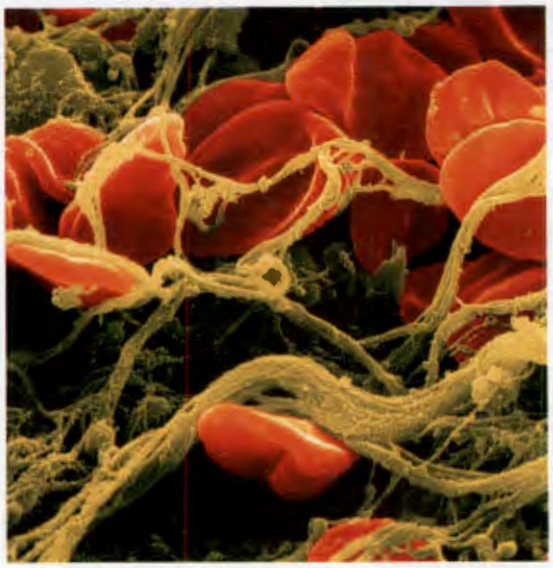
Key Concepts

- The cardiovascular system carries needed substances to cells and carries waste products away from cells. In addition, blood contains cells that fight disease.
- The heart pushes blood through the cardiovascular system. The right side of the heart is separated from the left side by the septum. Each side has an upper chamber and a lower chamber.
- Blood circulates in two loops. First, it travels from the heart to the lungs and then back to the heart. Second, it is pumped from the heart to the body and then it returns to the heart.
- Blood leaves the heart through arteries. When it reaches the capillaries, materials are exchanged between the blood and the body's cells. Veins carry blood back to the heart. The walls of arteries and veins consist of three layers. Capillary walls are only one cell thick.

Key Terms

cardiovascular system
heart
atrium
pacemaker
ventricle
valve
artery
capillary
vein
aorta
coronary artery
pulse
diffusion
blood pressure





2 Blood and Lymph

Key Concepts

- Blood is made up of four components: plasma, red blood cells, white blood cells, and platelets.
- The marker molecules on your red blood cells determine your blood type and the type of blood that you can safely receive in transfusions.
- The lymphatic system is a network of vein-like vessels that returns the fluid to the bloodstream.

Key Terms

• plasma • red blood cell • hemoglobin
• white blood cell • platelet • lymphatic system
• lymph • lymph node

3 Cardiovascular Health

Key Concepts

- Diseases of the cardiovascular system include atherosclerosis and hypertension.
- To help maintain cardiovascular health, people should exercise regularly; eat a balanced diet that is low in saturated fats and trans fats, cholesterol, and sodium; and avoid smoking.

Key Terms

atherosclerosis
heart attack
hypertension

Review and Assessment

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Organizing Information

Comparing and Contrasting Copy the compare/contrast table about the two loops of the circulatory system onto a sheet of paper. Then complete it and add a title. (For more on Comparing and Contrasting, see the Skills Handbook.)

Loop	Side of heart where loop starts	Where blood flows to	Where blood returns to
Loop One	a. ?	Lungs	b. ?
Loop Two	Left side	c. ?	d. ?

Reviewing Key Terms

Choose the letter of the best answer.

1. The heart's upper chambers are called
   a. ventricles.
   b. atria.
   c. valves.
   d. arteries.
2. Nutrients are exchanged between the blood and body cells in the
   a. capillaries.
   b. veins.
   c. aorta.
   d. arteries.
3. The alternating expansion and relaxation of the artery that you feel in your wrist is your
   a. pulse.
   b. coronary artery.
   c. blood pressure.
   d. plasma.
4. Blood components that help the body to control bleeding are
   a. platelets.
   b. red blood cells.
   c. white blood cells.
   d. hemoglobin.
5. Cholesterol is a waxy substance associated with
   a. lymph nodes.
   b. white blood cells.
   c. atherosclerosis.
   d. plasma.

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

6. The two lower chambers of the heart are called <u>atria</u>.
7. The <u>veins</u> are the narrowest blood vessels in the body.
8. <u>White blood cells</u> contain hemoglobin.
9. The <u>lymphatic system</u> is involved in returning fluid to the bloodstream.
10. Elevated blood pressure is called <u>atherosclerosis</u>.

Writing in Science

Letter Write a letter to a friend describing what you do to stay active. For example, do you participate in team sports, jog, or take long walks with your dog? Include in your letter additional ways you can be even more active.

Discovery CHANNEL SCHOOL

Circulation
Video Preview
Video Field Trip
▶ Video Assessment

Review and Assessment

Checking Concepts

11. Contrast the forces with which the right and left ventricles contract. How does this relate to each ventricle's function?

12. A red blood cell is moving through an artery in your leg. Describe the path that the blood cell will follow back to your heart. Identify the chamber of the heart to which it will return.

13. How is a capillary's structure adapted to its function?

14. What is the function of hemoglobin?

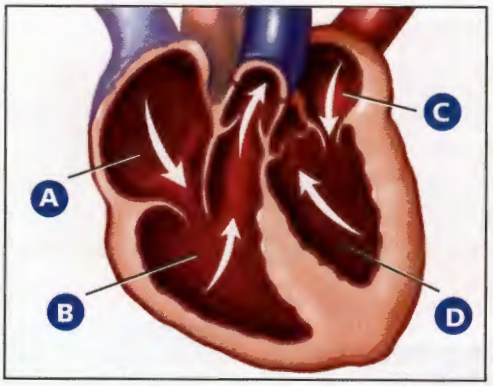
15. What is lymph? How does lymph return to the cardiovascular system?

16. Give two reasons why food choices are important to cardiovascular health.

Thinking Critically

17. **Predicting** Some babies are born with an opening between the left and right ventricles of the heart. How would this heart defect affect the ability of the cardiovascular system to deliver oxygen to body cells?

18. **Classifying** Which two chambers of the heart shown below are the ventricles? Through which chamber does oxygen-poor blood enter the heart from the body?



19. **Relating Cause and Effect** People who do not have enough iron in their diets sometimes develop a condition in which their blood cannot carry a normal amount of oxygen. Explain why this is so.

20. **Making Generalizations** Why is atherosclerosis sometimes called a "lifestyle disease"?

Math Practice

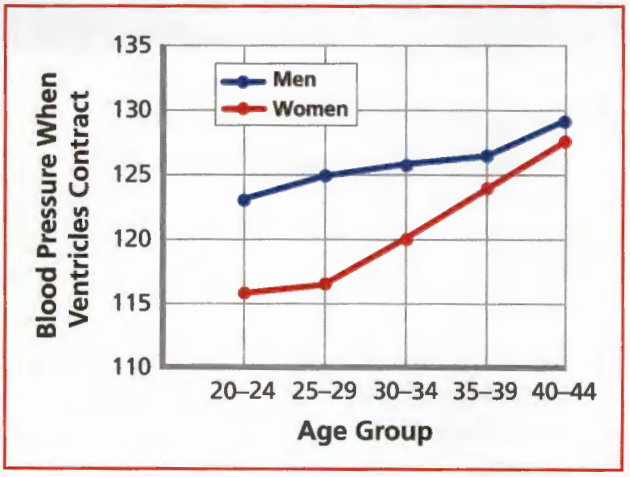
21. **Calculating a Rate** The veterinarian listens to your cat's heart and counts 30 beats in 15 seconds. What is your cat's heart rate?

Applying Skills

Use the graph to answer Questions 22–25.

The graph below shows how average blood pressure changes as men and women grow older.

Changes in Blood Pressure



22. **Reading Graphs** What is plotted on each axis?

23. **Interpreting Data** At age 20, who is likely to have higher blood pressure—men or women?

24. **Drawing Conclusions** In general, what happens to blood pressure as people age?

25. **Predicting** Do you think that there is some age at which both men and women have about the same blood pressure? Use the graph lines to explain your prediction.

Lab zone Chapter Project

Performance Assessment You should now be ready to present your display. First show it to a small group of classmates to make sure it is clear and accurate. When you present your display, be ready to answer questions.

Standardized Test Prep

Test-Taking Tip

Anticipating the Answer

You can sometimes figure out an answer to a question before you look at the answer choices. After you answer the question in your mind, compare your answer with the answer choices. Choose the answer that most closely matches your own answer. Try to answer the sample question below before you look at the answer choices.

Sample Question

The upper chambers of the heart are the

A ventricles.
B valves.
C atria.
D capillaries.

Answer

Choice **C** is correct because the blood that comes into the heart enters through the atria, the upper chambers of the heart. Choice **A** is incorrect because ventricles are the lower chambers of the heart. Choices **B** and **D** are incorrect because valves and capillaries are not heart chambers.

Choose the letter of the best answer.

1. The most important function of the cardiovascular system is to
A transport needed materials to body cells and remove wastes.
B provide structural support for the lungs.
C generate blood pressure so the arteries and veins do not collapse.
D produce blood and lymph.

2. The correct sequence for the path of blood through the body is
F heart—lungs—other body parts.
G heart—lungs—heart—other body parts.
H lungs—other body parts—heart.
J heart—other body parts—lungs—heart.

3. Which of the following is true about blood in the aorta?
A The blood is going to the lungs.
B The blood is oxygen-rich.
C The blood is dark red in color.
D The blood is going to the heart.

Use the table below and your knowledge of science to answer Questions 4 and 5.

Blood Types

Blood Type	Marker Molecules	Clumping Proteins
A	A	anti-B
B	B	anti-A
AB	A and B	none
O	none	anti-A and anti-B

4. A person who has type O blood can safely receive blood from a person with
F type O blood.
G type A blood.
H type AB blood.
J type B blood.

5. A person who has type O blood can safely donate blood to a person with
A type AB blood.
B type O blood.
C types A, B, AB, or O blood.
D type A or type B blood.

Constructed Response

6. Explain what blood pressure is and what causes it. How is blood pressure measured and what is the significance of the two numbers in a blood pressure reading? Why can high blood pressure be dangerous?