SECTION 1

The Cardiovascular System

When you hear the word heart, *what do you think of first? Many people think of romance. Some people think of courage. But the heart is much more than a symbol of love or bravery. Your heart is an amazing pump.*

The heart is an organ that is part of your circulatory system. The *circulatory system* includes your heart; your blood; your veins, capillaries, and arteries; and your lymphatic system.

READING WARM-UP

Objectives

- List four main parts of the cardiovascular system, and describe their functions.
- Describe the two types of circulation of blood in the body.
- List four cardiovascular problems.

Terms to Learn

cardiovascular system
artery
capillary
vein
pulmonary circulation
systemic circulation

READING STRATEGY

Paired Summarizing Read this section silently. In pairs, take turns summarizing the material. Stop to discuss ideas that seem confusing.

Your Cardiovascular System

Your heart creates pressure every time it beats. This pressure moves blood to every cell in your body through your cardiovascular system (KAR dee OH VAS kyoo luhr SIS tuhm). The **cardiovascular system** consists of the heart and the three types of blood vessels that carry blood throughout your body. The word *cardio* means "heart," and *vascular* means "blood vessel." The blood vessels—arteries, capillaries, and veins—carry blood pumped by the heart. **Figure 1** shows the major arteries and veins.

cardiovascular system a collection of organs that transport blood throughout the body

Reading Check **What are the four main parts of the cardiovascular system?** (*See the Appendix for answers to Reading Checks.*)

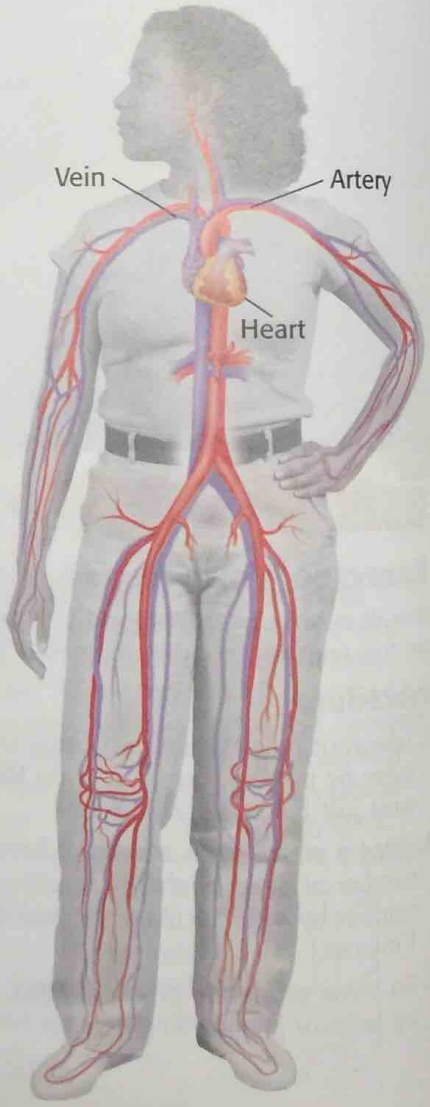


Figure 1 *The cardiovascular system carries blood to every cell in your body.*

The Heart

Your *heart* is an organ made mostly of cardiac muscle tissue. It is about the size of your fist and is almost in the center of your chest cavity. Like hearts of all mammals, your heart has a left side and a right side that are separated by a thick wall. The right side of the heart pumps oxygen-poor blood to the lungs. The left side pumps oxygen-rich blood to the body. As you can see in **Figure 2,** each side has an upper chamber and a lower chamber. Each upper chamber is called an *atrium* (plural, *atria*). Each lower chamber is called a *ventricle*.

Flaplike structures called *valves* are located between the atria and ventricles and in places where large arteries are attached to the heart. As blood moves through the heart, these valves close to prevent blood from going backward. The "lub-dub, lub-dub" sound of a beating heart is caused by the valves closing. **Figure 3** shows the flow of blood through the heart.

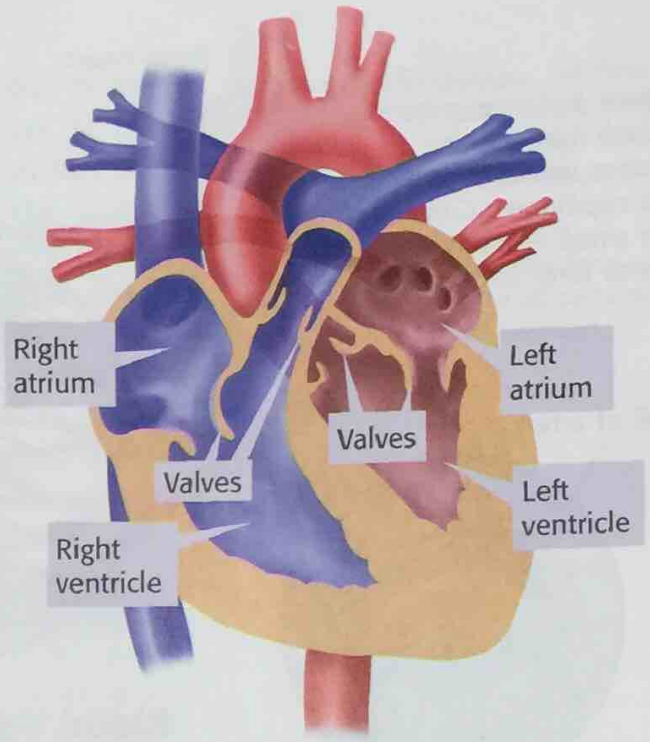
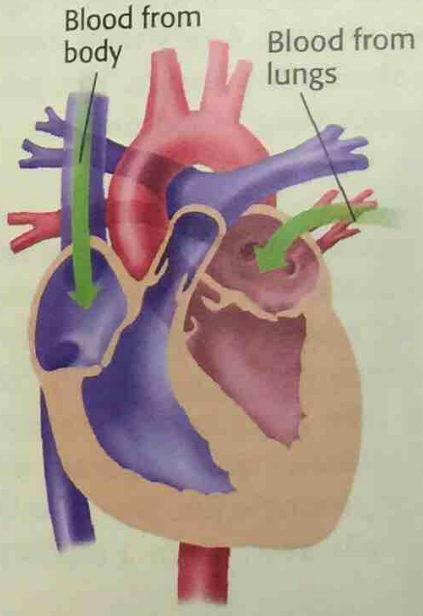
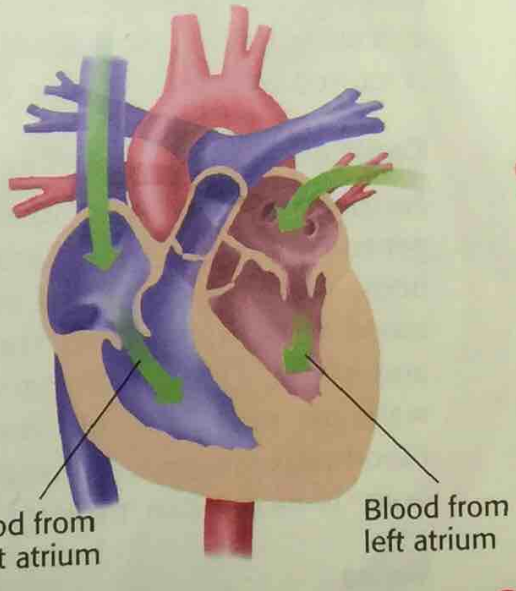


Figure 2 *The heart pumps blood through blood vessels. The vessels carrying oxygen-rich blood are shown in red. The vessels carrying oxygen-poor blood are shown in blue.*

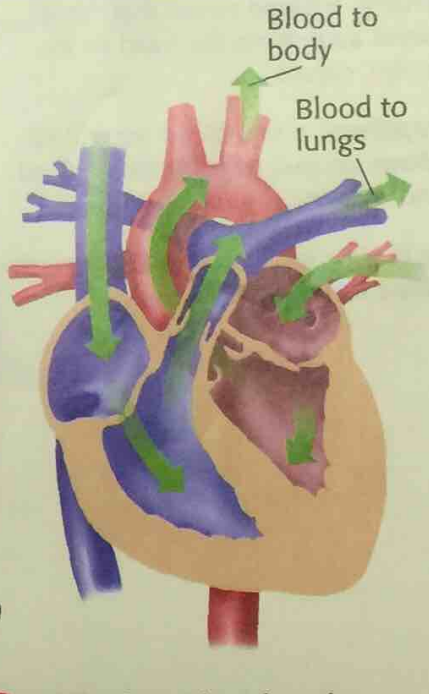
Figure 3 **The Flow of Blood Through the Heart**



1 Blood enters the atria first. The left atrium receives oxygen-rich blood from the lungs. The right atrium receives oxygen-poor blood from the body.



2 When the atria contract, blood is squeezed into the ventricles.



3 While the atria relax, the ventricles contract and push blood out of the heart. Blood from the right ventricle goes to the lungs. Blood from the left ventricle goes to the rest of the body.

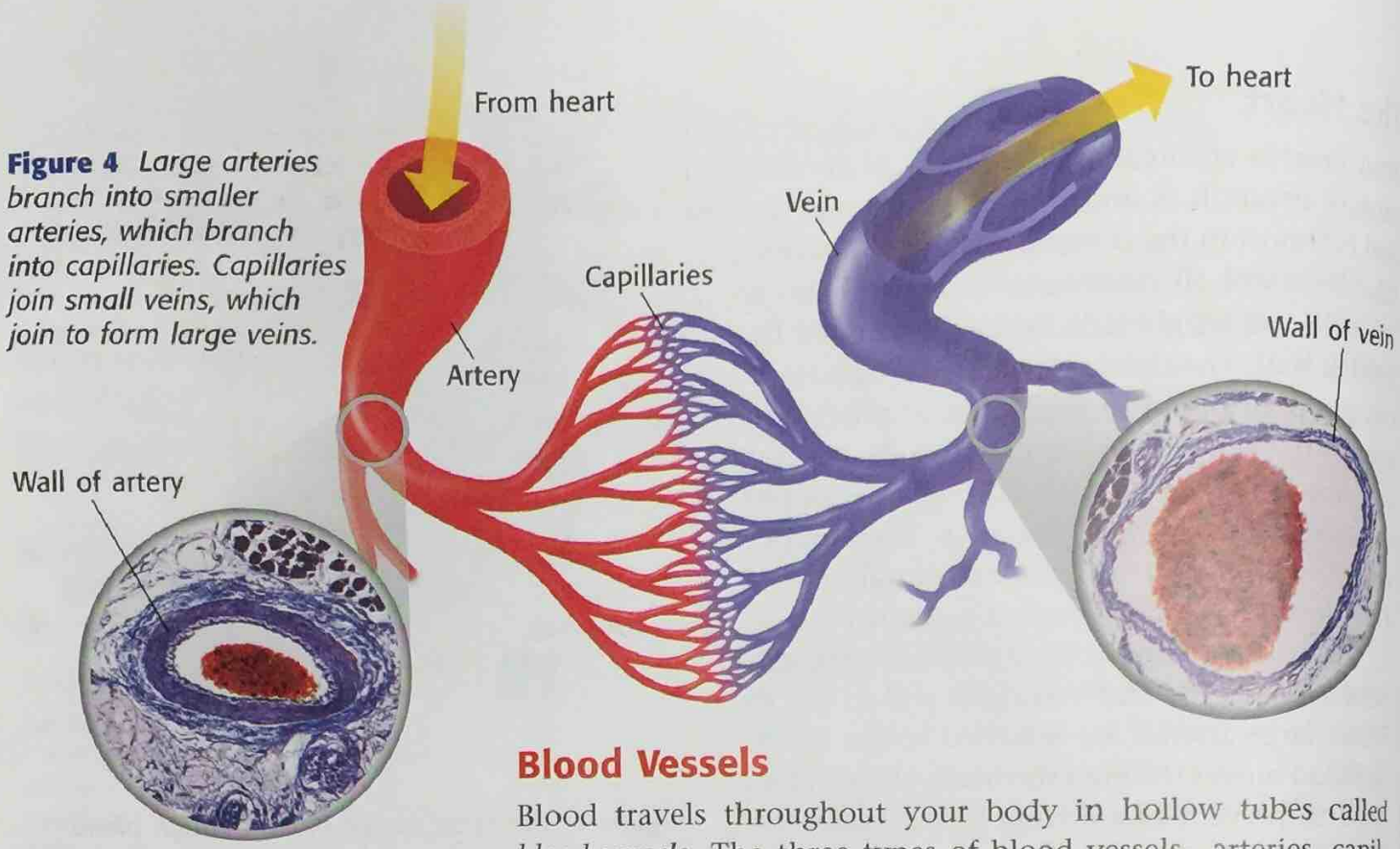


Figure 4 *Large arteries branch into smaller arteries, which branch into capillaries. Capillaries join small veins, which join to form large veins.*

Blood Vessels

Blood travels throughout your body in hollow tubes called *blood vessels*. The three types of blood vessels—arteries, capillaries, and veins—are shown in **Figure 4.**

artery a blood vessel that carries blood away from the heart to the body's organs

capillary a tiny blood vessel that allows an exchange between blood and cells in other tissue

vein in biology, a vessel that carries blood to the heart

Arteries

A blood vessel that carries blood away from the heart is an **artery.** Arteries have thick walls, which contain a layer of smooth muscle. Each heartbeat pumps blood into your arteries at high pressure. This pressure is your *blood pressure*. Artery walls stretch and are usually strong enough to stand the pressure. Your *pulse* is caused by the rhythmic change in your blood pressure.

Capillaries

Nutrients, oxygen, and other substances must leave blood and get to your body's cells. Carbon dioxide and other wastes leave body cells and are carried away by blood. A **capillary** is a tiny blood vessel that allows these exchanges between body cells and blood. These exchanges can take place because capillary walls are only one cell thick. Capillaries are so narrow that blood cells must pass through them in single file. No cell in the body is more than three or four cells away from a capillary.

Veins

After leaving capillaries, blood enters veins. A **vein** is a blood vessel that carries blood back to the heart. As blood travels through veins, valves in the veins keep the blood from flowing backward. When skeletal muscles contract, they squeeze nearby veins and help push blood toward the heart.

Reading Check **Describe the three types of blood vessels.**

Two Types of Circulation

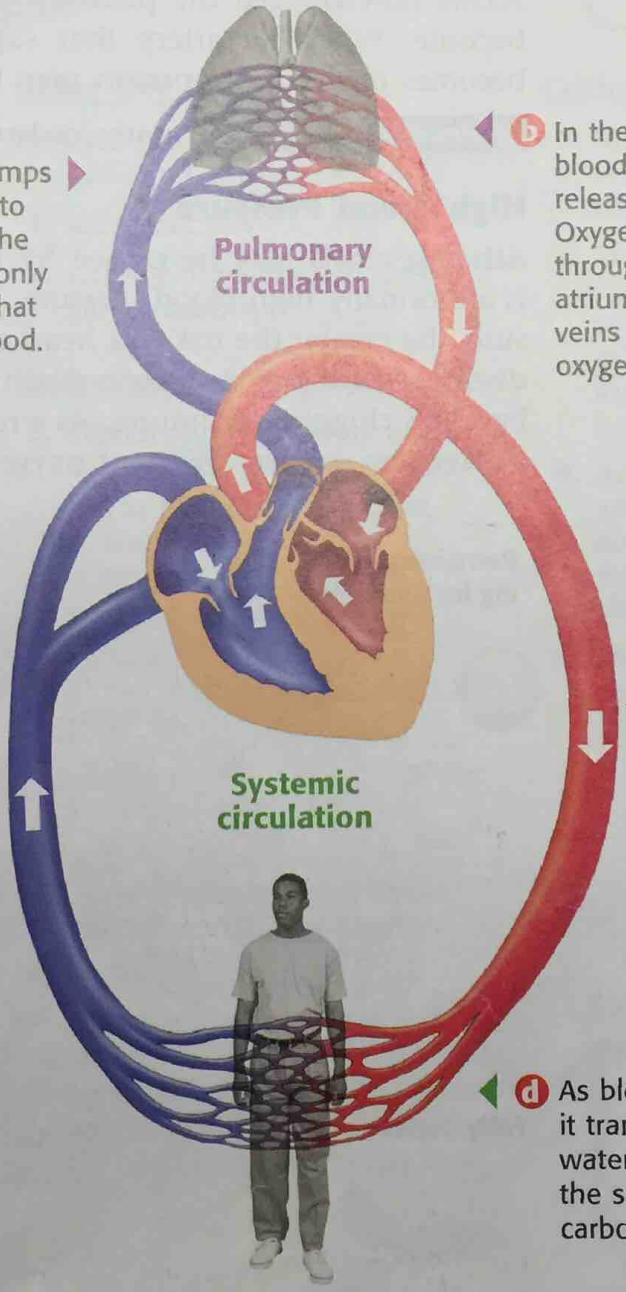
Where does blood get the oxygen to deliver to your body? From your lungs! Your heart pumps blood to the lungs. In the lungs, carbon dioxide leaves the blood and oxygen enters the blood. The oxygen-rich blood then flows back to the heart. This circulation of blood between your heart and lungs is called **pulmonary circulation** (PUL muh NER ee SUHR kyoo LAY shuhn).

The oxygen-rich blood returning to the heart from the lungs is then pumped to the rest of the body. The circulation of blood between the heart and the rest of the body is called **systemic circulation** (sis TEM ik SUHR kyoo LAY shuhn). Both types of circulation are shown in **Figure 5.**

pulmonary circulation the flow of blood from the heart to the lungs and back to the heart through the pulmonary arteries, capillaries, and veins

systemic circulation the flow of blood from the heart to all parts of the body and back to the heart

Figure 5 The Flow of Blood Through the Body



a The right ventricle pumps oxygen-poor blood into arteries that lead to the lungs. These are the only arteries in the body that carry oxygen-poor blood.

b In the capillaries of the lungs, blood takes up oxygen and releases carbon dioxide. Oxygen-rich blood travels through veins to the left atrium. These are the only veins in the body that carry oxygen-rich blood.

c The heart pumps oxygen-rich blood from the left ventricle into arteries and then into capillaries.

d As blood travels through capillaries, it transports oxygen, nutrients, and water to the cells of the body. At the same time, waste materials and carbon dioxide are carried away.

e Oxygen-poor blood travels back to the heart and is delivered into the right atrium by two large veins.

Cardiovascular Problems

More than just your heart and blood vessels are at risk if you have cardiovascular problems. Your whole body may be harmed. Cardiovascular problems can be caused by smoking, high levels of cholesterol in the blood, stress, physical inactivity, or heredity. Eating a healthy diet and getting plenty of exercise can reduce the risk of having cardiovascular problems.

Atherosclerosis

Heart diseases are the leading cause of death in the United States. A major cause of heart diseases is a cardiovascular disease called *atherosclerosis* (ATH uhr OH skluh ROH sis). Atherosclerosis happens when cholesterol (kuh LES tuhr AWL) builds up inside of blood vessels. This cholesterol buildup causes the blood vessels to become narrower and less elastic. **Figure 6** shows how clogged the pathway through a blood vessel can become. When an artery that supplies blood to the heart becomes blocked, the person may have a heart attack.

Reading Check **Why is atherosclerosis dangerous?**

High Blood Pressure

Atherosclerosis may be caused by hypertension. *Hypertension* is abnormally high blood pressure. The higher the blood pressure, the greater the risk of a heart attack, heart failure, kidney disease, and stroke. A *stroke* is when a blood vessel in the brain becomes clogged or ruptures. As a result, that part of the brain receives no oxygen. Without oxygen, brain cells die.

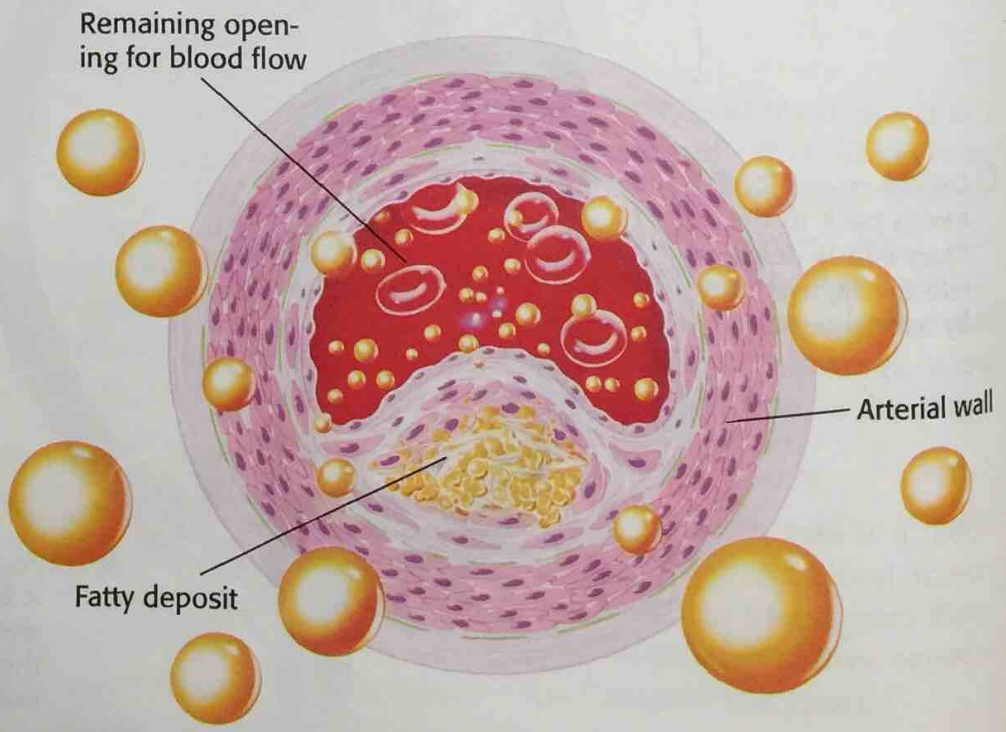


Figure 6 *This illustration shows the narrowing of an artery as the result of high levels of cholesterol in the blood. Lipid deposits (yellow) build up inside the blood vessel walls and block the flow of blood. Red blood cells and lipid particles (yellow balls) are shown escaping.*

MATH PRACTICE

The Beat Goes On

A person's heart averages about 70 beats per minute.

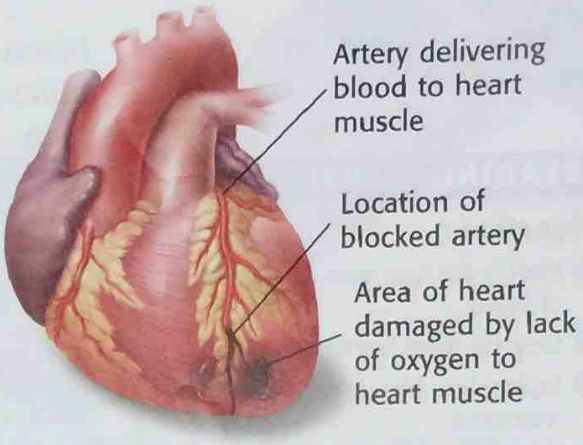
1. Calculate how many times a heart beats in a day.
2. If a person lives for 75 years, how many times will his or her heart beat?
3. If an athlete's heart beats 50 times a minute, how many fewer times than an average heart will his or her heart beat in 30 days?

Heart Attacks and Heart Failure

Two cardiovascular problems are heart attacks and heart failure. A *heart attack* happens when heart muscle cells die and part of the heart muscle is damaged. As shown in **Figure 7,** arteries that deliver oxygen to the heart may be blocked. Without oxygen, heart muscle cells die quickly. When enough heart muscle cells die, the heart may stop.

Heart failure is different. *Heart failure* happens when the heart cannot pump enough blood to meet the body's needs. Organs, such as the brain, lungs, and kidneys, may be damaged by lack of oxygen or nutrients, or by the buildup of fluids or wastes.

Figure 7 Heart Attack



SECTION Review

Summary

- The cardiovascular system is made up of the heart and three types of blood vessels.
- The three types of blood vessels are arteries, veins, and capillaries.
- Oxygen-poor blood flows from the heart through the lungs, where it picks up oxygen.
- Oxygen-rich blood flows from the heart to the rest of the body.
- Cardiovascular problems include atherosclerosis, hypertension, heart attacks, and strokes.

Using Key Terms

For each pair of terms, explain how the meanings of the terms differ.

1. *artery* and *vein*
2. *systemic circulation* and *pulmonary circulation*

Understanding Key Ideas

3. Which of the following is true of blood in the pulmonary veins?
   - **a.** The blood is going to the body.
   - **b.** The blood is oxygen poor.
   - **c.** The blood is going to the lungs.
   - **d.** The blood is oxygen rich.
4. What are the four parts of the cardiovascular system? Describe the functions of each part.
5. What is the difference between a heart attack and heart failure?

Math Skills

6. An adult male's heart pumps about 2.8 million liters of blood a year. If his heart beats 70 times a minute, how much blood does his heart pump with each beat?

76 mL per beat this is right

Critical Thinking

7. **Identifying Relationships** How is the heart's structure related to its function?
8. **Making Inferences** One of aspirin's effects is that it prevents platelets from being too "sticky." Why might doctors prescribe aspirin for patients who have had a heart attack?
9. **Analyzing Ideas** Veins and arteries are everywhere in your body. When a pulse is taken, it is usually taken at an artery in the neck or wrist. Explain why.
10. **Making Comparisons** Why is the structure of arteries different from the structure of capillaries?