

# Cardiovascular system

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Blood circulates throughout the body in the **cardiovascular system**, which consists of:

1. The heart
2. The blood vessels .

This system forms a continuous circuit that delivers oxygen and nutrients to all cells and carries away waste products.

Also functioning in circulation is the **lymphatic system**, which drains fluid and proteins from the tissues and returns them to the bloodstream.

# 1 –The Heart

- ▶ Terminology related to the heart (cardium) is often presented as “cardi” or “cardio”.
- ▶ The three distinct layers of heart wall:
  1. Endocardium  
Deepest layer. This layer lines the heart chambers and covers its valves
  2. Myocardium  
The heart muscle itself
  3. Epicardium  
Outermost layer. It is the **visceral layer** of the pericardium

- ▶ Each of the upper receiving chambers of the heart is an atrium (plural, atria). Each of the lower pumping chambers is a ventricle (plural, ventricles).
- ▶ 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.

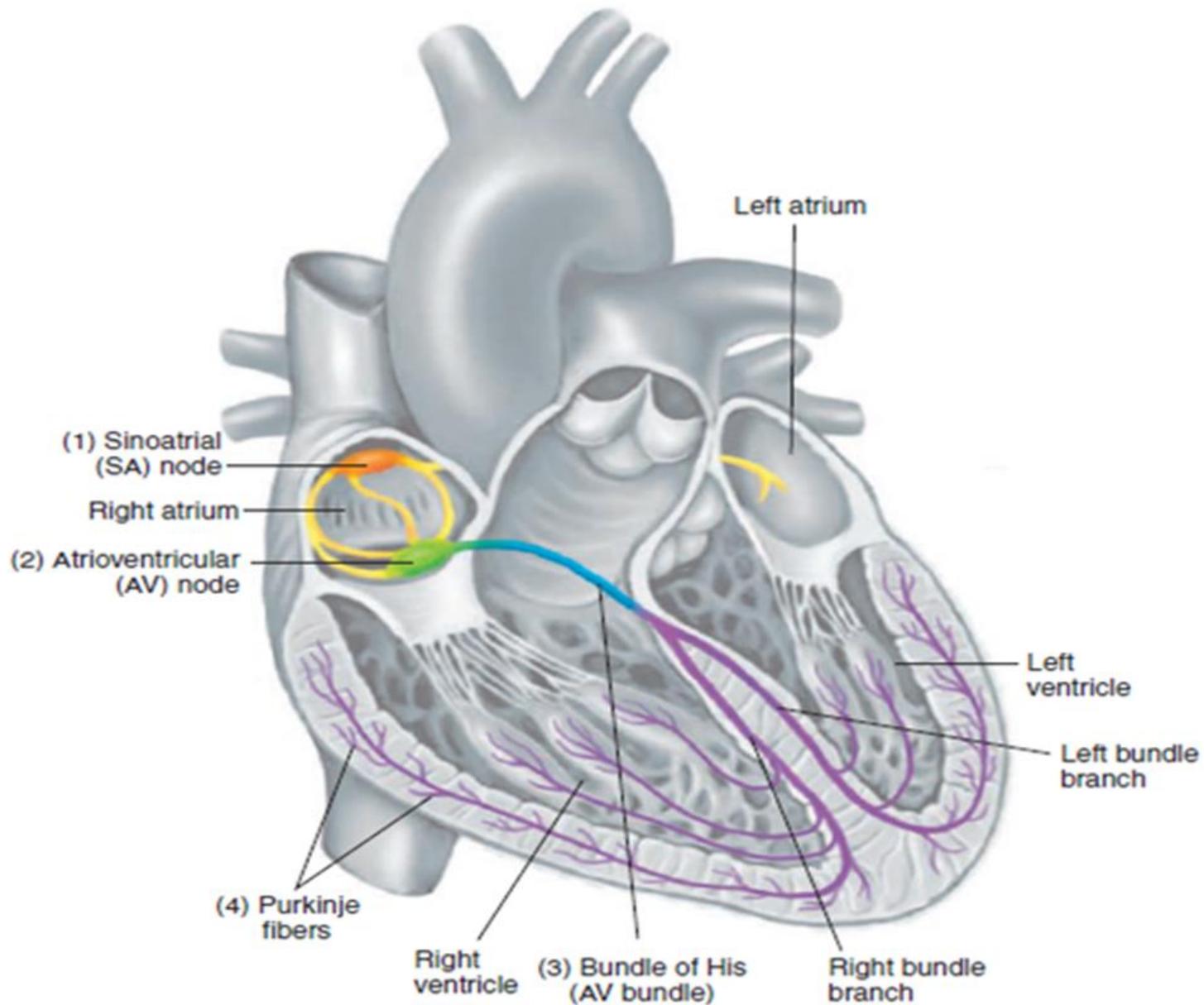
# Heart sounds

- ▶ **Heart sounds** are produced as the heart functions. The loudest of these, the familiar lubb and dupp that can be heard through the chest wall, are produced by alternate closing of the valves.
- ▶ The first heart sound (**S1**) is heard when the valves between the chambers close.
- ▶ The second heart sound (**S2**) is produced when the valves leading into the aorta and pulmonary artery close.
- ▶ The word **murmur** used alone with regard to the heart describes an abnormal sound.

# The Heartbeat

- ▶ Each contraction of the heart, termed systole (SIS-to\_-le\_), is followed by a relaxation phase, diastole (di\_-ASto\_-le\_), during which the chambers fill. Each time the heart beats, both atria contract and immediately thereafter both ventricles contract. The wave of increased pressure produced in the vessels each time the ventricles contract is the pulse.
- ▶ Contractions are stimulated by a built-in system that regularly transmits electrical impulses through the heart.  
(The conducting system of the heart) INCLUDES:

1. Sinoatrial (SA) node
2. Atrioventricular (AV) node
3. Bundle of His (AV bundle)
4. Rt. & Lt. bundle branch
5. Purkinje fibers



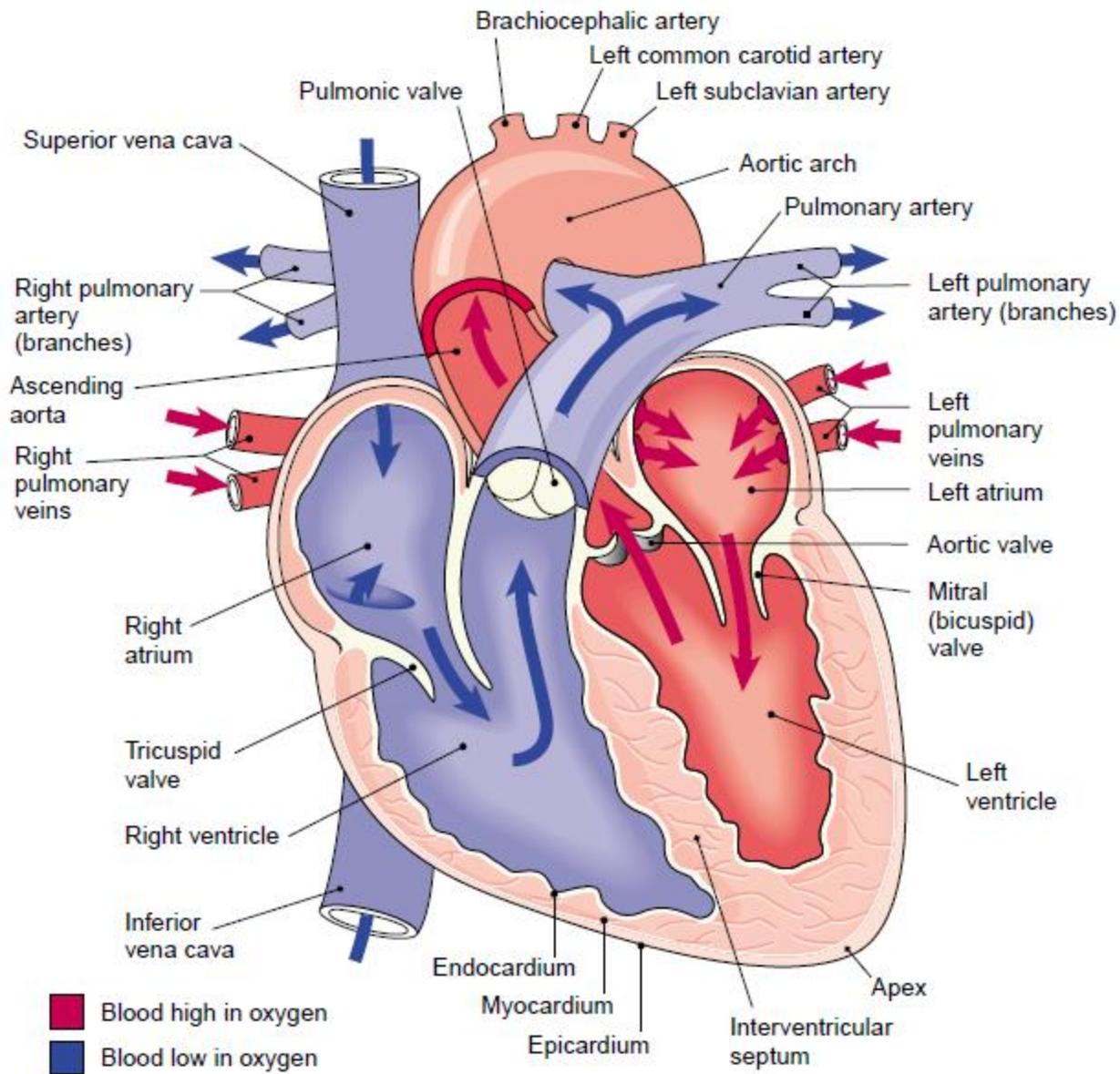
The pace maker and the conductin system

# Cardiac valves

- ▶ The valve in the septum between the right atrium and ventricle is the **tricuspid valve** (meaning three cusps or flaps).
- ▶ The valve in the septum between the left atrium and ventricle is the **bicuspid valve** (having two cusps), usually 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 **pulmonic valve**.
- ▶ The valve at the entrance to the aorta is the **aortic valve**.

# Blood Flow Through the Heart

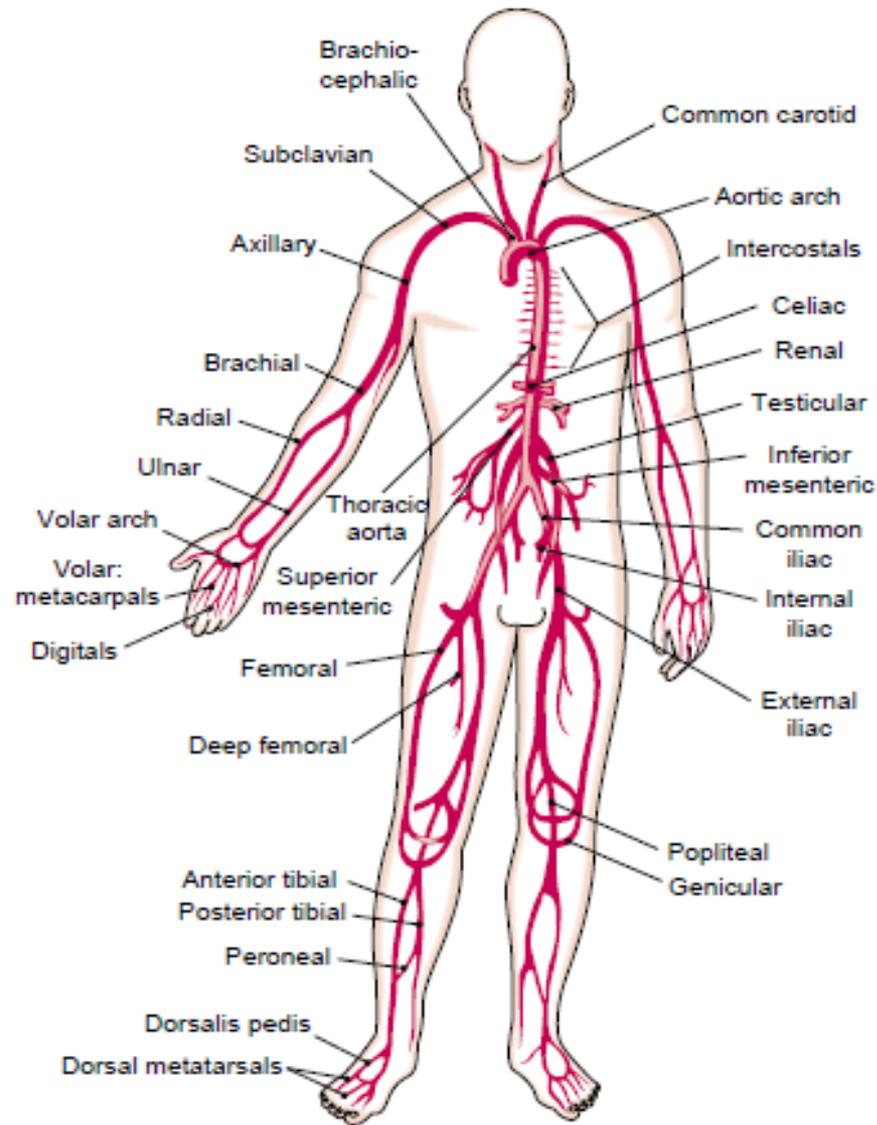
- The right atrium receives blood low in oxygen from all body tissues through the **superior vena cava** and the **inferior vena cava**. The blood then enters the right ventricle and is pumped to the lungs through the **pulmonary artery**. Blood returns from the lungs high in oxygen and enters the left atrium through the **pulmonary veins**. From here it enters the left ventricle and is forcefully pumped into the **aorta** to be distributed to all tissues.
- Blood is kept moving in a forward direction by **one-way valves**.



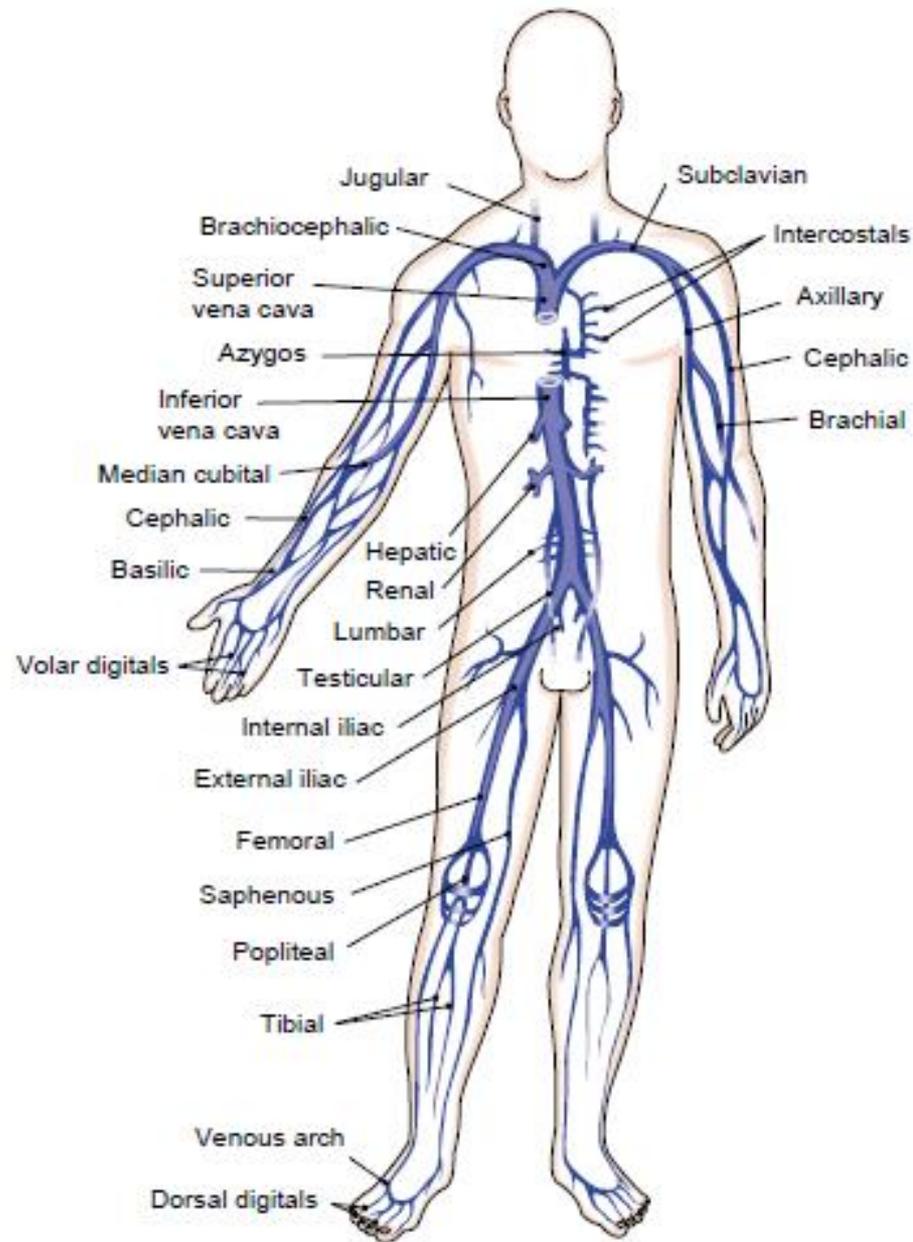
**FIGURE 9-2.** The heart and great vessels.

# 2-The blood vessels

- ▶ Arteries - this term was derived from aer (Greek) = air & terein = to keep. “Greek believed that arteries contained air”. Arteries carry oxygenated blood from the heart, exception is the pulmonary artery.
- ▶ Arterioles
- ▶ Capillaries - (in Latin means hair-like)
- ▶ Venules
- ▶ Veins - carry blood toward the heart. Veins carry deoxygenated blood, exception are the pulmonary veins.



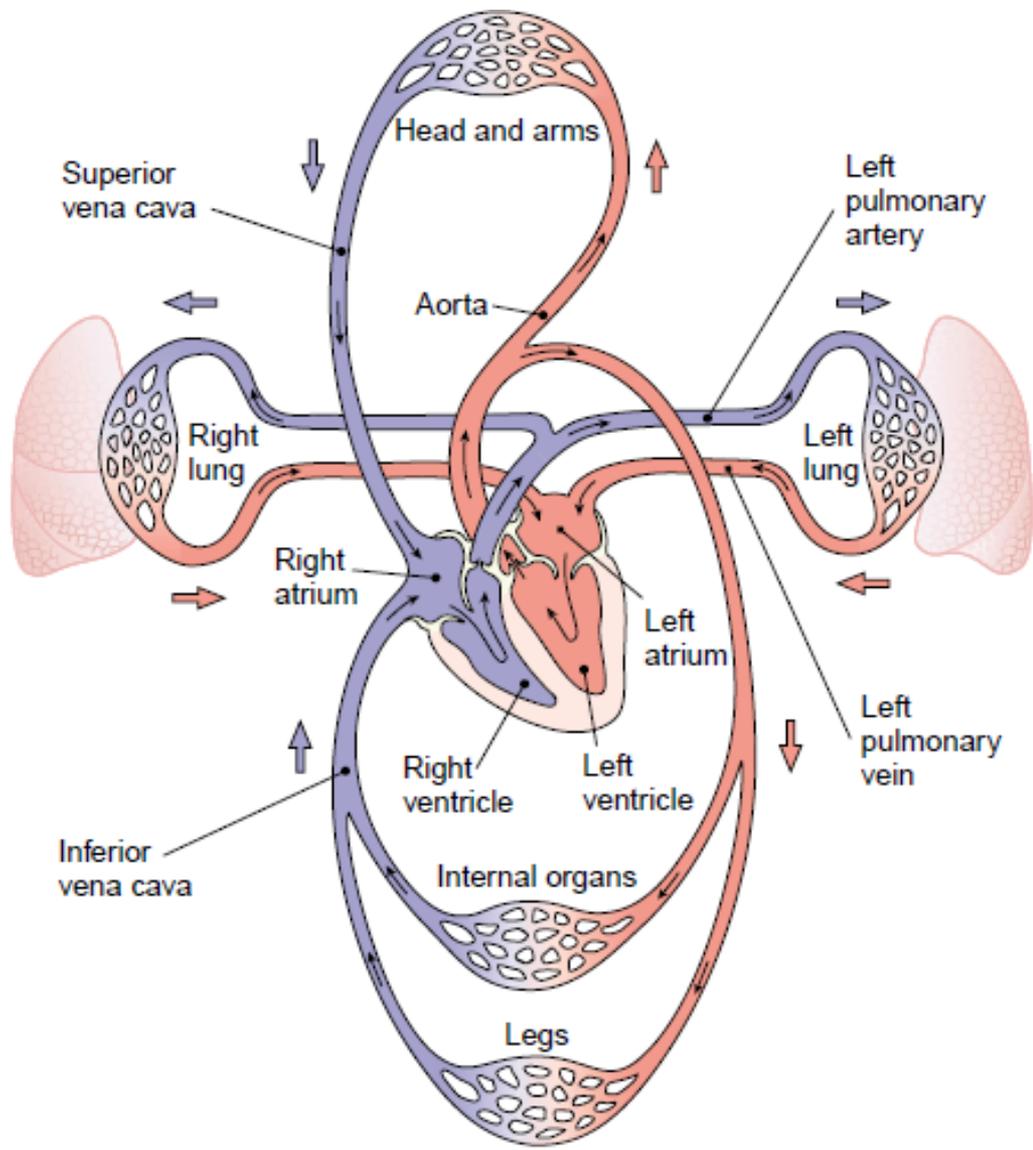
**FIGURE 9-5.** Principal systemic arteries.



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

# BLOOD CIRCULATION

- ▶ Blood circulates throughout the body in the cardiovascular system, which consists of:
  - The heart.
  - The blood vessels.
  - This system forms a continuous circuit that delivers oxygen and nutrients to all cells and carries away waste products.
- ▶ 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**.



. The cardiovascular system.

# Lymphatic system

- ▶ The **lymphatic system** is a widely distributed system with multiple functions :
  1. Its role in circulation is to return excess fluid and proteins from the tissues to the bloodstream.
  2. Another function of the lymphatic system is to absorb digested fats from the small intestine. One other major function of the lymphatic system is to protect the body from impurities and invading microorganisms
- ▶ 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, which travels upward through the chest and empties into the left subclavian vein near the heart. The right lymphatic duct drains the upper right side of the body and empties into the right subclavian vein.
- ▶ Along the path of the lymphatic vessels are small masses of lymphoid tissue, the lymph nodes. Their function is to filter the lymph as it passes through. They are concentrated

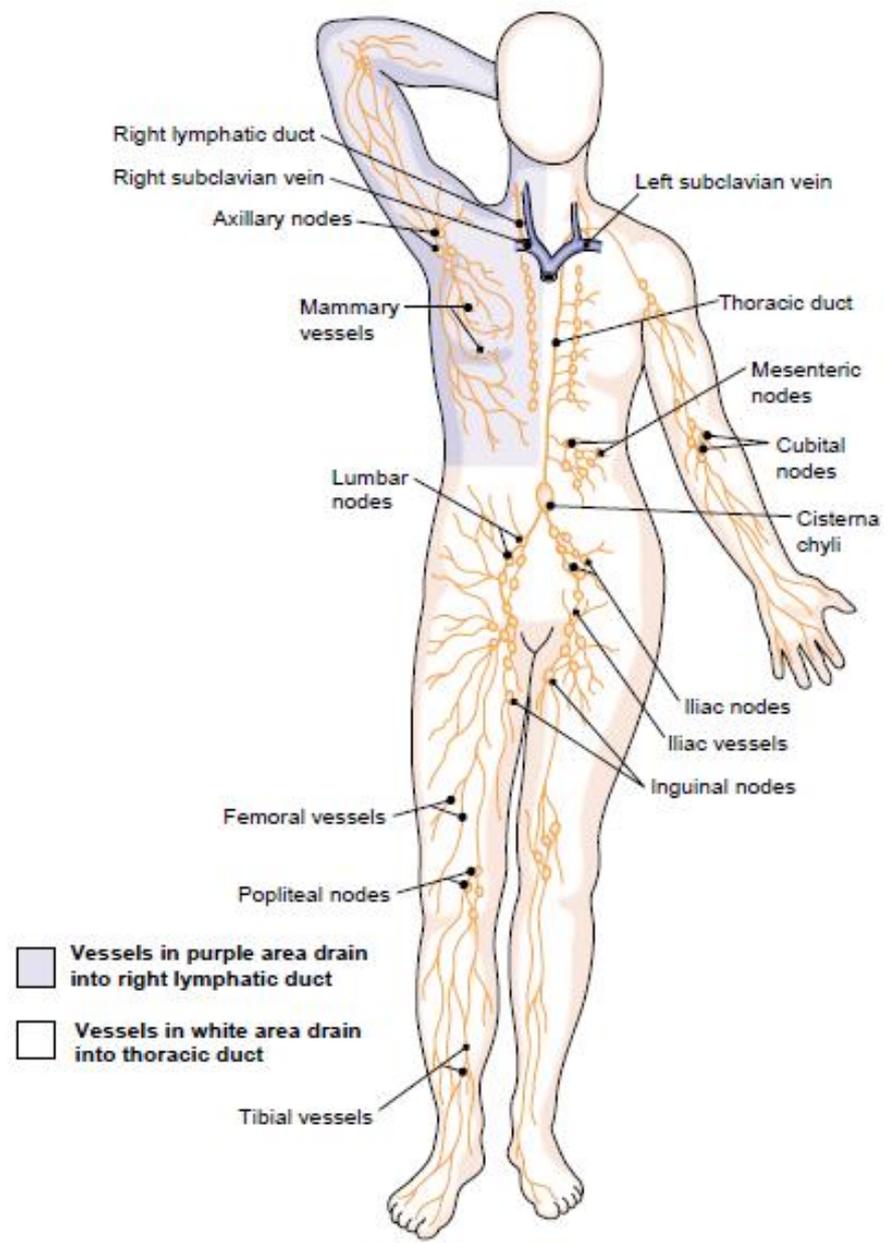


FIGURE 9-7. Lymphatic system.

## NORMAL STRUCTURE AND FUNCTION

### Cardiovascular System

aorta <i>ā-OR-ta</i>	The largest artery. It receives blood from the left ventricle and branches to all parts of the body (root <i>aort/o</i> ).
aortic valve <i>ā-OR-tik</i>	The semilunar valve at the entrance to the aorta
apex <i>Ā-peks</i>	The point of a cone-shaped structure (adjective, apical). The apex of the heart is formed by the left ventricle. It is inferior and pointed toward the left (see Fig. 9-2).
artery	A vessel that carries blood away from the heart. All except the pulmonary and umbilical arteries carry oxygenated blood (root <i>arter, arteri/o</i> ).
arteriole <i>ar-TĒ-rē-ōl</i>	A small artery (root <i>arteriol/o</i> )
atrioventricular (AV) node <i>ā-trē-ō-ven-TRIK-ū-lar</i>	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.
atrium <i>Ā-trē-um</i>	An entrance chamber, one of the two upper receiving chambers of the heart (root <i>atri/o</i> )

bicuspid valve <i>bī-KUS-pid</i>	The valve between the left atrium and the left ventricle; the mitral valve
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 <i>KAP-i-lar-ē</i>	A microscopic blood vessel through which materials are exchanged between the blood and the tissues
cardiovascular system <i>kar-dē-ō-VAS-kū-lar</i>	The part of the circulatory system that consists of the heart and the blood vessels
diastole <i>dī-AS-tō-lē</i>	The relaxation phase of the heartbeat cycle
endocardium <i>en-dō-KAR-dē-um</i>	The thin membrane that lines the chambers of the heart and covers the valves
epicardium <i>ep-i-KAR-dē-um</i>	The thin outermost layer of the heart wall

heart <i>hart</i>	The muscular organ with four chambers that contracts rhythmically to propel blood through vessels to all parts of the body (root <i>cardi/o</i> )
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 <i>VĒ-na-KĀ-va</i>	The large inferior vein that brings blood back to the right atrium of the heart from the lower part of the body
mitral valve <i>MĪ-tral</i>	The valve between the left atrium and the left ventricle; the bicuspid valve
myocardium <i>mī-ō-KAR-dē-um</i>	The thick middle layer of the heart wall composed of cardiac muscle
pericardium <i>per-i-KAR-dē-um</i>	The fibrous sac that surrounds the heart
pulmonary artery <i>PUL-mo-nar-e</i>	The vessel that carries blood from the right side of the heart to the lungs
pulmonary circuit	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
pulmonic valve <i>pul-MON-ik</i>	The semilunar valve at the entrance to the pulmonary artery
pulse	The wave of increased pressure produced in the vessels each time the ventricles contract

Purkinje fibers <i>pur-KIN-jē</i>	The terminal fibers of the conducting system of the heart. They carry impulses through the walls of the ventricles.
septum <i>SEP-tum</i>	A wall dividing two cavities, such as the chambers of the heart
sinoatrial (SA) node <i>sī-nō-Ā-trē-al</i>	A small mass in the upper part of the right atrium that initiates the impulse for each heartbeat; the pacemaker
sphygmomanometer <i>sfig-mō-man-OM-e-ter</i>	An instrument for determining arterial blood pressure (root <i>sphym/o</i> means “pulse”); blood pressure apparatus or cuff (see Fig. 9-4)
superior vena cava <i>VĒ-na-KĀ-va</i>	The large superior vein that brings deoxygenated blood back to the right atrium from the upper part of the body
systemic circuit <i>sis-TEM-ik</i>	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 <i>SIS-tō-lē</i>	The contraction phase of the heartbeat cycle

tricuspid valve <i>trī-KUS-pid</i>	The valve between the right atrium and the right ventricle
valve	A structure that keeps fluid flowing in a forward direction (root <i>valv/o, valvul/o</i> )
vein <i>vān</i>	A vessel that carries blood back to the heart. All except the pulmonary and umbilical veins carry blood low in oxygen (root <i>ven, phleb/o</i> ).
ventricle <i>VEN-trik-l</i>	A small cavity. One of the two lower pumping chambers of the heart (root <i>ventricul/o</i> ).
venule <i>VEN-ūl</i>	A small vein
vessel <i>VES-el</i>	A tube or duct to transport fluid (root <i>angi/o, vas/o, vascul/o</i> )

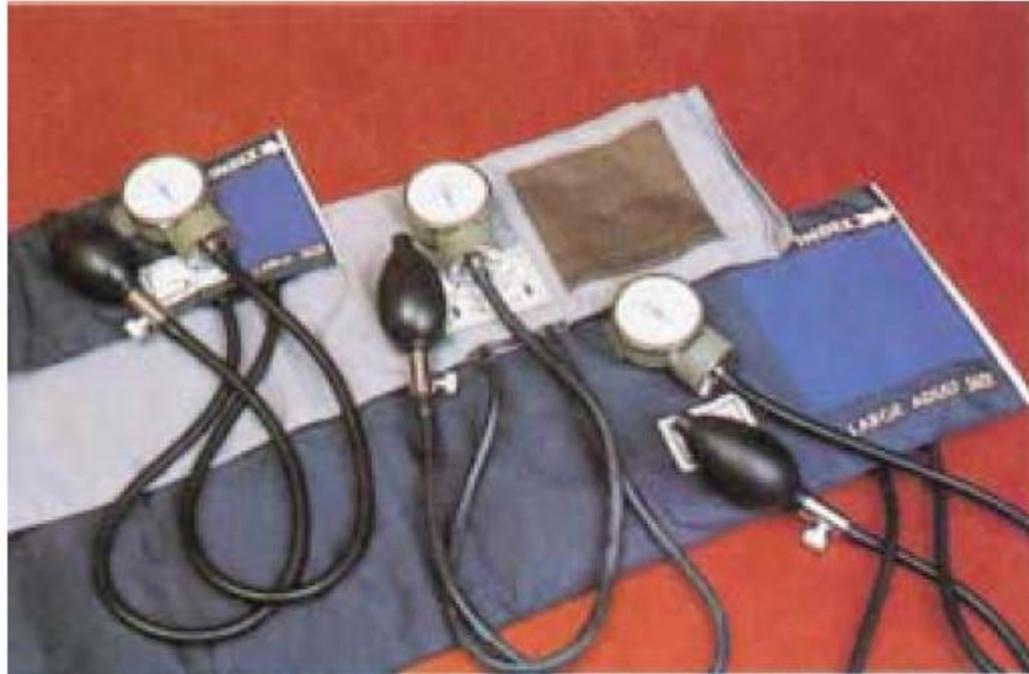
## Lymphatic System

lymph <i>limf</i>	The thin plasmalike fluid that drains from the tissues and is transported in lymphatic vessels (root <i>lymph/o</i> )
lymph node	A small mass of lymphoid tissue along the path of a lymphatic vessel that filters lymph (root <i>lymphaden/o</i> )
lymphatic system <i>lim-FAT-ik</i>	The system that drains fluid and proteins from the tissues and returns them to the bloodstream. This system also aids in absorption of fats from the digestive tract and participates in immunity.
right lymphatic duct	The lymphatic duct that drains fluid from the upper right side of the body
spleen	A large reddish-brown organ in the upper left region of the abdomen. It filters blood and destroys old red blood cells (root <i>splen/o</i> ).
thoracic duct	The lymphatic duct that drains fluid from the upper left side of the body and all of the lower portion of the body
thymus gland <i>THĪ-mus</i>	A gland in the upper part of the chest beneath the sternum. It functions in immunity (root <i>thym/o</i> ).
tonsils <i>TON-silz</i>	Small masses of lymphoid tissue located in the region of the throat

# Blood Pressure

- ▶ Blood pressure is the force exerted by blood against the wall of a blood vessel.
- ▶ It is commonly measured in a large artery with an inflatable cuff known as a blood pressure cuff or blood pressure apparatus, but technically called a sphygmomanometer.
- ▶ Both systolic and diastolic pressures are measured and 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.
- ▶ 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.

**FIGURE 9-4.** Blood pressure cuffs in three sizes. Shown are the cuff, the bulb for inflating the cuff, and the manometer for measuring pressure.



**TABLE 9-1 Roots for the Heart**

ROOT	MEANING	EXAMPLE	DEFINITION OF EXAMPLE
cardi/o	heart	cardiomyopathy* <i>kar-dē-ō-mī-OP-a-thē</i>	any disease of the heart muscle
atri/o	atrium	atriotomy <i>ā-trē-OT-ō-mē</i>	surgical incision of an atrium
ventricul/o	cavity, ventricle	supraventricular <i>SŪ-pra-ven-TRIK-ŭ-lar</i>	above a ventricle
valv/o, valvul/o	valve	valvectomy <i>val-VEK-tō-mē</i>	surgical removal of a valve

\*Preferred over myocardopathy.

**TABLE 9-2 Roots for the Blood Vessels**

ROOT	MEANING	EXAMPLE	DEFINITION OF EXAMPLE
angi/o*	vessel	angiopathy <i>an-jē-OP-a-thē</i>	any disease of blood vessels
vas/o, vascul/o	vessel, duct	vasodilation <i>vas-ō-dī-LĀ-shun</i>	widening of a blood vessel
arter/o, arteri/o	artery	endarterial <i>end-ar-TĒ-rē-al</i>	within an artery
arteriol/o	arteriole	arteriolar <i>ar-tē-rē-Ō-lar</i>	pertaining to an arteriole
aort/o	aorta	aortoptosis <i>a-or-top-TŌ-sis</i>	downward displacement of the aorta
ven/o, ven/i	vein	venous <i>VĒ-nus</i>	pertaining to a vein
phleb/o	vein	phlebectasia <i>fleb-ek-TĀ-zē-a</i>	dilatation of a vein

\*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.

**TABLE 9-3 Roots for the Lymphatic System**

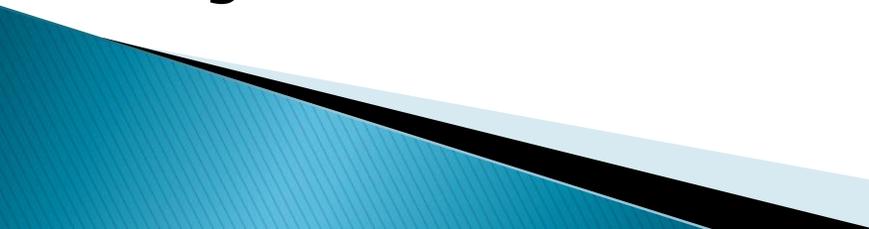
<b>ROOT</b>	<b>MEANING</b>	<b>EXAMPLE</b>	<b>DEFINITION OF EXAMPLE</b>
lymph/o	lymph, lymphatic system	lymphoid <i>LIM-foyd</i>	resembling lymph or lymphatic tissue
lymphaden/o	lymph node	lymphadenectomy <i>lim-fad-e-NEK-tō-mē</i>	surgical removal of a lymph node
lymphangi/o	lymphatic vessel	lymphangioma <i>lim-fan-jē-Ō-ma</i>	tumor of lymphatic vessels
splen/o	spleen	splenomegaly <i>splē-nō-MEG-a-lē</i>	enlargement of the spleen
thym/o	thymus gland	athymia <i>a-THĪ-mē-a</i>	absence of the thymus gland
tonsill/o	tonsil	tonsillar <i>TON-sil-ar</i>	pertaining to a tonsil

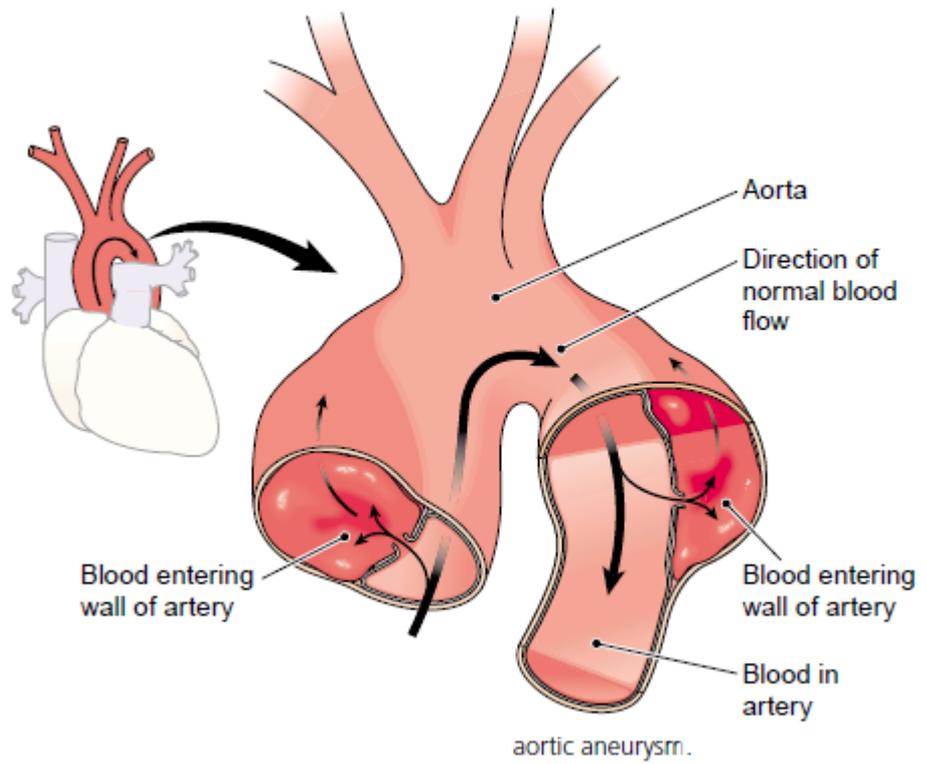
# Anatomy and Physiology Key Terms

- **Autonomic nervous system (ANS):** Portion of the nervous system that regulates involuntary actions, such as heart rate, digestion, and peristalsis.
  - **Leaflet lumen:** Tubular space or channel within any organ or structure of the body; space within an artery, vein, intestine, or tube.
  - **Regurgitation:** Backflow or ejecting of contents through an opening.
  - **Sphincter:** Circular muscle found in a tubular structure or hollow organ that constricts or dilates to regulate passage of substances through its opening.
  - **Vasoconstriction:** Narrowing of the lumen of a blood vessel that limits blood flow, usually as a result of diseases, medications, or physiological processes.
  - **Vasodilation:** Widening of the lumen of a blood vessel caused by the relaxing of the muscles of the vascular walls.
  - **Viscosity:** State of being sticky or gummy.
  - **Perfusion:** The passage of fluid, such as blood, through an organ or tissue
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# Clinical Aspects of the Circulatory System

- ▶ **Cyanosis**; bluish discoloration (cyanos (Greek) = dark blue).
- ▶ **Pallor**; paleness or absence of color in the skin
- ▶ **Edema**; accumulation of fluid in the intercellular tissues, pericardium, pleural cavity or peritoneal cavity.
- ▶ **Diaphoresis**; profuse perspiration; as with fever, physical exertion, and mental or emotional stress.
- ▶ **Angina** (or angina pectoris); severe short lasting chest pain due to inadequate blood supply to heart muscle.

- ▶ **Atherosclerosis:** The accumulation of fatty deposits within the lining of an artery.
  - ▶ **Thrombosis:** the formation of a blood clot within a vessel.
  - ▶ **Embolism:** Blockage of a vessel by a thrombus or other mass carried in the bloodstream.
  - ▶ An embolus from a carotid artery often blocks a cerebral vessel, causing a **cerebrovascular accident (CVA)**.
  - ▶ **Aneurysm:** An arterial wall weakened by atherosclerosis, malformation, injury, or other causes may balloon out.
  - ▶ **Palpitation:** A sensation of abnormally rapid or irregular heartbeat.
- 



- ▶ **Coronary artery disease (CAD):** which results from atherosclerosis of the vessels that supply blood to the heart muscle.
- ▶ **Hypertension** is defined as a systolic pressure greater than 140 mm Hg or a diastolic pressure greater than 90 mm Hg.
- ▶ **Arrhythmia** is any irregularity of heart rhythm, such as a higher- or lower-than-average heart rate, extra beats, or an alteration in the pattern of the beat.
- ▶ **Bradycardia** is a slower-than-average rate, and **tachycardia** is a higher-than-average rate.
- ▶ **Fibrillation:** an extremely rapid, ineffective beating of the heart.
- ▶ **Heart block:** an interruption in the electrical conduction system of the heart.
- ▶ **Cardioversion:** is the general term for restoration of a normal heart rhythm.
- ▶ **Heart failure:** refers to any condition in which the heart fails to empty effectively.
- ▶ **Myocardial infarction:** Localized necrosis (death) of cardiac muscle tissue resulting from blockage or narrowing of the coronary artery that supplies that area.
- ▶ **Stasis:** Stoppage of normal blood normal flow.

- ▶ A breakdown in the valves of the veins in combination with a chronic dilatation of these vessels results in **varicose veins**.
- ▶ **Hemorrhoid**: A varicose vein in the rectum.
- ▶ **Dyspnea**: Difficult or labored breathing.
- ▶ **Edema**: Swelling of body tissues caused by the presence of excess fluid. Causes include cardiovascular disturbances, kidney failure, inflammation, and malnutrition.
- ▶ **Stenosis**: Constriction or narrowing of an opening.
- ▶ **Lymphedema**: Swelling of tissues with lymph caused by obstruction or excision of lymphatic vessels.
- ▶ **Lymphangiitis**: Inflammation of lymphatic vessels as a result of bacterial infection.
- ▶ **Lymphadenitis**: Inflammation and enlargement of lymph nodes, usually as a result of infection
- ▶ **Lymphoma**: Any neoplastic disease of lymphoid tissue.
- ▶ **Phlebitis** is any inflammation of the veins and may be caused by infection, injury, poor circulation, or damage to valves in the veins.

Good Luck

