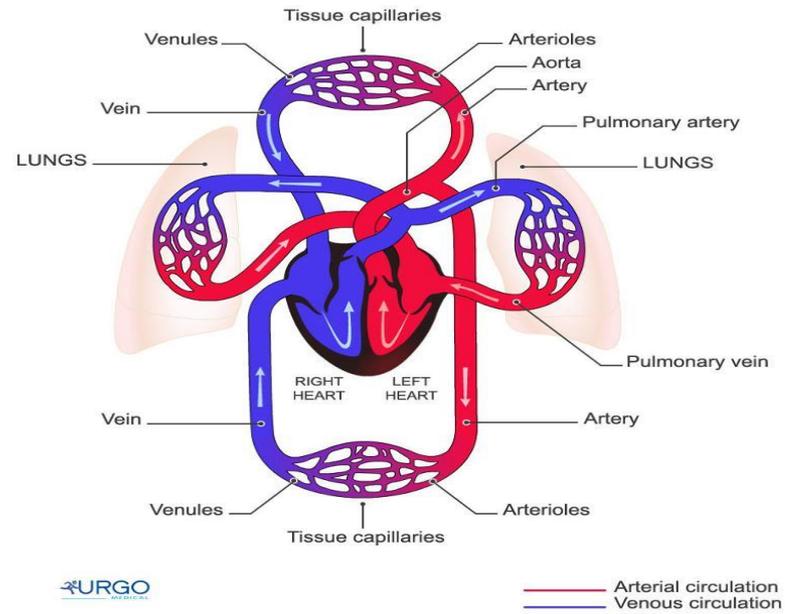


# Cardiovascular System



BY

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## General

-The cardiovascular system (also, called circulatory system) is a series of tubes and a muscular pump that provides a one-way traffic for blood, oxygen, and nutrients through blood vessels (arteries, veins, and capillaries).

Terminology related to the heart (cardium) is often presented as “cardi” or “cardio”

- **Cardiology**
- **Electrocardiogram**
- **Tachycardia**
- **Pericardium**

## **Functions of cardiovascular (CV) system**

- Maintain distribution of blood throughout body.
- Delivery of oxygen and nutrients like glucose and amino acids to cells.
- Disposal of wastes from body (carbon dioxide and other waste products) through lungs, liver, and kidneys.

## **Cardiovascular system components:**

- It is composed of heart and blood vessels (arteries-arterioles-capillaries -venules-veins).

- Divided into:

### **A- Systemic circulation** (between heart and body cells).

- Carries oxygenated blood away from left side of heart to body and deoxygenated blood from body to right side of heart.

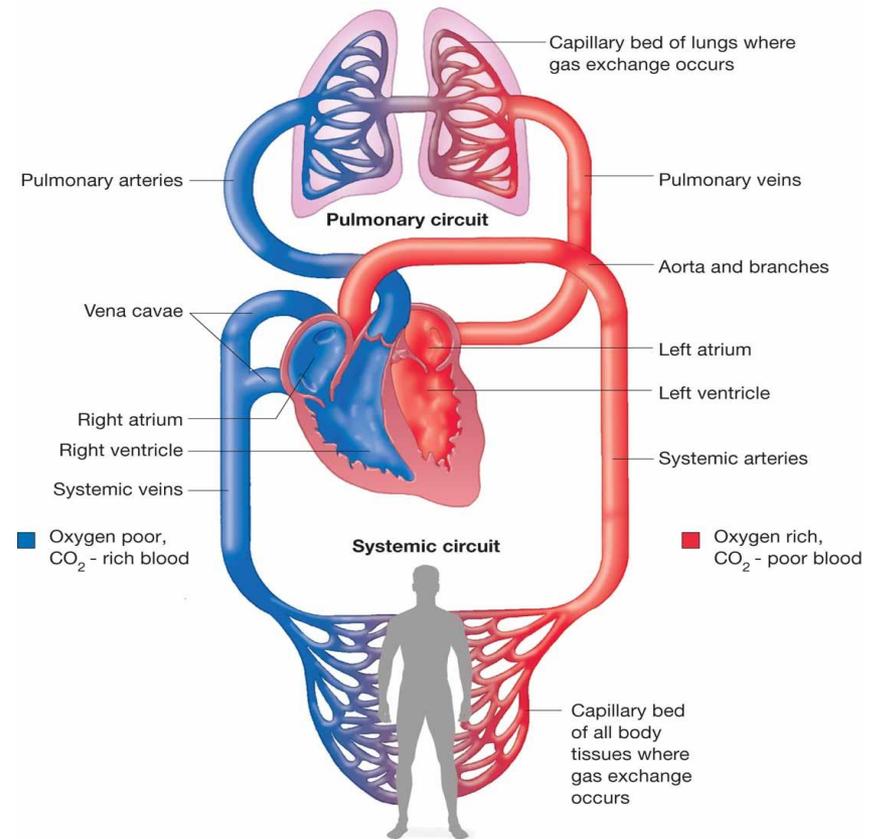
## **B- Pulmonary circulation** (between heart and lungs).

- Carries deoxygenated blood away from right side of heart to lungs and oxygenated blood from lungs to left side of heart.



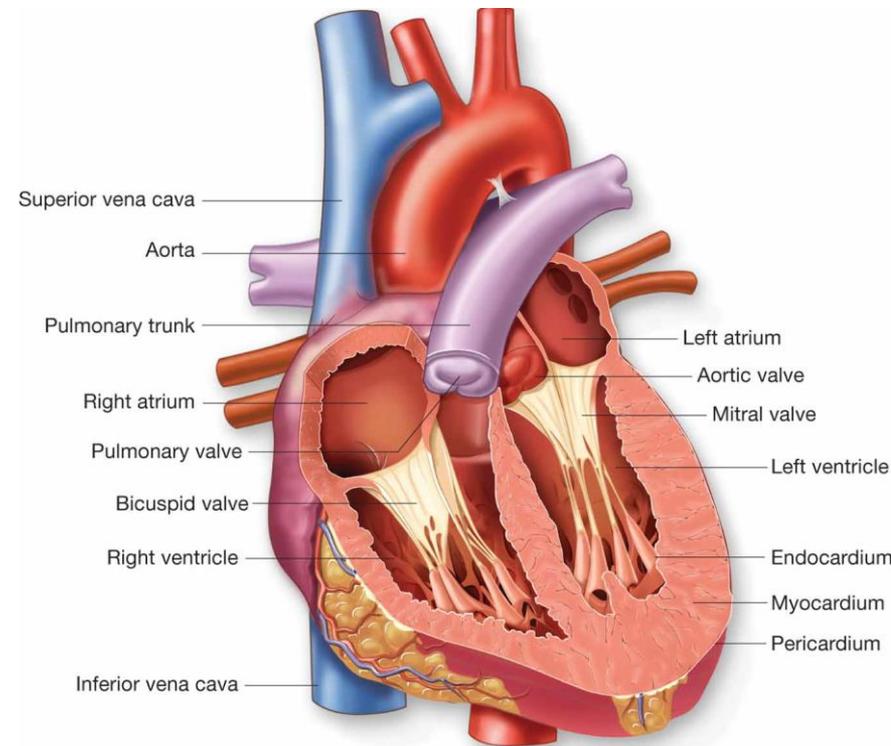
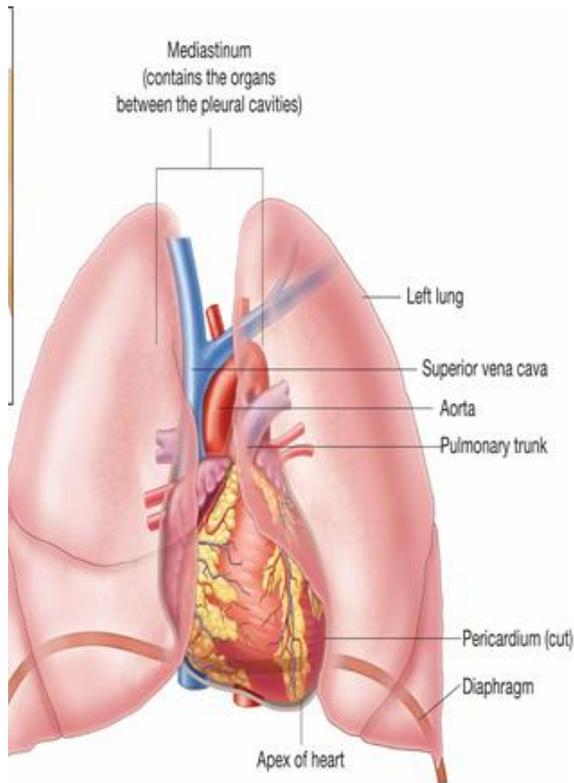
## **Heart**

- Muscular pump, made up of cardiac muscle fibers (called a muscle instead of an organ).
- It beats 60-80 beats/minute.
- Located in the mediastinum, more to left side of chest.
- About size of a fist.
- Tip of heart at lower edge (called the apex).



# The three distinct layers of heart wall

- 1- Endocardium (deepest layer), thin layer lines the heart chambers and covers its valves
- 2- Myocardium (the heart thick muscle) (middle layer)
- 3- Epicardium (outermost layer, it is the visceral layer of the pericardium).



← **Location of the heart within the mediastinum of the thoracic cavity**

## **Heart chambers**

- Divided into four chambers, two atria and two ventricles.
- Heart is divided into right and left sides by a wall called the septum.

## **Atria**

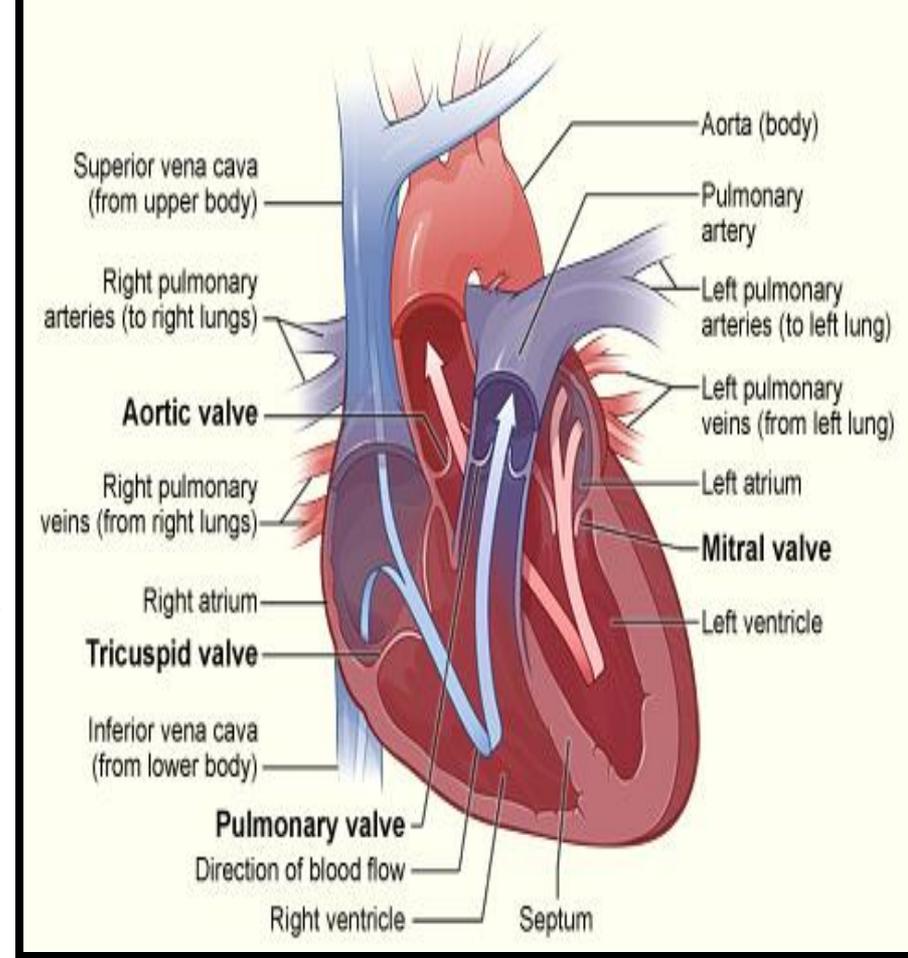
- Left and right upper chambers (receiving chambers).
- Blood returns to atria in veins (superior, inferior vena cava and pulmonary veins).

## **Ventricles**

- Left and right lower chambers (pumping chambers).
- Thick myocardium
- Blood exits ventricles into arteries (aorta and pulmonary artery).

## Heart valves

- Four valves in heart (tricuspid, pulmonary, mitral and aortic).
- Found at entrance and exit to ventricles.
- Allow blood to flow only in forward direction by blocking it from returning back.



## Tricuspid valve

- An atrioventricular valve which has 3 leaflets or cusps.
- Between right atrium and right ventricle to prevent blood in ventricle from flowing back into atrium.

## **Pulmonary valve** (looks like half moon)

- A semilunar valve between right ventricle and pulmonary artery to prevent blood in artery from flowing back into ventricle.

## **Mitral valve** (has two cusps) (bicuspid)

- An atrioventricular valve between left atrium and ventricle to prevent blood in ventricle from flowing back into atrium.

## **Aortic Valve**

- A semilunar valve between left ventricle and aorta to prevent blood in aorta from flowing back into ventricle

## **Systole and diastole**

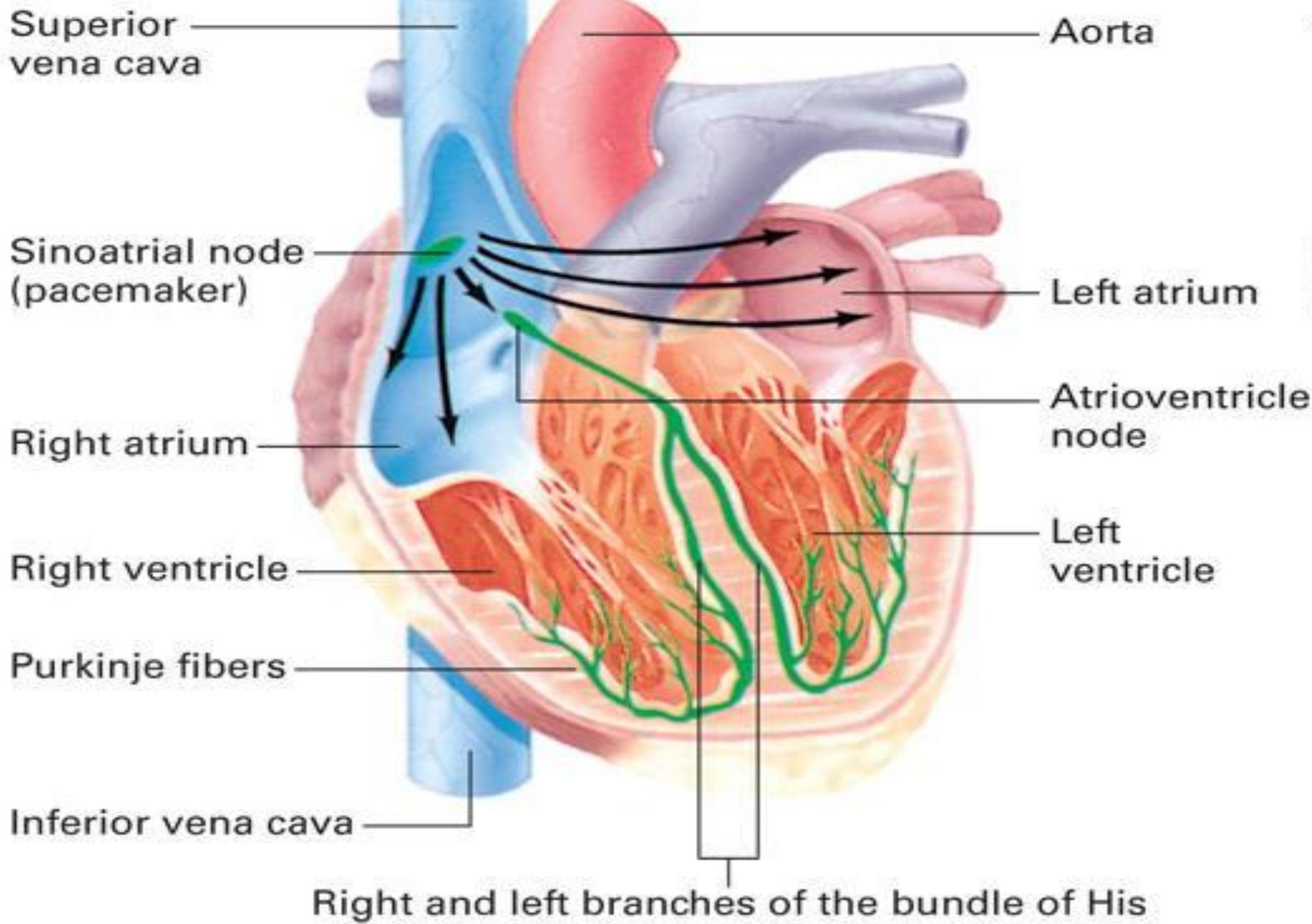
- Heart chambers alternate between:
- Relaxing to fill and contracting to push blood forward.
- Relaxation phase is diastole and contraction phase is systole.

## The pacemaker and the conduction system of the heart

- **Autonomic** nervous system controls heart rate, therefore, no voluntary control over heart.
- Special heart tissue conducts electrical impulses to stimulate different chambers to contract in correct order.

## The conduction system pathway

- 1- Sinoatrial (SA) node, or pacemaker, where electrical impulse begins where a wave of electricity travels through atria causing them to contract (go into systole).
- 2- Next, atrioventricular node (AV) is stimulated to transfer stimulation wave to bundle of His
- 3- Electrical wave travels down right and left bundle branches within interventricular septum
- 4- Finally, Purkinje fibers in ventricular myocardium are stimulated resulting in ventricular systole.



## Blood Vessels

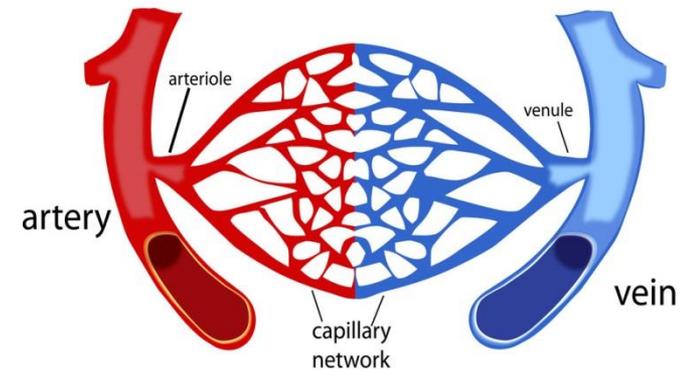
- Pipes that circulate blood through body.
- Three types: 1- Arteries                      2- Capillaries                      3- Veins
- Lumen is the channel within blood vessels.

## Arteries

- Large thick-walled vessels.
- Wall contains smooth muscle and can dilate or constrict
- As arteries travel through body they branch into progressively smaller vessels called arterioles.
- Carry blood away from heart towards either lungs or cells of the body.
- Pulmonary artery carries deoxygenated blood to lungs.
- Aorta carries oxygenated blood to body.
- Coronary arteries supply myocardium.

# Capillaries

- Network of tiny, thin-walled blood vessels.
- Connecting unit between arteries and veins.
- Arterial blood flows into capillary bed and venous blood flows out of capillary bed.
- Location for:
  - 1-Oxygen and nutrients to diffuse out.
  - 2-Carbon dioxide and wastes to diffuse in.



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# Veins

- Much thinner walls than arteries.
- Much lower pressure system than in arteries.
- Have valves to insure blood flows only towards heart.

- Squeezing by skeletal muscles also assists blood return to heart
- Smallest veins are called venules
- Carry blood towards the heart from either the lungs or the cells and tissues of body.
- Pulmonary veins carry oxygenated blood from lungs
- Superior and inferior vena cava carry deoxygenated blood from body

# Blood Pressure

- Measurement of force exerted by blood against walls of a vessel
- During ventricular systole, blood is under great pressure to give highest pressure: systolic (top number of blood pressure reading).
- During ventricular diastole, blood isn't being pushed from heart at all, so, blood pressure drops to lowest point- diastolic (bottom number of blood pressure reading).
- Pulse pressure = difference between systolic and diastolic blood pressure
- Measurement of blood pressure;
  - 1- Sphygmomanometer (an instrument)
  - 2- Stethoscope



- Korotkoff's sounds – they are five sounds can be heard during measurement of blood pressure, the first sound is the snapping sound first heard at the systolic pressure, while ,the fifth sound is silence is considered diastolic blood pressure.

## The blood's path

- Superior, inferior vena cava and coronary sinus →  
Rt. atrium → Rt. ventricle →  
pulmonary artery →  
pulmonary veins →  
Lt. atrium →  
Lt. ventricle →  
aorta

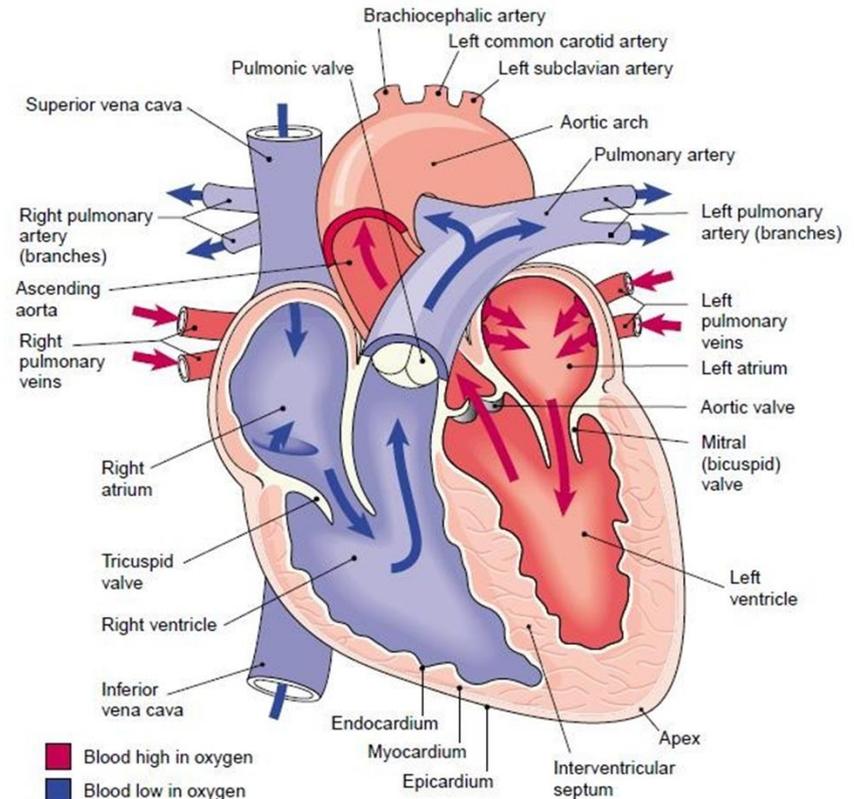
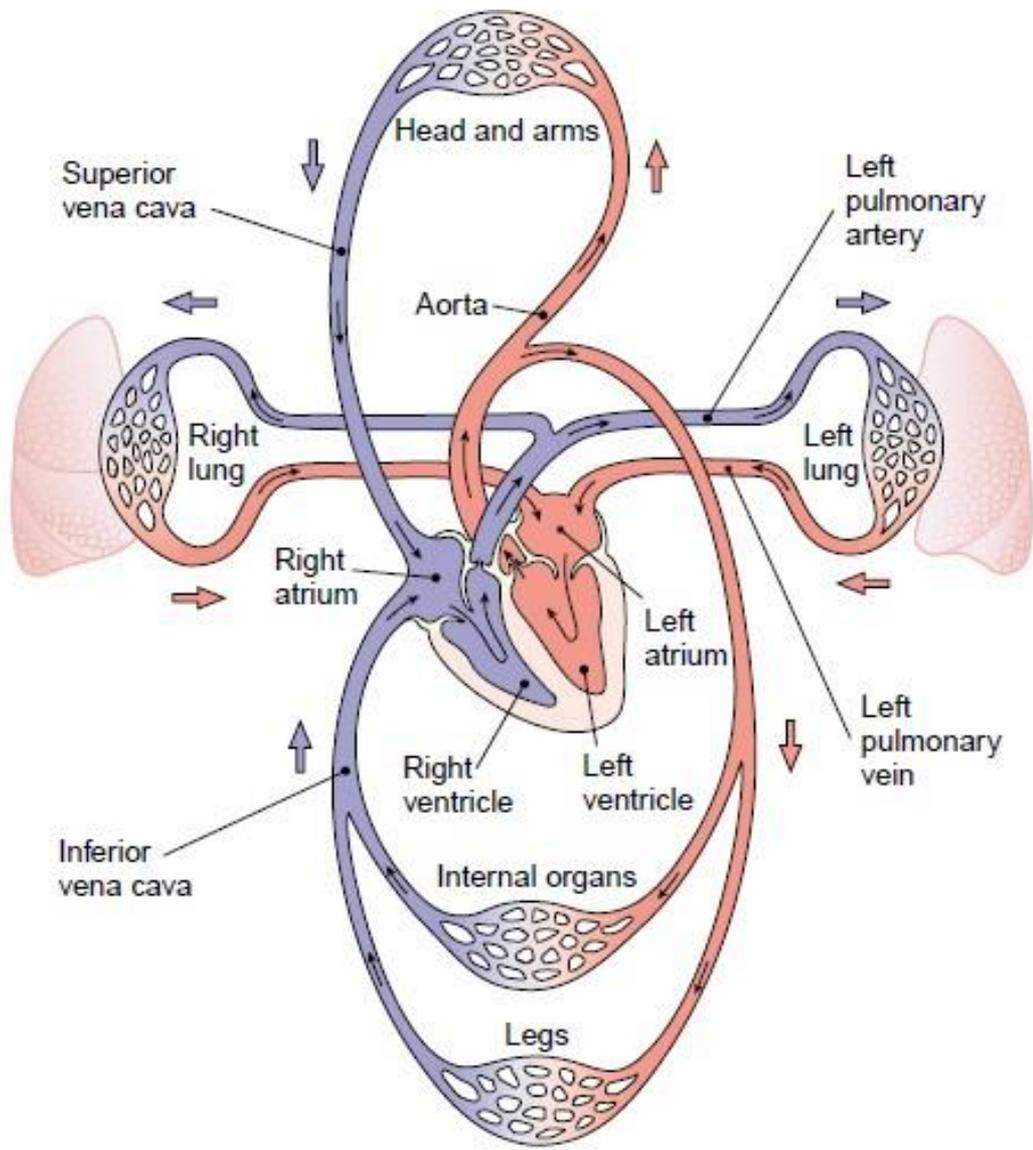


FIGURE 9-2. The heart and great vessels.



. The cardiovascular system.

# Cardiovascular combining forms

angi/o	vessel	hemangi/o	blood vessel
aort/o	aorta	phleb/o	vein
arteri/o	artery	sphygm/o	pulse
ather/o	fatty substance	steth/o	chest
atri/o	atrium	thromb/o	clot
cardi/o	heart	valv/o	valve
coron/o	heart	valvul/o	valve
vascul/o	blood vessel	ven/o	vein
vas/o	vessel, duct	ventricul/o	ventricle
–ole	small	–ule	small
manometer	instrument to measure pressure	–tension	pressure

## Word building with angi/o

–gram	angiogram	record of a vessel
–itis	angitis	inflammation of a vessel
–plasty	angioplasty	surgical repair of vessel
–spasm	angiospasm	involuntary muscle contraction in a vessel
–stenosis	angiostenosis	narrowing of a vessel

## Word building with aort/o & arteri/o

-al	arterial	pertaining to an artery
-ole	arteriole	small artery
-ic	aortic	pertaining to the aorta

## Word building with ather/o & atri/o

-ectomy	atherectomy	surgical removal of fatty substance
-oma	atheroma	fatty substance tumor/growth
-al	atrial	pertaining to the atrium
Inter- -al	interatrial	pertaining to between the atrium

## Word building with cardi/o

-ac	cardiac	pertaining to the heart
brady- -ia	bradycardia	state of slow heart
electr/o -gram	electrocardiogram	record of heart's electricity
-megaly	cardiomegaly	enlarged heart
My/o -al	myocardial	pertaining to heart muscle
-ologist	cardiologist	heart specialist
-rrhexis	cardiorrhesis	ruptured heart
Tachy- -ia	tachycardia	state of fast heart

## Word building with coron/o, phleb/o, and vascul/o

-ary	coronary	pertaining to the heart
-itis	phlebitis	inflammation of a vein
-ar	vascular	pertaining to a blood vessel

## Word building with valv/o & valvul/o

-plasy	valvoplasty	surgical repair of valve
-itis	valvulitis	inflammation of a valve
-ar	valvular	pertaining to a valve

## Word building with ven/o & ventricul/o

-ous	venous	pertaining to veins
-ul	venule	small vein
-gram	venogram	record of a vein
-ar	ventricular	pertaining to ventricles
Inter- -ar	interventricular	pertaining to between ventricles

# Cardiovascular vocabulary

auscultation	listening to sounds within body using a stethoscope
cardiology	branch of medicine for diagnosis and treatment of cardiovascular disease; physician is a cardiologist
catheter	flexible tube inserted in body to move fluids into or out of body; may be used to place dye into a vein to view blood vessels
infarct	area of necrotic tissue due to loss of blood supply
ischemia	local and temporary deficiency of blood supply due to a circulatory obstruction
murmur	abnormal heart sound such as soft blowing sound or a harsh click; also called a bruit
orthostatic hypotension	sudden drop in blood pressure when standing up suddenly
palpitation	pounding, racing heart beats
plaque	yellow, fatty deposit of lipids in an artery; hallmark of atherosclerosis

regurgitation	to flow backwards; in CV system refers to backflow of blood through a valve
sphygmomanometer	blood pressure cuff; measures blood pressure
stent	stainless steel tube placed within blood vessel to widen the lumen
stethoscope	instrument for listening to body sounds
cyanosis	bluish discoloration
pallor	paleness or absence of color in the skin
diaphoresis	perfused perspiration; as with fever, physical exertion, and mental or emotional stress.

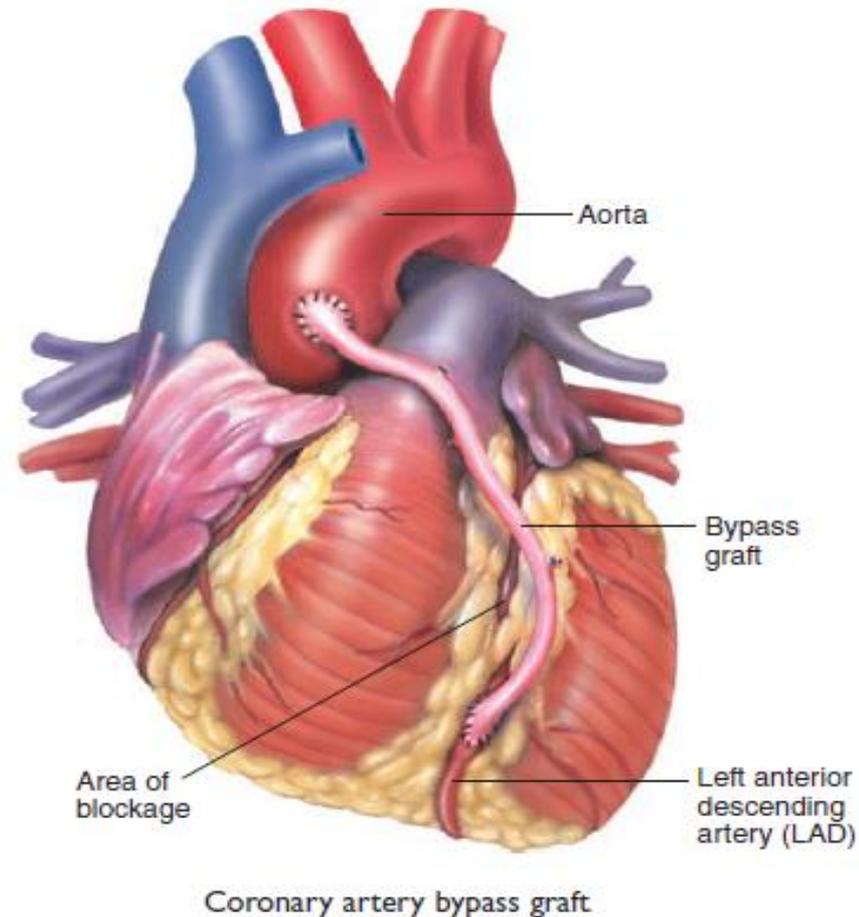
## **Heart pathology**

angina pectoris	severe pain and sensation of constriction around heart; caused by myocardial ischemia
Arrhythmia	irregularity in heartbeat; some are mild and others are life threatening
Bundle branch block (BBB)	electrical impulse is blocked from traveling down bundle branches; results in ventricles beating at different rate than atria; also called heart block

coronary artery bypass graft (CABG)	using a portion of a vein to bypass an occluded coronary artery
	the replacement of the diseased heart with the healthy heart of a brain-dead donor

## Cardiovascular pharmacology

Antianginal	for the cases of angina pectoris
ACE inhibitors	for treatment of hypertension
Adrenergic	for cases of hypotension
Statins	used to ↓ cholesterol production in the liver
Thrombolytic therapy	used to dissolve clots
Nitrates	for treating angina and given sublingually



## Blood components

- 1- Plasma (about 55% of whole blood, contains 90–92% water and the remaining 8–10% is dissolved substances).  
including:
  - a- Plasma proteins
    - Albumin: helps transport fatty substances
    - Globulin:  $\gamma$  globulins are antibodies
    - Fibrinogen: blood clotting protein
  - b- Additional important substances as  $K^+$ ,  $Na^+$ , glucose, A. A.s, fats urea, uric acid and creatinine.
- 2- Blood cells (erythrocytes, platelets and leukocytes)  
produced in red bone marrow by a process called hematopoiesis
  - Average adult has about five liters of blood

## **Blood typing**

- Each person's blood is different from others' due to presence of marker proteins on surface of erythrocytes
- Must do blood typing test before blood transfusion to make sure that donated blood is compatible with recipient's blood
- There are many different blood markers
  - Two most important ones for transfusions are ABO system and Rh factor

## **ABO system**

- There are two possible RBC markers, A and B
- Type A blood has anti-B antibodies to attack blood types B and AB
- Type B blood has anti-A antibodies to attack blood types A and AB
- Type O blood has no markers but contains anti-A and anti-B antibodies that attacks blood types A, B, and AB.
- Type AB blood has both markers but no antibodies, therefore, it will not attack any other blood types.

## **Universal donor (type O blood)**

- Type O blood does not have either marker A or B, so, it will not react with anti-A or anti-B antibodies found in other blood types. In an emergency, type O blood may be given to a person with any other blood type

## **Universal recipient (type AB blood)**

- Type AB blood has no antibodies against other blood types, it will not react with other blood. In an emergency, a person with type AB blood may receive any type of blood

## **Rh factor**

- Person with Rh factor on red blood cells is Rh-positive (Rh+) will not make anti-Rh antibodies
- Person without Rh factor is Rh-negative (Rh-) will produce anti-Rh antibodies
- Rh+ person may receive either Rh+ or Rh- transfusion, but Rh- person can receive only Rh- blood

# Blood vocabulary

blood clot	hard collection of fibrin, blood cells, and tissue debris; end result of hemostasis
coagulate	to convert a liquid to a solid; as in blood clotting
dyscrasia	general term for disease affecting blood
hematology	branch of medicine specializing in blood conditions; physician is a hematologist
hematoma	collection of blood under skin as a result of blood escaping into tissue from damaged blood vessels
hemostasis	to stop bleeding or stagnation of blood flow through tissues
packed cells	transfusion of only blood cells without plasma
whole blood	mixture of both plasma and formed elements

## Blood pathology

hemophilia	genetic disorder; blood fails to clot due to lack of one clotting factor
hyperlipidemia	excessive level of lipids in the blood stream; risk factor for atherosclerosis
septicemia	having bacteria or their toxins in the bloodstream; also called blood poisoning

## Erythrocytes pathology

anemia	group of conditions characterized by a reduction in number of RBCs or the amount of hemoglobin; results in less oxygen reaching tissues
aplastic anemia	severe anemia in which red bone marrow stops making sufficient blood cells; may require bone marrow transplant
hemolytic anemia	results from excessive loss of RBCs

hemolytic reaction	destruction of RBCs when patient receives mismatched blood transfusion
hypochromic anemia	results from insufficient amount of hemoglobin in RBCs; unable to transport sufficient oxygen
iron deficiency anemia	results from insufficient amount of iron to make hemoglobin for RBCs
polycythemia	condition of having too many RBCs; blood is too thick and flows sluggishly
sickle cell anemia	genetic disorder where RBCs take on abnormal sickle shape; become more fragile leading to hemolytic anemia
thalassemia	genetic disorder where unable to produce functioning hemoglobin
pernicious anemia	insufficient absorption of vitamin B <sub>12</sub> ; unable to make enough RBCs