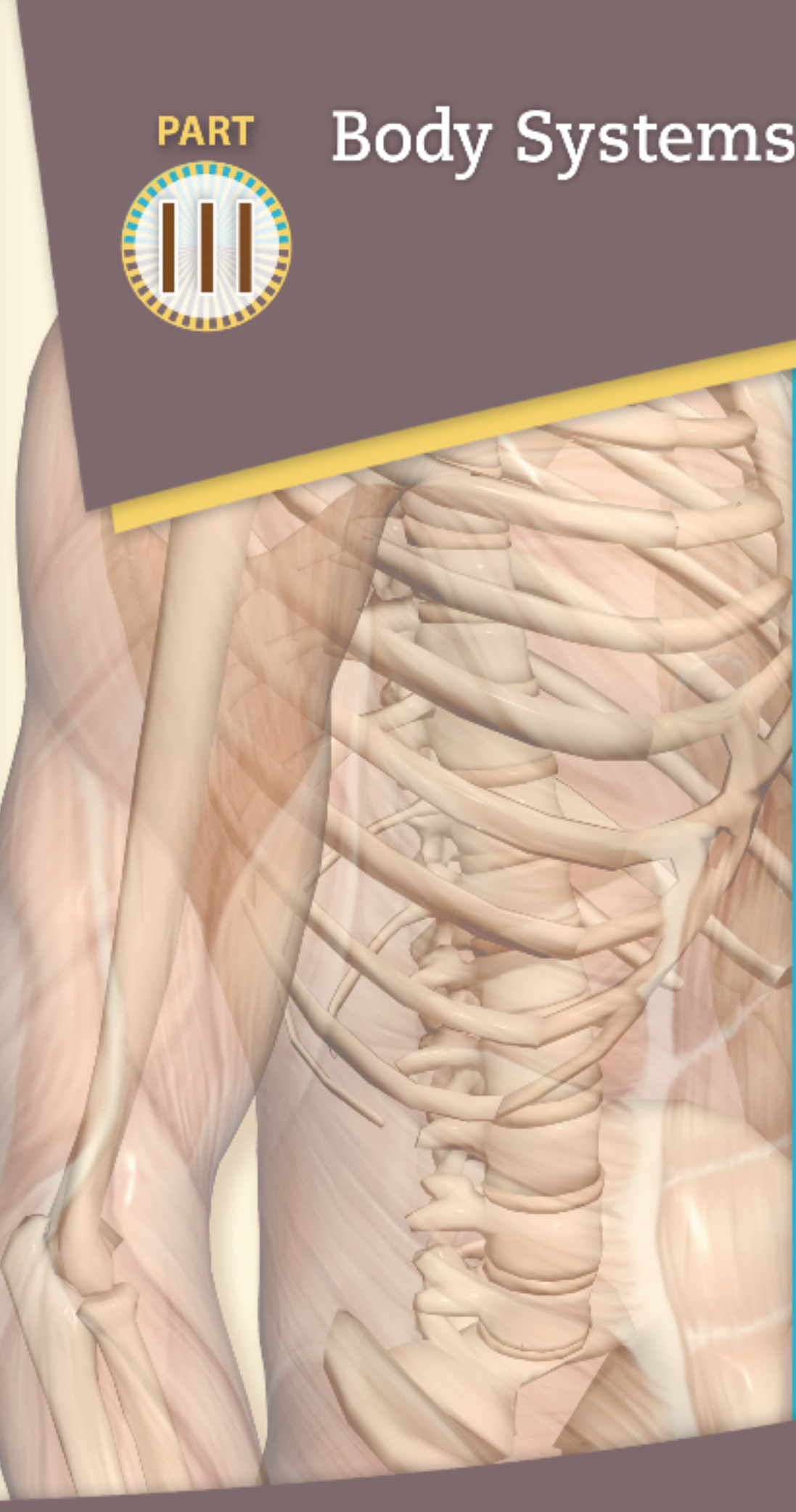
PART III

Body Systems



Circulation: The Cardiovascular and Lymphatic Systems

CHAPTER CONTENTS

OBJECTIVES

After study of this chapter you should be able to:

1. Label a diagram of the heart.
2. Trace the path of blood flow through the heart.
3. Trace the path of electrical conduction through the heart.
4. Identify the components of an electrocardiogram.
5. Differentiate among arteries, arterioles, capillaries, venules, and veins.
6. Explain blood pressure and describe how blood pressure is measured.
7. Identify and use the roots pertaining to the cardiovascular and lymphatic systems.
8. Describe the main disorders that affect the cardiovascular and lymphatic systems.
9. Define medical terms pertaining to the cardiovascular and lymphatic systems.
10. List the functions and components of the lymphatic system.
11. Interpret medical abbreviations referring to circulation.
12. Analyze case studies involving circulation.

PRETEST

Multiple choice. Select the best answer and write the letter of your choice to the left of each number.

___ 1. The cardiovascular system includes the heart and:

a. lungs
b. blood vessels
c. digestive organs
d. endocrine system

___ 2. The thick, muscular layer of the heart wall is the:

a. endocardium
b. valve
c. myocardium
d. apex

___ 3. The lower chambers of the heart are the:

a. ventricles
b. atria
c. base
d. systole

___ 4. A vessel that carries blood away from the heart is a(n):

a. vein
b. chamber
c. lymph node
d. artery

___ 5. The tonsils, spleen, thymus, and nodes are part of the:

a. digestive system
b. endocrine system
c. epicardium
d. lymphatic system

___ 6. Study of the heart's electrical activity is:

a. electrocardiography
b. electromyography
c. fluoroscopy
d. electroencephalography

___ 7. The medical term for a "heart attack" is:

a. myocardial infarction
b. cerebrovascular accident
c. aneurysm
d. pneumonia

___ 8. Any abnormality in the heart's rhythm is called:

a. monorrhythmia
b. embolism
c. arrhythmia
d. dysphagia

___ 9. The accumulation of fatty deposits in the lining of a vessel is called:

a. obesity
b. atherosclerosis
c. stent
d. angiogenesis

___10. Phlebitis is inflammation of a:

a. blood cell
b. vein
c. heart
d. nerve

9

Blood circulates throughout the body in the **cardiovascular system**, which consists of the **heart** and the blood vessels (Fig. 9-1). This system forms a continuous circuit that delivers oxygen and nutrients to all cells and carries away waste products. The **lymphatic system** also functions in circulation. Its **vessels** drain fluid and proteins left in the tissues and return them to the bloodstream. The lymphatic system plays a part in immunity and in the digestive process as well, as explained in Chapters 10 and 12. This chapter discusses the circulatory system in detail, in both its normal and clinical aspects, and then proceeds to study of the lymphatic system.

The Heart

The **heart** is located between the lungs, with its point or **apex** directed toward the inferior and left (Fig. 9-2). The wall of the heart consists of three layers, all named with the root *cardi*, meaning "heart." Moving from the innermost to the outermost layer, these are the:

1. **Endocardium**—a thin membrane that lines the chambers and **valves** (the prefix *endo-* means "within")
2. **Myocardium**—the thick muscle layer that makes up most of the heart wall (the root *my/o* means "muscle")
3. **Epicardium**—a thin membrane that covers the heart (the prefix *epi-* means "on")

A fibrous sac, the **pericardium**, contains the heart and anchors it to surrounding structures, such as the sternum (breastbone) and diaphragm (the prefix *peri-* means "around").

Each of the heart's upper receiving chambers is an **atrium** (plural: atria). Each of the lower pumping chambers is a **ventricle** (plural: ventricles). The chambers of the heart are divided by walls, each of which is called a **septum**. The interventricular septum separates the two ventricles; the interatrial septum divides the two atria. There is also a septum between the atrium and ventricle on each side.

The heart pumps blood through two circuits. The right side pumps blood to the lungs to be oxygenated through the **pulmonary circuit**. The left side pumps to the remainder of the body through the **systemic circuit** (see Fig. 9-1).

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See the Student Resources for the animation *Blood Circulation*.

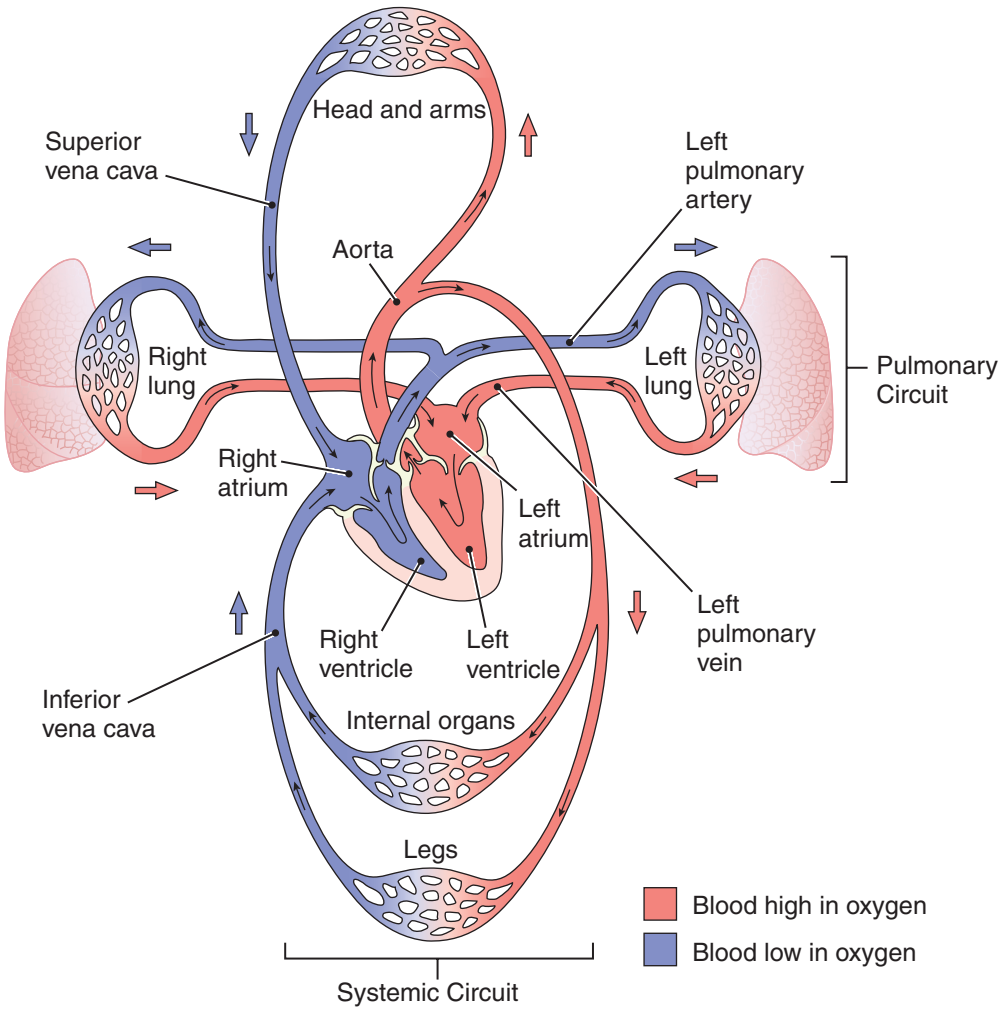

Figure 9-1 The cardiovascular system. The pulmonary circuit carries blood to and from the lungs; the systemic circuit carries blood to and from all other parts of the body.

Blood Flow through the Heart

The pathway of blood through the heart is shown by the arrows in Figure 9-2. The sequence is as follows:

1. The right atrium receives blood low in oxygen, or deoxygenated, from all body tissues through the **superior vena cava** and the **inferior vena cava**.
2. The blood then enters the right ventricle and is pumped to the lungs through the **pulmonary artery**.
3. Blood returns from the lungs high in oxygen, or oxygenated, and enters the left atrium through the **pulmonary veins**.
4. Blood enters the left ventricle and is forcefully pumped into the **aorta** to be distributed to all tissues.

One-way **valves** in the heart keep blood moving in a forward direction. The valves between the atrium and ventricle on each side are the **atrioventricular (AV) valves** (see Fig. 9-2). The valve between the right atrium and ventricle is the **right AV valve**, also known as the tricuspid valve because it has three cusps (flaps). The valve between the left atrium and ventricle is the **left AV valve**, which is a bicuspid valve with two cusps; it is often called the **mitral valve** (so named because it resembles a bishop's miter).

The valves leading into the pulmonary artery and the aorta have three cusps. Each cusp is shaped like a half-moon, so these valves are described as *semilunar valves*. The valve at the entrance to the pulmonary artery is specifically named the **pulmonary valve**; the valve at the entrance to the aorta is the **aortic valve**.

PASSport to Success® See the Student Resources for the animation *Cardiac Cycle*.

Heart sounds are produced as the heart functions. The loudest of these, the familiar lub and dup that can be

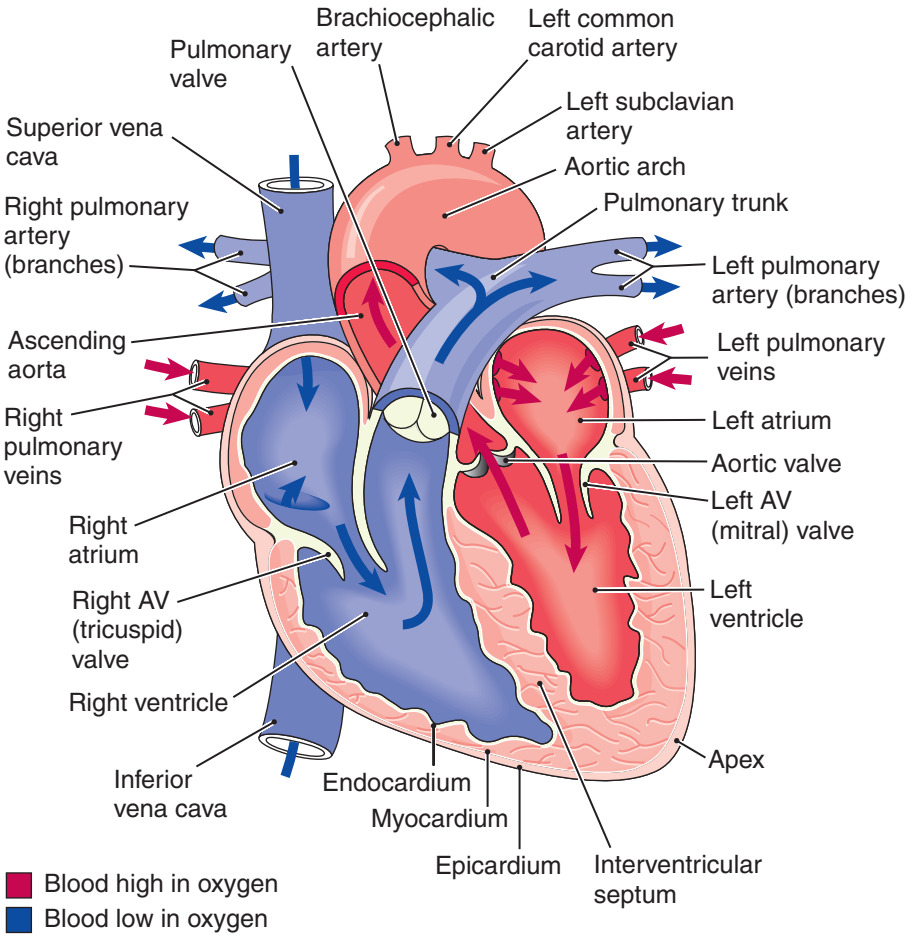

Figure 9-2 The heart and great vessels. AV, atrioventricular.

heard through the chest wall, are produced by alternate closing of the valves. The first heart sound (S_1) is heard when the valves between the chambers close. The second heart sound (S_2) is produced when the valves leading into the aorta and pulmonary artery close. Any sound made as the heart functions normally is termed a **functional murmur**. (The word *murmur* used alone with regard to the heart describes an abnormal sound.)

The Heartbeat

Each contraction of the heart, termed **systole** (*SIS-tō-lē*), is followed by a relaxation phase, **diastole** (*dī-AS-tō-lē*), during which the chambers fill. Each time the heart beats, both atria contract and immediately thereafter both ventricles contract. The number of times the heart contracts per minute is the **heart rate**. The wave of increased pressure produced in the vessels each time the ventricles contract is the **pulse**. Pulse rate is usually counted by palpating a peripheral artery, such as the radial artery at the wrist or the carotid artery in the neck (see Fig. 7-4).

Cardiac contractions are stimulated by a built-in system that regularly transmits electrical impulses through the heart. The components of this conduction system are shown in Figure 9-3. In the sequence of action they include the:

1. **Sinoatrial (SA) node,** located in the upper right atrium and called the pacemaker because it sets the rate of the heartbeat.
2. **Atrioventricular (AV) node,** located at the bottom of the right atrium near the ventricle. Internodal fibers between the SA and AV node carry stimulation throughout both atria.
3. **AV bundle** (bundle of His) at the top of the interventricular septum.
4. Left and right **bundle branches,** which travel along the left and right sides of the septum.
5. **Purkinje** (*pur-KIN-jē*) **fibers,** which carry stimulation throughout the walls of the ventricles. (See information on naming in Box 9-1.)

Although the heart itself generates the heartbeat, factors such as nervous system stimulation, hormones, and drugs can influence the rate and the force of contractions.

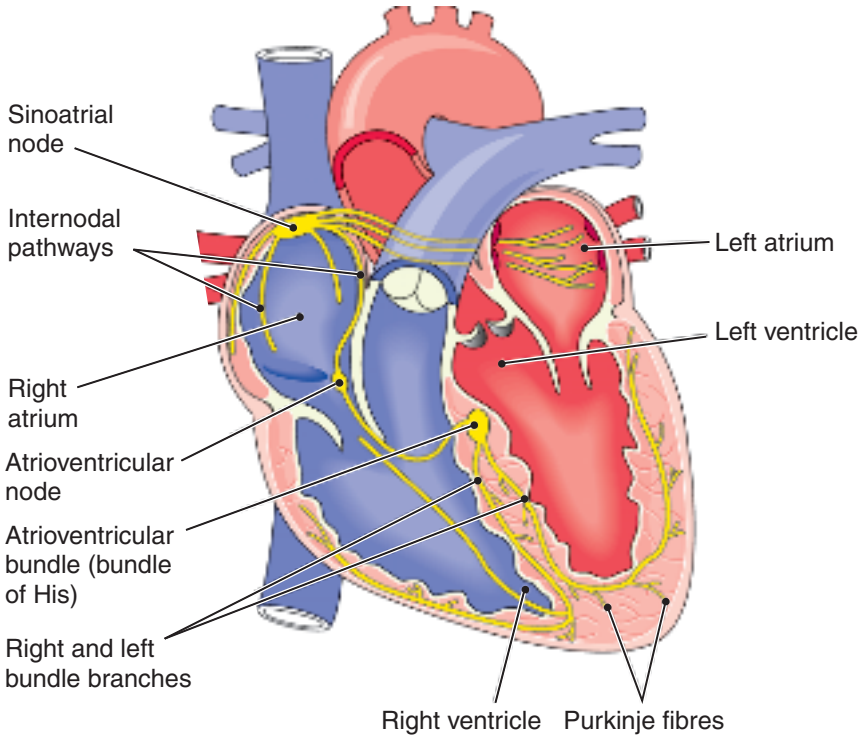

Figure 9-3 **The heart's conduction system.** Impulses travel from the sinoatrial (SA) node to the atrioventricular (AV) node, then to the atrioventricular bundle, bundle branches, and Purkinje fibers. Internodal pathways carry impulses throughout the atria.

Box 9-1 Focus on Words

Name That Structure

An eponym (*EP-o-nim*) is a name that is based on the name of a person, usually the one who discovered a particular structure, disease, principle, or procedure. Everyday examples are graham cracker, Ferris wheel, and boycott. In the heart, the bundle of His and Purkinje fibers are part of that organ's conduction system. Korotkoff sounds are heard in the vessels when taking blood pressure. Cardiovascular disorders named for people include the tetralogy of Fallot, a combination of four congenital heart defects; Raynaud disease of small vessels; and the cardiac arrhythmia known as Wolff–Parkinson–White syndrome. In treatment, Doppler echocardiography is named for a physicist of the 19th century. The Holter monitor and the Swan–Ganz catheter give honor to their developers.

In other systems, the islets of Langerhans are cell clusters in the pancreas that secrete insulin. The graafian follicle in the ovary surrounds the developing egg cell. The eustachian tube connects the middle ear to the throat.

Many disease names are eponymic: Parkinson and Alzheimer, which affect the brain; Graves, a disorder of the thyroid; Addison and Cushing, involving the adrenal cortex; and Down syndrome, a hereditary disorder. The genus and species names of microorganisms often are based on the names of their discoverers, *Escherichia*, *Salmonella*, *Pasteurella*, and *Rickettsia* to name a few.

Many reagents, instruments, and procedures are named for their developers. The original name for a radiograph was roentgenograph (*RENT-jen-ō-graf*), named for Wilhelm Roentgen, discoverer of x-rays. A curie is a measure of radiation, derived from the name of Marie Curie, a codiscoverer of radioactivity.

Although eponyms give honor to physicians and scientists of the past, they do not convey any information and may be more difficult to learn. There is a trend to replace these names with more descriptive ones; for example, auditory tube instead of eustachian tube, ovarian follicle for graafian follicle, pancreatic islets for islets of Langerhans, and trisomy 21 for Down syndrome.

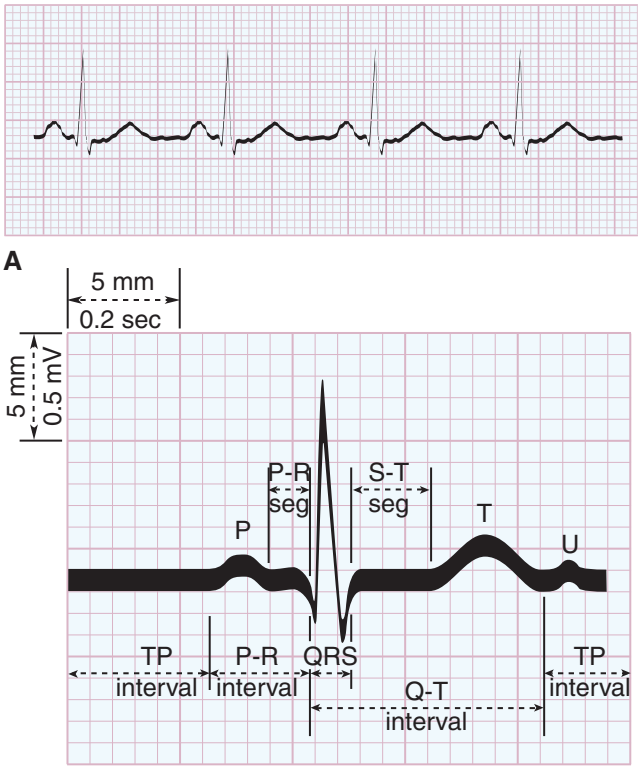

Figure 9-4 **Electrocardiography (ECG).** (*A*) ECG tracing showing a normal sinus rhythm. (*B*) Components of a normal ECG tracing. Shown are the P, QRS, T, and U waves, which represent electrical activity in different parts of the heart. Intervals measure from one wave to the next; segments are smaller components of the tracing.

ELECTROCARDIOGRAPHY

Electrocardiography (ECG) measures the heart's electrical activity as it functions (Fig. 9-4). Electrodes (leads) placed on the body's surface detect the electrical signals, which are then amplified and recorded as a tracing. A normal, or **sinus rhythm**, which originates at the SA node, is shown in Figure 9-4A. Figure 9-4B shows the letters assigned to individual components of one complete cycle:

1. The P wave represents electrical change, or **depolarization**, of the atrial muscles.
2. The QRS component shows depolarization of the ventricles.
3. The T wave shows return, or **repolarization**, of the ventricles to their resting state. Atrial repolarization is hidden by the QRS wave.
4. The small U wave, if present, follows the T wave. It is of uncertain origin.

An *interval* measures the distance from one wave to the next; a *segment* is a smaller component of the tracing. Many heart disorders, some of which are described later in the chapter, appear as abnormalities in ECG components.

The Vascular System

The vascular system consists of:

1. **Arteries** that carry blood away from the heart (Fig. 9-5).
2. **Arterioles**, vessels smaller than arteries that lead into the capillaries.
3. **Capillaries**, the smallest vessels, through which exchanges take place between the blood and the tissues.
4. **Venules**, small vessels that receive blood from the capillaries and drain into the veins.
5. **Veins** that carry blood back to the heart (Fig. 9-6).

All arteries, except the pulmonary artery (and the umbilical artery in the fetus), carry oxygenated blood. They are thick-walled, elastic vessels that carry blood under high pressure. All veins, except the pulmonary vein (and the umbilical vein in the fetus), carry deoxygenated blood. Veins have thinner, less elastic walls and tend to give way under pressure. Like the heart, veins have one-way valves that keep blood flowing forward.

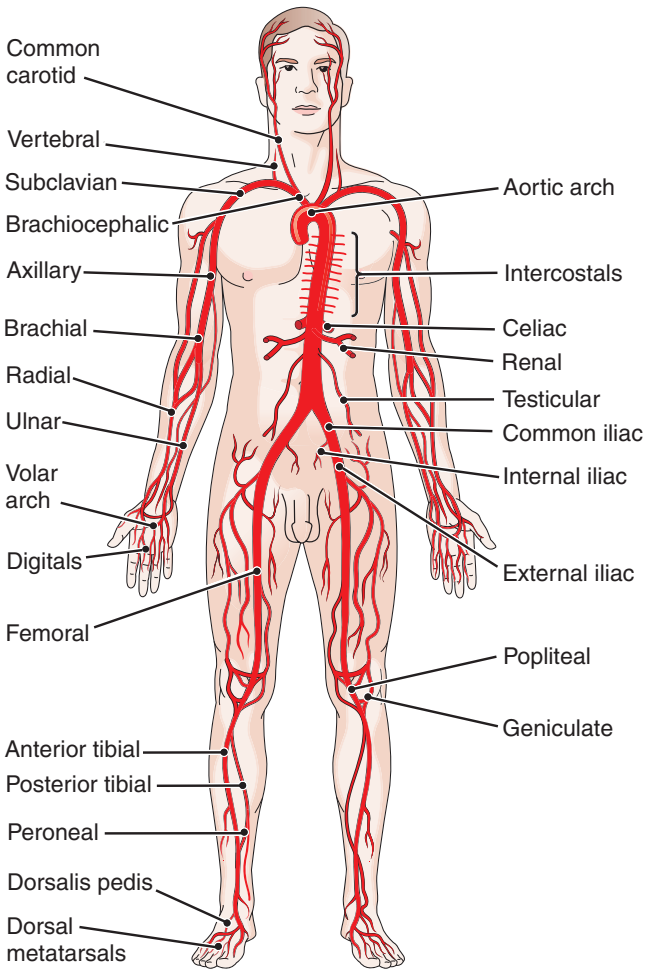

Figure 9-5 **Principal systemic arteries.**

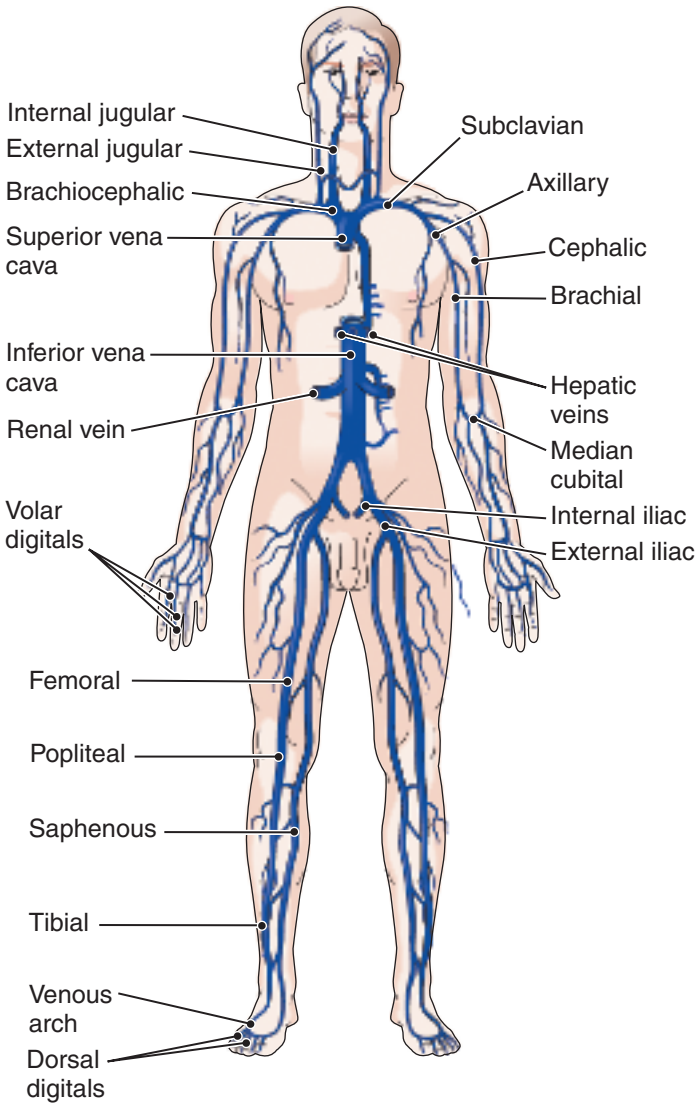

Figure 9-6 **Principal systemic veins.**

Nervous system stimulation can cause the diameter of a vessel to increase (vasodilation) or decrease (vasoconstriction). These changes alter blood flow to the tissues and affect blood pressure.

Blood Pressure

Blood pressure (BP) is the force exerted by blood against the wall of a blood vessel. It falls as the blood travels away from the heart and is influenced by a variety of factors, including cardiac output, vessel diameters, and total blood volume. Vasoconstriction increases blood pressure in a vessel; vasodilation decreases pressure.

Blood pressure is commonly measured in a large artery with an inflatable cuff (Fig. 9-7) known as a blood pressure cuff or blood pressure apparatus, but

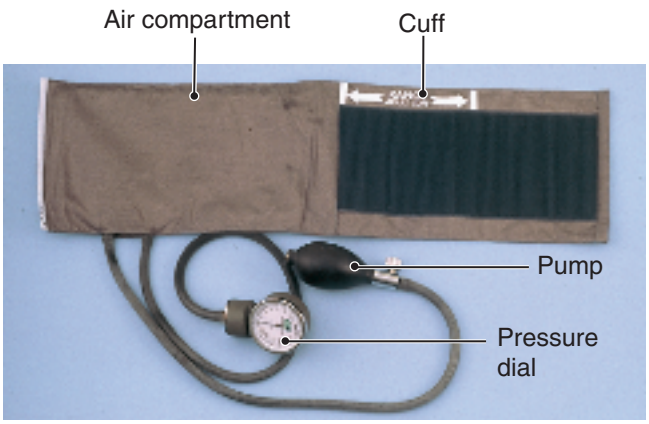

Figure 9-7 **Blood pressure cuff (sphygmomanometer).** Shown are the cuff, the bulb for inflating the cuff, and the manometer for measuring pressure.

Box 9-2 Clinical Perspectives

Cardiac Catheterization: Measuring Blood Pressure from Within

Because arterial blood pressure decreases as blood flows further away from the heart, measurement of blood pressure with a simple inflatable cuff around the arm is only a reflection of the pressure in the heart and pulmonary arteries. Precise measurement of pressure in these parts of the cardiovascular system is useful in diagnosing certain cardiac and pulmonary disorders.

More accurate readings can be obtained using a catheter (thin tube) inserted directly into the heart and large vessels. One type commonly used is the pulmonary artery catheter (also known as the Swan–Ganz catheter), which has an inflatable balloon at the tip. This device is threaded into the right side of the heart through a large vein. Typically, the right internal jugular vein is used because it is the shortest and most direct route to the heart, but the subclavian and femoral veins may also be used. The catheter's position in the heart is confirmed by a chest x-ray and, when appropriately positioned, the atrial and ventricular blood pressures are recorded. As the catheter continues into the pulmonary artery, pressure in this vessel can be read. When the balloon is inflated, the catheter becomes wedged in a branch of the pulmonary artery, blocking blood flow. The reading obtained is called the **pulmonary capillary wedge (PCW) pressure.** It gives information on pressure in the heart's left side and on resistance in the lungs. Combined with other tests, cardiac catheterization can be used to diagnose cardiac and pulmonary disorders such as shock, pericarditis, congenital heart disease, and heart failure.

technically called a **sphygmomanometer.** The examiner inflates the cuff to stop blood flow in a vessel. He or she then uses a stethoscope to listen for blood flow in the vessel as the pressure is slowly released (see Fig. 7-5). The blood pressure reading includes both systolic pressure, measured while the heart is contracting, and diastolic pressure, measured when the heart relaxes. These are reported as systolic then diastolic separated by a slash, such as 120/80. Pressure is expressed as millimeters of mercury (mm Hg)—that is, the height to which the pressure can push a column of mercury in a tube. Blood pressure is a valuable diagnostic measurement that is easily obtained. (See Box 9-2 for more information on blood pressure measurement.)

Terminology Key Terms

CARDIOVASCULAR SYSTEM

Normal Structure and Function

aorta *ā-OR-ta*	The largest artery. It receives blood from the left ventricle and branches to all parts of the body (root: *aort/o*)
aortic valve *ā-OR-tik*	The valve at the entrance to the aorta
apex *Ā-peks*	The point of a cone-shaped structure (adjective: apical). The apex of the heart is formed by the left ventricle and is pointed toward the inferior and left
artery *AR-te-rē*	A vessel that carries blood away from the heart. All except the pulmonary and umbilical arteries carry oxygenated blood (roots: *arter*, *arteri/o*)
arteriole *ar-TĒ-rē-ōl*	A small vessel that carries blood from the arteries into the capillaries (root: *arteriol/o*)
atrioventricular (AV) node *ā-trē-ō-ven-TRIK-ū-lar*	A small mass in the lower septum of the right atrium that passes impulses from the sinoatrial (SA) node toward the ventricles
AV bundle	A band of fibers that transmits impulses from the atrioventricular (AV) node to the top of the interventricular septum. It divides into the right and left bundle branches, which descend along the two sides of the septum; the bundle of His
atrioventricular (AV) valve	A valve between the atrium and ventricle on the right and left sides of the heart. The right AV valve is the tricuspid valve; the left is the mitral valve

(continued)

Terminology Key Terms *(continued)*

atrium *Ā-trē-um*	An entrance chamber, one of the two upper receiving chambers of the heart (root: *atri/o*)
blood pressure	The force exerted by blood against the wall of a vessel
bundle branches	Branches of the AV bundle that divide to the right and left sides of the interventricular septum
capillary *KAP-i-lar-ē*	A microscopic blood vessel through which materials are exchanged between the blood and the tissues
cardiovascular system *kar-dē-ō-VAS-kū-lar*	The part of the circulatory system that consists of the heart and the blood vessels
depolarization *dē-pō-lar-i-ZĀ-shun*	A change in electrical charge from the resting state in nerves or muscles
diastole *dī-AS-tō-lē*	The relaxation phase of the heartbeat cycle; adjective: diastolic
electrocardiography (ECG) *ē-lek-trō-kar-dē-OG-ra-fē*	Study of the electrical activity of the heart as detected by electrodes (leads) placed on the surface of the body. Also abbreviated EKG from the German *electrokardiography*
endocardium *en-dō-KAR-dē-um*	The thin membrane that lines the chambers of the heart and covers the valves
epicardium *ep-i-KAR-dē-um*	The thin outermost layer of the heart wall
functional murmur	Any sound produced as the heart functions normally
heart *hart*	The muscular organ with four chambers that contracts rhythmically to propel blood through vessels to all parts of the body (root: *cardi/o*)
heart rate	The number of times the heart contracts per minute; recorded as beats per minute (bpm)
heart sounds	Sounds produced as the heart functions. The two loudest sounds are produced by alternate closing of the valves and are designated S_1 and S_2
inferior vena cava *VĒ-na KĀ-va*	The large inferior vein that brings blood back to the right atrium of the heart from the lower body
left AV valve	The valve between the left atrium and the left ventricle; the mitral valve or bicuspid valve
mitral valve *MĪ-tral*	The valve between the left atrium and the left ventricle; the left AV valve or bicuspid valve
myocardium *mī-ō-KAR-dē-um*	The thick middle layer of the heart wall composed of cardiac muscle
pericardium *per-i-KAR-dē-um*	The fibrous sac that surrounds the heart
pulmonary artery *PUL-mō-nār-ē*	The vessel that carries blood from the right side of the heart to the lungs
pulmonary circuit *SER-kit*	The system of vessels that carries blood from the right side of the heart to the lungs to be oxygenated and then back to the left side of the heart
pulmonary veins	The vessels that carry blood from the lungs to the left side of the heart
pulmonary valve *PUL-mō-nār-ē*	The valve at the entrance to the pulmonary artery
pulse *puls*	The wave of increased pressure produced in the vessels each time the ventricles contract
Purkinje fibers *pur-KIN-jē*	The terminal fibers of the cardiac conducting system. They carry impulses through the walls of the ventricles
repolarization *rē-pō-lar-i-ZĀ-shun*	A return of electrical charge to the resting state in nerves or muscles

(continued)

Terminology Key Terms *(continued)*

right AV valve	The valve between the right atrium and right ventricle; the tricuspid valve
septum *SEP-tum*	A wall dividing two cavities, such as two chambers of the heart
sinus rhythm *SĪ-nus*	Normal heart rhythm
sinoatrial (SA) node *sī-nō-Ā-trē-al*	A small mass in the upper part of the right atrium that initiates the impulse for each heartbeat; the pacemaker
sphygmomanometer *sfig-mō-man-OM-e-ter*	An instrument for determining arterial blood pressure (root *sphygm/o* means "pulse"); blood pressure apparatus or cuff
superior vena cava *VĒ-na KĀ-va*	The large superior vein that brings deoxygenated blood back to the right atrium from the upper body
systemic circuit *sis-TEM-ik SER-kit*	The system of vessels that carries oxygenated blood from the left side of the heart to all tissues except the lungs and returns deoxygenated blood to the right side of the heart
systole *SIS-tō-lē*	The contraction phase of the heartbeat cycle; adjective: systolic
valve *valv*	A structure that keeps fluid flowing in a forward direction (roots: *valv/o*, *valvul/o*)
vein *vān*	A vessel that carries blood back to the heart. All except the pulmonary and umbilical veins carry blood low in oxygen (roots: *ven/o*, *phleb/o*)
ventricle *VEN-trik-l*	A small cavity. One of the two lower pumping chambers of the heart (root: *ventricul/o*)
venule *VEN-ūl*	A small vessel that carries blood from the capillaries to the veins
vessel *VES-el*	A tube or duct to transport fluid (roots: *angi/o*, *vas/o*, *vascul/o*)

PASSport to Success® Go to the pronunciation glossary on the Student Resources to hear these words pronounced.

Roots Pertaining to the Cardiovascular System

See Tables 9-1 and 9-2.

Table 9-1 Roots for the Heart

Root	Meaning	Example	Definition of Example
cardi/o	heart	cardiomyopathy* *kar-dē-ō-mī-OP-a-thē*	any disease of the heart muscle
atri/o	atrium	atriotomy *ā-trē-OT-ō-mē*	surgical incision of an atrium
ventricul/o	cavity, ventricle	supraventricular *sū-pra-ven-TRIK-ū-lar*	above a ventricle
valv/o, valvul/o	valve	valvulotome *VAL-vū-lō-tōm*	instrument for incising a valve

*Preferred over myocardiopathy.

EXERCISE 9-1

Fill in the blanks:

1. The word *cardiogenic* (*kar-dē-ō-GEN-ik*) means originating in the _____.
2. Interatrial (*in-ter-Ā-trē-al*) means between the _____.
3. Ventriculotomy (*ven-trik-ū-LOT-ō-mē*) means surgical incision of a(n) _____.
4. A valvuloplasty (*val-vū-lō-PLAS-tē*) is plastic repair of a(n) _____.

Write the adjective for the following definitions. The proper suffix is given for each.

5. Pertaining to the heart (-ac) _____
6. Pertaining to the myocardium (-al; ending differs from adjective ending for the heart) _____
7. Pertaining to an atrium (-al) _____
8. Pertaining to a valve (-ar) _____
9. Pertaining to a ventricle (-ar) _____
10. Pertaining to the pericardium (-al) _____

Following the example, write a word for the following definitions pertaining to the tissues of the heart:

11. Inflammation of the lining of the heart (usually at a valve) endocarditis
12. Inflammation of the heart muscle _____
13. Inflammation of the fibrous sac around the heart _____

Write a word for the following definitions:

14. Pertaining to an atrium and a ventricle _____
15. Between (inter-) the ventricles _____
16. Study (-logy) of the heart _____
17. Surgical incision of a valve _____
18. Enlargement (-megaly) of the heart _____

Table 9-2 Roots for the Blood Vessels

Root	Meaning	Example	Definition of Example
angi/o*	vessel	angiography *an-jē-OG-ra-fē*	x-ray imaging of a vessel
vas/o, vascul/o	vessel, duct	vasospasm *vas-ō-spazm*	sudden contraction of a vessel
arter/o, arteri/o	artery	endarterial *end-ar-TĒ-rē-al*	within an artery
arteriol/o	arteriole	arteriolar *ar-tē-rē-Ō-lar*	pertaining to an arteriole
aort/o	aorta	aortoptosis *ā-or-top-TŌ-sis*	downward displacement of the aorta
ven/o, ven/i	vein	venous *VĒ-nus*	pertaining to a vein
phleb/o	vein	phlebotomy *fle-BOT-ō-mē*	incision of a vein to withdraw blood

*The root *angi/o* usually refers to a blood vessel but is used for other types of vessels as well. *Hemangi/o* refers specifically to a blood vessel.

EXERCISE 9-2

Fill in the blanks:

1. Vasoconstriction (*vas-ō-kon-STRIK-shun*) means narrowing of a(n) _____.

2. Endarterectomy (*end-ar-ter-EK-tō-mē*) is removal of the inner lining of a(n) _____

_____.

3. Arteriolitis (*ar-tē-rē-ō-LĪ-tis*) is inflammation of a(n) _____.

4. Angioedema (*an-jē-ō-e-DĒ-ma*) is localized swelling caused by changes in _____

_____.

5. Aortostenosis (*ā-or-tō-ste-NŌ-sis*) is narrowing of the _____.

6. Phlebectasia (*fleb-ek-TĀ-zē-a*) is dilatation of a(n) _____.

7. The term *microvascular* (*mī-krō-VAS-kū-lar*) means pertaining to small _____

_____.

Define the following words:

8. cardiovascular (*kar-dē-ō-VAS-kū-lar*) _____

9. intraaortic (*in-tra-ā-OR-tik*) _____

10. angiitis (*an-jē-Ī-tis*) (note spelling); also angitis or vasculitis _____

11. arteriorrhexis (*ar-tē-rē-ō-REK-sis*) _____

12. phlebitis (*fleb-Ī-tis*) _____

Use the ending *-gram* to form a word for a radiograph of the following:

13. vessels (use angi/o) _____

14. aorta _____

15. veins _____

Use the root *angi/o* to write words with the following meanings:

16. Formation (-genesis) of a vessel _____

17. Dilatation (-ectasis) of a vessel _____

18. Any disease (-pathy) of a vessel _____

19. Plastic repair (-plasty) of a vessel _____

Use the appropriate root to write words with the following meanings:

20. Within (intra-) a vein _____

21. Incision of an artery _____

22. Excision of a vein _____

23. Hardening (-sclerosis) of the aorta _____

Clinical Aspects of the Cardiovascular System

Atherosclerosis

The accumulation of fatty deposits within the lining of an **artery** is termed **atherosclerosis** (Fig. 9-8). This type of deposit, called **plaque** (*plak*), begins to form when a vessel receives tiny injuries, usually at a point of branching. Plaques gradually thicken and harden with fibrous material, cells, and other deposits, restricting the vessel's lumen (opening) and reducing blood flow to the tissues, a condition known as **ischemia** (***is-KĒ-mē-a***). A major risk factor for the development of atherosclerosis is **dyslipidemia**, abnormally high levels or imbalance in **lipoproteins** that are carried in the blood, especially high levels of cholesterol-containing, low-density lipoproteins (LDLs). Other risk factors for atherosclerosis include smoking, high blood pressure, poor diet, inactivity, stress, and a family history of the disorder. Atherosclerosis may involve any arteries, but most of its effects are seen in the coronary vessels of the heart, the aorta, the carotid arteries in the neck, and vessels in the brain. The techniques described later for treating coronary artery disease (CAD) are used for these other vessels as well.

Atherosclerosis is the most common form of a more general condition known as **arteriosclerosis** in which vessel walls harden from any cause. In addition to plaque, calcium salts and scar tissue may contribute to arterial wall thickening, with a narrowing of the lumen and loss of elasticity.

Thrombosis and Embolism

Atherosclerosis predisposes a person to **thrombosis**, the formation of a blood clot within a vessel (see Fig. 9-8). The clot, called a **thrombus**, interrupts blood flow to the tissues supplied by that vessel, resulting in necrosis (tissue death). Blockage of a vessel by a thrombus or other mass carried in the bloodstream is **embolism**, and the mass itself is called an **embolus**. Usually, the mass is a blood clot that breaks loose from a vessel's wall, but it may also be air (as from injection or trauma), fat (as from marrow released after a bone break), bacteria, or other solid materials. Often a venous thrombus will travel through the heart and then lodge in an artery of the lungs, resulting in a life-threatening pulmonary embolism. An embolus from a carotid artery often blocks a cerebral vessel, causing a **cerebrovascular accident** (**CVA**), commonly called **stroke** (see Chapter 17).

Aneurysm

An arterial wall weakened by atherosclerosis, malformation, injury, or other changes may balloon out, forming an **aneurysm**. If an aneurysm ruptures, hemorrhage results. Rupture of a cerebral artery is another cause of stroke. The abdominal aorta and carotid arteries are also common aneurysm sites. In a **dissecting aneurysm** (Fig. 9-9), blood hemorrhages into the arterial wall's thick middle layer, separating the muscle as it spreads and sometimes rupturing the vessel. The aorta is most commonly involved. It may be possible to repair a dissecting aneurysm surgically with a graft.

Hypertension

High blood pressure, or **hypertension** (HTN), is a contributing factor in all of the conditions described above. In simple terms, HTN is defined as a systolic pressure greater than 140 mm Hg or a diastolic pressure greater than 90 mm Hg. HTN causes the left ventricle to enlarge (hypertrophy) as a result of increased work. Some cases of HTN are secondary to other disorders, such as kidney malfunction or endocrine disturbance, but most of the

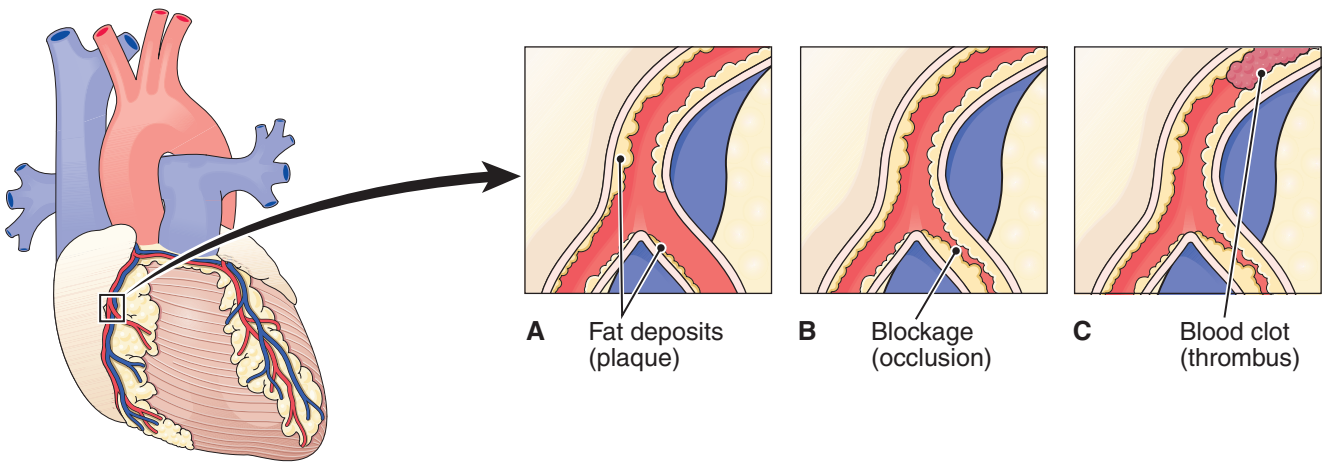

Figure 9-8 **Coronary atherosclerosis.** (*A*) Fat deposits (plaque) narrow an artery, leading to ischemia (lack of blood supply). (*B*) Plaque causes blockage (occlusion) of a vessel. (*C*) Formation of a blood clot (thrombus) in a vessel leads to myocardial infarction (MI).

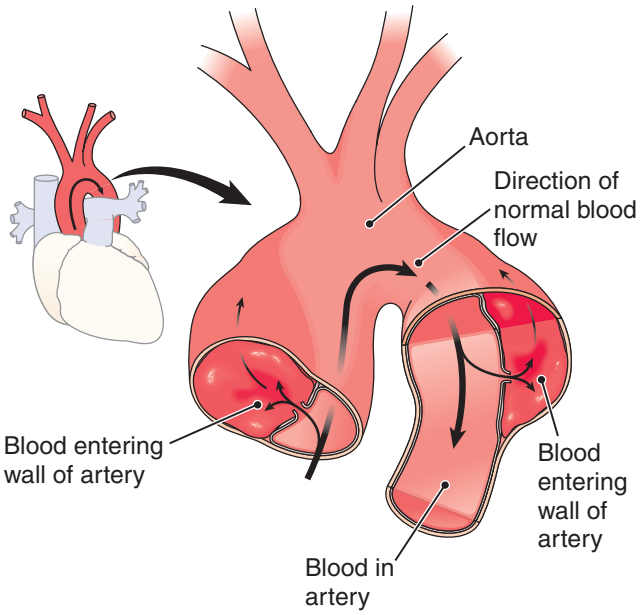

Figure 9-9 Dissecting aortic aneurysm. Blood separates the layers of the arterial wall.

time the causes are unknown, a condition described as primary, or essential, HTN.

Changes in diet and life habits are the first line of defense in controlling HTN. Drugs that are used include diuretics to eliminate fluids, vasodilators to relax the blood vessels, and drugs that prevent the formation or action of angiotensin, a substance in the blood that normally acts to increase blood pressure (see Chapter 13).

PASSport to Success®

The animation *Hypertension* on the Student Resources illustrates the effects of this disorder.

Heart Disease

CORONARY ARTERY DISEASE

CAD, which results from atherosclerosis in the vessels that supply blood to the heart muscle, is a leading cause of death in industrialized countries (see Fig. 9-8). An early sign of CAD is the type of chest pain known as **angina pectoris**. This is a feeling of constriction around the heart or pain that may radiate to the left arm or shoulder, usually brought on by exertion. Often there is anxiety, **diaphoresis** (profuse sweating), and **dyspnea** (difficulty in breathing). CAD is diagnosed by ECG, **stress tests**, **coronary angiography** (imaging), **echocardiography**, and other tests. Researchers have also found that a substance called **C-reactive protein** (**CRP**) is associated with poor cardiovascular health. This protein is produced during systemic inflammation, which may contribute to atherosclerosis. CRP levels can indicate cardiovascular disease and predict its outcome (prognosis). A more specific test for heart attack risk is the more accurate hs-CRP (high-sensitivity CRP) test.

CAD is treated by control of exercise and administration of nitroglycerin to dilate coronary vessels. Other drugs may be used to regulate the heartbeat, strengthen the force of heart contraction, or prevent blood clot formation.

Patients with severe cases of CAD may be candidates for **angioplasty**, surgical dilatation of the blocked vessel by means of a balloon catheter, a procedure technically called **percutaneous transluminal coronary angioplasty** (**PTCA**) (Fig. 9-10). Angioplasty may include placement of a **stent**, a small mesh tube, to keep the vessel open (Fig. 9-11). Stents prevent recoil of the vessel, and newer versions release drugs to prevent vascular restenosis.

If further intervention is required, surgeons can bypass the blocked vessel or vessels with a vascular graft (Fig. 9-12). In this procedure, known as a **coronary artery bypass graft** (**CABG**), another vessel or a piece of another vessel, usually the left internal mammary artery or part of the leg's saphenous vein, is grafted to carry blood from the aorta to a point past the coronary vessel obstruction.

MYOCARDIAL INFARCTION

Degenerative changes in the arteries predispose a person to thrombosis and sudden coronary artery **occlusion** (obstruction). The resultant area of myocardial necrosis is termed an **infarct** (Fig. 9-13), and the process is known as **myocardial infarction** (MI), the "heart attack" that may cause sudden death. Symptoms of MI include pain over the heart (precordial pain) or upper part of the abdomen (epigastric pain) that may extend to the jaw or arms, pallor (paleness), diaphoresis, nausea, fatigue, anxiety, and dyspnea. There may be a burning sensation similar to indigestion or heartburn. In women, because degenerative changes more commonly affect multiple small vessels rather than the major coronary pathways, MI symptoms are often more long-term and more subtle and diffuse than the intense chest pain that is more typical in men.

MI is diagnosed by ECG and assays for specific substances in the blood. **Creatine kinase** (CK) is an enzyme normal to muscle cells. It is released in increased amounts when muscle tissue is injured. The form of CK specific to cardiac muscle cells is creatine kinase MB (CK-MB). **Troponin** (Tn) is a protein that regulates contraction in muscle cells. Increased serum levels, particularly the forms TnT and TnI, indicate MI.

Patient outcome is based on the degree of damage and the speed of treatment to dissolve the clot and to reestablish normal blood flow and heart rhythm.

ARRHYTHMIA

Arrhythmia is any irregularity of heart rhythm, such as an altered heart rate, extra beats, or a change in the

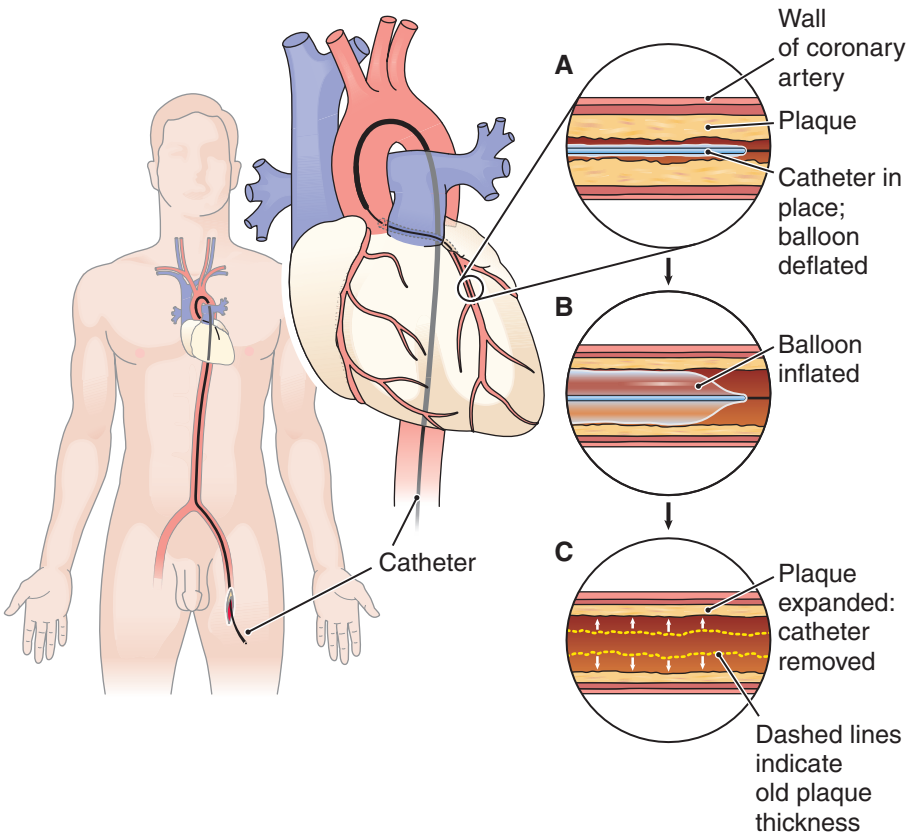

Figure 9-10 **Coronary angioplasty (PTCA).** (*A*) A guide catheter is threaded into the coronary artery. (*B*) A balloon catheter is inserted through the occlusion. (*C*) The balloon is inflated and deflated until plaque is flattened and the vessel is opened.

pattern of the beat. **Bradycardia** is a slower-than-average rate, and **tachycardia** is a higher-than-average rate.

Damage to cardiac tissue, as by MI, may result in **heart block**, an interruption in the heart's electrical conduction system resulting in arrhythmia (Fig. 9-14). Heart block is classified in order of increasing severity as first-, second-, or third-degree heart block. Block in a bundle branch is designated as a left or right bundle branch block (BBB).

If, for any reason, the SA node is not generating a normal heartbeat or there is heart block, an **artificial pacemaker** may be implanted to regulate the beat (Fig. 9-15). Usually, the pacemaker is inserted under the skin below the clavicle, and leads are threaded through veins into one or both of the right chambers. Some pacemakers act only when the heart is not functioning on its own, and some adjust to the need for a change in heart rate based on activity.

MI is also a common cause of **fibrillation**, an extremely rapid, ineffective heartbeat, especially dangerous when it affects the ventricles. **Cardioversion** is the general term for restoration of a normal heart rhythm, either by drugs or application of electric current. Hospital personnel use external chest "paddles" for emergency electrical **defibrillation**. In addition to **cardiopulmonary resuscitation** (CPR), automated external defibrillators (AEDs) can help save lives when available for high-risk patients or in public places, such as malls, aircraft, and sports venues. The AED detects fatal arrhythmia and automatically delivers a correct preprogrammed shock. An implantable cardioverter–defibrillator (ICD), applied much like a pacemaker, detects potential fibrillation and automatically shocks the heart to restore normal rhythm.

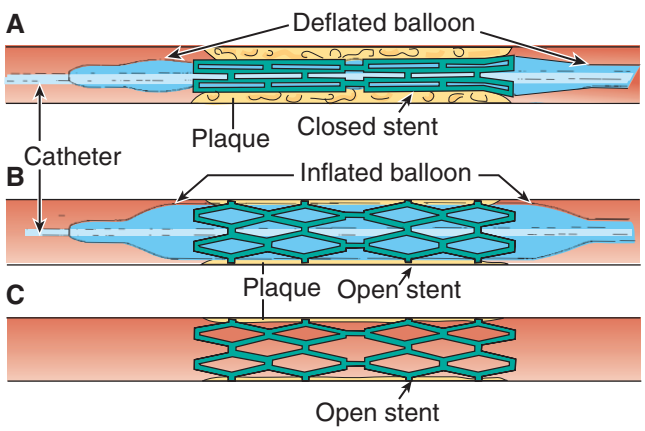

Figure 9-11 **Arterial stent.** (*A*) Stent closed, before balloon inflation. (*B*) Stent open, balloon inflated; stent will remain expanded after balloon is deflated and removed. (*C*) Stent open, balloon removed.

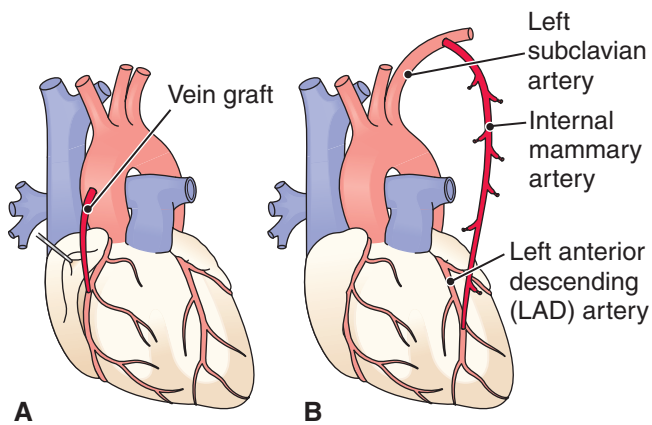

Figure 9-12 **Coronary artery bypass graft (CABG).** (*A*) A segment of the saphenous vein carries blood from the aorta to a part of the right coronary artery that is distal to an occlusion. (*B*) The mammary artery is used to bypass an obstruction in the left anterior descending (LAD) coronary artery.

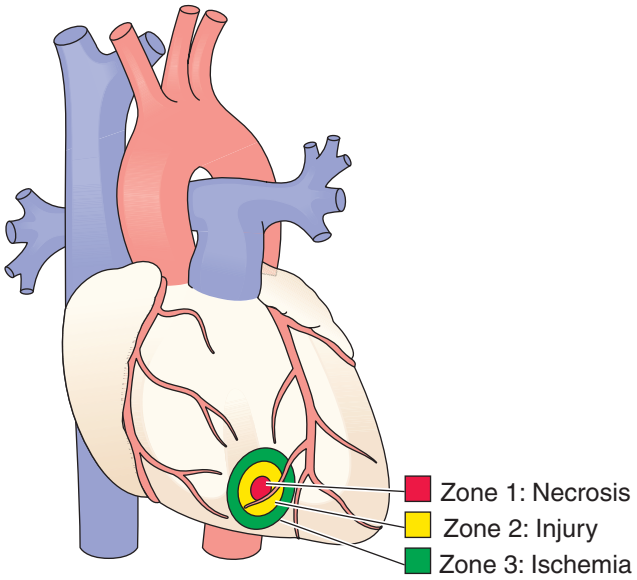

Figure 9-13 **Myocardial infarction (MI).** A blood clot (thrombus) causes a zone of necrosis (tissue death). Surrounding tissue suffers from lack of blood supply (ischemia).

A newer approach to the treatment of heart rhythm irregularities is **ablation**, or destruction, of that portion of the conduction pathway that is involved in the arrhythmia. Electrode catheter ablation uses high-frequency sound waves, freezing (cryoablation), or electrical energy delivered through an intravascular catheter to ablate a defect in the conduction pathway.

HEART FAILURE

The general term **heart failure** refers to any condition in which the heart fails to empty effectively. The resulting increased pressure in the venous system leads to **edema**, justifying the description *congestive heart failure* (CHF). Left-side failure results in pulmonary edema with breathing difficulties (dyspnea); right-side failure causes peripheral edema with tissue swelling, especially in the legs, along with weight gain from fluid retention. Other symptoms of CHF are **cyanosis** and **syncope** (fainting).

Heart failure is treated with rest, drugs to strengthen heart contractions, diuretics to eliminate fluid, and restriction of salt in the diet.

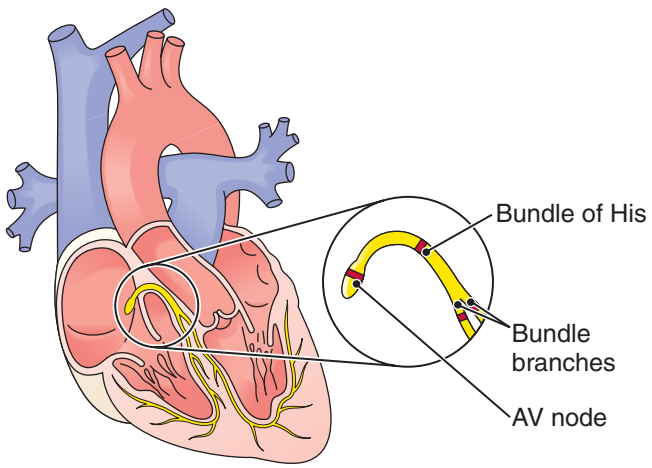

Figure 9-14 **Potential sites for heart block in the atrioventricular (AV) portion of the heart's conduction system.**

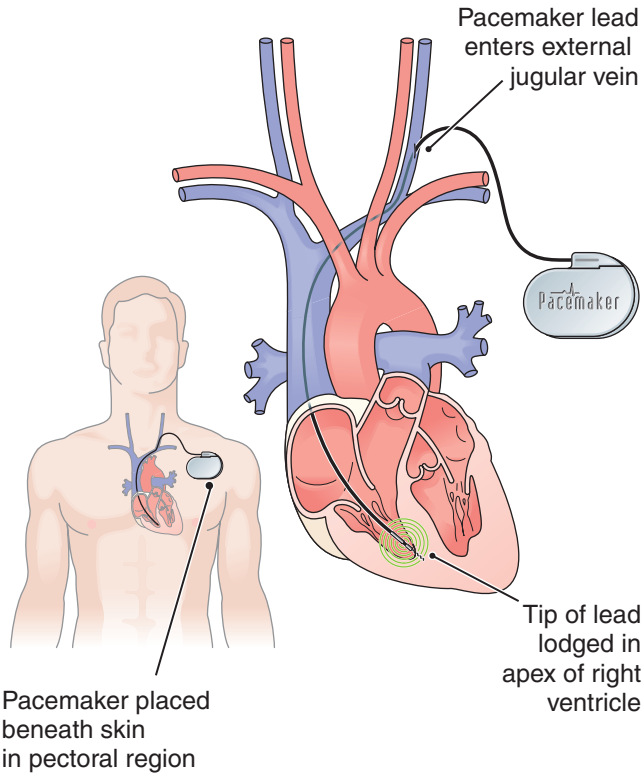

Figure 9-15 **Placement of a pacemaker.** The lead is placed in an atrium or ventricle, usually on the right side. A dual-chamber pacemaker has leads in both chambers.

PASSport to Success® See the animation *Heart Failure* on the Student Resources.

Heart failure is one cause of **shock**, a severe disturbance in the circulatory system resulting in inadequate blood delivery to the tissues. Shock is classified according to cause as:

- Cardiogenic shock, caused by heart failure
- Hypovolemic shock, caused by loss of blood volume
- Septic shock, caused by bacterial infection
- Anaphylactic shock, caused by severe allergic reaction

CONGENITAL HEART DISEASE

A congenital defect is any defect that is present at birth. The most common type of congenital heart defect is a **septal defect**, a hole in the septum (wall) that separates

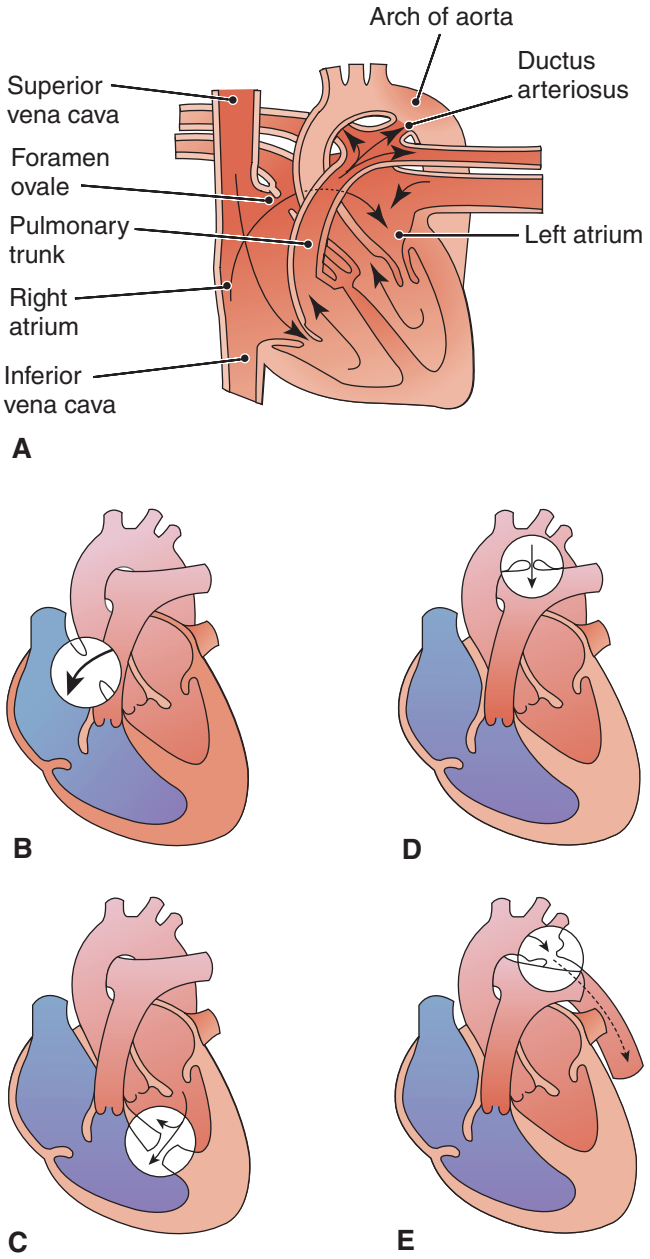

Figure 9-16 **Congenital heart defects.** (*A*) Normal fetal heart showing the foramen ovale and ductus arteriosus. (*B*) Persistence of the foramen ovale results in an atrial septal defect. (*C*) A ventricular septal defect. (*D*) Persistence of the ductus arteriosus (patent ductus arteriosus) forces blood back into the pulmonary artery. (*E*) Coarctation of the aorta restricts outward blood flow in the aorta.

the atria or the septum that separates the ventricles (Fig. 9-16). An atrial septal defect often results from persistence of an opening, the foramen ovale, that allows blood to bypass the lungs in fetal circulation. A septal defect permits blood to shunt from the left to the right side of the heart and return to the lungs instead of flowing out to the body. The heart has to work harder to meet the tissues' oxygen needs. Symptoms of septal defect include cyanosis (leading to the description "blue baby"), syncope, and **clubbing** of the fingers.

Another congenital defect that results from persistence of a fetal modification is **patent ductus arteriosus** (see Fig. 9-16D). In this case, a small bypass between the pulmonary artery and the aorta fails to close at birth. Blood then can flow from the aorta to the pulmonary artery and return to the lungs.

Heart valve malformation is another type of congenital heart defect. Failure of a valve to open or close properly is evidenced by a **murmur**, an abnormal sound heard as the heart cycles. A localized aortic narrowing, or **coarctation of the aorta**, is a congenital defect that restricts blood flow through that vessel (see Fig. 9-16E). Most of the congenital defects described can be corrected surgically.

RHEUMATIC HEART DISEASE

In **rheumatic heart disease**, infection with a specific type of streptococcus sets up an immune reaction that ultimately damages the heart valves. The infection usually begins as a "strep throat," and most often the mitral valve is involved. Scar tissue fuses the valve's leaflets, causing a narrowing or **stenosis** that interferes with proper function. People with rheumatic heart disease are subject to repeated valvular infections and may need to take antibiotics prophylactically (preventively) before invasive medical or dental procedures. Severe cases of rheumatic heart disease may require surgical correction or even valve replacement. The incidence of rheumatic heart disease has declined with the use of antibiotics.

Disorders of the Veins

A breakdown in the valves of the veins in combination with a chronic dilatation of these vessels results in **varicose veins** (Fig. 9-17). These appear twisted and swollen under

Figure 9-17 **Varicose veins.**

Box 9-3 Health Professions

Vascular Technology

Vascular technologists obtain information about the blood vessels and circulation to help physicians in the diagnosis of vascular disorders. They use a wide range of noninvasive instrumentation, mainly ultrasound, in their studies. Using ultrasound techniques, they obtain two-dimensional images of blood vessels and measure the speed and direction of blood flow (Doppler ultrasound). Using other instruments, they can measure blood pressure, changes in blood volume, and the blood's oxygen saturation. Based on clinical signs, they typically investigate circulation to the brain, extremities, or abdominal organs.

Most vascular technologists work in hospitals, where they prepare patients for tests, take clinical histories, perform physical examinations, carry out appropriate tests, and report results. They may also work in offices, clinics, or laboratories. Many of their patients are debilitated or critically ill and may need mobile service and/or assistance to undergo testing.

Unlike early workers in this field who often were trained on the job, most vascular technologists today complete a 2- or 4-year educational program accredited by the Commission on Accreditation of Allied Health Education Programs (CAAHEP). Certification specific to vascular technology is available from the American Registry for Diagnostic Medical Sonography at www.ardms.org and from other organizations. Certification requires appropriate education, clinical experience, examination, and continuing education. Additional information on this career is available from the Society for Vascular Ultrasound at www.svunet.org.

the skin, most commonly in the legs. Contributing factors include heredity, obesity, prolonged standing, and pregnancy, which increases pressure in the pelvic veins. Varicosities can impede blood flow and lead to edema, thrombosis, hemorrhage, or ulceration. Treatment includes the wearing of elastic stockings and, in some cases, surgical removal of the varicose veins, after which collateral circulation is naturally established. A varicose vein in the rectum or anal canal is referred to as a **hemorrhoid**.

Phlebitis is any inflammation of the veins and may be caused by infection, injury, poor circulation, or damage to valves in the veins. Such inflammation typically initiates blood clot formation, resulting in **thrombophlebitis**. Any veins are subject to thrombophlebitis, but the more serious condition involves the deep veins as opposed to the superficial veins, in the condition termed **deep vein thrombosis** (DVT). The most common sites for DVT are the deep leg veins, causing serious reduction in venous drainage from these areas.

Vascular technologists obtain information on the blood vessels and circulation to aid in diagnosis. See Box 9-3 for information on this career.

Terminology Key Terms

Cardiovascular Disorders

aneurysm *AN-ū-rizm*	A localized abnormal dilation of a blood vessel, usually an artery, caused by weakness of the vessel wall; may eventually burst
angina pectoris *an-JĪ-na PEK-tō-ris*	A feeling of constriction around the heart or pain that may radiate to the left arm or shoulder, usually brought on by exertion; caused by insufficient blood supply to the heart
arrhythmia *a-RITH-mē-a*	Any abnormality in the rate or rhythm of the heartbeat (literally "without rhythm"; note doubled r). Also called *dysrhythmia*
arteriosclerosis *ar-tēr-ē-ō-skler-Ō-sis*	Hardening (sclerosis) of the arteries, with loss of capacity and loss of elasticity, as from fatty deposits (plaque), deposit of calcium salts, or scar tissue formation
atherosclerosis *ath-er-ō-skler-Ō-sis*	The development of fatty, fibrous patches (plaques) in the lining of arteries, causing narrowing of the lumen and hardening of the vessel wall. The most common form of arteriosclerosis is hardening of the arteries. The root *ather/o* means "porridge" or "gruel"
bradycardia *brad-ē-KAR-dē-a*	A slow heart rate, of less than 60 bpm

(continued)

Terminology Key Terms *(continued)*

cerebrovascular accident (CVA) *ser-e-brō-VAS-kū-lar*	Sudden damage to the brain resulting from reduction of blood flow. Causes include atherosclerosis, embolism, thrombosis, or hemorrhage from a ruptured aneurysm; commonly called stroke
clubbing *KLUB-ing*	Enlargement of the ends of the fingers and toes caused by growth of the soft tissue around the nails (see Fig. 7-12). Seen in a variety of diseases in which there is poor peripheral circulation
coarctation of the aorta *kō-ark-TĀ-shun*	Localized narrowing of the aorta with restriction of blood flow (see Fig. 9-16E)
C-reactive protein (CRP)	Protein produced during systemic inflammation, which may contribute to atherosclerosis; high CRP levels can indicate cardiovascular disease and its prognosis
cyanosis *sī-a-NŌ-sis*	Bluish discoloration of the skin caused by lack of oxygen (see Fig. 3-4)
deep vein thrombosis (DVT)	Thrombophlebitis involving the deep veins
diaphoresis *dī-a-fō-RĒ-sis*	Profuse sweating
dissecting aneurysm	An aneurysm in which blood enters the arterial wall and separates the layers. Usually involves the aorta (see Fig. 9-9)
dyslipidemia *dis-lip-i-DĒ-mē-a*	Disorder in serum lipid levels, which is an important factor in development of atherosclerosis. Includes hyperlipidemia (high lipids), hypercholesterolemia (high cholesterol), and hypertriglyceridemia (high triglycerides)
dyspnea *DYSP-nē-a*	Difficult or labored breathing (-pnea)
edema *e-DĒ-ma*	Swelling of body tissues caused by the presence of excess fluid (see Fig. 6-4). Causes include cardiovascular disturbances, kidney failure, inflammation, and malnutrition
embolism *EM-bō-lizm*	Obstruction of a blood vessel by a blood clot or other matter carried in the circulation
embolus *EM-bō-lus*	A mass carried in the circulation. Usually a blood clot, but also may be air, fat, bacteria, or other solid matter from within or from outside the body
fibrillation *fi-bri-LĀ-shun*	Spontaneous, quivering, and ineffectual contraction of muscle fibers, as in the atria or the ventricles
heart block	An interference in the conduction system of the heart resulting in arrhythmia (see Fig. 9-14)
heart failure	A condition caused by the inability of the heart to maintain adequate blood circulation
hemorrhoid *HEM-ō-royd*	A varicose vein in the rectum
hypertension *hī-per-TEN-shun*	A condition of higher-than-normal blood pressure. Essential (primary, idiopathic) hypertension has no known cause
infarct *in-FARKT*	An area of localized tissue necrosis (death) resulting from a blockage or a narrowing of the artery that supplies the area
ischemia *is-KĒ-mē-a*	Local deficiency of blood supply caused by circulatory obstruction (root: *hem/o*)
murmur	An abnormal heart sound
myocardial infarction (MI) *mī-ō-KAR-dē-al in-FARK-shun*	Localized necrosis (death) of cardiac muscle tissue resulting from blockage or narrowing of the coronary artery that supplies that area. Myocardial infarction is usually caused by formation of a thrombus (clot) in a vessel (see Fig. 9-13)

Terminology Key Terms *(continued)*

occlusion *ō-KLŪ-zhun*	A closing off or obstruction, as of a vessel
patent ductus arteriosus *PĀ-tent DUK-tus ar-tēr-ē-Ō-sus*	Persistence of the ductus arteriosus after birth. The ductus arteriosus is a vessel that connects the pulmonary artery to the descending aorta in the fetus to bypass the lungs (see Fig. 9-16D)
phlebitis *fle-BĪ-tis*	Inflammation of a vein
plaque *plak*	A patch. With regard to the cardiovascular system, a deposit of fatty material and other substances on a vessel wall that impedes blood flow and may block the vessel. Atheromatous plaque
rheumatic heart disease *rū-MAT-ik*	Damage to heart valves after infection with a type of streptococcus (group A hemolytic streptococcus). The antibodies produced in response to the infection produce valvular scarring, usually involving the mitral valve
septal defect *SEP-tal*	An opening in the septum between the atria or ventricles; a common cause is persistence of the foramen ovale (*for-Ā-men ō-VAL-ē*), an opening between the atria that bypasses the lungs in fetal circulation (see Fig. 9-16B and C)
shock	Circulatory failure resulting in an inadequate blood supply to the tissues. Cardiogenic shock is caused by heart failure; hypovolemic shock is caused by a loss of blood volume; septic shock is caused by bacterial infection
sinus rhythm *SĪ-nus*	A normal heart rhythm originating from the sinoatrial (SA) node
stenosis *ste-NŌ-sis*	Constriction or narrowing of an opening
stroke	See *cerebrovascular accident*
syncope *SIN-kō-pē*	A temporary loss of consciousness caused by inadequate blood flow to the brain; fainting
tachycardia *tak-i-KAR-dē-a*	An abnormally rapid heart rate, usually over 100 bpm
thrombophlebitis *throm-bō-fle-BĪ-tis*	Inflammation of a vein associated with formation of a blood clot
thrombosis *throm-BŌ-sis*	Development of a blood clot within a vessel
thrombus *THROM-bus*	A blood clot that forms within a blood vessel (root: *thromb/o*)
varicose vein *VAR-i-kōs*	A twisted and swollen vein resulting from breakdown of the valves, pooling of blood, and chronic dilatation of the vessel (root: *varic/o*); also called varix (*VAR-iks*) or varicosity (*var-i-KOS-i-tē*) (see Fig. 9-17)

Diagnosis and Treatment

angioplasty *AN-jē-ō-plas-tē*	A procedure that reopens a narrowed vessel and restores blood flow. Commonly accomplished by surgically removing plaque, inflating a balloon within the vessel, or installing a device (stent) to keep the vessel open (see Figs. 9-10 and 9-11)
artificial pacemaker	A battery-operated device that generates electrical impulses to regulate the heartbeat. It may be external or implanted, may be designed to respond to need, and may have the capacity to prevent tachycardia (see Fig. 9-15)
cardiopulmonary resuscitation (CPR) *rē-sus-i-TĀ-shun*	Restoration of cardiac output and pulmonary ventilation after cardiac arrest using artificial respiration and chest compression or cardiac massage

(continued)

Terminology Key Terms *(continued)*

cardioversion *KAR-dē-ō-ver-zhun*	Correction of an abnormal cardiac rhythm. May be accomplished pharmacologically, with antiarrhythmic drugs, or by application of electric current (see defibrillation)
coronary angiography *an-jē-OG-ra-fē*	Radiographic study of the coronary arteries after introduction of an opaque dye by means of a catheter
coronary artery bypass graft (CABG)	Surgical creation of a shunt to bypass a blocked coronary artery. The aorta is connected to a point past the obstruction with another vessel or a piece of another vessel, usually the left internal mammary artery or part of the leg's saphenous vein (see Fig. 9-12)
creatine kinase MB (CK-MB) *krē-a-tin KĪ-nāz*	Enzyme released in increased amounts from cardiac muscle cells following myocardial infarction (MI). Serum assays help diagnose MI and determine the extent of muscle damage
defibrillation *dē-fib-ri-LĀ-shun*	Use of an electronic device (defibrillator) to stop fibrillation by delivering a brief electric shock to the heart. The shock may be delivered to the surface of the chest, as by an automated external defibrillator (AED), or directly into the heart through wire leads, using an implantable cardioverter defibrillator (ICD)
echocardiography *ek-ō-kar-dē-OG-ra-fē*	A noninvasive method that uses ultrasound to visualize internal cardiac structures
lipoprotein *lip-ō-PRŌ-tēn*	A compound of protein with lipid. Lipoproteins are classified according to density as very-low-density (VLDL), low-density (LDL), and high-density (HDL). Relatively higher levels of HDLs have been correlated with cardiovascular health
percutaneous transluminal coronary angioplasty (PTCA)	Dilatation of a sclerotic blood vessel by means of a balloon catheter inserted into the vessel and then inflated to flatten plaque against the arterial wall (see Fig. 9-10)
stent	A small metal device in the shape of a coil or slotted tube that is placed inside an artery to keep the vessel open after balloon angioplasty (see Fig. 9-11)
stress test	Evaluation of physical fitness by continuous ECG monitoring during exercise. In a thallium stress test, a radioactive isotope of thallium is administered to trace blood flow through the heart during exercise
troponin (Tn) *trō-PŌ-nin*	A protein in muscle cells that regulates contraction. Increased serum levels, primarily in the forms TnT and TnI, indicate recent myocardial infarction (MI)

PASSport to Success® Go to the pronunciation glossary on the Student Resources to hear these words pronounced.

The Lymphatic System

The lymphatic system is a widely distributed system with multiple functions (Fig. 9-18). Its role in circulation is to return excess fluid and proteins from the tissues to the bloodstream. Blind-ended lymphatic capillaries pick up these materials in the tissues and carry them into larger vessels (Fig. 9-19). The fluid carried in the lymphatic system is called **lymph**. Lymph drains from the lower part of the body and the upper left side into the **thoracic duct** (left lymphatic duct), which travels upward through the chest and empties into the left subclavian vein near the heart (see Fig. 9-18). The **right lymphatic duct** drains the body's upper right side and empties into the right subclavian vein.

Another major function of the lymphatic system is to protect the body from impurities and invading microorganisms (see discussion of immunity in Chapter 10). Along the path of the lymphatic vessels are small masses of lymphoid tissue, the **lymph nodes** (Fig. 9-20). Their function is to filter the lymph as it passes through. They are concentrated in the cervical (neck), axillary

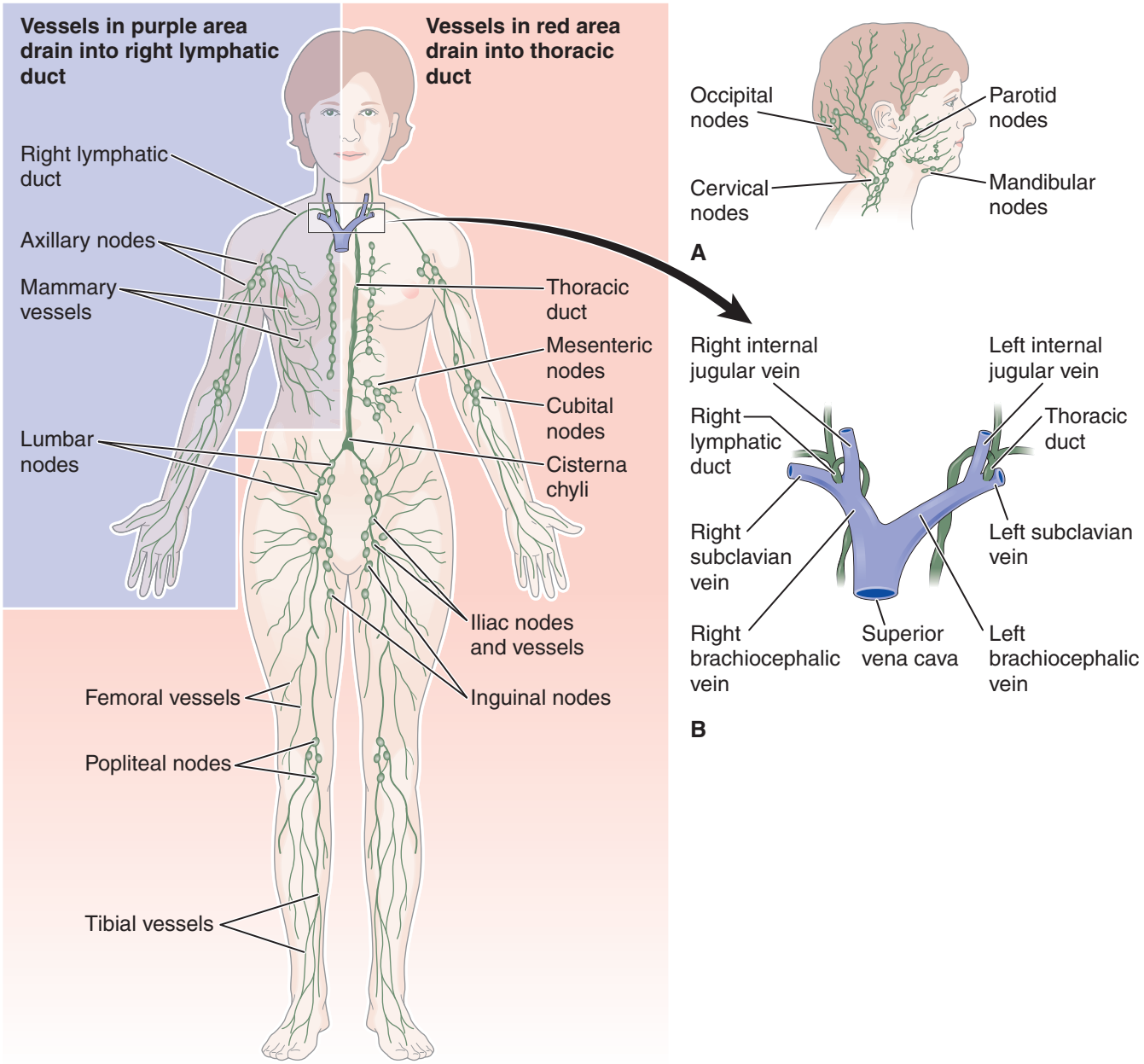

Figure 9-18 **Lymphatic system.** (*A*) Lymph nodes and vessels of the head. (*B*) Drainage of the right lymphatic duct and the thoracic duct into the subclavian veins.

(armpit), mediastinal (chest), and inguinal (groin) regions. Other protective organs and tissues of the lymphatic system include the:

- **Tonsils,** located in the throat (pharynx). They filter inhaled or swallowed materials and aid in immunity early in life. The tonsils are further discussed in Chapter 11.
- **Thymus gland** in the chest, above the heart. It processes and stimulates lymphocytes active in immunity.
- **Spleen** in the upper left region of the abdomen. It filters blood and destroys old red blood cells.
- **Appendix,** attached to the large intestine. It may aid in the development of immunity.
- **Peyer patches,** in the lining of the intestine. They help protect against invading microorganisms.

A final function of the lymphatic system is to absorb digested fats from the small intestine (see Chapter 12). These fats are then added to the blood with the lymph that drains from the thoracic duct.

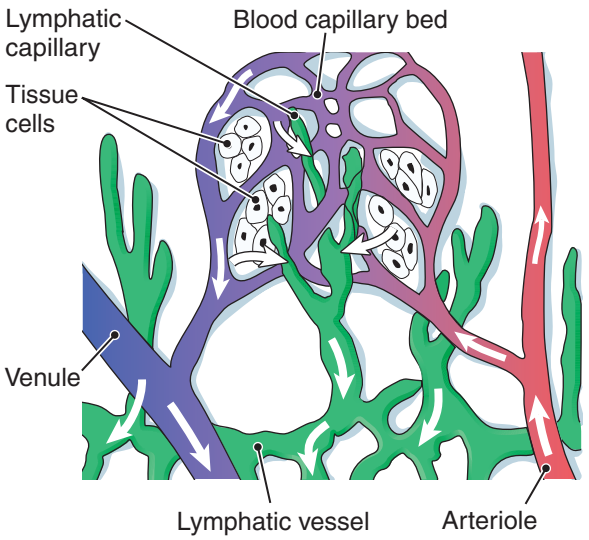

Figure 9-19 **Lymphatic drainage in the tissues.** Lymphatic capillaries pick up fluid and proteins left in the tissues and carry them back to the bloodstream.

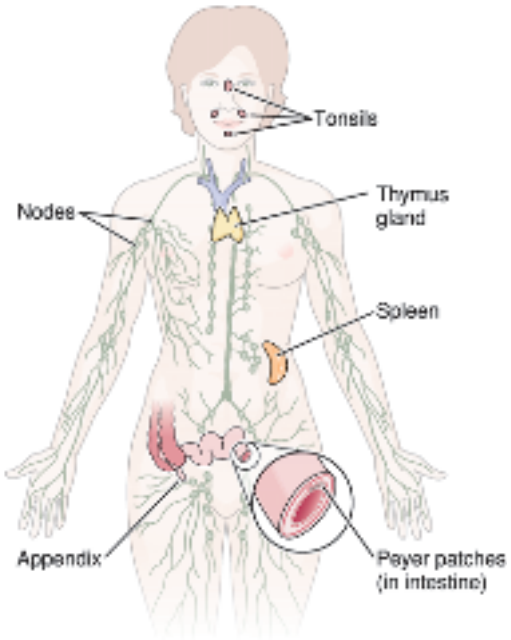

Figure 9-20 **Location of lymphoid tissue.**

Terminology Key Terms

LYMPHATIC SYSTEM

Normal Structure and Function

appendix *a-PEN-diks*	A small, fingerlike mass of lymphoid tissue attached to the first part of the large intestine
lymph *limf*	The thin plasmalike fluid that drains from the tissues and is transported in lymphatic vessels (root: *lymph/o*)
lymph node	A small mass of lymphoid tissue along the path of a lymphatic vessel that filters lymph (root: *lymphaden/o*)
lymphatic system *lim-FAT-ik*	The system that drains fluid and proteins from the tissues and returns them to the bloodstream. This system also participates in immunity and aids in absorption of fats from the digestive tract
Peyer patches *PĪ-er*	Aggregates of lymphoid tissue in the lining of the intestine
right lymphatic duct	The lymphatic duct that drains fluid from the body's upper right side
spleen	A large reddish-brown organ in the upper left region of the abdomen. It filters blood and destroys old red blood cells (root: *splen/o*)
thoracic duct	The lymphatic duct that drains fluid from the upper left side of the body and all of the lower body; left lymphatic duct
thymus gland *THĪ-mus*	A gland in the upper part of the chest beneath the sternum. It functions in immunity (root: *thym/o*)
tonsils *TON-silz*	Small masses of lymphoid tissue located in regions of the throat (pharynx)

PASSport to Success® Go to the pronunciation glossary on the Student Resources to hear these words pronounced.

Roots Pertaining to the Lymphatic System

See Table 9-3.

Table 9-3 Roots for the Lymphatic System

Root	Meaning	Example	Definition of Example
lymph/o	lymph, lymphatic system	lymphoid *LIM-foyd*	resembling lymph or lymphatic tissue
lymphaden/o	lymph node	lymphadenitis *lim-fad-e-NĪ-tis*	inflammation of a lymph node
lymphangi/o	lymphatic vessel	lymphangiogram *lim-FAN-jē-ō-gram*	x-ray image of lymphatic vessels
splen/o	spleen	splenalgia *splē-NAL-jē-a*	pain in the spleen
thym/o	thymus gland	athymia *a-THĪ-mē-a*	absence of the thymus gland
tonsill/o	tonsil	tonsillar *TON-sil-ar*	pertaining to a tonsil

9

EXERCISE 9-3

Fill in the blanks:

1. Lymphedema (*limf-e-DĒ-ma*) means swelling caused by obstruction of the flow of _____.
2. Lymphadenectomy (*lim-fad-e-NEK-tō-mē*) is surgical removal of a(n) _____.
3. A lymphangioma (*lim-fan-jē-Ō-ma*) is a tumor of _____.
4. The adjective *splenic* (*SPLEN-ik*) means pertaining to the _____.
5. Thymectomy (*thī-MEK-tō-mē*) is surgical removal of the _____.
6. Tonsillopathy (*ton-sil-OP-a-thē*) is any disease of the _____.

Identify and define the root in the following words:

	Root	Meaning of Root
7. lymphangial (*lim-FAN-jē-al*)	lymphangi/o	lymphatic vessel
8. perisplenitis (*per-i-splē-NĪ-tis*)		
9. lymphadenography (*lim-fad-e-NOG-ra-fē*)		
10. tonsillectomy (*ton-sil-EK-tō-mē*)		
11. hypothymism (*hī-pō-THĪ-mizm*)		

Use the appropriate root to write words with the following meanings:

12. Inflammation of lymphatic vessels _____
13. A tumor (-oma) of lymphatic tissue _____
14. Any disease (-pathy) of the lymph nodes _____
15. Enlargement (-megaly) of the spleen _____
16. Pertaining to (-ic) the thymus gland _____
17. Inflammation of a tonsil _____

Clinical Aspects of the Lymphatic System

Changes in the lymphatic system are often related to infection and may consist of inflammation and enlargement of the nodes, called **lymphadenitis**, or inflammation of the vessels, called **lymphangiitis**. Obstruction of lymphatic vessels because of surgical excision or infection results in tissue swelling, or **lymphedema** (see Box 9-4). Any neoplastic disease involving lymph nodes is termed **lymphoma**. These neoplastic disorders affect the white cells found in the lymphatic system, and they are discussed more fully in Chapter 10.

Terminology Key Clinical Terms

Lymphatic Disorders

lymphadenitis *lim-fad-e-NĪ-tis*	Inflammation and enlargement of lymph nodes, usually as a result of infection
lymphangiitis *lim-fan-jē-Ī-tis*	Inflammation of lymphatic vessels as a result of bacterial infection. Appears as painful red streaks under the skin (also spelled *lymphangitis*)
lymphedema *lim-fe-DĒ-ma*	Swelling of tissues with lymph caused by obstruction or excision of lymphatic vessels (see Box 9-4)
lymphoma *lim-FŌ-ma*	Any neoplastic disease of lymphoid tissue

PASSport to Success® Go to the pronunciation glossary on the Student Resources to hear these words pronounced.

Box 9-4 Clinical Perspectives

Lymphedema: When Lymph Stops Flowing

Fluid balance in the body requires appropriate distribution of fluid among the cardiovascular system, lymphatic system, and the tissues. **Edema** occurs when the balance is tipped toward excess fluid in the tissues. Often, edema is due to heart failure. However, blockage of lymphatic vessels (with resulting fluid accumulation in the tissues) can cause another form of edema, called **lymphedema**. The clinical hallmark of lymphedema is chronic swelling of an arm or leg, whereas heart failure usually causes swelling of both legs.

Lymphedema may be either primary or secondary. Primary lymphedema is a rare congenital condition caused by abnormal development of lymphatic vessels. Secondary lymphedema, or acquired lymphedema, can develop as a result of trauma to a limb, surgery, radiation therapy, or infection of the lymphatic vessels (lymphangitis). One of the most common causes of lymphedema is the removal of axillary lymph nodes during mastectomy, which disrupts lymph flow from the adjacent arm. Lymphedema may also occur following prostate surgery.

Therapies that encourage the flow of fluid through the lymphatic vessels are useful in treating lymphedema. These therapies may include elevation of the affected limb, manual lymphatic drainage through massage, light exercise, and firm wrapping of the limb to apply compression. In addition, changes in daily habits can lessen the effects of lymphedema. For example, further blockage of lymph drainage can be prevented by wearing loose clothing and jewelry, carrying a purse or handbag on the unaffected arm, and not crossing the legs when sitting. Lymphangitis requires the use of appropriate antibiotics. Prompt treatment is necessary because, in addition to swelling, other complications include poor wound healing, skin ulcers, and increased risk of infection.

Terminology Supplementary Terms

Normal Structure and Function

apical pulse	Pulse felt or heard over the heart's apex. It is measured in the fifth left intercostal space (between the ribs) about 8 to 9 cm from the midline
cardiac output	The amount of blood pumped from the right or left ventricle per minute
Korotkoff sounds *ko-ROT-kof*	Arterial sounds heard with a stethoscope during determination of blood pressure with a cuff
perfusion *per-FŪ-zhun*	The passage of fluid, such as blood, through an organ or tissue
precordium *prē-KOR-dē-um*	The anterior region over the heart and the lower part of the thorax; adjective: precordial
pulse pressure	The difference between systolic and diastolic pressure
stroke volume	The amount of blood ejected by the left ventricle with each beat
Valsalva maneuver *val-SAL-va*	Bearing down, as in childbirth or defecation, by attempting to exhale forcefully with the nose and throat closed. This action has an effect on the cardiovascular system

Symptoms and Conditions

bruit *brwē*	An abnormal sound heard in auscultation
cardiac tamponade *tam-pon-ĀD*	Pathologic accumulation of fluid in the pericardial sac. May result from pericarditis or injury to the heart or great vessels
ectopic beat *ek-TOP-ik*	A heartbeat that originates from some part of the heart other than the SA node
extrasystole *eks-tra-SIS-tō-lē*	Premature heart contraction that occurs separately from the normal beat and originates from a part of the heart other than the SA node
flutter	Very rapid (200 to 300 bpm) but regular contractions, as in the atria or the ventricles
hypotension *hī-po-TEN-shun*	A condition of lower-than-normal blood pressure
intermittent claudication *claw-di-KĀ-shun*	Pain in a muscle during exercise caused by inadequate blood supply. The pain disappears with rest
mitral valve prolapse	Movement of the mitral valve cusps into the left atrium when the ventricles contract
occlusive vascular disease	Arteriosclerotic disease of the vessels, usually peripheral vessels
palpitation *pal-pi-TĀ-shun*	A sensation of abnormally rapid or irregular heartbeat
pitting edema	Edema that retains the impression of a finger pressed firmly into the skin (Fig. 9-21)
polyarteritis nodosa *nō-DŌ-sa*	Potentially fatal collagen disease causing inflammation of small visceral arteries. Symptoms depend on the organ affected
Raynaud disease *rā-NŌ*	A disorder characterized by abnormal constriction of peripheral vessels in the arms and legs on exposure to cold
regurgitation *rē-gur-ji-TĀ-shun*	A backward flow, such as the backflow of blood through a defective valve
stasis *STĀ-sis*	Stoppage of normal flow, as of blood or urine. Blood stasis may lead to dermatitis and ulcer formation
subacute bacterial endocarditis (SBE)	Bacterial growth in a heart or valves previously damaged by rheumatic fever
tetralogy of Fallot *fal-Ō*	A combination of four congenital heart abnormalities: pulmonary artery stenosis, interventricular septal defect, displacement of the aorta to the right, and right ventricular hypertrophy

(continued)

Terminology — Supplementary Terms *(continued)*

thromboangiitis obliterans	Inflammation and thrombus formation resulting in occlusion of small vessels, especially in the legs. Most common in young men and correlated with heavy smoking. Thrombotic occlusion of leg vessels may lead to gangrene of the feet. Patients show a hypersensitivity to tobacco. Also called *Buerger disease*
vegetation	Irregular bacterial outgrowths on the heart valves; associated with rheumatic fever
Wolff–Parkinson–White syndrome (WPW)	A cardiac arrhythmia consisting of tachycardia and a premature ventricular beat caused by an alternative conduction pathway

Diagnosis

cardiac catheterization	Passage of a catheter into the heart through a vessel to inject a contrast medium for imaging, diagnosis, obtaining samples, or measuring pressure
central venous pressure (CVP)	Pressure in the superior vena cava
cineangiocardiography *sin-e-an-jē-ō-kar-dē-OG-ra-fē*	The photographic recording of fluoroscopic images of the heart and large vessels using motion picture techniques
Computed tomography angiography (CTA)	Method for imaging the interior of arteries using computed tomography; uses less dye and is less invasive than standard angiography
Doppler echocardiography	An imaging method used to study the rate and pattern of blood flow
heart scan	Imaging of the heart after injection of a radioactive isotope. The PYP (pyrophosphate) scan using technetium-99m (^{99m}Tc) is used to test for myocardial infarction because the isotope is taken up by damaged tissue. The MUGA (multigated acquisition) scan gives information on heart function
Holter monitor	A portable device that can record up to 24 hours of an individual's ECG readings during normal activity
homocysteine *hō-mō-SIS-tēn*	An amino acid in the blood that at higher-than-normal levels is associated with increased risk of cardiovascular disease
phlebotomist *fle-BOT-ō-mist*	Technician who specializes in drawing blood
phonocardiography *fō-nō-kar-dē-OG-ra-fē*	Electronic recording of heart sounds
plethysmography *ple-thiz-MOG-ra-fē*	Measurement of changes in the size of a part based on the amount of blood contained in or passing through it. Impedance plethysmography measures changes in electrical resistance and is used in the diagnosis of deep vein thrombosis
pulmonary capillary wedge pressure (PCWP)	Pressure measured by a catheter in a branch of the pulmonary artery. It is an indirect measure of pressure in the left atrium (see Box 9-2)
Swan–Ganz catheter	A cardiac catheter with a balloon at the tip that is used to measure pulmonary arterial pressure. It is flow guided through a vein into the right side of the heart and then into the pulmonary artery
transesophageal echocardiography (TEE)	Use of an ultrasound transducer placed endoscopically into the esophagus to obtain images of the heart
triglycerides *trī-GLIS-er-īdz*	Simple fats that circulate in the bloodstream
ventriculography *ven-trik-ū-LOG-ra-fē*	X-ray study of the heart's ventricles after introduction of an opaque dye by means of a catheter

Treatment and Surgical Procedures

atherectomy *ath-er-EK-tō-mē*	Removal of atheromatous plaque from the lining of a vessel. May be done by open surgery or through the vessel's lumen

(continued)

Terminology Supplementary Terms *(continued)*

commissurotomy *kom-i-shur-OT-ō-mē*	Surgical incision of a scarred mitral valve to increase the size of the valvular opening
embolectomy *em-bō-LEK-tō-mē*	Surgical removal of an embolus
intraaortic balloon pump (IABP)	A mechanical assist device that consists of an inflatable balloon pump inserted through the femoral artery into the thoracic aorta. It inflates during diastole to improve coronary circulation and deflates before systole to allow blood ejection from the heart
left ventricular assist device (LVAD)	A pump that takes over the left ventricle's function in delivering blood into the systemic circuit. These devices are used to assist patients awaiting heart transplantation or those who are recovering from heart failure

Drugs

angiotensin-converting enzyme (ACE) inhibitor	A drug that lowers blood pressure by blocking the formation of angiotensin II, a substance that normally acts to increase blood pressure
angiotensin receptor blocker (ARB)	A drug that blocks tissue receptors for angiotensin II; angiotensin II receptor antagonist
antiarrhythmic agent	A drug that regulates the rate and rhythm of the heartbeat
beta-adrenergic blocking agent	Drug that decreases the rate and strength of heart contractions; beta-blocker
calcium-channel blocker	Drug that controls the rate and force of heart contraction by regulating calcium entrance into the cells
digitalis *dij-i-TAL-is*	A drug that slows and strengthens heart muscle contractions
diuretic *dī-ū-RET-ik*	Drug that eliminates fluid by increasing the kidneys' output of urine. Lowered blood volume decreases the heart's workload
hypolipidemic agent *hī-pō-lip-i-DĒ-mik*	Drug that lowers serum cholesterol
lidocaine *LĪ-dō-kān*	A local anesthetic that is used intravenously to treat cardiac arrhythmias
loop diuretic	Drug that increases urine output by inhibiting electrolyte reabsorption in the kidney nephrons (loops) (see Chapter 13)
nitroglycerin *nī-trō-GLIS-er-in*	A drug used in the treatment of angina pectoris to dilate coronary vessels
statins	Drugs that act to lower lipids in the blood. The drug names end with *-statin*, such as lovastatin, pravastatin, atorvastatin
streptokinase (SK) *strep-tō-KĪ-nās*	An enzyme used to dissolve blood clots
tissue plasminogen activator (tPA)	A drug used to dissolve blood clots. It activates production of a substance (plasmin) in the blood that normally dissolves clots
vasodilator *vas-ō-dī-LĀ-tor*	A drug that widens blood vessels and improves blood flow

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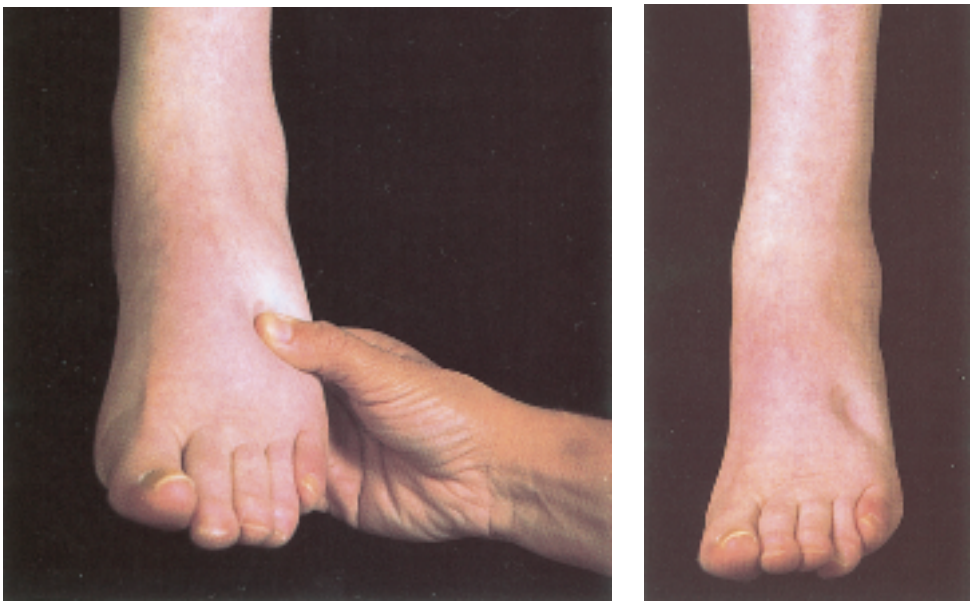
Go to the pronunciation glossary on the Student Resources to hear these words pronounced.



A B

Figure 9-21 **Pitting edema.** When the skin is pressed firmly with the finger (*A*), a pit remains after the finger is removed (*B*).

Terminology Abbreviations

ACE	Angiotensin-converting enzyme
AED	Automated external defibrillator
AF	Atrial fibrillation
AMI	Acute myocardial infarction
APC	Atrial premature complex
AR	Aortic regurgitation
ARB	Angiotensin receptor blocker
AS	Aortic stenosis; arteriosclerosis
ASCVD	Arteriosclerotic cardiovascular disease
ASD	Atrial septal defect
ASHD	Arteriosclerotic heart disease
AT	Atrial tachycardia
AV	Atrioventricular
BBB	Bundle branch block (left or right)
BP	Blood pressure
bpm	Beats per minute
CABG	Coronary artery bypass graft
CAD	Coronary artery disease
CCU	Coronary/cardiac care unit
CHD	Coronary heart disease
CHF	Congestive heart failure
CK-MB	Creatine kinase MB
CPR	Cardiopulmonary resuscitation
CRP	C-reactive protein
CTA	Computed tomography angiography
CVA	Cerebrovascular accident
CVD	Cardiovascular disease
CVI	Chronic venous insufficiency
CVP	Central venous pressure
DOE	Dyspnea on exertion
DVT	Deep vein thrombosis
ECG (EKG)	Electrocardiogram, electrocardiography
HDL	High-density lipoprotein
hs-CRP	High-sensitivity C-reactive protein (test)
HTN	Hypertension
IABP	Intraaortic balloon pump
ICD	Implantable cardioverter–defibrillator
IVCD	Intraventricular conduction delay
JVP	Jugular venous pulse
LAD	Left anterior descending (coronary artery)

(continued)

Terminology Abbreviations *(continued)*

LAHB	Left anterior hemiblock
LDL	Low-density lipoprotein
LV	Left ventricle
LVAD	Left ventricular assist device
LVEDP	Left ventricular end-diastolic pressure
LVH	Left ventricular hypertrophy
MI	Myocardial infarction
mm Hg	Millimeters of mercury
MR	Mitral regurgitation, reflux
MS	Mitral stenosis
MUGA	Multigated acquisition (scan)
MVP	Mitral valve prolapse
MVR	Mitral valve replacement
NSR	Normal sinus rhythm
P	Pulse
PAC	Premature atrial contraction
PAP	Pulmonary arterial pressure
PCI	Percutaneous coronary intervention
PCWP	Pulmonary capillary wedge pressure
PMI	Point of maximal impulse
PSVT	Paroxysmal supraventricular tachycardia
PTCA	Percutaneous transluminal coronary angioplasty
PVC	Premature ventricular contraction
PVD	Peripheral vascular disease
PYP	Pyrophosphate (scan)
S_1	First heart sound
S_2	Second heart sound
SA	Sinoatrial
SBE	Subacute bacterial endocarditis
SK	Streptokinase
SVT	Supraventricular tachycardia
^{99m}Tc	Technetium-99m
TEE	Transesophageal echocardiography
Tn	Troponin
tPA	Tissue plasminogen activator
VAD	Ventricular assist device
VF, v fib	Ventricular fibrillation
VLDL	Very-low-density lipoprotein
VPC	Ventricular premature complex
VSD	Ventricular septal defect
VT	Ventricular tachycardia
VTE	Venous thromboembolism
WPW	Wolff–Parkinson–White syndrome

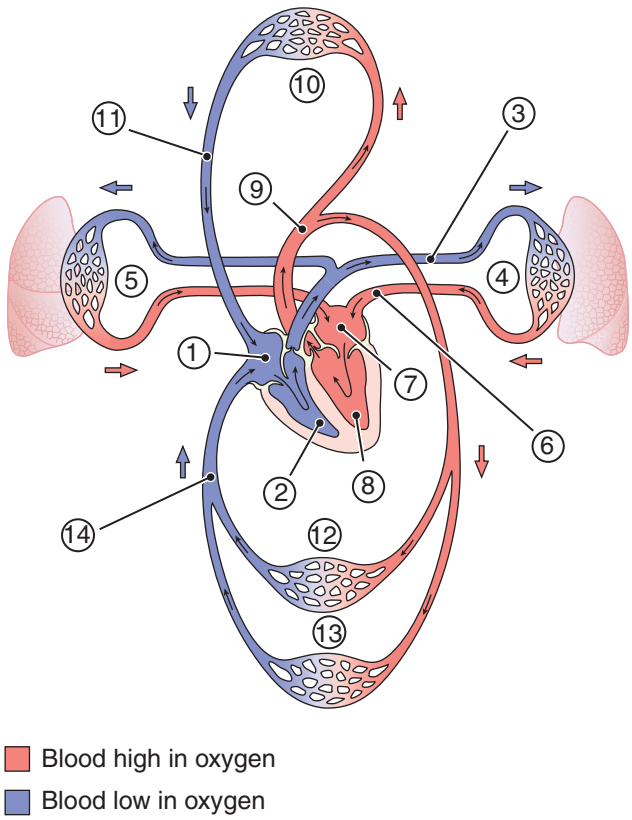
Chapter Review

LABELING EXERCISE

The Cardiovascular System > Write the name of each numbered part on the corresponding line of the answer sheet:

Aorta
Head and arms
Inferior vena cava
Internal organs
Left atrium
Left lung
Left pulmonary artery
Left pulmonary vein
Left ventricle
Legs
Right atrium
Right lung
Right ventricle
Superior vena cava

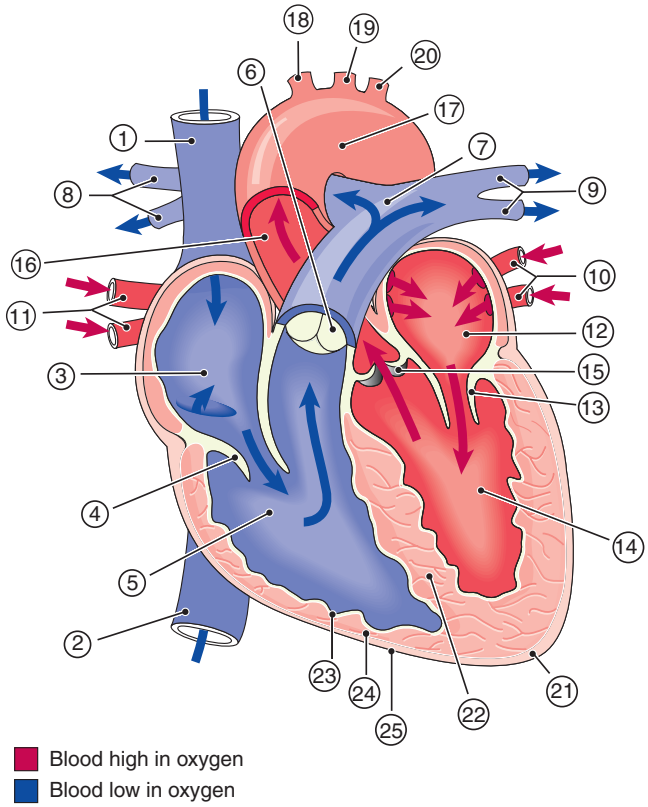
1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____



Chapter Review *(continued)*

The Heart and Great Vessels > Write the name of each numbered part on the corresponding line of the answer sheet.

Aortic arch
Aortic valve
Apex
Ascending aorta
Brachiocephalic artery
Endocardium
Epicardium
Inferior vena cava
Interventricular septum
Left atrium
Left AV (mitral) valve
Left common carotid artery
Left pulmonary artery (branches)
Left pulmonary veins
Left subclavian artery
Left ventricle
Myocardium
Pulmonary artery
Pulmonary valve
Right atrium
Right AV (tricuspid) valve
Right pulmonary artery (branches)
Right pulmonary veins
Right ventricle
Superior vena cava



1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____
16. _____
17. _____
18. _____
19. _____
20. _____
21. _____
22. _____
23. _____
24. _____
25. _____

Chapter Review *(continued)*

Location of Lymphoid Tissue **> Write the name of each numbered part on the corresponding line of the answer sheet:**

Appendix
Nodes
Peyer patches (in intestine)
Spleen
Thymus gland
Tonsils

1. _____

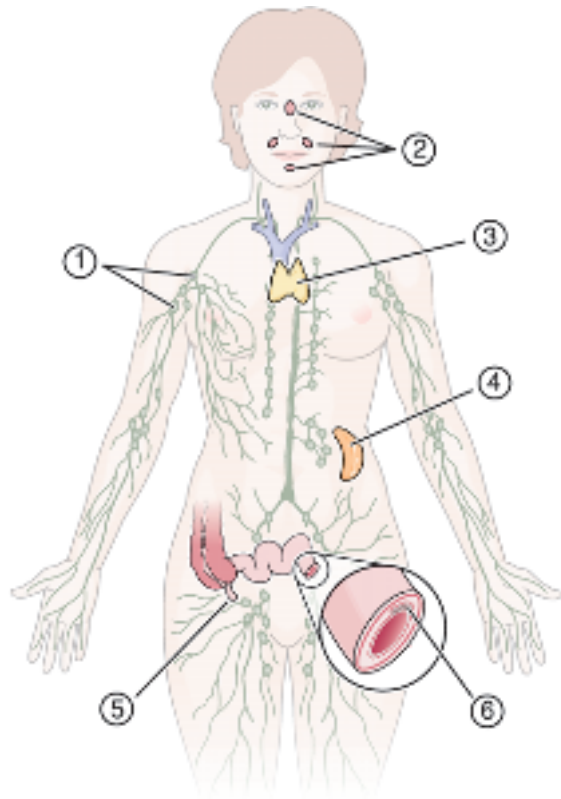
2. _____

3. _____

4. _____

5. _____

6. _____



TERMINOLOGY

Matching > Match the following terms and write the appropriate letter to the left of each number:

_____ **1.** valve	**a.**	vessel that empties into the right atrium
_____ **2.** vena cava	**b.**	fibrous sac around the heart
_____ **3.** apex	**c.**	structure that keeps fluid moving forward
_____ **4.** pericardium	**d.**	central opening of a vessel
_____ **5.** lumen	**e.**	lower pointed region of the heart

_____ **6.** thrombosis	**a.**	ineffective quivering of muscle
_____ **7.** myocarditis	**b.**	formation of a blood clot in a vessel
_____ **8.** infarction	**c.**	inflammation of the heart muscle
_____ **9.** fibrillation	**d.**	local deficiency of blood
_____ **10.** ischemia	**e.**	local death of tissue

_____ **11.** atherosclerosis	**a.**	twisted and swollen vessel
_____ **12.** varix	**b.**	blockage
_____ **13.** occlusion	**c.**	absence of a heartbeat
_____ **14.** asystole	**d.**	localized dilatation of a vessel
_____ **15.** aneurysm	**e.**	accumulation of fatty deposits

_____ **16.** VT	**a.**	stroke
_____ **17.** CVA	**b.**	a type of blood lipid
_____ **18.** HTN	**c.**	rapid beat in the heart's lower chambers
_____ **19.** HDL	**d.**	high blood pressure
_____ **20.** CABG	**e.**	surgery to bypass a blocked vessel

Chapter Review *(continued)*

Supplementary Terms

_____ **21.** diuretic	**a.** removal of plaque
_____ **22.** regurgitation	**b.** drug that increases urinary output
_____ **23.** streptokinase	**c.** premature contraction
_____ **24.** atherectomy	**d.** drug used to dissolve blood clots
_____ **25.** extrasystole	**e.** backward flow

Fill in the blanks:

26. Each upper receiving chamber of the heart is a(n) _____.

27. The microscopic vessels through which materials are exchanged between the blood and the tissues are the _____

_____.

28. The heart muscle is the _____.

29. The largest artery is the _____.

30. A sinus rhythm originates in the _____.

31. Blood returning to the heart from the systemic circuit enters the chamber called the _____.

32. The term *varicoid* pertains to a(n) _____.

33. The lymphoid organ in the chest is the _____.

34. A phlebotomist (*fle-BOT-ō-mist*) is one who drains blood from a(n) _____.

35. At its termination in the abdomen, the aorta divides into the right and left (see Fig. 9-5) _____

_____.

36. The large artery in the neck that supplies blood to the brain is the (see Fig. 9-5) _____.

37. The large vein that drains the lower body and empties into the heart is the (see Fig. 9-6) _____.

38. The right lymphatic duct and the thoracic duct drain into vessels called the (see Fig. 9-18) _____.

True–False **> Examine the following statements. If the statement is true, write T in the first blank. If the statement is false, write F in the first blank and correct the statement by replacing the underlined word in the second blank.**

39. The left AV valve is the <u>mitral</u> valve. _____ _____

40. The <u>systemic circuit</u> pumps blood to the lungs. _____ _____

41. An <u>artery</u> is a vessel that carries blood back to the heart. _____ _____

42. <u>Diastole</u> is the relaxation phase of the heart cycle. _____ _____

43. The <u>right ventricle</u> pumps blood into the aorta. _____ _____

44. Blood returning from the lungs to the heart enters the <u>left atrium</u>. _____ _____

45. The brachial artery supplies blood to the <u>leg</u>. _____ _____

46. Peyer patches are in the <u>intestine</u>. _____ _____

47. <u>Bradycardia</u> is a lower-than-average heart rate. _____ _____

Chapter Review *(continued)*

Eliminations **> In each of the sets below, underline the word that does not fit in with the rest and explain the reason for your choice:**

48. SA node — Purkinje fibers — apex — AV node — AV bundle

_____

49. murmur — systolic — sphygmomanometer — mm Hg — diastolic

_____

50. U — S_1 — QRS — T — P

_____

51. thymus — spleen — cusp — tonsil — Peyer patches

_____

Define the following terms:

52. Avascular (*ā-VAS-kū-lar*) _____

53. Atriotomy (*ā-trē-OT-ō-mē*) _____

54. Splenectomy (*splē-NEK-tō-mē*) _____

55. Supraventricular (*sū-pra-ven-TRIK-ū-lar*) _____

56. Phlebectasis (*fleb-EK-ta-sis*) _____

Write words for the following definitions:

57. Physician who specializes in study and treatment of the heart _____

58. Suture (-rhaphy) of an artery _____

59. Surgical fixation (-pexy) of the spleen _____

60. An instrument (-tome) for incising a valve _____

61. Stoppage (-stasis) of lymph flow _____

62. Excision of a lymph node _____

Use the root *aort/o* to write words with the following meanings:

63. Downward displacement (-ptosis) of the aorta _____

64. Narrowing (-stenosis) of the aorta _____

65. Radiograph (-gram) of the aorta _____

66. Before or in front of (pre-) the aorta _____

Adjectives **> Write the adjective form of the following words:**

67. atrium _____

68. thymus _____

69. vein _____

Chapter Review *(continued)*

70. septum _____

71. sclerosis _____

72. spleen _____

Plurals > Write the plural form of the following words:

73. thrombus _____

74. varix _____

75. stenosis _____

76. septum _____

Write the meaning of the following abbreviations as they apply to the cardiovascular system:

77. AED _____

78. LVAD _____

79. DVT _____

80. VF _____

81. BBB _____

82. PCTA _____

Word Building > Write words for the following definitions using the word parts given.

-pathy lymph/o -oma angi/o -itis aden/o plasty

83. inflammation of a vessel _____

84. any disease of a lymph node _____

85. neoplasm involving the lymphatic system _____

86. plastic repair of a vessel _____

87. inflammation of a lymphatic vessel _____

88. any disease of a vessel _____

89. inflammation of a lymph node _____

90. neoplasm of a lymph node _____

91. tumor involving vessels _____

Word Analysis > Define the following words, and give the meaning of the word parts in each. Use a dictionary if necessary.

92. Endarterectomy (*end-ar-ter-EK-tō-mē*) _____

a. end/o- _____

b. arteri/o _____

c. ecto- _____

d. -tomy _____

Chapter Review *(continued)*

93. Telangiectasia (*tel-an-jē-ek-TĀ-zē-a*) _____

a. tel- _____

b. angi/o _____

c. -ectasia _____

94. Lymphangiophlebitis (*lim-fan-jē-ō-fle-BĪ-tis*) _____

a. lymph/o _____

b. angi/o _____

c. phleb/o _____

d. -itis _____

PASSport to Success® Go to the word exercises on the Student Resources for additional review exercises.

Case Studies

Case Study 9-1: PTCA and Echocardiogram

A.L., a 68-year-old woman, was admitted to the CCU with chest pain, dyspnea, diaphoresis, syncope, and nausea. She had taken three sublingual doses of nitroglycerin tablets within a 10-minute time span without relief before dialing 911. A previous stress test and thallium uptake scan suggested cardiac disease.

Her family history was significant for cardiovascular disease. Her father died at the age of 62 of an acute myocardial infarction. Her mother had bilateral carotid endarterectomies and a femoral–popliteal bypass procedure and died at the age of 72 of congestive heart failure. A.L.'s older sister died from a ruptured aortic aneurysm at the age of 65. A.L.'s ECG on admission showed tachycardia with a rate of 126 bpm with inverted T waves. A murmur was heard at S_1. Her skin color was dusky to cyanotic on her lips and fingertips. Her admitting diagnosis was possible coronary artery disease, acute myocardial infarction, and valvular disease.

Cardiac catheterization with balloon angioplasty (PTCA) was performed the next day. Significant stenosis of the left anterior descending coronary artery was shown and was treated with angioplasty and stent placement. Left ventricular function was normal.

Echocardiography, 2 days later, showed normal-sized left and enlarged right ventricular cavities. The mitral valve had normal amplitude of motion. The anterior and posterior leaflets moved in opposite directions during diastole. There was a late systolic prolapse of the mitral leaflet at rest. The left atrium was enlarged. The impression of the study was mitral prolapse with regurgitation. Surgery was recommended.

Case Study 9-2: Mitral Valve Replacement Operative Report

A.L. was transferred to the operating room, placed in a supine position, and given general endotracheal anesthesia. Her pericardium was entered longitudinally through a median sternotomy. The surgeon found that her heart was enlarged, with a dilated right ventricle. The left atrium was dilated. Preoperative transesophageal echocardiography revealed severe mitral regurgitation with severe posterior and anterior prolapse. Extracorporeal circulation was established. The aorta was cross-clamped, and cardioplegic solution (to stop the heartbeat) was given into the aortic root intermittently for myocardial protection.

The left atrium was entered via the interatrial groove on the right, exposing the mitral valve. The middle scallop of the posterior leaflet was resected. The remaining leaflets were removed to the areas of the commissures and preserved for the sliding plasty. The elongated chordae were shortened to better anchor the valve cusps. The surgeon slid the posterior leaflet across the midline and sutured it in place. A no. 30 annuloplasty ring was sutured in place with interrupted no. 2-0 Dacron suture. The valve was tested by inflating the ventricle with NSS and proved to be competent. The left atrium was closed with continuous no.

(continued)