

TIU - Faculty of Science
Medical Analysis Department

Lec. 1: Cardiovascular system

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Systematic physiology- 2nd Stage /2nd Semester



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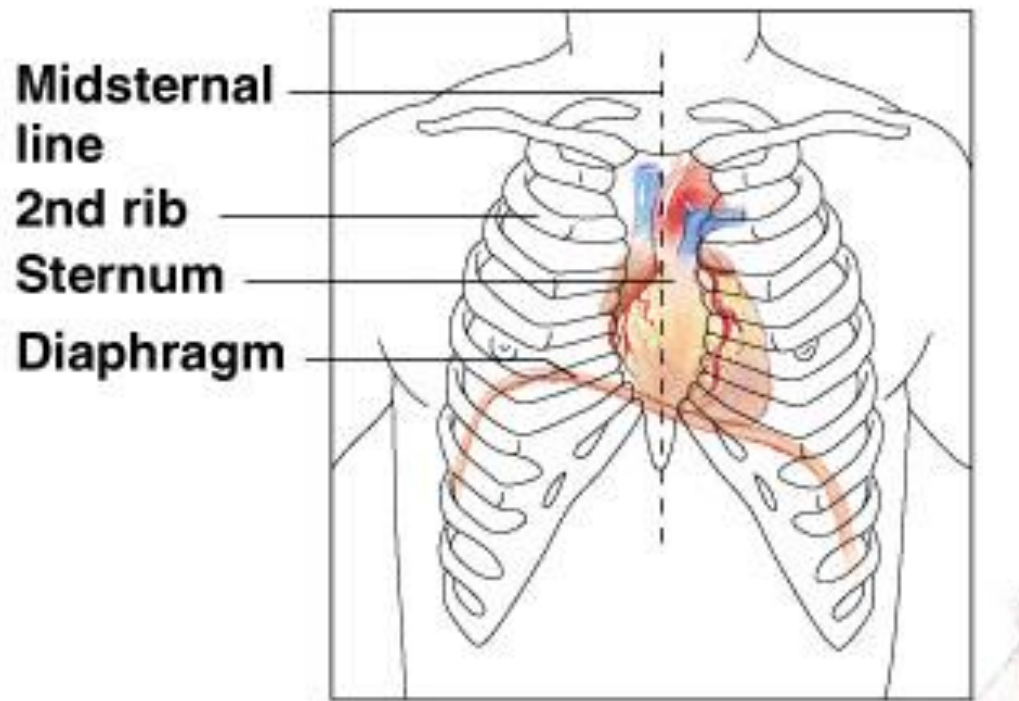
Overview of the Cardiovascular System

- The cardiovascular system is a closed system of the heart and blood vessels
 - the heart pumps blood into blood vessels
 - blood vessels circulate the blood to all parts of the body, to ALL cells
- Functions:
 - to deliver oxygen and nutrients to all body cells,
 - transport enzymes and hormones,
 - and to remove carbon dioxide and other waste products from the cells

A) Anatomy of the Heart

1. Location

- thoracic cavity
- in the mediastinum, between the lungs



2. Size

- approximately the size of a person's fist & less than 1 pound
 - ~ 14 cm long; 9 cm wide

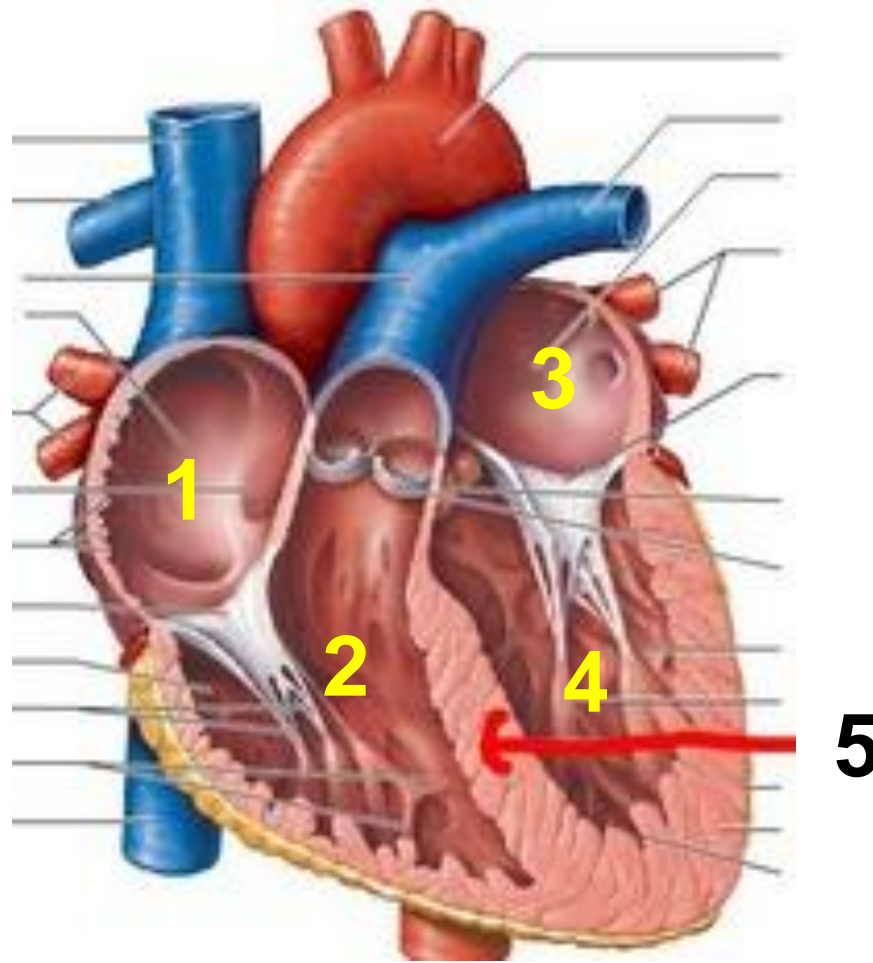
3. Heart wall

- a) epicardium** (aka visceral pericardium)
outside layer of connective tissue on
surface of the heart
- b) myocardium** = thick wall of cardiac
muscle
- c) endocardium**—inner epithelial &
connective tissue lining of heart and
valves

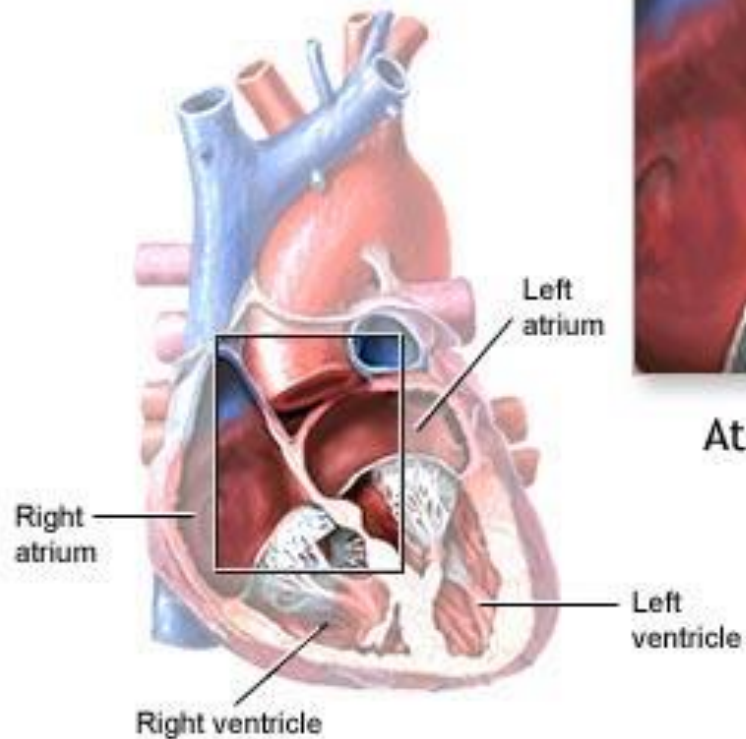
4. Chambers of the heart (4)

- **atrium** (R & L)—receive blood
 - each atria extends into a smaller, external chamber called an **auricle**
- **ventricle** (R & L)—inferior to the atria; expel blood out of the heart
- The chambers on the left are separated from the chambers on the right by a septum (wall of cardiac muscle)
 - interatrial septum
 - interventricular septum

Can you name each numbered part of the heart?



An atrial septal defect is a hole between the two atria



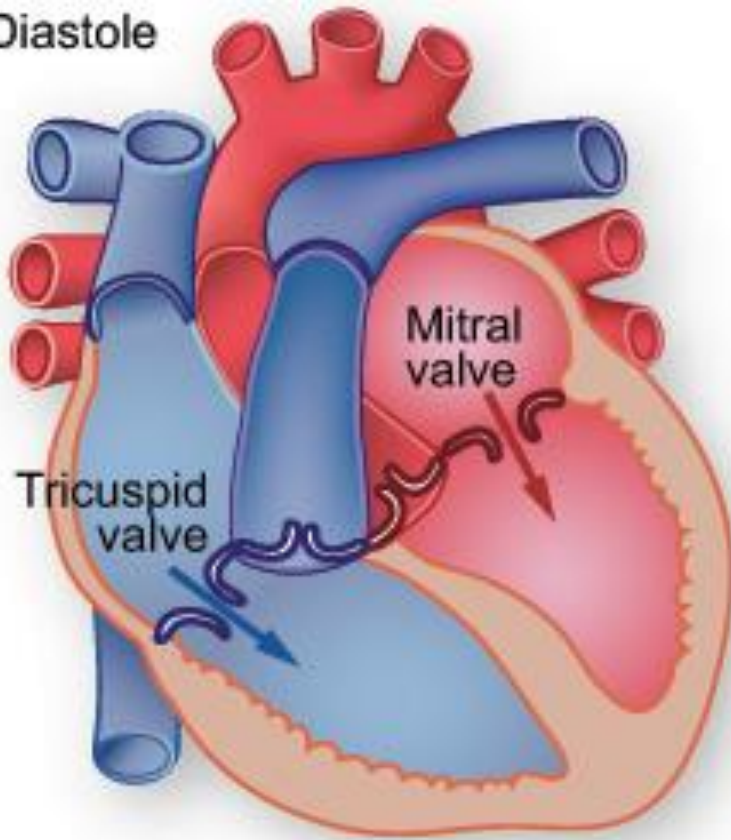
Atrial septal defect

6. Heart Valves

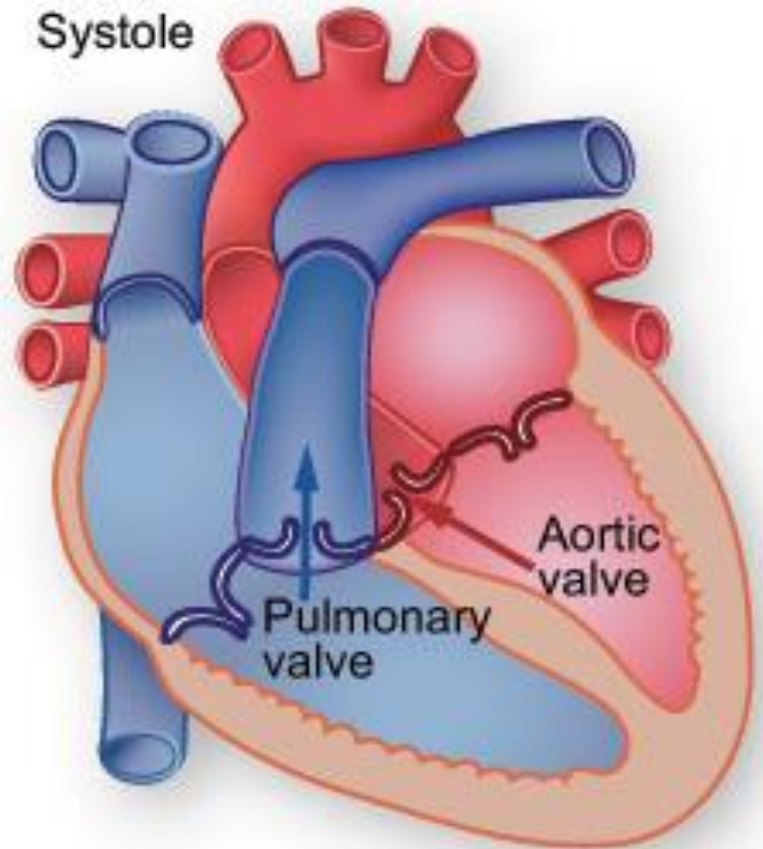


a) are flaps that allow blood to flow in only one direction

Diastole



Systole



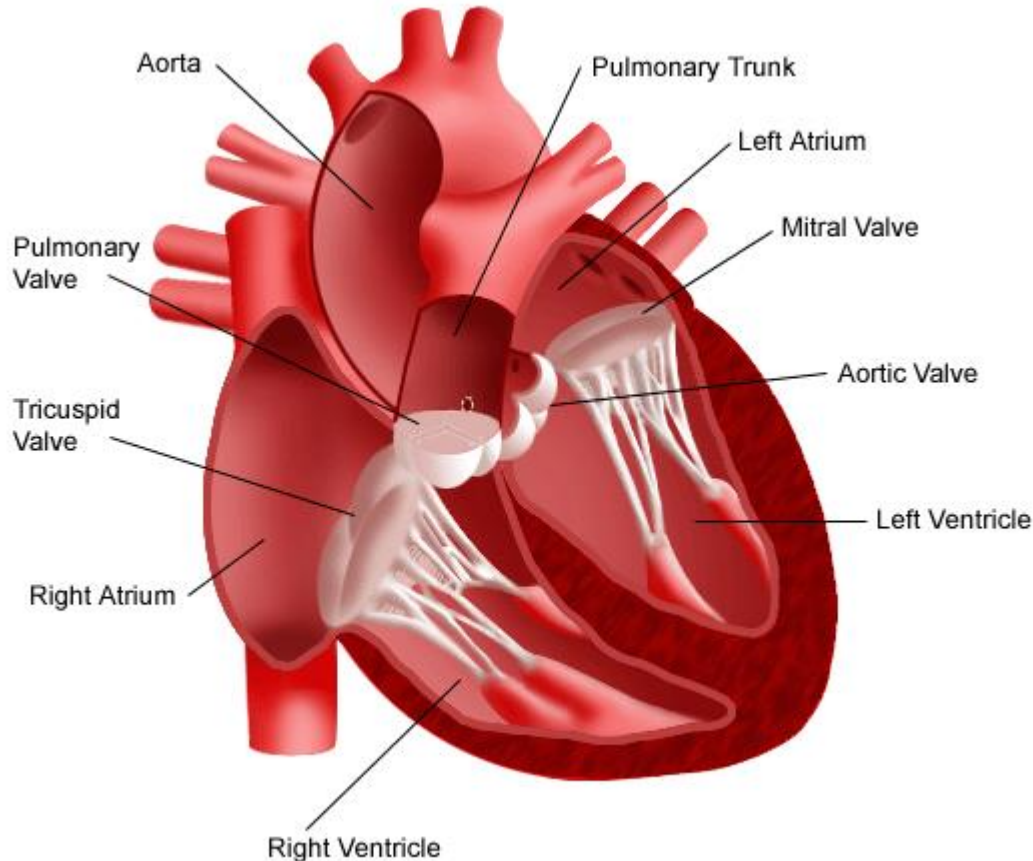
b) **atrioventricular (AV) valves** – between each atrium and ventricle; allow blood flow from each atrium down into the ventricle

- **bicuspid/mitral valve** (left side)
- **tricuspid valve** (right side)

c) **semilunar valves** - between ventricle and major heart artery; allow blood flow out of each ventricle through one of the major heart arteries; 3 cusps

- **pulmonary valve** (R ventricle & pulmonary trunk)
- **aortic valve** (L ventricle & aorta)

d) The valve cusps are held in place by chordae tendineae (“heart strings”) which originate from papillary muscles protruding from the inside of the ventricle wall



e) valve function

- ★ when a chamber wall contracts blood is pumped through a valve
- ★ any backflow increases pressure on the cusps and closes the valves
- ★ AV valves close during ventricular contraction; papillary muscles also contract pulling the chordae tendineae which keep the valve cusps from prolapsing back into the atrium

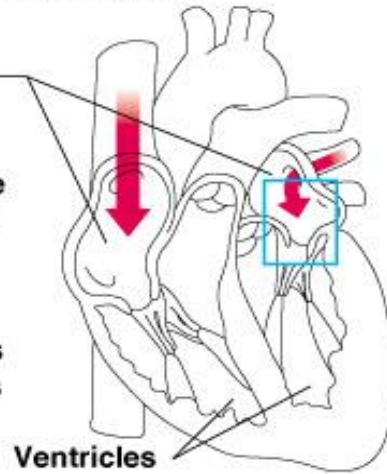
f) heartbeat sound

“lub” = when AV valves close

“dup” = when semilunar valves close

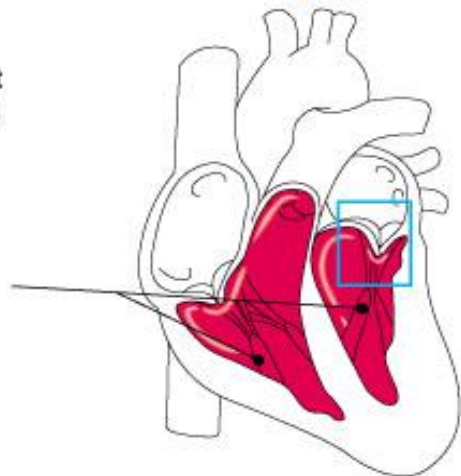
Operation of the AV valves

- 1 Blood returning to the heart fills atria, putting pressure against atrioventricular valves; the atrioventricular valves are forced open
- 2 As the ventricles fill, atrioventricular valve flaps hang limply into ventricles
- 3 Atria contract, forcing additional blood into ventricles



AV valves open

- 1 Ventricles contract, forcing blood against atrioventricular valve cusps
- 2 Atrioventricular valves close
- 3 Chordae tendineae tighten, preventing valve flaps from everting into atria

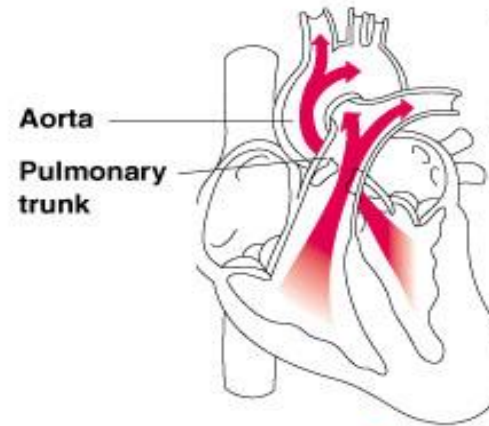


AV valves closed

(a)

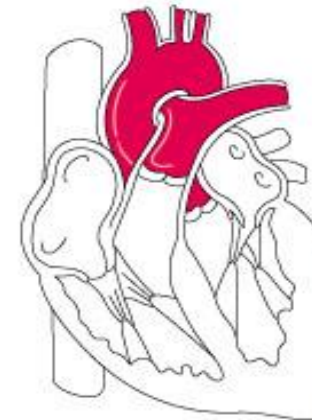
Operation of the semilunar valves

As ventricles contract and intraventricular pressure rises, blood is pushed up against semilunar valves, forcing them open



Semilunar valve open

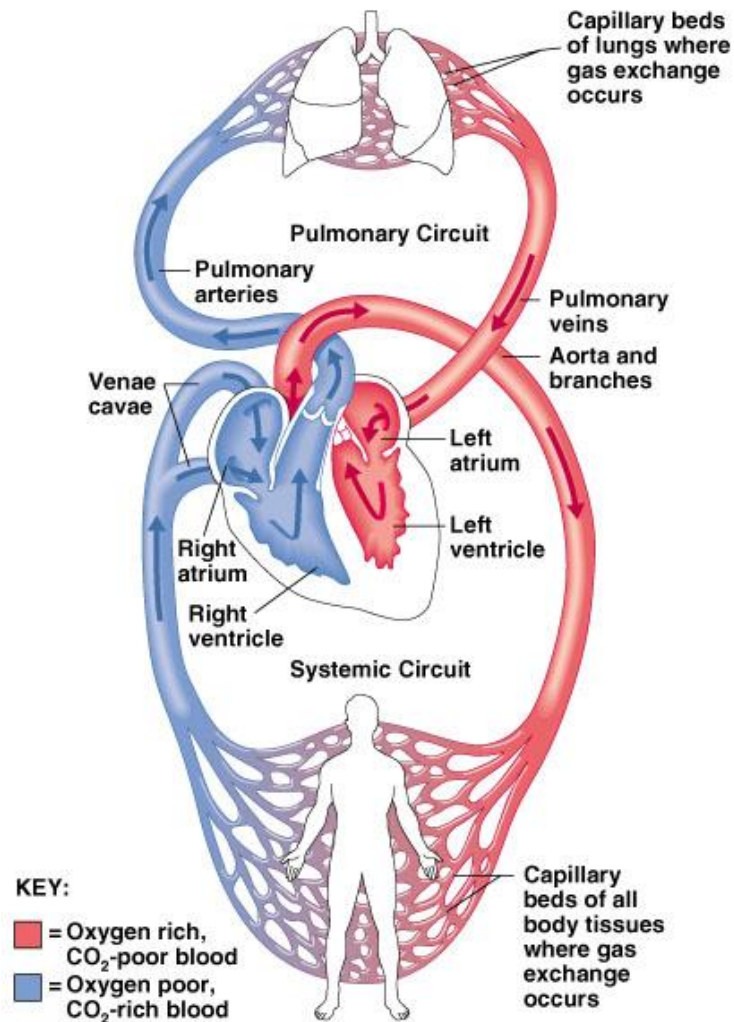
As ventricles relax, and intraventricular pressure falls, blood flows back from arteries, filling the cusps of semilunar valves and forcing them to close



Semilunar valve closed

(b)

B) Paths of Blood Circulation

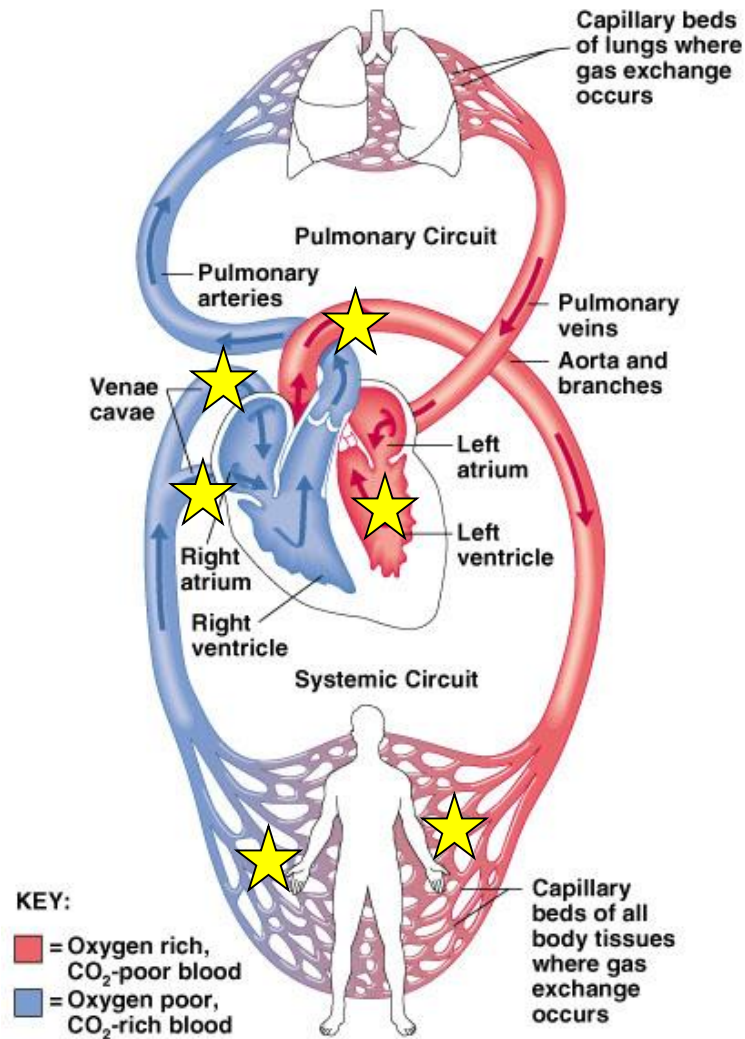


1. Major Blood Vessels of the Heart

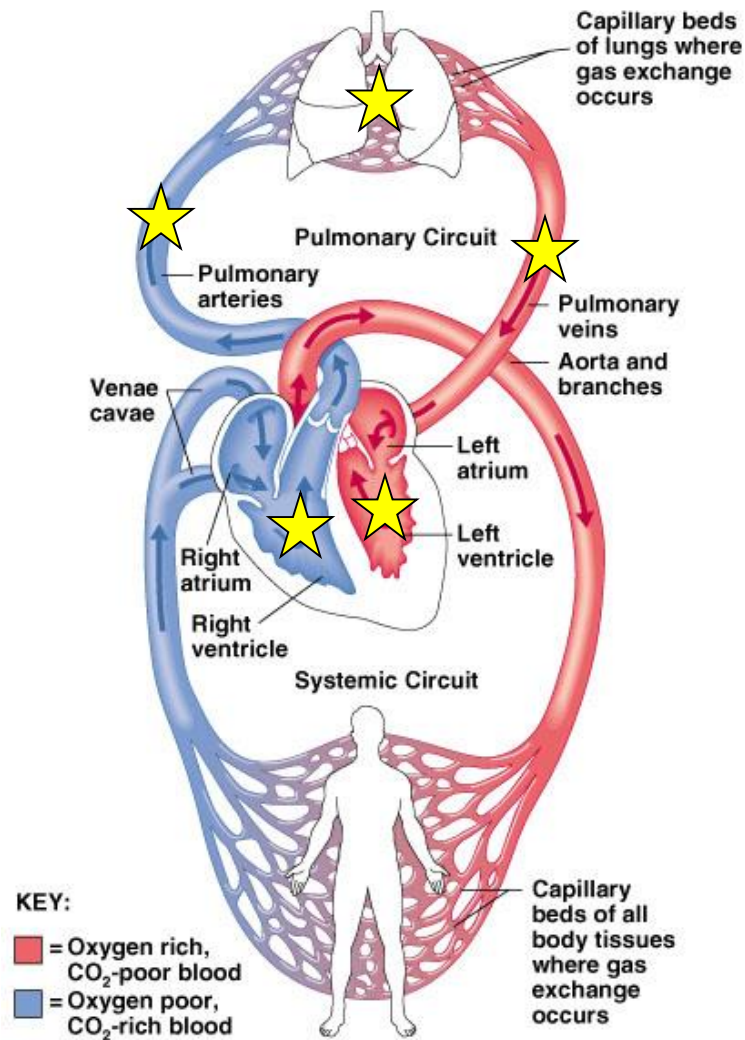
- **aorta** carries _____ blood from the left ventricle to upper & lower body
- **pulmonary arteries** (L & R): carries _____ blood from right ventricle to lungs
- **vena cava** (superior & inferior): carries _____ blood from upper & lower body into right atria
- **pulmonary veins** (2 pairs, L & R): carry _____ blood from lungs into left atria

- **aorta** carries **oxygenated** blood from the left ventricle to upper & lower body
- **pulmonary arteries** : carries **deoxygenated** blood from right ventricle to lungs
- **vena cava**: carries **deoxygenated** blood from upper & lower body into right atria
- **pulmonary veins**: carry **oxygenated** blood from lungs into left atria

2. Systemic circuit

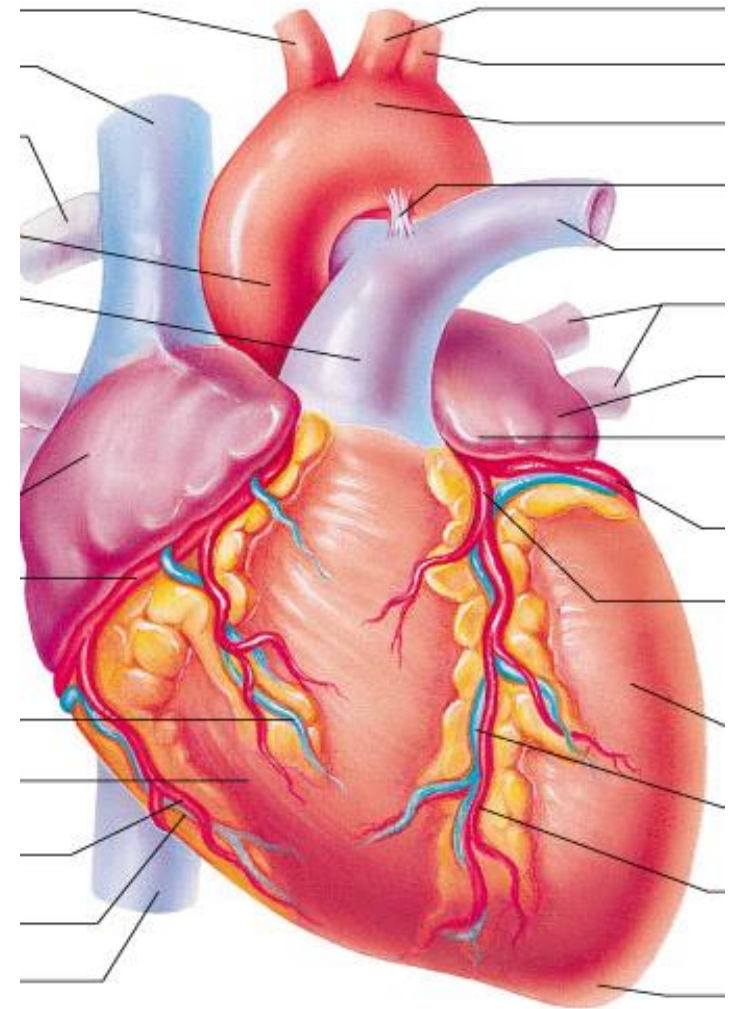


3. Pulmonary circuit



3. Coronary circuit

- The heart has its own network of blood vessels to supply the cardiac muscle cells
 - coronary arteries & veins, capillaries
- NOTE: The blood flowing *through the heart chambers* does NOT nourish the myocardium



Heart Physiology

How does the heart **function**?

A) The Cardiac Cycle

1. A cardiac cycle refers to the series of contractions & relaxations of the heart to produce a complete heartbeat

systole = contraction

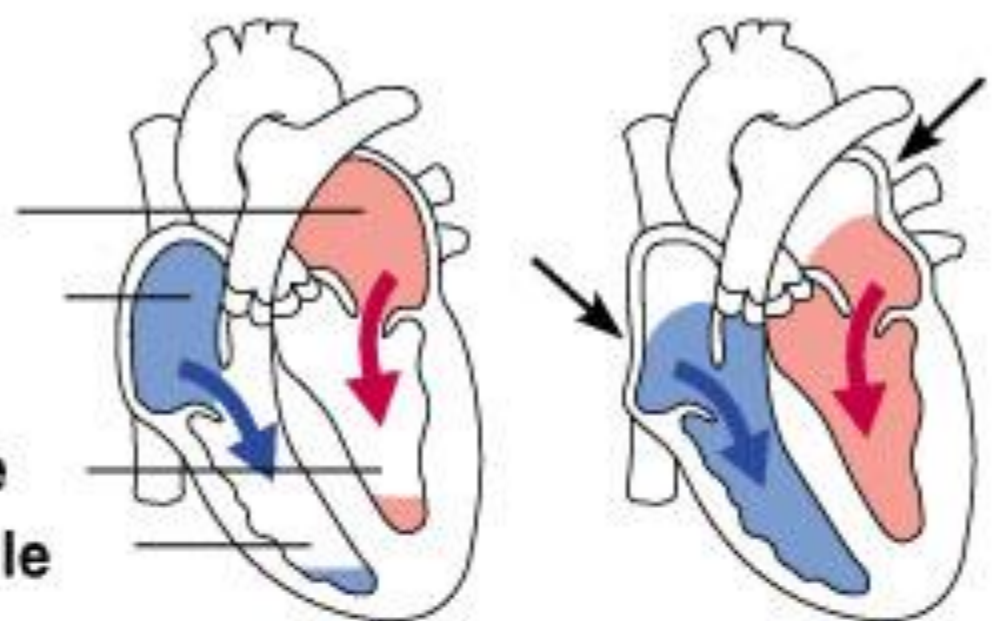
diastole = relaxation

2. Events of the cardiac cycle

Diastole

- I. Atria and ventricles fill with blood
- II. Atria contract (simultaneously) to complete the filling of ventricles;
ventricles are relaxed

Left atrium
Right atrium
Left ventricle
Right ventricle



Ventricular filling

Atrial contraction

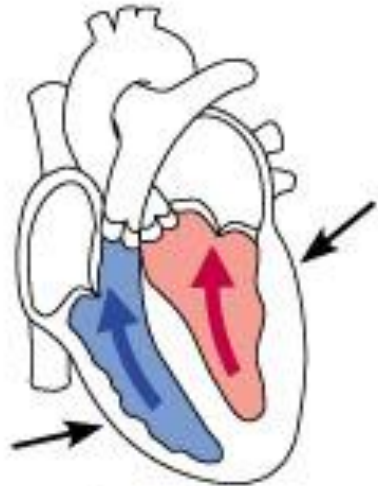
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**(Ventricular filling)
mid-to-late diastole**

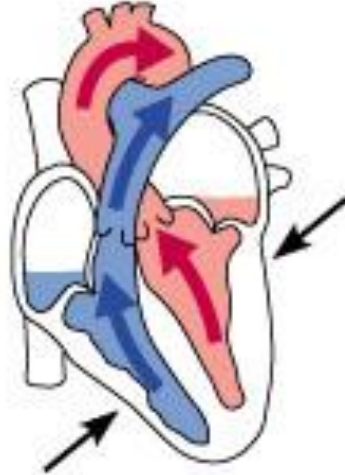
Systole

III. **Ventricles contract** forcing blood up and out of the heart arteries; AV valves shut (“lup”)

IV. Backflow in the aorta & pulmonary arteries cause semilunar valves to shut (“dup”)



**Isovolumetric
contraction phase**



**Ventricular
ejection phase**



**Isovolumetric
relaxation**

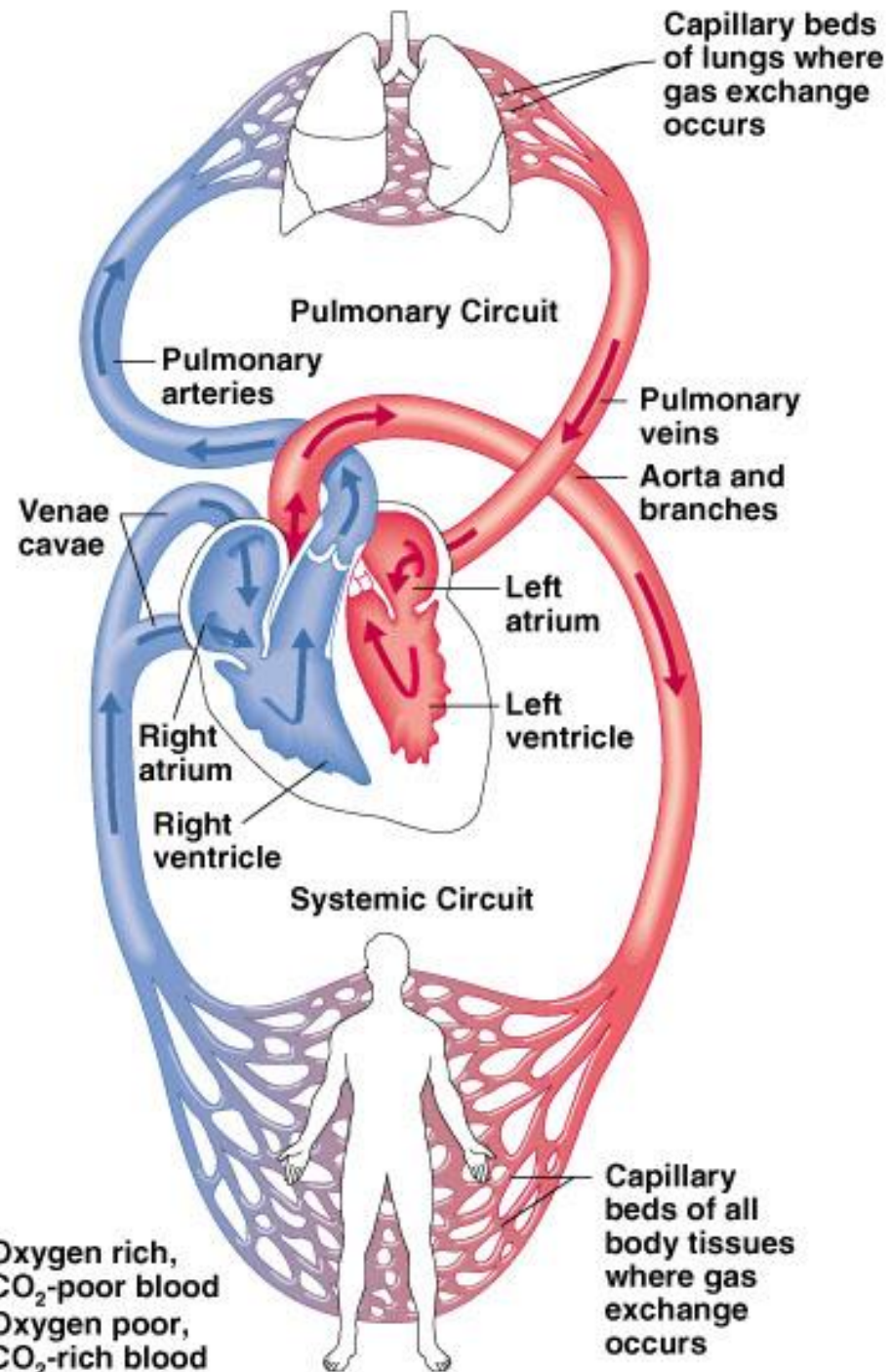
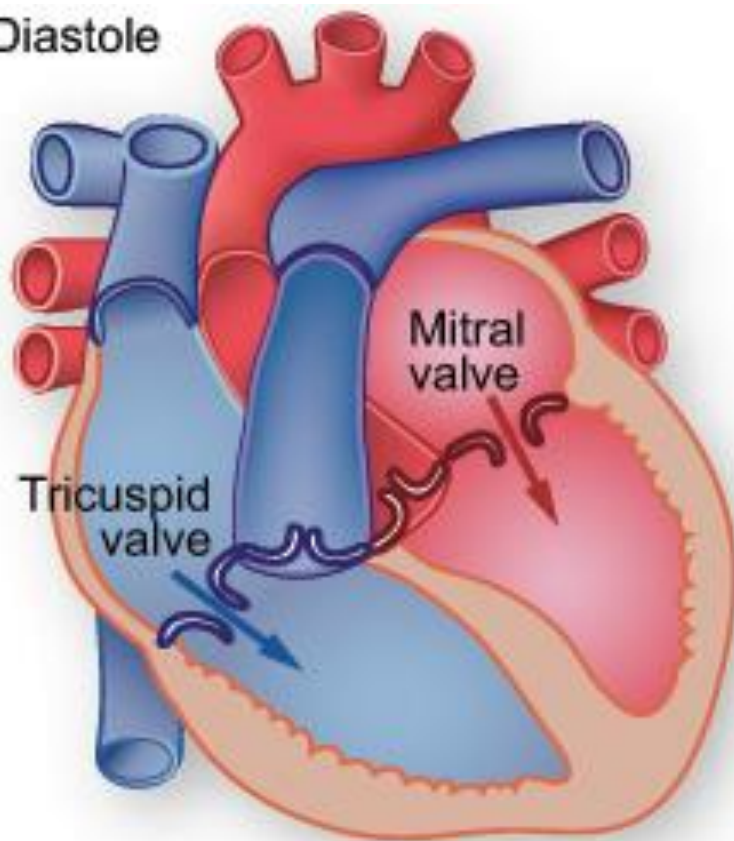
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**Ventricular systole
(atria in diastole)**



3

Early diastole

Diastole



KEY:

-  = Oxygen rich, CO₂-poor blood
-  = Oxygen poor, CO₂-rich blood

B) Conduction System

- is an intrinsic, nodal conduction system that regulates heart wall contractions via electrical impulses
- Specialized muscle tissue regulates contractions by carrying nerve impulses

- i. sinoatrial (SA) node** = “pacemaker”
(located in the wall of the right atrium)
- ii. atrioventricular (AV) node** (in septum at the junction of the R & L atria)
- iii. atrioventricular bundle** or Bundle of His
(in the interventricular septum)
- iv. bundle branches** (right and left)
- v. Purkinje fibers** (in the myocardium wall)

Superior
vena cava

Sinoatrial node
(pacemaker)

Atrioventricular
node

Right atrium

Bundle branches

Purkinje fibers

Left atrium

Atrioventricular
bundle
(Bundle of His)

Purkinje fibers

Interventricular
septum

