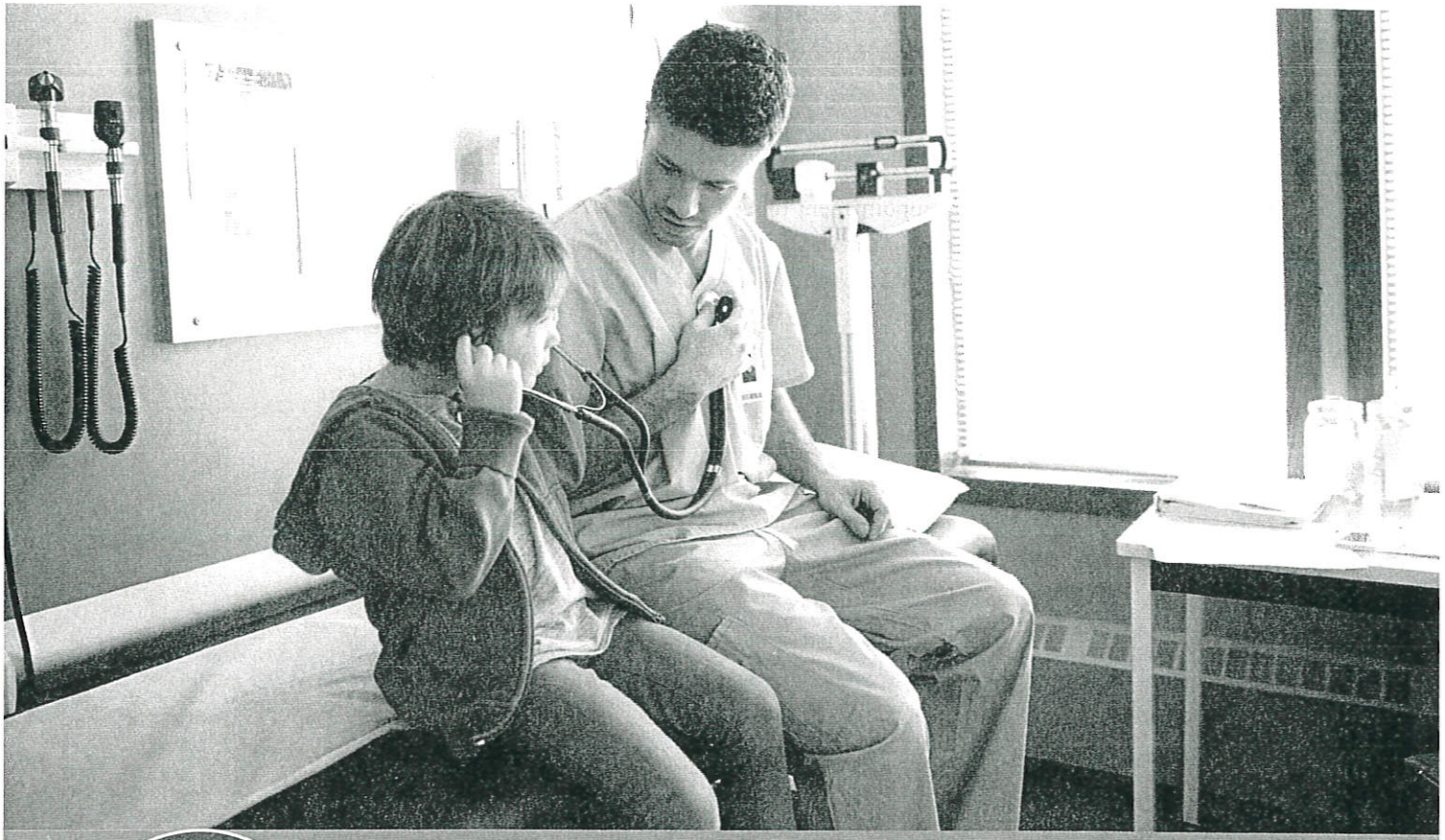


CHAPTER

26 The Cardiovascular System

Learning Objectives

After completing this chapter, you should be able to:

- **26.1** Define and spell the terms for this chapter.
- **26.2** Identify the structures that make up the cardiovascular system.
- **26.3** Explain how the cardiovascular system functions.
- **26.4** Explain cardiovascular changes between children and the older adult.
- **26.5** Differentiate between pulmonary and systemic circulation.
- **26.6** Explain the correlation between blood pressure and pulse pressure.
- **26.7** Describe the components of blood.
- **26.8** List the functions of blood.
- **26.9** Describe common pathology associated with the cardiovascular system.

Case Study

Jamal Washington has made an appointment to see Dr. Miller at Pearson Physicians Group. He was reluctant to make the appointment and made it only because his wife, Tania, urged him. Now he does not want to go to the doctor. Jamal has been complaining of intense headaches and has had frequent episodes of nosebleeds.

Terms to Learn

agglutination
anemia
aneurysm
angioplasty
aorta
arrhythmia
arteriosclerosis
atherosclerosis
atria
atrioventricular (AV) node
bicuspid valve
blood pressure
bradycardia
bruit
buffers
bundle of His
cardiac arrest
cardiac tamponade
cardiogenic shock
carditis
carotid artery
congestive heart failure (CHF)
coronary arteries
coronary artery disease (CAD)
cor pulmonale
cyanosis
diastolic blood pressure
dyspnea
endocardium
erythrocytes
heart
heart murmur
hemoglobin
hemophilia
hemostasis
hypertension (HTN)
hypotension
hypoxia
infarction
inferior vena cava
ischemia
leukemia
leukocytes
mitral valve
myocardial infarction (MI)
myocardium
occlusion
pericardium
petechiae
phlebotomy
plasma
platelets
prehypertension
pulmonary artery
pulmonary vein
pulse pressure
Purkinje fibers
RhoGAM
septum
sinoatrial (SA) node
sphygmomanometer
stroke
superior vena cava
systolic blood pressure
tachycardia
thrombophlebitis
tricuspid valve
venipuncture
ventricles

The human organism could not live without the powerful cardiovascular system. The heart, never ceasing to beat until death, circulates blood and other important materials through a system of arteries, veins, arterioles, and capillaries.

THE STRUCTURES OF THE CARDIOVASCULAR SYSTEM

The cardiovascular system consists of the heart, the blood vessels, and the blood. In this section, the heart and blood vessels are discussed. Blood is covered later in the chapter.

The Heart

The **heart** is a four-chambered muscular organ. It lies to the left of the chest's midline under the breastbone, or sternum (Figure 26-1). The heart is similar in size and shape to a fist, weighing between 9 and 11 ounces. The apex, or pointed portion of the heart, is at the lowest point of the organ. The heart is composed of three layers (Figure 26-2):

- **Pericardium**—The outer lining, or layer; covers the heart and the large blood vessels attached to it
- **Myocardium**—The middle layer, or heart muscle; is the thickest layer

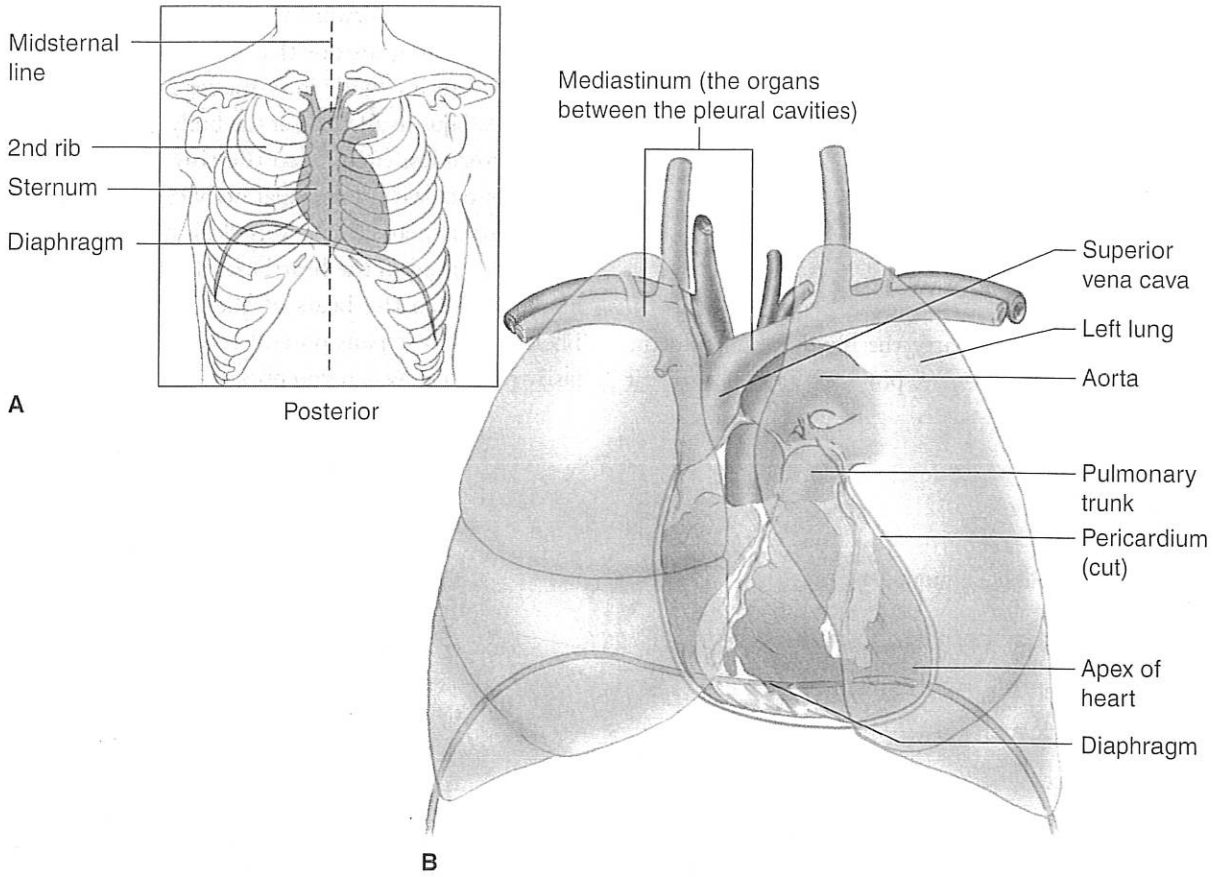


FIGURE 26-1 Location of the heart in the chest cavity.

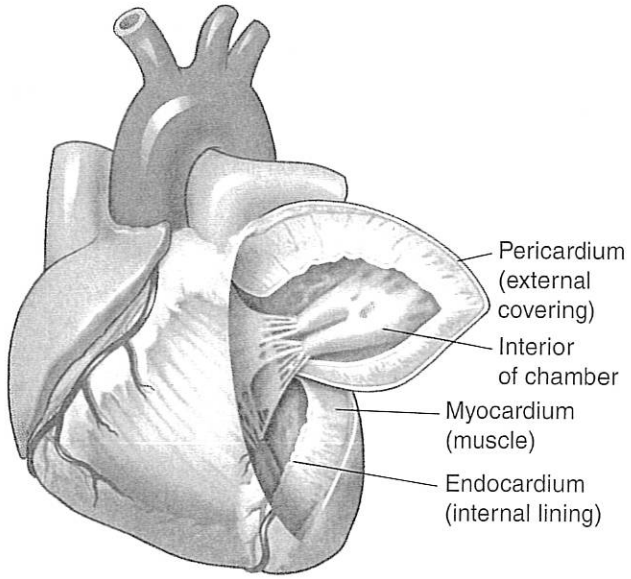


FIGURE 26-2 Linings of the heart.

- **Endocardium**—The innermost lining; is thin and smooth and contains part of the electrical conduction system of the heart

As discussed in the chapter "The Nervous System," the autonomic nervous system controls the heartbeat, which is actually muscular contractions of the heart.

The **septum** is a wall that separates the sides of the heart, creating left and right sides. The right side moves blood from the body to the lungs, and the left side pumps the blood that is returned from the lungs back to the body (Figure 26-3).

The **atria** are the two upper chambers of the heart: the right atrium (singular form of atria) and the left atrium. The **ventricles** are the two lower chambers, also identified as right and left. The atria receive blood from the body or lungs; the ventricles, by contrast, pump blood out to the lungs or body.

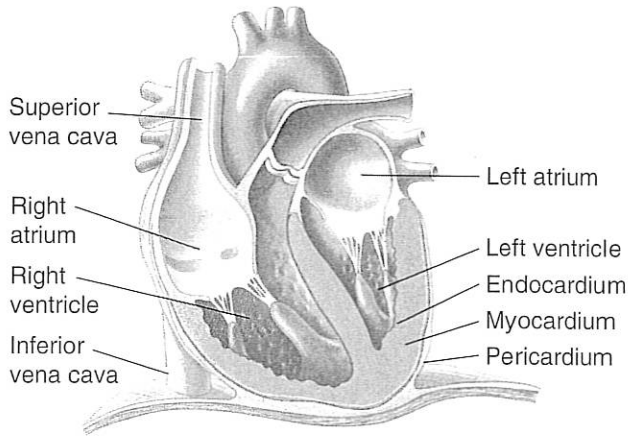


FIGURE 26-3 The heart: interior view of the heart chambers.

Blood Vessels

Some blood vessels carry blood from the heart to the cells of the body, providing the cells with oxygen and nourishment. Other vessels carry away wastes produced by the same cells. Blood vessels vary in size. The largest are arteries and veins, next smaller are arterioles and venules, and the smallest are capillaries.

Arteries and Arterioles

Arteries are the vessels that carry the blood away from the heart (Figure 26-4). High pressure provided by the heartbeat propels the blood forward through the arteries. The largest artery is the aorta, the one that directly exits the heart. From the aorta, arteries divide into smaller and smaller branches as they spread out to all parts of the body. The smallest arteries, called arterioles, connect to the tiny capillaries that make direct contact with individual body cells.

The arteries are thick-walled elastic tubes that expand with pressure from the heartbeat as it pushes blood through them. Between the beats of the heart, the arteries relax. Their constant expansion and relaxation make the arteries easily palpable. When you obtain a patient's pulse rate, it is

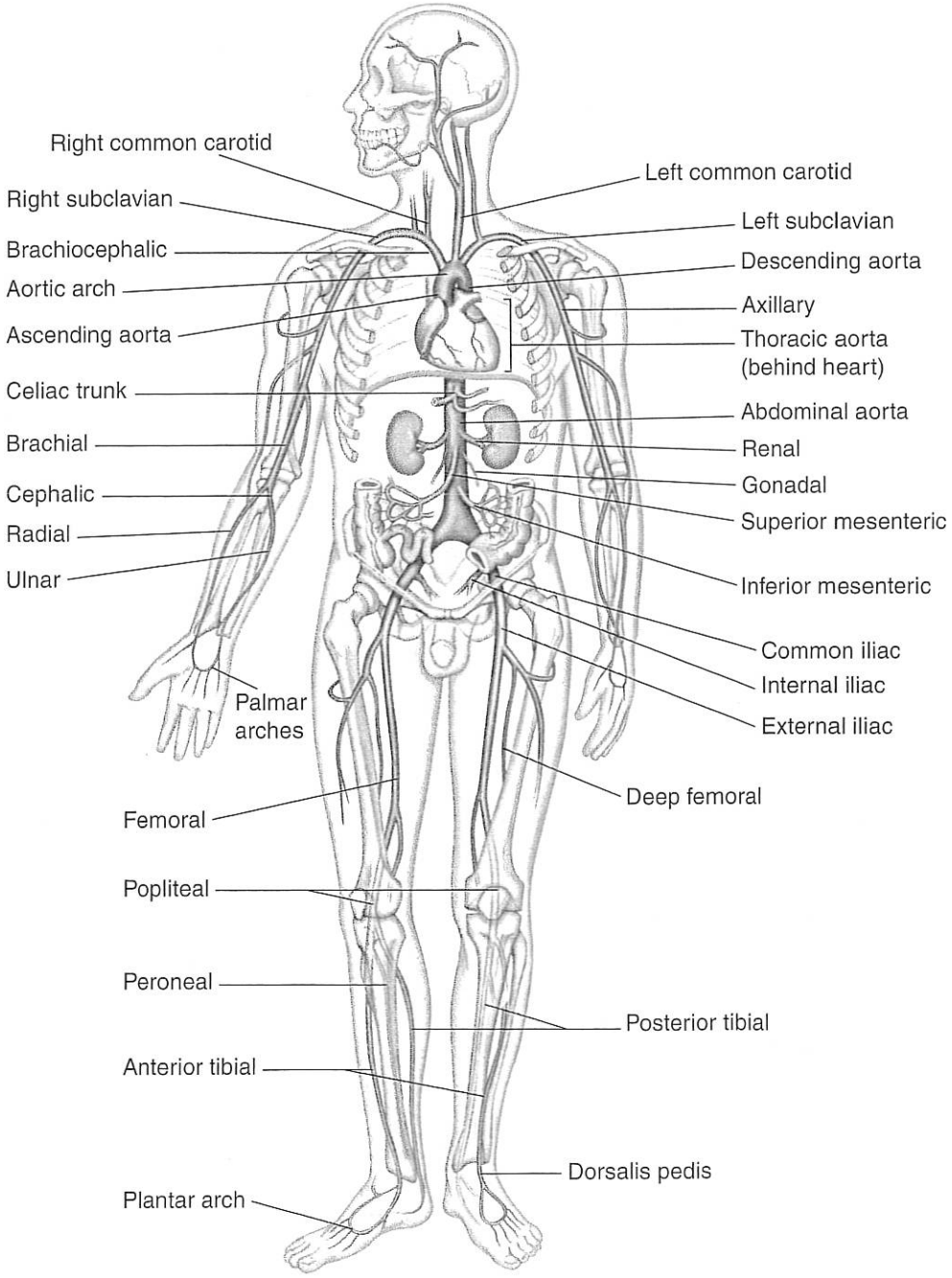


FIGURE 26-4 An overview of the arterial circulation.

usually an artery that you palpate, feeling the expansion and contraction of the artery beneath your fingers. The most common sites for palpating an artery to measure heart rate include the following (Figure 26-5):

- **Radial artery**—In the lateral wrist, just proximal to the thumb
- **Brachial artery**—In the antecubital space of the elbow; also between the biceps and triceps muscles in pediatric and thinner adult patients
- **Carotid artery**—In the lateral neck. Note that a **carotid artery**, located on either side of the neck, is the site most commonly checked for the presence or absence of a pulse, for example in a suspected cardiac arrest.
- **Temporal artery**—In the temple area
- **Femoral artery**—In the groin
- **Popliteal artery**—Behind the knee on the posteromedial (inside rear) aspect

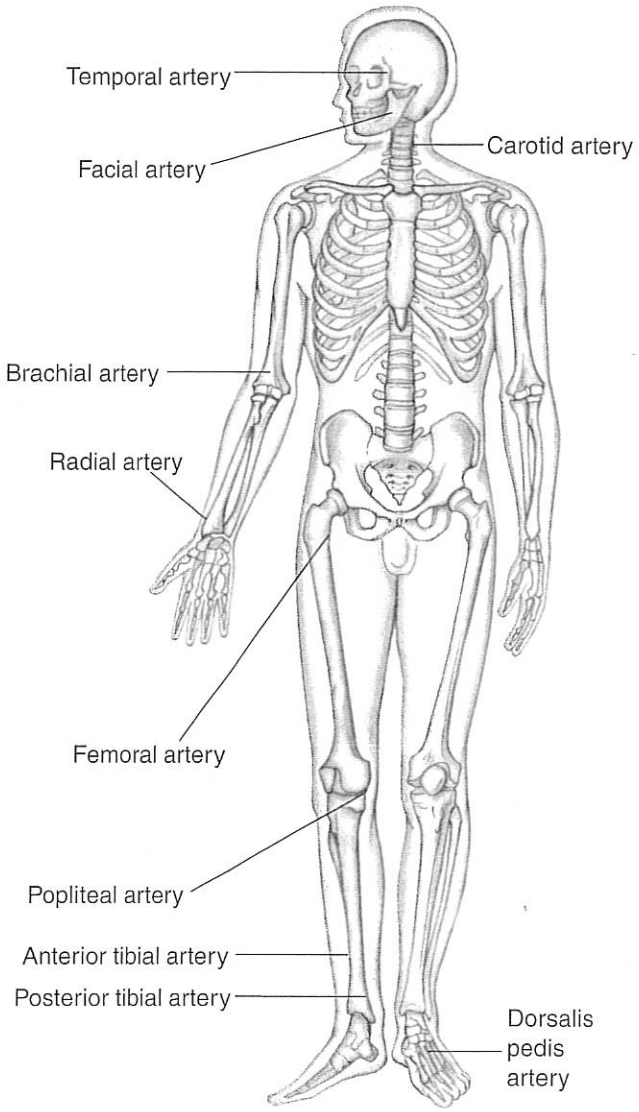


FIGURE 26-5 The primary pulse points of the body.

- **Dorsalis pedis artery**—On the upper surface of the foot
- **Anterior tibial artery**—In the ankle medial to (inside) the Achilles tendon

Veins and Venules

Veins are the vessels that transport blood from all parts of the body back to the heart (Figure 26-6). The smallest veins, called venules, branch off from the tiny capillaries and then join to form the full-sized veins. Veins are larger but thinner-walled than arteries, and they contain valves that prevent blood from flowing backward. Like arteries, veins have elastic walls, but the pressure in the veins is significantly lower than in the arteries. The low pressure in the veins is the reason why veins need valves to prevent backflow, in contrast to the high pressure that prevents backflow in the arteries.

Venipuncture, or **phlebotomy**, is the process of removing blood from the veins for examination. It is easier to draw blood from and administer intravenous (IV) medications into veins because they are under less pressure and are more superficial than arteries.

Capillaries

Capillaries are microscopic blood vessels with walls that are just one cell thick. Oxygenated blood travels through the arteries, then to the smaller arterioles, and then to the tiny capillaries within the tissues. Through the extremely thin capillary walls, the blood offloads oxygen and nutrients to the cells and picks up waste material from the cells. The blood then transports carbon dioxide and waste material from the capillaries to the small venules and on to the larger veins that return it to the heart.

Small breaks in the capillaries can lead to **petechiae**, or tiny broken blood vessels that may appear on the surface of the skin.

Vascular System of the Heart

The heart's dense musculature requires its own blood supply. Now, with our general understanding of blood vessels, we can develop an appreciation of the heart's unique vascular system.

The **coronary arteries**, illustrated in Figure 26-7, supply oxygenated blood to the heart. It is important to understand that this is *not* the blood that moves through the chambers of the heart to and from the lungs and the body. This is blood that directly nourishes the heart muscle itself. After nourishing the myocardium (*myo-* means "muscle"; *cardium* means "heart"), the deoxygenated blood is drained into the coronary sinus by the coronary veins and then back into the right atrium for oxygenation. **Occlusion** (blockage) of these

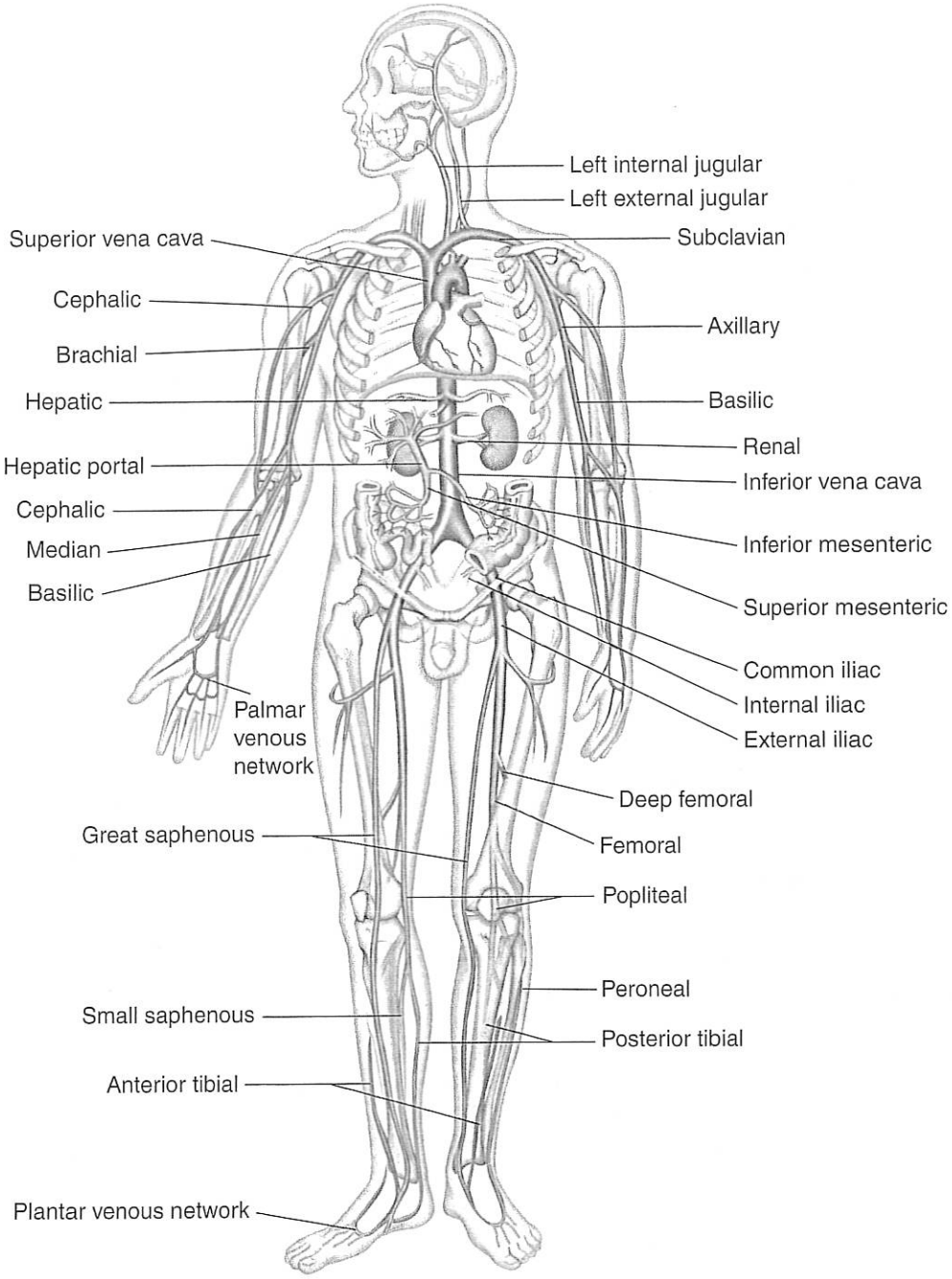


FIGURE 26-6 An overview of the venous circulation.

coronary blood vessels deprives the heart muscle of oxygen, causing chest pain.

Permanent damage to the heart muscle, including death of the muscle tissue, can occur if cardiac muscle is deprived of oxygen for a long period of time. Lack of blood flow to the heart muscle is known as myocardial **ischemia**, whereas death of heart muscle is known as a myocardial **infarction** (MI). Cardiac arrest occurs if an occlusion in the heart causes the heart to stop beating (or pumping blood). Occlusion of vessels that supply the heart is the most common cause of cardiac arrest, but arrest can also be caused by trauma or other medical conditions. The lack of oxygen to the tissues caused by ischemia and infarction is known as **hypoxia**.

HOW THE CARDIOVASCULAR SYSTEM FUNCTIONS

As mentioned earlier, the heart is responsible for the movement of blood through the cardiovascular system and throughout the entire body, providing oxygen and nutrients

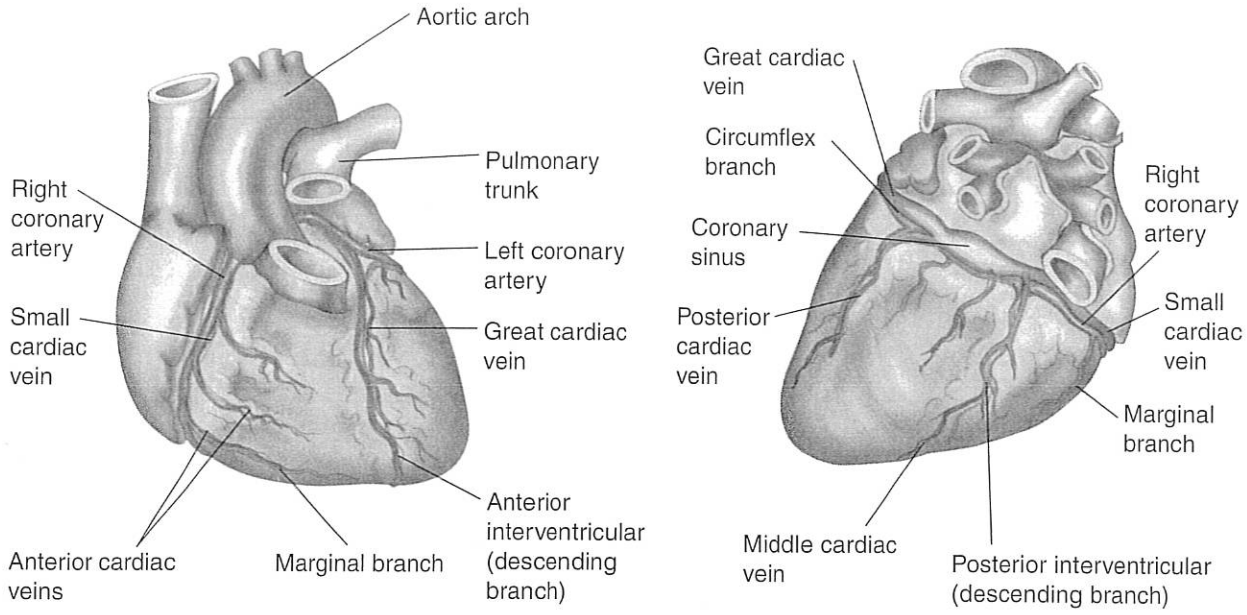


FIGURE 26-7 Coronary circulation: **(A)** coronary vessels portraying the complexity and extent of the coronary circulation; **(B)** coronary vessels that supply the anterior surfaces of the heart.

to cells and removing waste. The following list identifies other functions of the cardiovascular system. These are discussed in greater detail later in the chapter when blood is more closely examined.

- Maintaining fluid balance at a cellular level
- Helping to regulate body temperature
- Protecting the body from infection and illness through the special functions of various types of blood cells

For the cardiovascular system to properly execute its vital functions, it must be able to do two things: initiate and sustain heartbeats, and pump blood throughout the heart and body. The entire process involved in one complete heartbeat is known as the cardiac cycle.

Blood Flow Through the Heart

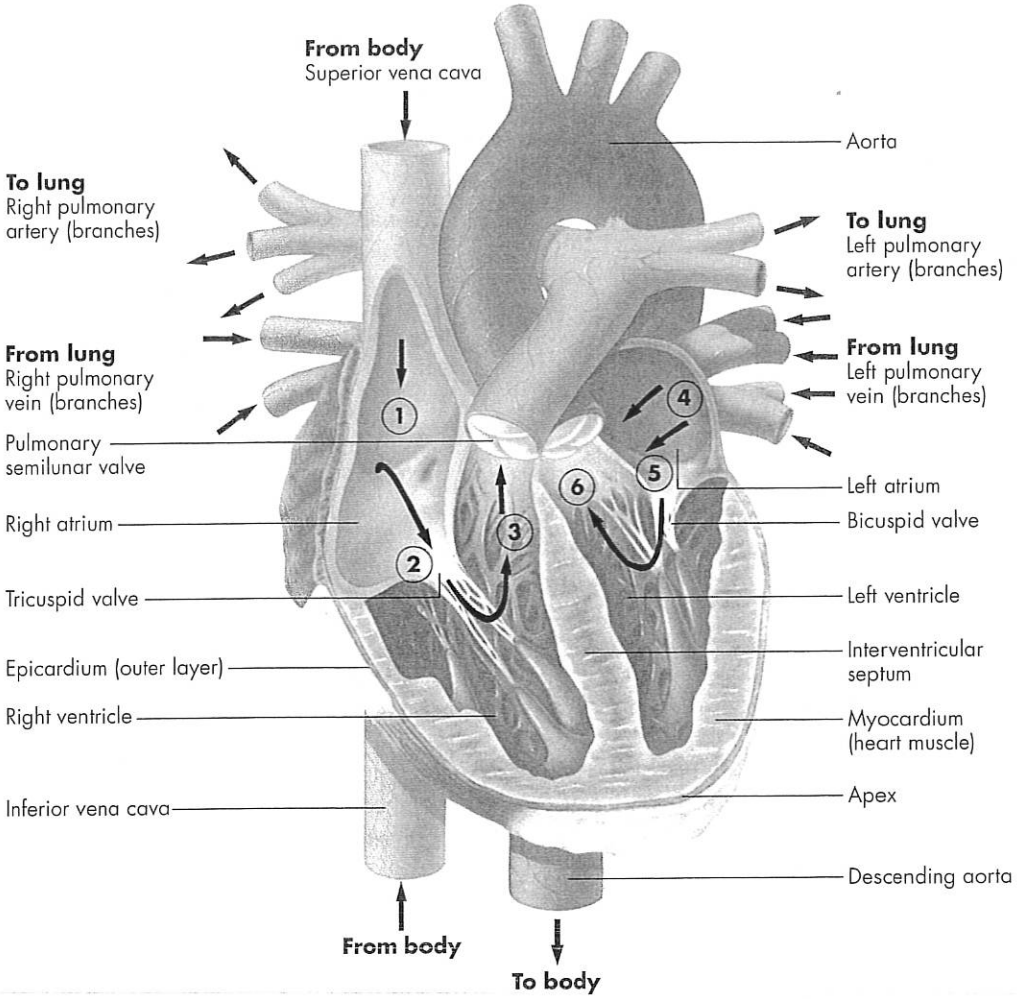
The mechanical, or pumping, action of the heart occurs with the contraction of the cardiac muscle. During this muscular contraction, an intricate pumping process occurs. First, blood from the body enters the right side of the heart through two large veins. The **superior vena cava** brings blood from the head and upper chest. The **inferior vena cava** brings blood from below the heart.

The right atrium, the smallest of the heart chambers, has the thinnest wall. It receives all the blood delivered to the heart from the body via the superior vena cava and the inferior vena cava. From the right atrium, the heart pumps the blood through a valve into the right ventricle. The valve that connects the right atrium to the right ventricle is the **tricuspid valve**. (It is called "tricuspid" because this valve has three cusps, or leaves, that close to seal the valve and move apart to open it.)

The right ventricle, which is more muscular than the right atrium, pumps the blood out through the pulmonary valve into the **pulmonary artery**, which carries the blood to the lungs.

Keep in mind that, while the blood was circulating through the body, it was giving up oxygen to nourish the body's cells and, at the same time, accumulating waste and carbon dioxide given off by the cells. So the blood that enters the right atrium and then the right ventricle is deoxygenated blood—blood that contains too much carbon dioxide and not enough oxygen. When the right ventricle pumps this blood to the lungs, there is a gas exchange. The blood passes off its carbon dioxide into the alveoli (air sacs) of the lungs, from which it is exhaled from the body. At the same time, the blood takes on oxygen from the air that has been breathed into those same air sacs of the lungs. So the blood that returns to the heart from the lungs is now oxygenated blood.

The **pulmonary vein** carries the oxygenated blood from the lungs and empties it into the left atrium of the heart. The blood leaves the left atrium through the **bicuspid valve** (a valve with two cusps, which is also called the **mitral valve** because it resembles a bishop's mitre, a hat with two tall flaps).



RIGHT HEART PUMP

1. Deoxygenated blood returns from the upper and lower body to fill the right atrium of the heart creating a pressure against the tricuspid valve.
2. This pressure of the returning blood forces the tricuspid valve open and begins filling the ventricle. The final filling of the ventricle is achieved by the contracting of the right atrium.
3. The right ventricle contracts, increasing the internal pressure. This pressure closes the tricuspid valve and forces open the pulmonary semilunar valve, thus sending blood toward the lung via the pulmonary artery. This blood will become oxygenated as it travels through the capillary beds of the lung and then returns to the left side of the heart.

LEFT HEART PUMP

4. Oxygenated blood returns from the lung via the pulmonary vein and fills the left atrium creating a pressure against the bicuspid valve.
5. This pressure of returning blood forces the bicuspid valve open and begins filling the left ventricle. The final filling of the left ventricle is achieved by the contracting of the left atrium.
6. The left ventricle contracts, increasing internal pressure. This pressure closes the bicuspid valve and forces open the aortic valve causing oxygenated blood to flow through the aorta to deliver oxygen throughout the body.

FIGURE 26-8 The flow of blood through the heart.

After passing through the bicuspid valve, the blood enters the left ventricle. The left ventricle is called the powerhouse chamber. The highly muscular walls of this chamber must forcibly pump the oxygenated blood out from the heart to the farthest reaches of the body. The blood leaves the left ventricle through the aortic valve and enters the **aorta**, the largest artery in the body. From the aorta, the blood begins its journey through the various arteries that branch off from the aorta to all the different regions of the body. Figure 26-8 shows the flow of blood through the heart.

As the blood makes its way through the chambers of the heart, healthy valves function as gateways, never allowing

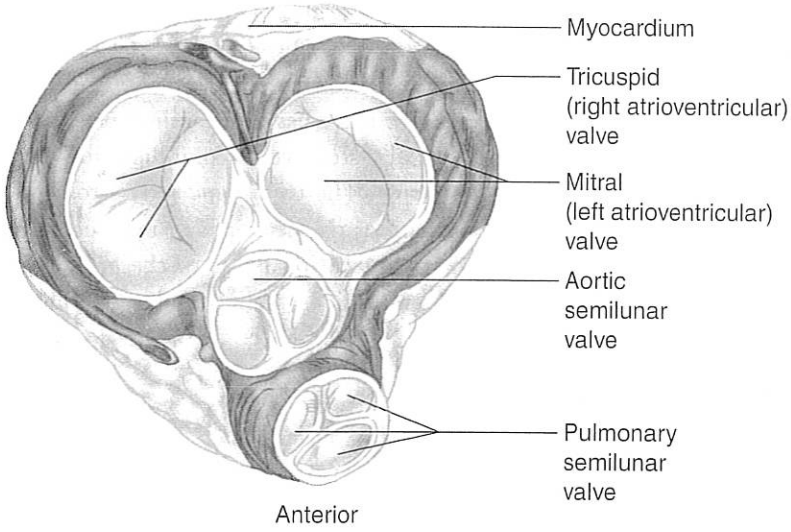


FIGURE 26-9 The valves of the heart.

the blood to flow backward (Figure 26-9). A damaged or diseased valve can allow blood to escape and flow backward through the valve, creating a **heart murmur**, the sound of the backflowing blood as heard through a stethoscope. A heart murmur can sometimes be confused with the sound of turbulent flow in the carotid artery, known as a **bruit**.

Conduction System of the Heart

An electrical conduction system is responsible for initiating the beats that send blood flowing through and from the heart. This cardiac conduction system, controlled by the autonomic nervous system, is responsible not only for creation of the heartbeat but also for its rate and rhythm. Three areas of specialized neuromuscular tissue initiate and sustain the heartbeat. They are the sinoatrial node, the atrioventricular node, and the atrioventricular bundle, also known as the bundle of His. Figure 26-10 shows the conduction system of the heart.

The **sinoatrial (SA) node** is considered the pacemaker of the heart because it initiates the heartbeat. It is located in the upper portion of the wall of the right atrium. The SA node signals the right and left atria to contract by discharging electrical signals. In a healthy adult at rest, the SA node initiates 60 to 80 beats (or contractions) per minute.

The **atrioventricular (AV) node** is located between the atria and ventricles in the endocardium layer of the heart. When the electrical impulse from the SA node reaches this point, the AV node slows down the impulse for a moment to allow the atria time to finish contracting before the ventricles begin their contraction. The AV node senses when the ventricles have filled and then sends an impulse that reaches the bundle of His.

Made up of muscle fibers, the **bundle of His** is also known as the atrioventricular (AV) bundle. The bundle of His is located in the septum of the heart, from which it divides into right and left bundle branches. As the impulse nears the end of the cardiac circuit, it travels from the bundle branches into the Purkinje fibers.

The **Purkinje fibers** are specialized conductive fibers located within the walls of the ventricles. They are responsible for relaying cardiac impulses to the cells of the ventricles, prompting the ventricles to contract.

The Cardiac Cycle

The cardiac cycle consists of all the events that occur during one complete heartbeat. On average, the heart beats about 70 times per minute, although normal adult heart rates can vary from 60 to 110 beats per minute. Various factors can impact the cardiac cycle. Factors

Professionalism The Life Span

The Child

- The development of the circulatory system begins with the development of the fetal heart during the first 2 months of gestation, and the newborn's circulation begins to function immediately after birth.
- Children have a smaller circulatory system, and their vital signs are typically different from those of adults. Their blood pressure is typically lower than that of an adult, although their pulse and respiratory rates are higher.

The Older Adult

- Cardiovascular disease in older adults is a real threat. One in four deaths in the United States are related to heart disease.
- Cardiac and other circulatory changes once attributed to aging may be minimized with appropriate lifestyle modifications. Without a healthy lifestyle or modifications, years of sedentary living, poor diet choices, and obesity can contribute to the development of cardiovascular disease.
- Healthy lifestyle choices for overall cardiac health for the older adult include choosing not to smoke, eating a healthy diet rich in vegetables and lean protein, exercise, and maintaining a healthy weight.
- With normal aging, the heart changes: lipofuscin occurs (which is an age-related pigmentation change to the heart), heart valves toughen and become stiffer, and the cells within the heart may begin to slowly degenerate.

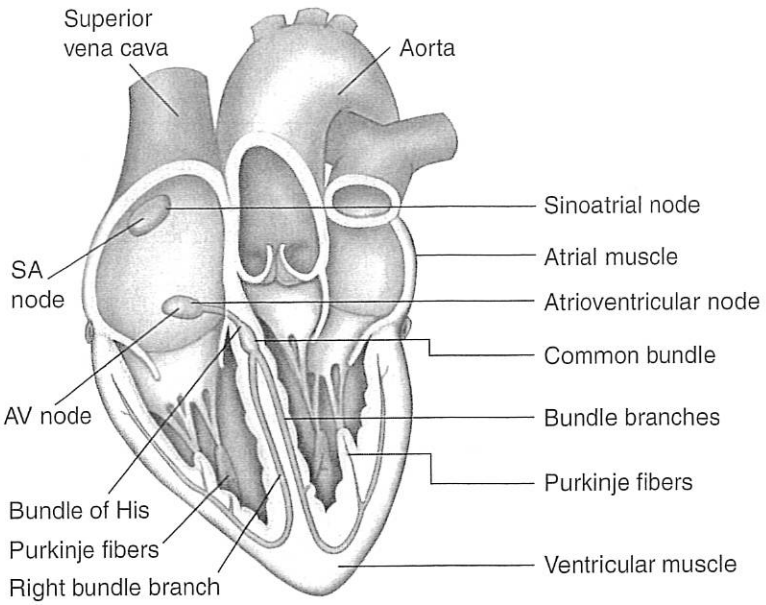


FIGURE 26-10 The conduction system of the heart.

that cause the heart rate to increase include exercise, stress, excitement, smoking, and a rise in body temperature.

The cardiac cycle has four distinct phases: atrial diastole, atrial systole, ventricular diastole, and ventricular systole. The term *systole* refers to the contraction phase of the heart and, conversely, *diastole* refers to the relaxation phase of the heart. Figure 26-11 illustrates the systolic and diastolic phases of the heart.

PULMONARY AND SYSTEMIC CIRCULATION

The cardiovascular system can be divided into the pulmonary circulation and the systemic circulation (Figure 26-12).

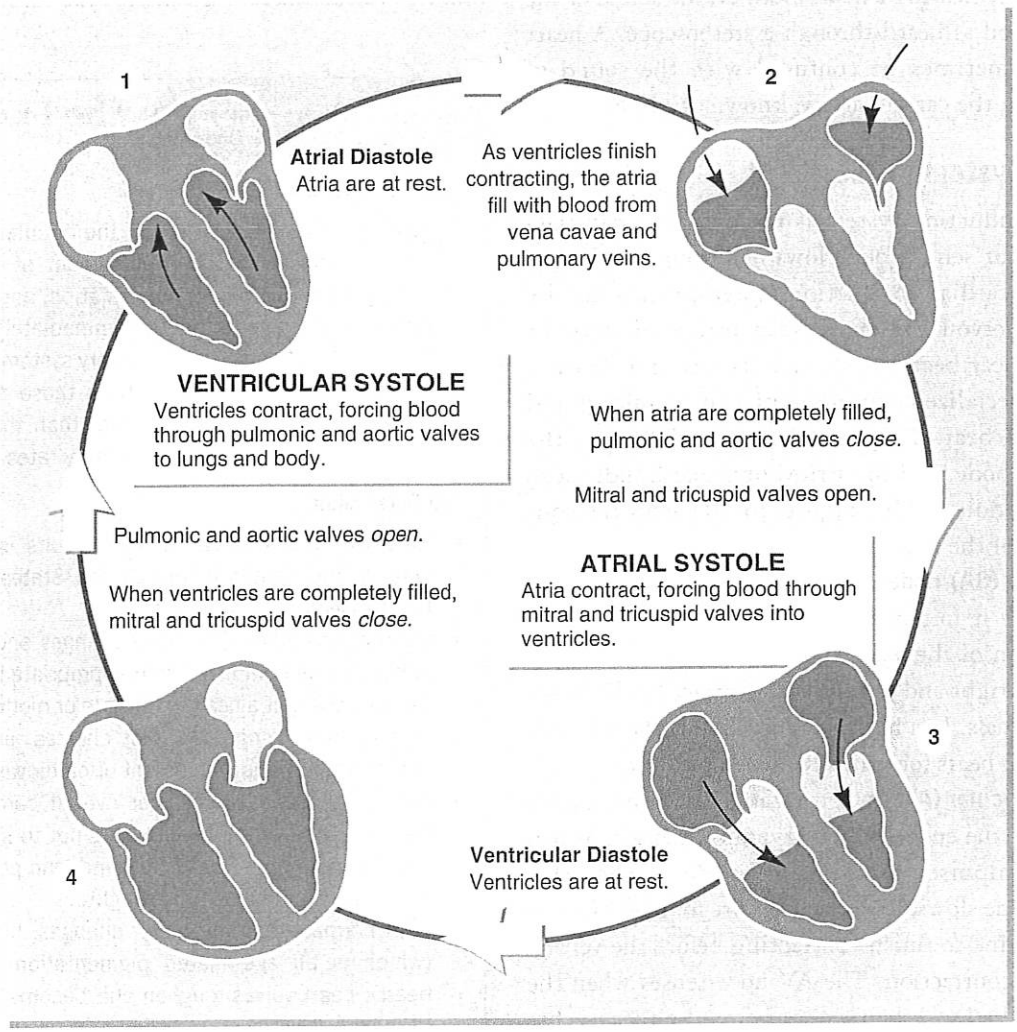


FIGURE 26-11 The cardiac cycle showing systole and diastole.

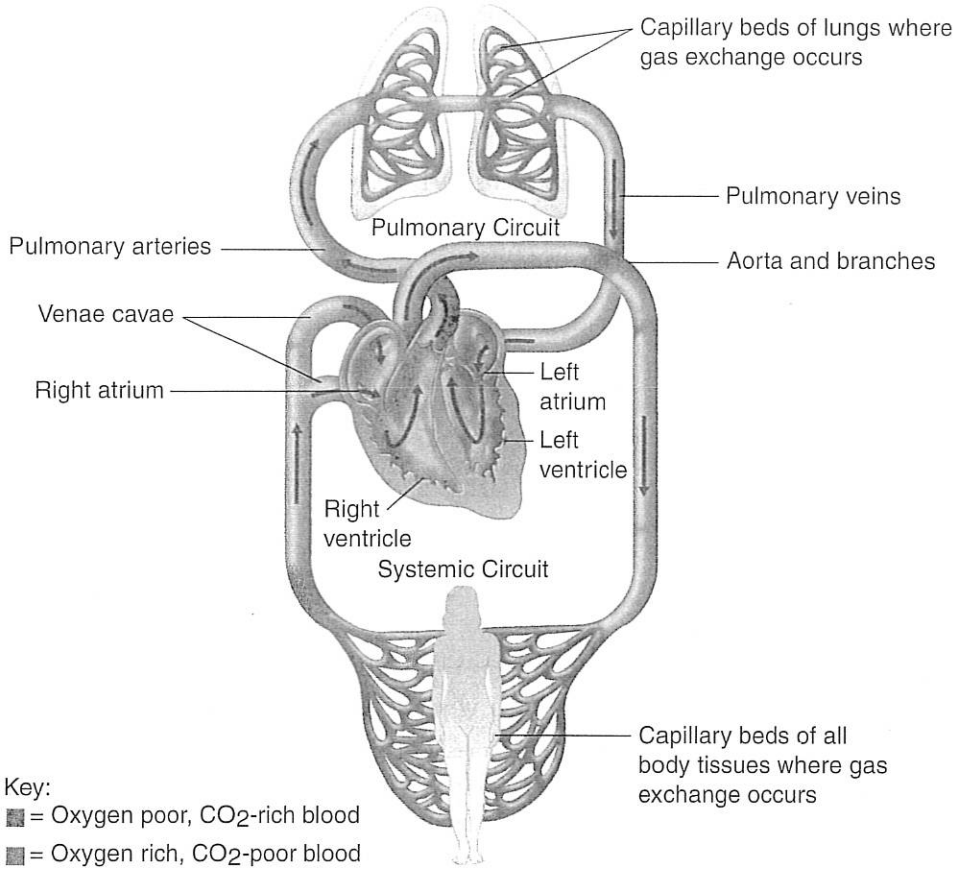


FIGURE 26-12 Systemic and pulmonary circulation.

Pulmonary Circulation

Pulmonary circulation is the route blood takes from the heart to the lungs via the pulmonary artery. It is then returned to the heart via the pulmonary vein. The function of pulmonary circulation is to carry deoxygenated blood from the right side of the heart to the lungs (where it gives off waste carbon dioxide and takes on fresh oxygen) and then to carry the oxygenated blood back to the left side of the heart. The oxygen-rich blood that returns to the left side of the heart from the lungs is then moved out to the cells of the body by the systemic circulation.

Systemic Circulation

Systemic circulation is the route blood takes around the body: It leaves the heart through the aorta; travels through the body via arteries, arterioles, capillaries, venules, and veins; and returns to the heart through the superior and inferior venae cavae. The function of systemic circulation is to deliver oxygenated blood and other nutrients to body cells and to carry carbon dioxide and waste products away from the cells for elimination from the body.

BLOOD PRESSURE

Blood pressure is defined as the force exerted by the blood against the inner walls of the arteries. A person's blood pressure continually changes, depending on activity, temperature, diet, emotional state, posture, physical condition, and medication use.

Blood pressure is usually measured in the brachial artery with a **sphygmomanometer**, an instrument that expresses measurements in terms of millimeters of mercury (mmHg). During ventricular contraction, blood pressure is at its highest in the arteries. The measurement obtained at this point is called the **systolic blood pressure**. By contrast, **diastolic blood pressure** is the measurement obtained when the ventricles relax and blood pressure is at its lowest.

Blood pressure is recorded as a fraction, placing the systolic blood pressure over the diastolic blood pressure. For example, a systolic of 120 mmHg and a diastolic of 80 mmHg would be recorded as 120/80. This blood pressure reading would be verbally expressed as "120 over 80."

The average and healthy resting blood pressure for a young adult is below 120/80.

Pulse Pressure

The **pulse pressure** is the difference between the systolic and diastolic blood pressures. Normal pulse pressure is 30 to 50 points. The pulse pressure is an indication of the tone of the arterial walls. It can be helpful when assessing a patient's risk profile for heart disease. A high pulse pressure may indicate a patient is at risk for developing heart disease. Conversely, a low pulse pressure (often below 40) may indicate a decrease in effective functioning of the heart.

BLOOD

Blood is a type of connective tissue that is composed of blood cells (the formed elements of the blood) and **plasma** (the fluid portion of the blood). Blood (along with the heart and the blood vessels) is one of the three main components of the cardiovascular system.

Professionalism The Workplace

The professional medical assistant takes pride in his appearance. Long hair should be tied back so there is no chance of contaminating laboratory specimens with hair nor any chance of contaminating hair with specimens. Jewelry should be simple and worn sparingly. Rings and bracelets should be kept to a minimum because of the need to wear latex gloves and to wash hands frequently. Long sleeves should not hang off the arms where they could touch laboratory specimens or get wet during hand washings. If scrubs are worn as a uniform, the scrubs should be pressed and neat in appearance. In a situation where the environment is cool, it is usually acceptable to wear a plain T-shirt underneath the scrub top for extra warmth. White lab coats should be bleached to remove stains.

The amount of blood that circulates in a person's body is known as blood volume. Blood volume levels vary from person to person and depend on factors such as the person's size, level of hydration, and amount of fat tissue. On average, about 5 liters of blood circulates throughout an adult's body.

In adults, the formation of blood cells (a process called hematopoiesis) takes place primarily in the bone marrow.

Composition of Blood

There are three main types of blood cells, also known as the formed elements of blood:

- **Erythrocytes**, or red blood cells
- **Leukocytes**, or white blood cells (There are five types of leukocytes: neutrophils, eosinophils, basophils, lymphocytes, and monocytes.)
- **Platelets**, or thrombocytes

Figure 26-13 shows the formed elements of blood. More information on blood composition is provided in the chapter titled "Hematology."

Red Blood Cells

Red blood cells (RBCs), or **erythrocytes**, are produced in the red bone marrow. Mature red blood cells do not contain nuclei but do contain **hemoglobin**, a red, iron-containing pigment that has the ability to bind oxygen to itself. The function of hemoglobin is to carry oxygen from the lungs to cells throughout the body.

An RBC count refers to the number of red blood cells in 1 microliter of blood. The average range for a healthy adult male is 4.7–6.1 million cells per microliter (mcL). A healthy adult female has 4.2–5.4 million cells/mcL.

White Blood Cells

White blood cells (WBCs), or **leukocytes**, differ from RBCs in that they are usually larger, have a nucleus, lack hemoglobin, and are translucent unless stained (which occurs during laboratory testing). There are not nearly as many leukocytes in the blood as there are erythrocytes. There are normally only 4,000 to 10,000 per microliter (mcL) of blood. WBCs fight infection and, in this function, are important contributors to homeostasis.

The five types of leukocytes are divided into two categories:

- **Granulocytes** have granules in their cytoplasm. Neutrophils, eosinophils, and basophils are granulocytes.
- **Agranulocytes** do not contain granules. Monocytes and lymphocytes are agranulocytes.

A differential WBC count is a type of blood test that is often ordered to measure the number of each of the five types of leukocytes. An increase or decrease in percentages may be indicative of infection or disease.

Blood Platelets

Platelets, or thrombocytes, are fragments of larger cells that have formed in the red bone marrow. They are smaller than erythrocytes and do not have a nucleus. Platelets control the loss of blood through the process of coagulation, or the formation of a clot at the point of injury. A normal platelet count is 150,000 to 400,000 per cubic mm of blood.

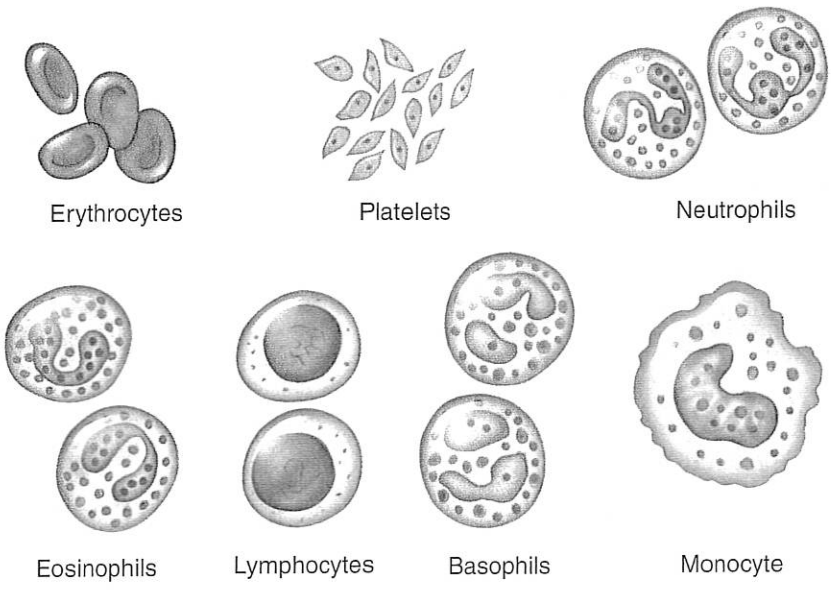


FIGURE 26-13 The formed elements of blood.

Blood Plasma

Plasma is the liquid portion of the blood. Plasma is 91 percent water. The other 9 percent is a mixture of proteins, nutrients, gases, electrolytes, fats, hormones, enzymes, and waste products. Plasma constitutes about 55 percent of the total volume of whole blood. Albumin, the most abundant protein found in plasma, helps maintain the fluid volume in the blood, thereby controlling blood pressure. Other major proteins found in plasma are fibrinogen and prothrombin (both of which play a role in clot formation), and globulin.

Functions of Blood

It was mentioned earlier that the cardiovascular system has three major functions: transportation, regulation, and defense. Blood is responsible for executing these functions and maintaining a state of balance throughout the body.

Transportation

Blood moves from the heart to all the tissues of the body. It is important to recall that, at the tissue level, gas and nutrient exchange takes place across thin capillary walls between the blood and the individual cells. The blood transports oxygen from the lungs and nutrients from the digestive tract and delivers these to the tissue cells. Various organs and tissues also secrete hormones into the blood, which transports them to other organs and tissues where they serve as signals that influence other metabolic functions. The blood also picks up waste materials from the cells that is later filtered and excreted by the kidneys as well as carbon monoxide that is exhaled from the lungs.

Regulation

Blood helps to regulate body temperature by absorbing heat, mostly from active muscles, and then distributing the heat throughout the body. If the blood is too warm, the heat dissipates from dilated blood vessels in the skin. The dilated vessels cause the skin to become flushed as heat is released. Salts and plasma proteins in the blood act to pull water into the blood vessels (to balance forces that push water out of the vessels) to maintain an adequate liquid content in the blood. In this way, the blood plays a key role in maintaining the body's water–salt balance. Blood also helps the body regulate the pH (acid/alkaline) balance of the body. The blood contains **buffers**, which are mechanisms within the blood that balance the pH level, thus preventing blood from becoming too acidic or too alkaline.

Defense

Leukocytes defend the body against pathogens such as bacteria and viruses. This is accomplished in several ways:

Professionalism The Law

When providing care and treatment to a patient with a cardiovascular disorder or any other medical condition, it is important for the medical assistant to be mindful of the patient's privacy. Patient privacy is a serious issue. As a result, the government has enacted the Health Insurance Portability and Accountability Act (HIPAA), under which regulations have been issued that provide for patient rights and protection. Therefore, when you are in the office talking to a patient either directly or on the telephone, you must ensure that other patients cannot hear your conversation. Medical records and daily schedules should always be kept so that patient information cannot be viewed by other patients or employees who are not providing direct patient care.

- Neutrophils and monocytes engulf and destroy pathogens. This process is called phagocytosis.
- Lymphocytes secrete antibodies into the blood. Antibodies help to weaken the pathogens, making them vulnerable to destruction.
- When an injury occurs, bleeding is stopped through the formation of clots, which, as noted earlier, are formed from platelets. When a blood vessel breaks, the smooth muscle at the site of the break causes the vessel wall to contract, which in turn causes the blood vessel to spasm. The spasm reduces the amount of blood lost through the break. Platelets begin to attach themselves to both the broken area and to each other to form a "plug" that eventually stops the bleeding. After a period of time, a blood clot forms and replaces the platelet plug.

  The clot is formed in this manner: During the coagulation process, the plasma protein fibrinogen is converted to fibrin. Similar to a glue, the fibrin adheres to the area of the vessel that is broken or damaged. This creates a system that entraps blood cells and platelets. The accumulation of cells and platelets forms a blood clot, which will stop the bleeding until the area has had time to repair. The stoppage of bleeding is termed **hemostasis**.

  Without this clotting capacity and resulting hemostasis, we could bleed to death from even a tiny cut.

BLOOD TYPES

Blood type is based on whether the blood contains or lacks specific antigens and antibodies. Blood type is determined by genetics (Figure 26-14). If an antigen on the surface of a red

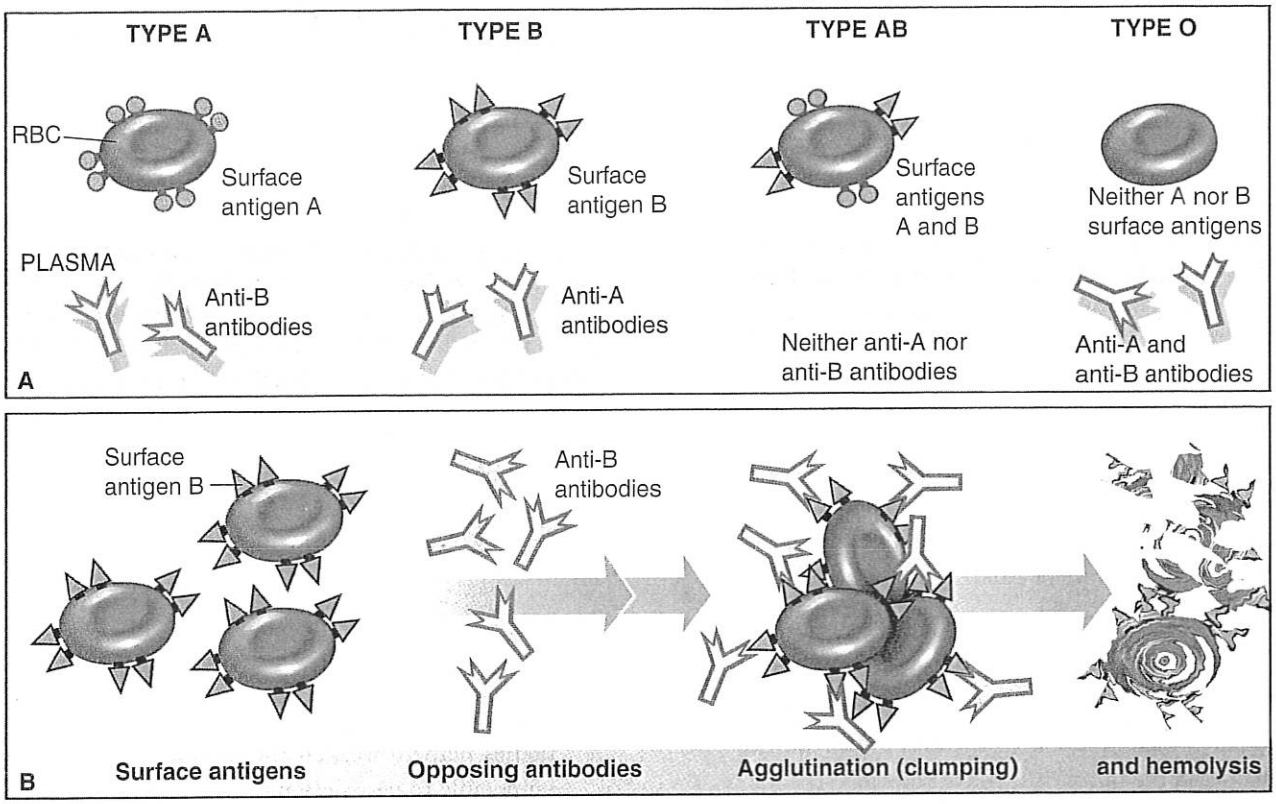


FIGURE 26-14 Blood typing and cross-reactions. The blood type depends on the presence of surface antigens (agglutinogens) on RBC surfaces. **(A)** The plasma antibodies (agglutinins) that will react with foreign surface antigens; **(B)** in a cross-reaction, antibodies that encounter their target antigens lead to agglutination and hemolysis of the affected RBCs.

blood cell binds with antibodies in plasma, **agglutination**, or clumping, occurs The presence of anti-A and anti-B antibodies in the plasma requires that blood be typed and cross-matched for transfusions. If a patient is given the wrong blood type, the new blood may clump with the patient's blood, causing occlusion and shock. For this reason, blood banks carefully type and match blood before it is given to the patient.

The ABO blood group system identifies four blood types (Table 26-1):

- Type A—Type A antigen on the surface of the red blood cells and anti-B antibody in the plasma. People with Type A blood can only be given Type A blood.
- Type B—Type B antigen on the surface of the red blood cells and anti-A antibody in their plasma; people with Type B blood can only be given Type B blood.
- Type AB—Type AB has both A and B antigens on the red blood cell surfaces and neither anti-A nor anti-B antibodies. People with type AB blood are considered universal recipients because the majority of them can receive all ABO blood types given that their plasma lacks antibodies.
- Type O—Neither A nor B antigens are found on the red blood cells; however, both anti-A and anti-B antibodies are in the plasma. People with type O blood are considered universal donors because their blood can be administered to most people regardless of the recipient's blood type.

TABLE 26-1 | Blood Group Identification by Antigen and Antibody

Blood Group	Antigen	Antibody
A	A	anti-B
B	B	anti-A
AB	A and B	neither
O	neither anti-A nor anti-B	anti-A, anti-B

The Rh Factor

The Rh factor is another characteristic of a person's blood (in addition to blood type). The Rh factor is an antigen first discovered on RBCs of the Rhesus monkey (hence the name *Rh*). A person is either Rh positive if they have the Rh antigen or Rh negative if they do not have the Rh antigen.

Complications can arise if an Rh-negative individual is given Rh-positive blood. In this scenario, when the Rh-negative person's blood is exposed to the Rh antigen, it will begin to create antibodies in response. Although it isn't a serious concern if given once, consequences arise if the person receives Rh-positive blood a second time. Upon the second exposure, a transfusion reaction occurs in which the antibodies bind to the donor cells, resulting in agglutination and destruction of the donor cells.

The Rh factor plays an important role during pregnancy, so it is vital that a woman know her Rh type. If an Rh-negative female conceives a child with an Rh-positive male, there is a 50–50 chance that the fetus will be Rh-positive. When the blood of an Rh-positive fetus mixes with the mother's Rh-negative blood, the mother will develop antibodies against the fetus's RBCs. Because of the length of time it takes for the mother's body to generate these antibodies, the first Rh-positive fetus generally does not suffer any effect. However, if a second Rh-positive fetus is conceived, the fetus's blood will be attacked by the mother's antibodies almost immediately. This can lead to a serious condition, erythroblastosis fetalis, in which the baby is born severely anemic. The condition can be prevented by giving the drug **RhoGAM** to the Rh-negative mother to inhibit the production of antibodies against the Rh antigen.

COMMON PATHOLOGY ASSOCIATED WITH THE CARDIOVASCULAR SYSTEM

Disorders of the cardiovascular system are very common in the United States. Many result from a combination of lifestyle factors (lack of exercise, smoking, stress, obesity) and genetics. Common tests and procedures used to diagnose and treat cardiovascular disorders are discussed in Table 26-2.

Anemia

Anemia is a condition in which the blood has an abnormally low number of red blood cells. Anemia can also occur if the RBCs do not contain enough hemoglobin or if the hemoglobin that is present is abnormal. Considered the most common dysfunction of RBCs, anemia affects about 3.5 million Americans.

The three most common causes of anemia are (1) decreased production of healthy red cells by the bone marrow, (2) increased hemolysis (erythrocyte destruction), and (3) blood loss from heavy menstrual periods, traumatic injury, or internal bleeding. Vitamin and mineral deficiencies in the diet can also slow the production of hemoglobin.

Professionalism Cultural Considerations

Cultural and ethnic factors are very important to take into consideration when working with patients with cardiovascular disorders. For instance, the African American population is more likely to be diagnosed with sickle cell anemia, peripheral artery disease (PAD), or hypertension. An alarming statistic from the National Stroke Association states that African Americans are twice as likely to die from a stroke as Caucasians. Women of Native American or Alaska Native descent are also categorized as populations at high risk for cardiovascular disorders. Understanding and having a knowledge of cultural predispositions will help you be more attuned to changes in patients' health and to assist in providing culturally beneficial patient education.

There are several types of anemia. Some may be inherited, whereas others are brought on by poor nutrition or toxins.

- **Iron-deficiency anemia**—The body needs iron for hemoglobin production. Decreased iron levels, resulting in decreased hemoglobin production, cause a decrease in the capacity of RBCs to transport oxygen.
- **Vitamin-deficiency anemia**—Like iron, vitamin B12 is essential for normal hemoglobin production. However, some individuals do not easily absorb vitamin B12. The result is a vitamin B12 deficiency, a condition known as *pernicious anemia.*
- **Hemolytic anemia**—This type of anemia is caused by the premature destruction of RBCs by antibodies produced by the immune system. This condition is sometimes associated with systemic disorders, such as lupus, or exposure to toxic materials. For instance, lead, copper, and benzene can also lead to the destruction of RBCs, causing hemolytic anemia.
- **Sickle cell anemia**—This form of anemia is one type of sickle cell disease, which is caused by hard, sickled (crescent-shaped) red blood cells. Normal red blood cells are round and flexible and pass easily through the smallest blood vessels to deliver oxygen to the body's tissues. In sickle cell anemia, the rigidity and irregularities of sickled cells create blockages that prevent normal blood flow to the tissues. The African American population is most susceptible to inheriting this serious and often life-threating form of anemia. Sickle cell anemia is one of the few forms of anemia that causes physical pain. Sickle cell disease is also known as hemoglobin S disease.

TABLE 26-2 | **Procedures and Diagnostic Tests Related to the Cardiovascular System**

Procedure/Test	Description
Aneurysmectomy	Surgical removal of an aneurysm, which is an abnormal dilation of a blood vessel.
Angiography	X-rays taken after the injection of an opaque material (also called contrast) into a blood vessel. They can be performed on the aorta as an aortic angiogram, on the heart as an angiocardiogram, and on the brain as a cerebral angiogram.
Angioplasty	Surgical procedure of altering the structure of a vessel by dilating the vessel using a balloon inside the vessel.
Arterial Blood Gases	Measurement of the amount of oxygen, carbon dioxide, and bicarbonate in the blood, and a pH reading of the blood. Blood gases are measured in emergency situations and provide valuable evaluation of cardiac failure, hemorrhage, and kidney failure.
Artery Graft	A piece of blood vessel that is transplanted from a part of the body to the aorta to repair a defect.
Artificial Pacemaker	Electrical device that substitutes for the natural pacemaker of the heart. It controls the beating of the heart by a series of rhythmic electrical impulses. An external pacemaker has the electrodes on the outside of the body. An internal pacemaker has the electrodes surgically implanted within the chest wall.
Cardiac Catheterization	Passage of thin tube (catheter) through an artery (commonly the femoral artery) and the blood vessels leading into the heart. Radiopaque contrast is injected, and X-rays are taken to view the coronary arteries.
Cardiac Enzyme Analysis	Complex proteins capable of inducing chemical changes within the body. Cardiac enzymes are obtained by blood sample to determine the amount of heart disease or damage.
Cardiac Magnetic Resonance Imaging (MRI)	Noninvasive procedure in which images of the heart and blood vessels are captured for examination to determine effects.
Cardiolysis	Surgical procedure to separate adhesions that involves a resection of the ribs and sternum over the pericardium.
Cardiorrhaphy	Surgical suturing of the heart.
Cardioversion	Converting a cardiac arrhythmia (irregular heart rhythm) to a normal sinus rhythm using a cardioverter to provide countershocks to the heart.
Commissurotomy	Surgical incision to change the size of an opening. For example, in mitral valve commissurotomy, a stenosis or narrowing is corrected by cutting away at the adhesions around the mitral opening.
Coronary Artery Bypass Surgery	Open heart surgery in which a shunt is created to permit blood to travel around the constriction in the coronary vessel(s).
Doppler Ultrasonography	Measurement of sound waves as they bounce off tissues and organs to produce an image. This noninvasive procedure can assist in determining heart and blood vessel damage; it is also called an echocardiogram.
Electrocardiogram (ECG)	Record of the electrical activity of the heart. Useful in the diagnosis of abnormal cardiac rhythm and heart muscle (myocardium) damage. This procedure is explained fully in the chapter on electrocardiography.
Electrolyte Levels	Measurement of blood sodium (Na), potassium (K), and chloride (Cl). Electrolyte balance is important for the heart to function at optimal levels.
Embolectomy	Surgical removal of an embolus or blood clot from a vessel.
Heart Transplantation	Replacement of a diseased or malfunctioning heart with a donor's heart.
Holter Monitor	Portable ECG monitor worn by the patient for a period of a few hours to a few days to assess the heart and pulse activity as the person goes through the activities of daily living. Used to assess a patient who experiences chest pain and unusual heart activity during exercise and normal activities when a cardiogram is inconclusive. This is further discussed in the chapter on electrocardiography.

TABLE 26-2 | Procedures and Diagnostic Tests Related to the Cardiovascular System (*continued*)

Procedure/Test	Description
Lipoproteins	Measurement of blood to determine serum cholesterol and triglyceride levels.
Open Heart Surgery	Surgery that involves the heart, the coronary arteries, or the heart valves. The heart is actually entered by the surgeon.
Percutaneous Balloon Valvuloplasty	Insertion of a balloon catheter through the skin and into a blood vessel across a narrowed, or stenotic, heart valve. When the balloon is inflated, the narrowing or constriction is decreased.
Percutaneous Transluminal Coronary Angioplasty (PTCA)	Method for treating localized coronary artery narrowing. A balloon catheter is inserted through the skin into an artery that leads to a coronary artery and inflated to dilate the narrow blood vessel.
Phleborrhaphy	Suturing of a vein.
Prothrombin Time	Measurement of the time it takes for a sample of blood to coagulate.
Stent	Insertion of a small mesh tube into a weak or narrowed artery. A stent can help improve blood flow as well as prevent an artery from bursting.
Stress Testing (Treadmill Test)	Method for evaluating cardiovascular fitness. The patient is placed on a treadmill or bicycle and then subjected to steadily increasing levels of work. An ECG and oxygen levels are taken while the patient exercises. The test is stopped if abnormalities occur on the ECG.
Valve Replacement	Surgical procedure to excise a diseased heart valve and replace with an artificial valve.
Venography	X-ray of the veins in which the venous flow is traced. Also called phlebography.

- Aplastic anemia—This is a condition in which fat cells replace bone marrow and the bone marrow that is present is unable to produce certain types of blood cells. The cause, or etiology, of this condition is unknown. It is one of the most life-threatening forms of anemia, but it is also one of the rarest. Adolescents and young adults are the patient population affected most by this form of anemia. Possible causes of this type of anemia include injury to the bone marrow and exposure to certain chemicals and pesticides.

Signs and Symptoms. The hallmark symptoms of anemia include increased tiredness and fatigue. Other symptoms and signs of anemia include weakness, heart palpitations and tachycardia (rapid heartbeat), shortness of breath, dizziness, headache, pale complexion, tinnitus or ringing in the ears, difficulty concentrating, and interrupted sleep patterns. Fainting is also common among anemic patients. Sickle cell anemia is characterized by pain in the abdomen, joints, and bones. Infections and heart failure may also occur with sickle cell anemia. Signs and symptoms of aplastic anemia can include bleeding in the mucous membranes, infections with high fevers, paleness, and dyspnea.

Treatment. The treatment for anemia depends on the type and cause. In some cases, injections of vitamin B_{12} may be necessary. Oral dietary supplements including iron, folic acid, and vitamin B_{12} have also been effective by helping produce and maintain healthy red blood cells. Elimination of specific medications that suppress the body's immune system may be needed. Blood transfusions, analgesics, and antibiotics may also be required for more serious forms of the disorder.

Aneurysm

Weakened walls of blood vessels may become abnormally wide or may balloon. When this occurs, it is termed an **aneurysm**. Aneurysms may occur in various locations throughout the body. The most common locations include:

- Aorta (aortic aneurysm)
- Brain (cerebral aneurysm)
- Leg (popliteal artery aneurysm)
- Spleen (splenic artery aneurysm)
- Intestine (mesenteric artery aneurysm)

Aneurysms can be congenital or acquired. The exact cause is unknown; however, defective portions of the arterial wall are suspected. Additionally, conditions that may contribute to the formation of aneurysms include hypertension (high blood pressure), high cholesterol, and atherosclerotic disease. Atherosclerotic disease is characterized by narrowing of the arterial walls from increased accumulation of plaque. This is discussed later in this section.

Signs and Symptoms. The signs and symptoms of an aneurysm vary, depending on its location. An aneurysm near the body's surface may be distinguished by a swelling, throbbing mass. Unfortunately, aneurysms within the body or

brain often have no symptoms and frequently go undetected until the aneurysm ruptures. A ruptured aneurysm leads to massive internal bleeding and is often fatal. Aneurysms of this type are sometimes discovered when the patient is undergoing an imaging procedure for some other reason.

Treatment. Surgical intervention may be required to repair and prevent rupturing of the vessel. Some people may be candidates for a stent (a mesh tube) placement within the affected vessel to keep it open or to reinforce the vessel wall. A healthy diet and exercise may help prevent certain types of aneurysms. Additionally, maintaining healthy blood pressure and cholesterol levels is beneficial.

Arrhythmia

An **arrhythmia** is an irregular heartbeat caused by a disturbance of the electrical conductivity of the heart. There are many types of arrhythmias. Two general categories are as follows:

- **Tachycardia** is an abnormally rapid heart rate, one that is greater than 100 beats per minute. A heart rate that is too fast may not allow the ventricles of the heart to fill properly, depriving the brain and body of oxygen. Extremely rapid tachycardia can be fatal if not treated immediately. Although the heart rate may be high, the rhythm may be either regular or irregular.
- **Bradycardia** is an abnormally slow heart rate of less than 60 beats per minute. The rhythm may be either regular or irregular.

Although the etiologies of arrhythmias vary, depending on the type, the major contributing factors are heart diseases. These include coronary artery disease (CAD), heart valve disease, problems arising from the SA node (the pacemaker of the heart) or conduction pathways of the heart, heart failure, and infections such as endocarditis.

Signs and Symptoms. Both tachycardia and bradycardia produce similar symptoms, including dizziness, palpitations, shortness of breath, fatigue, weakness, angina (chest pain), and fainting.

Treatment. Arrhythmias can be life threatening, especially when they significantly impact the pumping function of the heart. If the oxygen supply to the brain and major organs is interrupted for more than a few minutes, death can occur. Arrhythmias are often treated with medications. In more serious conditions, a procedure such as cardioversion (applying an electric current to the heart to restore a normal rhythm) or implantation of a pacemaker (to assist in maintaining a normal rhythm) may be necessary. Many patients can tolerate arrhythmias for years; however, the heart functions much better with a strong, evenly metered rhythm.

Arteriosclerosis

Arteriosclerosis is commonly known, in lay terms, as "hardening of the arteries." It develops when the walls of the arteries become thick and loose elasticity. Eventually, after many years, calcium deposits in the artery walls develop areas that are hard and brittle. Arteries of the brain, kidneys, and upper and lower extremities may be affected.

Signs and Symptoms. Because this disease occurs within the body, its effects cannot be seen and symptoms are usually not felt. Therefore it is not always recognized early or easily. However, a series of signs and symptoms that might seem unrelated at first should alert the individual and the physician. Signs and symptoms that are considered precursors to arteriosclerosis are high blood pressure, recurrent kidney infections, and impaired circulation, particularly to the fingers and toes, caused by peripheral vascular disease.

Treatment. Many prescription medications are available for the treatment of arteriosclerosis. However, the most effective treatments include treating the underlying causes. This is crucial to achieving a desirable long-term outcome.

Atherosclerosis

Atherosclerosis is the hardening and narrowing of the arteries from a buildup of fatty material and plaque within the vessel (Figure 26-15). This condition often results from unhealthy

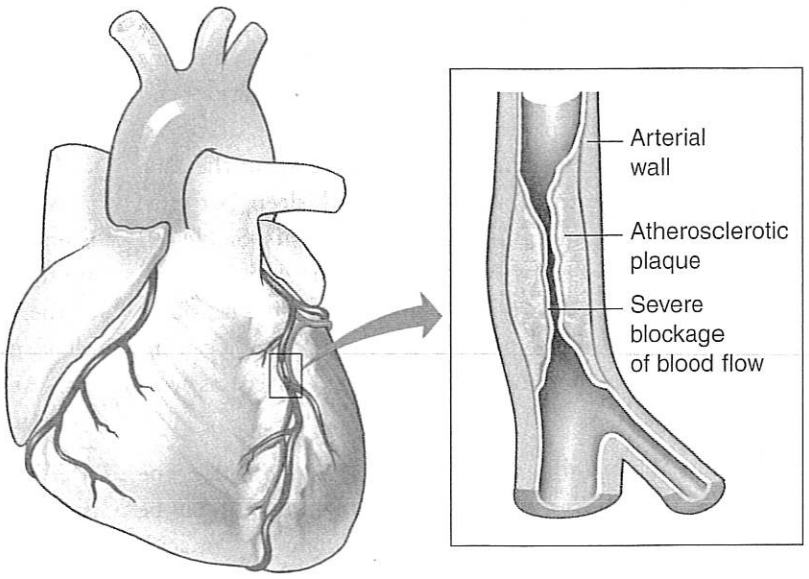


FIGURE 26-15 An atherosclerotic artery.

lifestyle factors including smoking, high cholesterol, excessive alcohol consumption, and a poor diet. There is also a familial link with the disease. Other conditions that often are related to atherosclerosis include diabetes and obesity.

Atherosclerosis is the leading cause of coronary artery disease (CAD). As the coronary arteries become more constricted, the flow of blood within the arteries may slow or even stop. The arteries can narrow to the point of total blockage. Plaque that breaks loose forms an embolus that can move and occlude a narrow vessel, causing death to the tissue and surrounding area supplied by that vessel.

Signs and Symptoms. When the heart needs more oxygen-rich blood than the vessels can supply, angina (chest pain) or other warning symptoms may occur. One of the first recognized symptoms of atherosclerosis is angina during exercise or other exertive activity. Shortness of breath and fatigue may accompany angina. If the blockage is large, angina can occur with little or no activity. With unstable angina, blood flow to the heart is so limited that the individual restricts daily activities because of the risk of chest pain.

Treatment. Typically, angina decreases with rest and oxygen, but unrelieved angina is a common symptom of impending myocardial infarction. Nitroglycerin, a prescription medication that dilates blood vessels and improves the flow of oxygenated blood to the heart, is often prescribed to relieve angina. Prevention and reversal of the disease may be accomplished by making lifestyle changes including avoiding fatty foods, decreasing alcohol consumption, stopping smoking, and engaging in physical exercise. In serious cases, surgical intervention to widen and remove the plaque clogs may be required.

Cardiac Tamponade

Cardiac tamponade, or cardiac compression, is pressure on the heart muscle caused by blood or fluid collecting in the pericardial sac that surrounds the heart. The pressure prevents the ventricles from expanding, making it impossible for the heart to pump enough blood for the body. The etiologies of cardiac tamponade vary, ranging from trauma to the heart to leukemia, heart tumors, radiation to the chest, kidney failure, acute heart attacks, thoracic aneurysm, and other cardiac related disorders.

Signs and Symptoms. Shortness of breath, pale or bluing skin, chest pain, dizziness, drowsiness, anxiety, and the feeling of impending doom are common symptoms of cardiac tamponade.

Treatment. Treatment requires an immediate procedure called pericardiocentesis, which is initiated by inserting a needle into the pericardial sac and removing fluid. Diuretic medications (that decrease body fluid through increased urination) and oxygen therapy may also be used to help reduce the workload of the heart.

Cardiogenic Shock

Cardiogenic shock is a collapse of the cardiovascular system. It is characterized by the inability of the heart to pump enough blood to the body's organs. It is caused by an extremely damaged heart, which may be the result of arrhythmias, ruptured cardiac muscle, or a tear in the septal wall.

Signs and Symptoms. Symptoms and signs of shock include chest pain and pressure, a change in consciousness, rapid breathing and pulse, heavy diaphoresis (perspiration), lightheadedness, and decreased urination.

Treatment. Emergency medical treatment is necessary in this extremely serious situation. Immediate treatment involves controlling and treating the underlying cause. It likely includes medications to restore heart function and normal rhythm, oxygen therapy, and pain medications. Cardiac stenting and catheterization may also be necessary. In some circumstances, heart surgery or the insertion of a pacemaker may be required.

Carditis (Endocarditis, Myocarditis, Pericarditis)

Carditis is an inflammation of the heart. It is more accurately referred to as endocarditis, myocarditis, or pericarditis, depending on the layer of the heart that is affected.

Endocarditis

Endocarditis is an inflammation of the lining of the heart, including the heart valves. It is most commonly caused by a bacterial infection and frequently affects patients with existing abnormal conditions of the heart valves. Endocarditis can also be present at birth.

Signs and Symptoms. Persons who suffer from this life-threatening condition may experience weakness, fever, chills, diaphoresis, **dyspnea** (difficulty breathing), and swelling in the feet and legs.

Treatment. Treatment generally consists of antibiotics given intravenously followed by oral antibiotics over a six-week period. In serious cases, heart valve replacement might be necessary.

Myocarditis

Myocarditis is inflammation of the muscular layer of the heart. Etiologies of myocarditis include viral infection;

however, exposure to bacteria, fungi, and certain drugs, chemicals, and allergens may also lead to its development.

Signs and Symptoms. Signs and symptoms generally resemble those of the flu and include fever, body aches, dyspnea, general fatigue and malaise, fainting, and decreased urine output. However, the most frequent symptom of myocarditis is chest pain.

Treatment. The best treatment for myocarditis is reduction of the inflammation with antiinflammatory medications, antibiotics if necessary, bed rest, and a low-sodium diet. Diuretics may also be prescribed to remove excessive fluid from the body.

Pericarditis

Pericarditis is inflammation of the membrane that surrounds the heart—the pericardium. It is most commonly caused by a viral infection. It may also accompany other diseases such as HIV/AIDS or kidney failure. Less common causes may include bacterial infection, tuberculosis, cancer that has spread to the pericardium, or following heart surgery or injury.

Signs and Symptoms. Symptoms and signs of this deadly condition frequently include sharp, stabbing chest pain, fatigue, fever, and dyspnea, especially while lying down, taking a deep breath, or coughing.

Treatment. Treatment often includes analgesics, diuretics to help reduce the amount of fluid around the heart, and antibiotics or antifungals to treat the infection. Chronic cases may require pericardiocentesis to remove fluid around the heart.

Congestive Heart Failure

Congestive heart failure (CHF), also called just heart failure, is a condition in which the heart is unable to pump sufficient blood to the body's other organs. This can result from several other conditions, including:

- Coronary artery disease
- History of myocardial infarction
- Hypertension
- Diseases or infections of the heart valves
- Primary diseases and infections of the heart muscle itself, such as endocarditis or myocarditis
- Heart defects present at birth

Signs and Symptoms. As the "failing" heart functions less efficiently than it should, exertion causes shortness of breath and general tiredness and fatigue. Some patients have trouble simply walking across a room without becoming out of breath and exhausted. Often swelling, or edema, results, usually in the legs and ankles, but sometimes in other parts of the body including the abdomen. Fluid may collect in the lungs and interfere with breathing, causing shortness of breath that becomes more pronounced when the person is lying down. Heart failure also affects the kidneys' ability to dispose of sodium and water. An increased frequency of urination during the night might be present. Weight gain may occur, and often rapidly, from the increased fluid and resulting edema. Other symptoms of CHF include a cough, decreased appetite, and an irregular pulse.

Treatment. A treatment program for CHF usually consists of rest, proper diet and maintaining a healthy weight, revising daily activities that may aggravate symptoms, oxygen therapy, and medications that help the heart to function more efficiently, including ACE inhibitors, beta blockers, digitalis, diuretics, and vasodilators. When the specific cause of CHF is discovered, it should be treated or, if possible, corrected. For example, some cases can be treated by addressing high blood pressure. If an abnormal heart valve is the cause, the valve can be surgically replaced.

Cor Pulmonale

Cor pulmonale is also known as right-sided heart disease. It is a result of prolonged hypertension of the pulmonary arteries and right ventricle of the heart. Its causes are primarily related to lung disorders such as chronic obstructive pulmonary disease (COPD), cystic fibrosis, chronic blood clots in the lungs, obstructive sleep apnea, and others.

Signs and Symptoms. Pain toward the front of the chest is a common symptom of cor pulmonale, as are frequent fainting episodes during activity. Peripheral swelling of legs and feet and coughing or wheezing may be present.

Treatment. Treatment seeks to relieve the pulmonary problems that precipitate the disease and to control symptoms. Medications that improve pulmonary function are usually prescribed. Other medications such as anticoagulants to thin the blood or antihypertensive medications and diuretics to lower blood pressure may also be prescribed. In severe cases, if medications fail, a lung or heart-lung transplant might be necessary.

Coronary Artery Disease

Coronary artery disease (CAD), also known as coronary heart disease (CHD), is the narrowing of the coronary arteries that supply blood to the heart, which results from a buildup of plaque on the artery walls (generally caused by atherosclerosis, a condition we discussed earlier), resulting in decreased blood flow. Left untreated, this progressive disease raises the

Professionalism

Patients with heart disease usually seek to understand their illness. Patients with a history of chest pain provide a great opportunity to educate about the importance of lifestyle changes (stop smoking, begin exercising, lose weight, eat a low-fat/low-salt diet, and so on). The medical assistant should be careful to explain the disease process in terms that the patient can understand. For example, using the terms *chest pain* for *angina* or *blood thinner* for *anticoagulant* might be more helpful than using the more formal medical terms. As a patient coach, the medical assistant should communicate with patients in the most effective manner that will meet the patient's needs.

risk of myocardial infarction, or heart attack, and possibly sudden death.

CAD is the most common form of heart disease and the leading cause of death in the United States, resulting in the deaths of more than 375,000 Americans each year. According to the American Heart Association, at least two people per minute—men and women—suffer from a CAD-related event, and one person dies from this cause every 40 seconds.

CAD affects people of all races. Lifestyle factors including obesity, unhealthy diet choices, lack of exercise, and stress are possible causes; genetic factors may play a role as well. Other diseases such as hypertension and diabetes also put people at risk for developing CAD. High levels of lipoproteins, or LDL cholesterol, are associated with a higher risk of CAD because this fatty substance is one of the main factors of plaque formation. Risk can be lowered by maintaining a total cholesterol level below 200 mg/dL, an HDL cholesterol (good cholesterol) level above 40 mg/dL, and an LDL cholesterol (bad cholesterol) level less than 100 mg/dL. Daily aerobic exercise, increasing dietary intake of vegetables and whole grain products, weight loss, and smoking cessation are all steps people can take to reach healthier cholesterol levels.

Signs and Symptoms. Shortness of breath and fatigue with exertion and a squeezing sensation of the heart are common symptoms. Edema (swelling) in the ankles may be a sign of CAD, as may a feeling of overall tiredness and weakness.

Treatment. Antihypertensive medications are prescribed to treat high blood pressure if it is an underlying cause of CAD. Nitroglycerin is administered during bouts of angina to help relieve chest pain by working as a vasodilator allowing the blood vessels to open and blood to flow more freely. Aspirin, taken in low doses on a daily basis, is also used to treat CAD. Additionally, patients are prescribed medications to help lower cholesterol levels and advised to make lifestyle changes (as listed earlier) that will assist in their progress. Diabetic patients are closely monitored and required to take medications to lower their blood sugar levels and ensure that insulin production and effectiveness are optimal.

Heart Attack (Myocardial Infarction) or Cardiac Arrest

A heart attack, or **myocardial infarction (MI)**, occurs when the blood supply to a part of the myocardium has stopped, causing tissue damage or death from oxygen deprivation (Figure 26-16). Coronary artery disease, particularly atherosclerosis (discussed earlier in the chapter) and thrombosis (blood clots), are the main causes of MIs. In a coronary thrombosis, accumulated plaque on artery walls tears loose or ruptures and forms a blood clot that blocks the artery. If the blood supply is cut off, the muscle tissues fed by that artery suffer damage that quickly becomes irreversible, resulting in death of the affected tissue. Depending on the extent of the damage, a patient may suffer disability or death from a heart attack.

A heart attack may or may not lead directly to **cardiac arrest**, the total cessation of heartbeat and breathing. Cardiac arrest may also occur suddenly (known as sudden death) with no prior symptoms of a heart attack.

Heart attack victims can recover if the area of damage to the heart muscle is limited or the infarction is recognized and treated quickly, before the damage becomes irreversible. Even victims of cardiac arrest can sometimes survive if emergency care is initiated within minutes.

Signs and Symptoms. The most common symptom of an MI is chest pain. The chest pain (angina pectoris) is often described as crushing or squeezing, with a feeling of fullness, heaviness, or aching in the center of the chest. This pain may radiate down the left arm or into the neck or back.

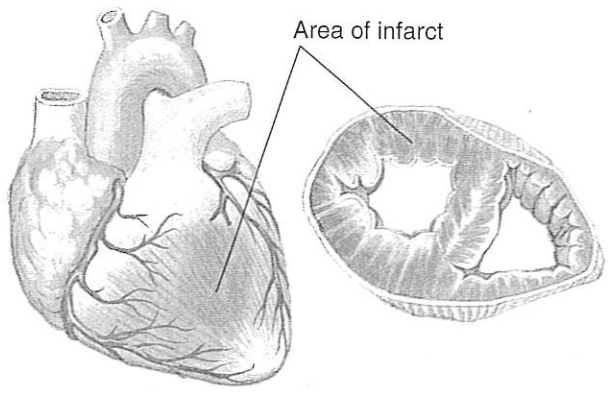


FIGURE 26-16 Cross section of a myocardial infarction.

Men experience chest pain as a symptom of an MI more frequently than do women. It has become clear that women experience different symptoms with a heart attack. A woman is more likely to feel pain in the arms, which may radiate across the shoulders and up into the jaw. Diaphoresis, shortness of breath, nausea, fainting, or dizziness and the overall feeling of impending doom are also common symptoms experienced by women.

Cyanosis, or blue skin, often visible in the lips and around the mouth, is a sign that oxygenated blood is not being perfused (forced through) by the heart.

If any of these symptoms are present for more than two minutes, emergency treatment must be started immediately. Waiting to treat the symptoms permits continuing deterioration of the heart muscle and increases the chances of serious disability or death.

A patient suffering a heart attack may still be conscious or be able to respond to voice or touch, will be breathing, and will have a pulse. Cardiac arrest has occurred if the patient is completely unresponsive, has no pulse, and is not breathing.

Treatment. Treatment for an MI, when administered quickly, can benefit most patients. If the patient is in cardiac arrest, cardiopulmonary resuscitation (CPR) and defibrillation within the first few minutes increase the survival rate. Medical assistants should have training in CPR and defibrillation; however, keep in mind that CPR or defibrillation should not be performed unless the patient is actually in cardiac arrest. Performing CPR or defibrillation on a patient who is having a heart attack but still has a pulse may be harmful. (CPR and defibrillation are discussed in the chapter titled "Assisting with Medical Emergencies.")

Thrombolytics (medications that dissolve clots) can stop some heart attacks in progress. **Angioplasty**, which is surgical vessel repair, is frequently performed to reopen blocked coronary arteries, and stents are used to hold the arteries open, allowing more blood flow. If more conservative measures fail or if the heart attack is too severe, a coronary artery bypass graft (CABG), a form of open heart surgery, will be attempted to bypass the blocked artery using a vein from the leg or arm.

The key to heart attack survival as well as survival of cardiac arrest is immediate intervention. Patients and their caregivers or loved ones must be educated on the warning signs of MI, the signs of cardiac arrest, and the necessity of seeking medical assistance immediately when they or someone they are with has any of these signs or symptoms. After emergency treatment at the scene of the event, transport to a hospital with cardiac care capability must be initiated.

Hemophilia

Hemophilia is a blood-clotting disorder. Its etiology is a genetic defect of the X chromosome. This hereditary deficiency of clotting factors (blood-clotting proteins) primarily affects male children, but in rare circumstances females are also affected. Without these blood-clotting proteins, platelets are unable to form clots to stop bleeding.

Signs and Symptoms. Excessive bleeding, or hemorrhaging (bleeding heavily), is the primary sign of hemophilia. A hemophiliac (a patient with hemophilia) may display signs including excessive nose bleeds, heavy bleeding from a minor cut, and the recurrence of bleeding after it has ceased for a short time. Easily bruising is a sign of internal bleeding as is blood that appears in urine or stool.

Treatment. Hemophilia is treated by transfusing the deficient clotting factor in a process called replacement therapy. Replacing the missing or lacking clotting factors allows the blood to properly coagulate as necessary.

Hypertension

Hypertension (HTN) is high blood pressure. It is the term used when the force of the pumped blood against the arterial walls is too great, causing unhealthy conditions for the body.

Hypertension is caused by congestion in the peripheral arteries. Peripheral artery disease (PAD) occurs when the arteries become diseased and narrowed, causing arteriostenosis. They can also become filled with fatty plaque, giving rise to atherosclerosis. PAD most often affects the arteries of the legs, but it can also affect arteries to the head, arms, and internal organs. When blood does not flow easily through the arteries, blood pressure rises.

It is important to note that a single high blood pressure reading is not enough for a physician to diagnose a patient with hypertension. Blood pressure readings must be consistently high over a period of time in order for a diagnosis of hypertension to be given. By diagnosing the patient with borderline hypertension, or prehypertension (as described in the next section, "Prehypertension"), treatment can be initiated earlier.

Risk factors for HTN include obesity, a sedentary lifestyle, a high salt diet, being of African-American descent, being diabetic, living a high-stress or anxious life, and excessive alcohol consumption. Smoking and family history of hypertension also are risk factors for high blood pressure.

Stages of Hypertension

The American Heart Association has staged hypertension into five categories: normal, prehypertension, stage I, stage II, and hypertensive crisis. Table 26-3 clearly indicates the blood pressure levels for each of these categories.

TABLE 26-3 | **Stages of Hypertension**

Stage	Blood Pressure Reading
Normal	• Systolic pressure below 120 mmHg AND • Diastolic pressure below 80 mmHg
Prehypertension	• Systolic pressure below between 120–139 mmHg OR • Diastolic pressure between 80–89 mmHg
Stage 1 Hypertension	• Systolic pressure below between 140–159 mmHg OR • Diastolic pressure between 90–99 mmHg
Stage 2 Hypertension	• Systolic pressure that is 160 mmHg or higher OR • Diastolic pressure that is 100 mmHg or higher
Hypertensive Crisis	• Systolic pressure that is higher than 180 mmHg OR • Diastolic pressure that is higher than 110 mmHg

Signs and Symptoms. Hypertension is well known as the "silent killer" because there are very few symptoms, and symptoms that may be present may be easily brushed off by the patient. Some of these symptoms include increased tiredness and fatigue, headaches, and changes in vision. More severe cases of HTN by be indicated by epistaxis (nosebleeds) and blood in the urine.

Treatment. HTN can be controlled in a variety of ways, such as with antihypertensive and diuretic medications as well as dietary and lifestyle changes, including exercise and smoking cessation. If left untreated, hypertension can lead to serious conditions such as kidney failure, stroke, heart attack, eye damage, and peripheral artery disease (which, as noted, may also be a cause of HTN).

Prehypertension

Often a precursor to hypertension, **prehypertension** is a classification of hypertension that is assigned to adults who consistently have blood pressure readings that range from 120/80 to 139/89 mmHg. According to a study by the Joint National Committee of the National Institutes of Health National Heart, Lung, and Blood Institute (NHLBI), adults at the upper end of the prehypertension blood pressure range are twice as likely to progress to hypertension as those with lower blood pressure.

Signs and Symptoms. Blood pressure ranging from 120/80 to 139/89 is a sign of prehypertension.

Treatment. The committee report just cited recommends lifestyle changes such as reducing dietary fat and sodium, increasing exercise, and limiting alcohol consumption.

Hypotension

Hypotension, or low blood pressure, is an abnormal condition in which a person's blood pressure is much lower than usual, generally below 90/60 mmHg. If blood pressure drops significantly, blood flow to the heart, brain, and other vital organs becomes inadequate, causing serious complications. Because blood circulation is the way oxygen is transported to the body cells, a sudden, significant drop in blood pressure is a warning that the body is not receiving enough oxygen and is in danger of shutting down.

Causes of hypotension include dehydration, heart failure, heart attack, changes in the heart's rhythm (arrhythmias), anaphylaxis (severe allergic reaction), severe blood loss (shock), certain medications, and drug overdose. A common form of hypotension is orthostatic hypotension, which occurs when there is a sudden change in body position, usually from lying down or sitting to an upright position.

Low blood pressure can also be a sign of a well-conditioned heart in those who get regular aerobic exercise, such as running. In these individuals, the myocardium is able to produce strong contractions to easily pump the blood through the body. Such cases, obviously, do not indicate an emergency situation but rather the normal functioning of a healthy body.

Signs and Symptoms. When the body is getting shortchanged on oxygen because of low blood pressure, normal body functions such as breathing, movement, and brain function can be impaired, and permanent damage can occur. Blurred vision, weakness, confusion, dizziness or fainting, and sleepiness are the most common symptoms of low blood pressure. Blood pressure may drop to life-threatening levels from loss of blood, shock, severe infection, or low body temperature caused by exposure to cold.

Treatment. The goal of emergency treatment for hypotension is to raise blood pressure to a more normal level. This may include the use of vasoconstrictors (medications that cause blood vessels to narrow, or constrict), and increasing fluid and sodium intake. If the patient suffers from

orthostatic hypotension, the patient may be instructed to form the habit of changing body position slowly.

Leukemia

Leukemia is a cancer of the bone marrow and blood. Like all cancers, leukemia is caused by uncontrolled growth of abnormal cells, in this case white blood cells (WBCs). Other body tissues are also affected. Leukemia can be acute or chronic.

- Acute leukemia—An increased number of nonfunctioning and abnormally developed cells are present in this aggressive form of cancer. The increased number of abnormal cells crowd out the healthy blood cells. Unfortunately, this increases the body's risk of infection and developing anemia. Another characteristic is a lack of platelets, which means that the patient may be at risk for extensive bleeding because of decreased clotting ability.
- Chronic leukemia—This form is less aggressive than acute leukemia because the abnormal cells accrue over a longer period of time. The type of leukocyte affected by leukemia provides a more distinct classification of the cancer. Lymphocytic or myeloid leukemia is indicated depending on whether the cancer has struck lymphocytes or myeloid cells, which are bone marrow cells.

Signs and Symptoms. The signs and symptoms of leukemia are broad. They include excessive bruising, fatigue, weakness, dyspnea (breathing difficulty), bleeding of the mucous membranes, bone and joint pain, abdominal pain, weight loss, abdominal bleeding, and enlargement of the lymph nodes, spleen, and/or liver. Anemia and frequent infections are common.

Treatment. Treatment options available for leukemia include chemotherapy, radiation, and bone marrow transplantation. Anticancer drugs are used to kill leukemia cells, and high energy radiation is used to irradiate the cancer cells.

Stroke

A **stroke**, sometimes called a cerebrovascular accident (CVA), occurs when the blood supply to part of the brain is suddenly interrupted. This can occur from blockage of an artery to the brain caused by an embolism (a foreign substance that has been carried to the point of blockage from a distant part of the body) or a thrombus (a fragment of plaque that has broken free of the artery wall). A ruptured artery has the same effect as a blocked artery in depriving an area of the brain of blood flow, oxygen, and nutrients, a condition called ischemia.

Signs and Symptoms. The symptoms and signs of a stroke generally occur suddenly: numbness or weakness on one side of the body, confusion or trouble speaking, vision problems, severe dizziness, loss of balance or coordination, and often a severe headache. The headache is sometimes described as "the worst headache of my life." The National Stroke Association encourages people to be aware of the first signs of stroke so that immediate help may be rendered. They have developed the acronym FAST to assist with recognition of the symptoms:

- F = Face—If a stroke is suspected, ask the individual to smile to ascertain if one side of the face droops.
- A = Arms—To evaluate balance, ask the individual to hold out both arms. Does one arm drift downward?
- S = Speech—The individual should be asked to repeat a simple phrase to assess the speech; look for signs of slurring or strange inflections.
- T = Time—If a person demonstrates any of these signs, time is valuable and treatment must be sought immediately by dialing 911. Quick recognition of the signs and prompt hospital treatment may lessen neurological damage.

The patient's first stroke may have been preceded by a transient ischemic attack (TIA), which has the symptoms of a stroke, probably from a temporary artery blockage, but resolves on its own. TIAs are considered to be precursors of stroke.

Treatment. Treatment for stroke is aimed at controlling factors that may place a patient at risk for stroke, or a recurrence of stroke. Risk factors with manageable treatment options include high blood pressure, diabetes, and atrial fibrillation. After a stroke occurs, rehabilitation may be necessary to help the patient with speech and mobility, which are often affected. Medications prevent the formation of thrombi.

Thrombophlebitis

Thrombo means "clot"; *phlebitis* is the inflammation of a vein. **Thrombophlebitis** occurs when a blood clot causes inflammation in one or more veins, typically in the lower extremities (Figure 26-17). On rare occasions, thrombophlebitis can also affect veins in the upper extremities. Superficial thrombophlebitis occurs when the affected vein is near the surface of the skin. A more serious condition is a deep vein thrombosis (DVT), which occurs when the affected vein is deep within a muscle. DVTs may lead to a very serious condition known as pulmonary embolism (PE), which occurs when a dislodged clot travels through the blood vessels to the lungs, where it lodges in and blocks a smaller artery.

Thrombophlebitis can be caused by a genetic clotting disorder or by trauma. It can also be caused by prolonged inactivity such as a long journey in an airplane or automobile, lengthy bed rest following surgery, or as a result of paralysis. Such inactivity decreases blood flow through the

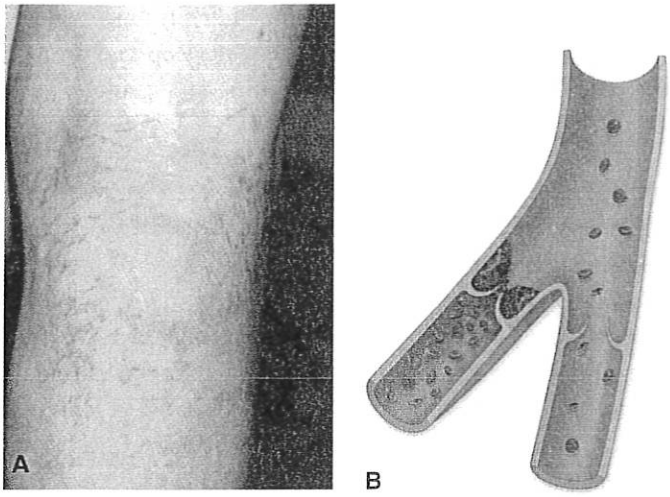


FIGURE 26-17 Examples of thrombophlebitis. **(A)** Superficial thrombophlebitis of the leg. **(B)** Deep venous thrombosis (DVT) commonly affects the veins of the leg.

veins, which may allow a clot to form. Other risk factors include the use of oral contraceptives or hormone replacement therapy. A history of varicose veins can also place someone at higher risk for thrombophlebitis.

Signs and Symptoms. The most common signs and symptoms of thrombophlebitis are redness, swelling, warmth, tenderness, and a dull ache or pain in the affected area. Superficial veins affected often visibly display as a hard and red cord of bulging vein just under the skin. If a deep vein is affected, the leg may become swollen, tender, and painful, particularly when the person stands or walks.

Treatment. For thrombophlebitis in a superficial vein, the physician generally encourages home remedies to alleviate symptoms and resolve the issue. Home remedies include limb elevation, heat application, and the use of NSAIDS (nonsteroidal antiinflammatory drugs) such as aspirin or ibuprofen. Massaging the painful area is never recommended as it could cause the thrombus to break away, forming a traveling embolus. The condition usually subsides within a month.

In more severe cases, as in deep venous thrombosis, an injection of an anticoagulant (blood-thinning) medication often prevents the clot from growing. Additional treatments may include the application of support (compression) stockings to constrict the superficial veins and increase blood flow in the deep veins. Varicose vein ligation or stripping, in which the doctor surgically removes the varicose veins that cause pain or recurrent thrombophlebitis, is also used as treatment. In the most severe cases, a thrombectomy or bypass surgery may be required to remove an acute clot blocking a pelvic or abdominal vein.

Transfusion Incompatibility Reaction

If the wrong type of blood is administered to a patient, a severe transfusion reaction can occur. The two blood types will create an antigen-versus-antibody reaction (as seen in Figure 26-14), and severe agglutination can occur. (We mentioned this kind of transfusion reaction earlier under "The Rh Factor.")

Signs and Symptoms. Signs and symptoms of transfusion incompatibility arise rapidly with collapse of the cardiovascular system. Symptoms of shock, such as confusion, restlessness, and shortness of breath, are dramatic.

Treatment. If an incompatibility reaction occurs, the transfusion of donor blood must be stopped immediately. Normal saline will be infused into the bloodstream intravenously. The physician may order the administration of antihistamines as well as frequent monitoring of vital signs. If the reaction is more aggressive, administration of epinephrine may be needed. Two people, generally advanced health care professionals such as registered nurses, should always double-check the compatibility of the donor blood with the patient's blood type before it is administered.

Valvular Heart Disease

Valvular heart disease is any damage or defect to one of the four valves of the heart: mitral or aortic on the left, tricuspid or pulmonary on the right.

Mitral Stenosis

Mitral stenosis is one of the most common types of valvular heart disease. In this disease, the mitral valve, between the left atrium and ventricle, is unable to fully open. This deficiency prevents proper blood flow and causes a buildup of blood in the left atrium. In turn, this can cause the atrial chamber to swell and lead to other problems, including a backup of blood and body fluid in the lung tissue. (Normally, oxygenated blood flows into the left atrium from the lungs. A blockage of this flow can lead to pulmonary edema, an excess of fluid in the lungs.)

Mitral stenosis can be a congenital condition, and it can occur in adults who suffered episodes of rheumatic fever earlier in their life. It also may be the result of bacterial endocarditis or hypertension or atherosclerosis that has damaged the valve.

Signs and Symptoms. Mitral stenosis can produce a heart murmur that is audible with a stethoscope. Symptoms and signs, which are generally mild, may include increased fatigue, cough, and frequent respiratory infections, discomfort with increased activity including breathing difficulties and chest discomfort, edema of the feet and legs, and heart palpitations.

Treatment. Treatment includes medication to strengthen heart function. However, in mild cases of the disorder, treatment might not be necessary. Short- or long-term antibiotics may be required if bacterial endocarditis is involved. Surgery to replace the damaged valve may be required.

Varicose Veins

Varicose veins are gnarled, enlarged veins, usually superficial veins in the legs. They may be caused by prolonged periods of standing, pregnancy, obesity, or aging.

Varicose veins develop when the valves in the veins malfunction. As a person gets older, the veins tend to lose elasticity and stretch. Blood pools in the veins, which become engorged with deoxygenated blood.

Signs and Symptoms. Symptoms include a feeling of heavy and aching limbs. When severe cases develop and are untreated, the affected veins could rupture and result in varicose ulcers (open sores) on the skin.

Treatment. Treatment for varicose veins falls into two categories: relief of the symptoms and removal of the affected veins (ligation). Symptom relief includes such measures as moderate exercise, avoiding long periods of standing, elevating the legs, and wearing support stockings, which compress the veins and hold them in place. Cosmetic treatments may decrease the size and visibility of the affected veins.

For a summary and additional information on disorders of the cardiovascular system, see Table 26-4.

TABLE 26-4 | **Disorders of the Cardiovascular System**

Disorder	Description
Angina pectoris	Condition in which there is severe pain with a sensation of constriction around the heart. It is caused by a deficiency of oxygen to the heart muscle.
Angioma	Tumor, usually benign, consisting of blood vessels.
Angiospasm	Spasm or contraction of blood vessels.
Aortic aneurysm	Localized, abnormal dilation of the aorta, causing pressure on the trachea, esophagus, veins, or nerves. This is a result of a weakness in the wall of the blood vessels.
Aortic insufficiency	A failure of the aortic valve to close completely, which results in blood leaking back into the left ventricle and inefficient heart action.
Aortic stenosis	Condition caused by narrowing of the aortic valve.
Arterial embolism	Blood clot moving within an artery. This can occur as a result of arteriosclerosis.
Cardiomyopathy	Disease of the cardiac muscle causing it to weaken and not function properly. It is often a symptom of another cardiovascular disease, and its main symptom is the inability of the heart to pump blood efficiently to the body.
Coronary thrombosis	Blood clot in a coronary vessel of the heart causing the vessel to close completely or partially.
Embolus	A blood clot that moves from one area to another and obstructs a blood vessel.
Fibrillation	Abnormal quivering or contractions of heart fibers. When this occurs within the fibers of the ventricle, arrest and death can occur. Emergency equipment to defibrillate, or convert the heart to a normal beat, is necessary.
Infarct	Area of tissue within an organ or part that undergoes necrosis (death) following the cessation of the blood supply.
Ischemia	A localized and temporary deficiency of blood supply caused by an obstruction to the circulation.
Mitral valve prolapse (MVP)	Common and serious condition in which the cusp of the mitral valve drops back (prolapses) into the left atrium during systole.
Murmur	A soft blowing or rasping sound heard on auscultation of the heart.
Patent ductus arteriosus	Congenital presence of a connection between the pulmonary artery and the aorta that remains after birth. This condition is normal in the fetus.
Phlebitis	Inflammation of a vein.
Reynaud's phenomenon	Intermittent attacks of pallor or cyanosis of the fingers and toes associated with cold or emotional distress. Numbness, pain, and burning may also occur during the attacks. It may be caused by decreased circulation as a result of smoking.

TABLE 26-4 | Disorders of the Cardiovascular System (*continued*)

Disorder	Description
Rheumatic heart disease	Valvular heart disease as a result of having had rheumatic fever.
Tetralogy of Fallot	Combination of four symptoms (tetralogy), resulting in pulmonary stenosis, a septal defect, abnormal blood supply to the aorta, and hypertrophy of the right ventricle. A congenital defect that is present at birth and needs immediate surgery to correct.
Thrombus	A blood clot.

SUMMARY

The cardiovascular system is made up of structures that circulate blood, oxygen, nutrients, and other substances throughout the body. These structures include the heart and the blood vessels. The heart is a muscular pump that moves oxygen- and nutrient-rich blood to the body and carries waste and carbon dioxide back to the lungs for excretion from the body. Arteries carry blood away from the heart to the body. The exchange of oxygen and nutrients for carbon dioxide and waste takes place in the capillaries; then, the veins carry the blood back to the heart and lungs.

Blood pressure keeps the heart functionally pumping blood to all the organs and cells. Blood is connective tissue that circulates through the body. Blood cells include red blood cells (erythrocytes), white blood cells (leukocytes), and clotting cells (platelets). The four blood types are A, B, AB, and O. Being an intricate system, many problems and diseases may arise in the cardiovascular system. Disease can occur in the heart, blood vessels, valves of the heart, or blood cells.

26 CHAPTER REVIEW

COMPETENCY REVIEW

1. Define and spell the terms for this chapter.
2. Name the three major components of the cardiovascular system.
3. Name the three layers of the heart.
4. Name the upper chambers of the heart.
5. Name the lower chambers of the heart.
6. What role do the arteries play in circulation?
7. What role do the veins play in circulation?
8. Name the structure that is considered to be the pacemaker of the heart.
9. Describe how blood pressure is recorded in the patient's chart.
10. Define pulse pressure.

PREPARING FOR THE CERTIFICATION EXAM

1. Which of the following is a valve?
   a. tricuspid
   b. vena cava
   c. sinoatrial node
   d. pacemaker
   e. intraventricular septum
2. Blood enters the left atrium of the heart through the
   a. pulmonary artery.
   b. superior and inferior venae cavae.
   c. pulmonary vein.
   d. descending aorta.
   e. coronary artery.