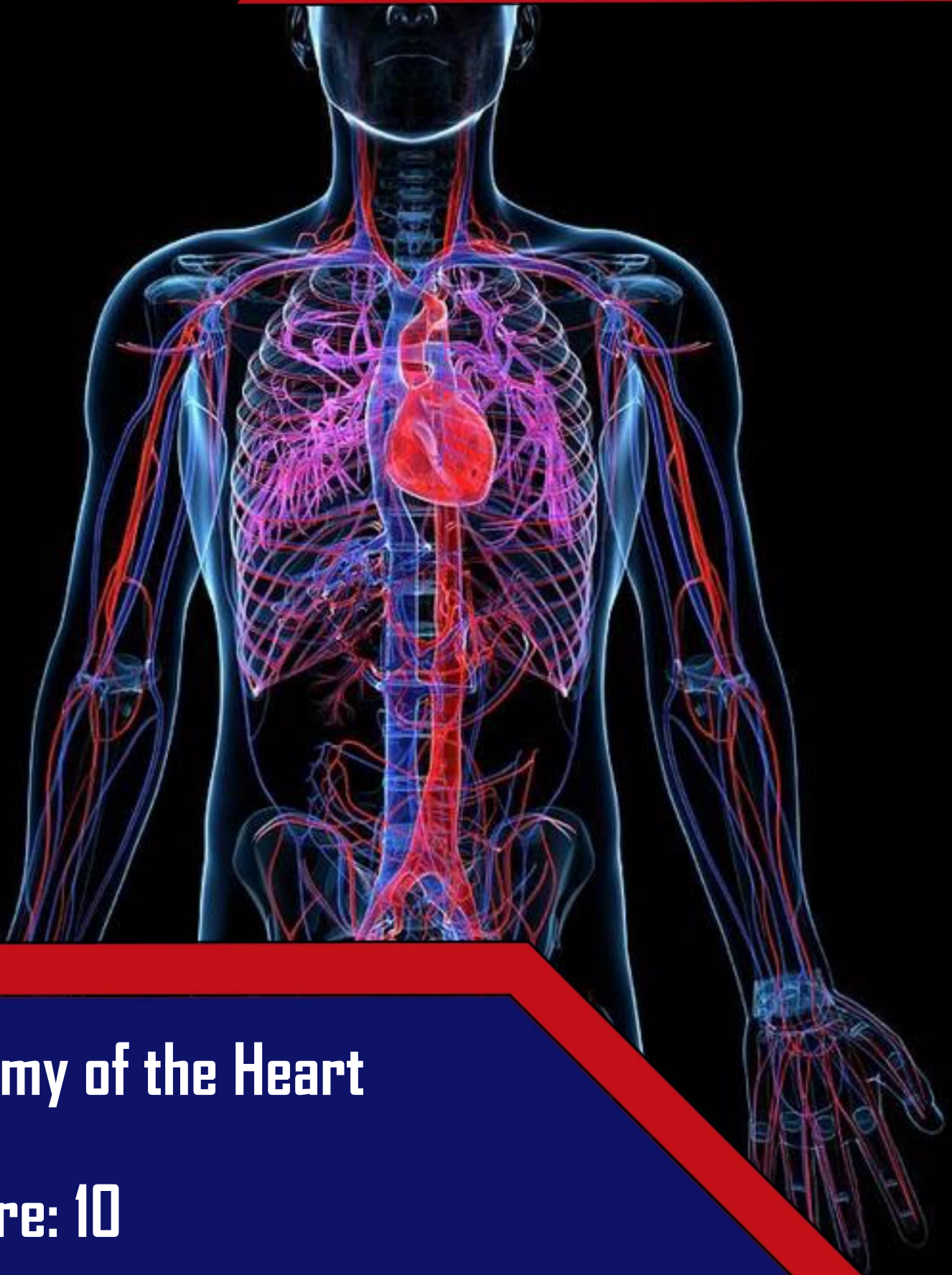


HATAHET ANATOMY



Anatomy of the Heart

Lecture: 10

Pages: 8

Lecture 10: The Heart

- **Cardiology**: the study of the normal heart and the diseases associated with it

The Cardiovascular System is composed of 3 main components:

- ⊗ Heart → hollow cone-shaped organ, functions as the main pump that circulates the blood through the vessels
- ⊗ Blood vessels → the tubes that supply all tissues of the body with blood, divided into: Arteries, Veins, Capillaries
- ⊗ Blood → the viscous fluid that circulates inside blood vessels and contains nutrients, wastes, cells, and proteins

Introduction to The Heart

Location & Surfaces

➤ Location

- the heart is located in the middle mediastinum
- posterior to sternum & anterior to T3 - T8 vertebrae
- $\frac{2}{3}$ of the heart is directed to the **left** of the midline

➤ Surfaces

❖ Apex

- the antero-inferior tip of the heart
- **made by**: LV

❖ Base (Posterior surface)

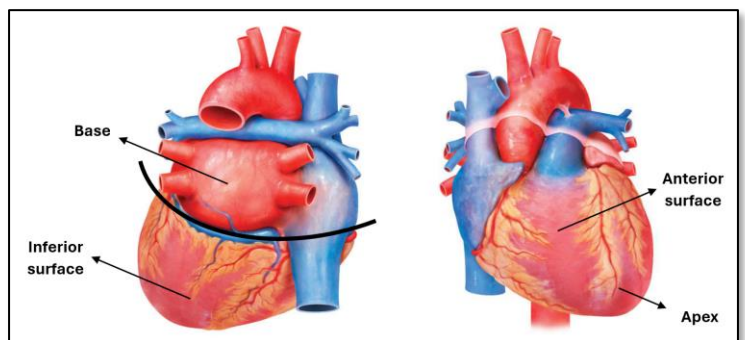
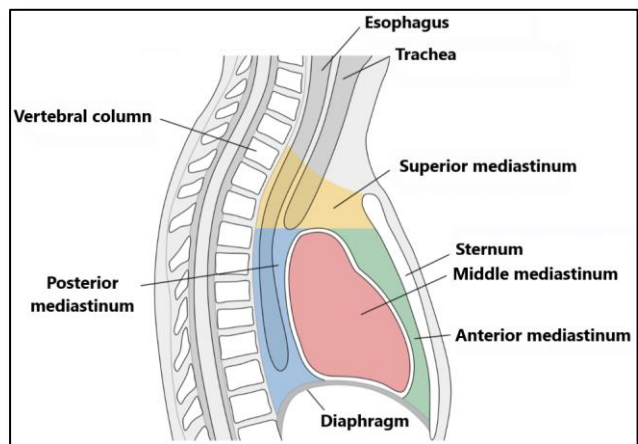
- **made by**: LA

❖ Anterior surface (Sternocostal surface)

- deep to both sternum and ribs
- **made by**: RV mainly, RA, LV

❖ Inferior surface (Diaphragmatic surface)

- faces the diaphragm and rests on it
- **made by**: RV, LV



Pericardium

- **Pericardium**: the membrane that surrounds and protects the heart

- ① **Fibrous layer**, the outer, tough, inelastic layer that protects, anchors, and prevents overstretching of the heart
- ② **Serous layer**, the inner, thin, elastic serous membrane of the heart, composed of:

A. **Parietal layer**, the outer layer of serous membrane

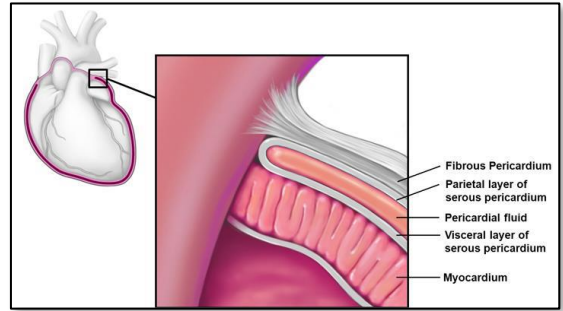
B. **Visceral layer (Epicardium)**, the inner layer of serous membrane that directly covers the heart and follows its grooves

C. **Pericardial cavity**, the cavity between the two layers, filled with the pericardial fluid to reduce friction

Heart wall layers

Heart wall is composed of 3 main layers:

- 1 **Epicardium**, the outer and the first layer of the heart wall, makes up 5% of its thickness
- 2 **Myocardium**, the thick middle muscular layer that contracts to pump the blood, makes up 95% of the wall thickness
- 3 **Endocardium**, the inner endothelium of the heart, it is the surface that contacts the blood in heart's chambers & it is continuous with the endothelial lining of the great vessels



*****Note:** The Epicardium is composed of (Visceral layer of serous pericardium + the adipose tissue beneath)

Anatomy of Heart

Valves of the Heart

There are 4 valves that prevent the backflow of the blood in the heart; ensuring the uni-directional bloodflow, these valves are composed of dense CT rings covered by endocardium, they are divided into 2 types:

1) Atrioventricular valves (AV valves)

- located between each atrium and ventricle
- composed of cusps (leaflets)
- open when the atria contract; when the (A-pressure > V-pressure)
- these 2 valves are:

A. **Bicuspid valve (Mitral valve)**, composed of 2 cusps, located between LA & LV, controlled by papillary muscles of LV

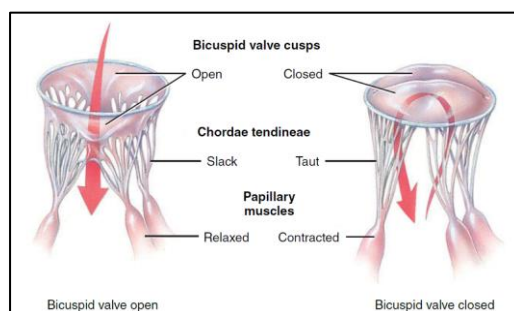
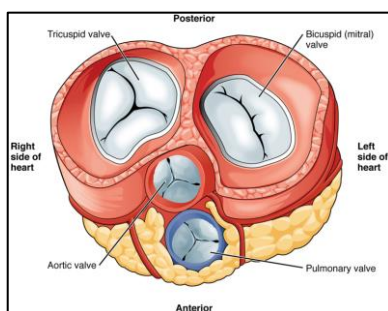
B. **Tricuspid valve**, composed of 3 cusps, located between RA & RV, controlled by the papillary muscles of RV

2) Semilunar valves (SL valves)

- located between each ventricle and associated great artery
- composed of semilunar cusps
- open when the atria contract; when the (V-pressure > A-pressure)
- back-flowing blood fills the valve cusps, which causes the free edges of semilunar valves to contact each other tightly and close the opening between the ventricle and great artery
- these 2 valves are:

A. **Pulmonary valve**, composed of 3 semilunar leaflets, located between the RV & Pulmonary trunk

B. **Aortic valve**, composed of 3 semilunar leaflets, located between the LV & Aorta



Chambers of the Heart

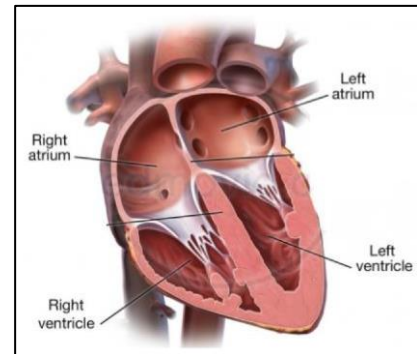
- **Heart Chambers:** compartments of the heart that receive (**atria**) & pump (**ventricles**) blood, divided based on function into:

➤ Pulmonary pumps

- responsible for the pulmonary circulation
- pump deoxygenated blood from heart to the lung
- composed of the right side of the heart: RA & RV

➤ Systemic pumps

- responsible for the systemic circulation
- pump oxygenated blood from heart to the entire body
- composed of the left side of the heart: LA & LV



❖ Right Atrium (RA)

- receives deoxygenated blood from:
 - ① **Superior vena cava (SVC)**, drains the veins above the heart: head, neck, axilla, and upper limbs
 - ② **Inferior vena cava (IVC)**, drains the veins below the heart: thorax, abdomen, pelvis, and lower limbs
 - ③ **Coronary sinus**, drains the coronary veins of the heart
- pumps the blood to the RV via the (**Tricuspid valve**)
- some features & structures of the RA:
 - **Anterior & Lateral walls**, have rough surfaces due to the presence of (**Pectinate muscles**)
 - **Pectinate muscles**, internal parallel ridges in the anterior and lateral walls of the RA
 - **Medial wall (Venous portion)**, have a smooth surface that contains the (**Interatrial septum**)
 - **Interatrial septum**, the septum between RA & LA, it contains the (**Fossa ovale**)
 - **Fossa ovale**, oval depression on the interatrial septum, it is a remnant of the fetal (**Foramen ovale**), an interatrial opening that has a significant role in the fetal circulation

❖ Right Ventricle (RV)

- receives deoxygenated blood from the RA
- pumps the blood to the (**Pulmonary trunk**) via the (**Pulmonary valve**)
- some features & structures of the RV:
 - **Interventricular septum**, the medial wall of both ventricles that separate them from each other
 - **Trabeculae carneae**, irregular ridges in the inner surface of both ventricles, formed by raised bundles of myocardium
 - **Papillary muscles**, cone-shaped muscles at the base of each ventricle, they arise as a part of trabeculae carneae, when they contract, the chordae tendineae will pull the leaflets of the AV valve; closing it
 - **Chordae tendineae**, cords between valve leaflets and papillary muscles

❖ Left Atrium (LA)

- receives oxygenated blood from the 4 pulmonary veins: (2 Right + 2 Left)
- pumps the blood to the LV via (**Bicuspid valve**)
- forms the **base** of the heart
- LA has a smooth inner surface and also has an auricle (**left Auricle**), the auricle wall is the only rough wall in the LA; due to the presence of **Pectinate muscle** there

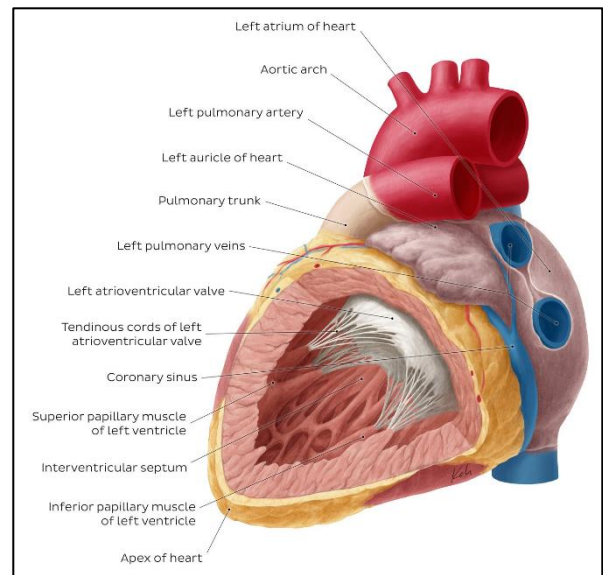
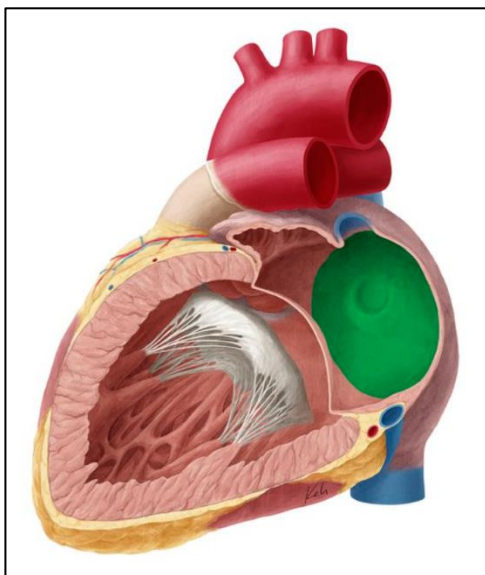
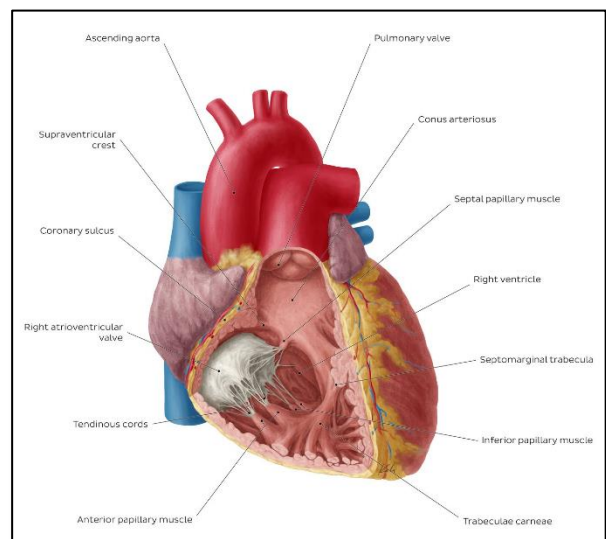
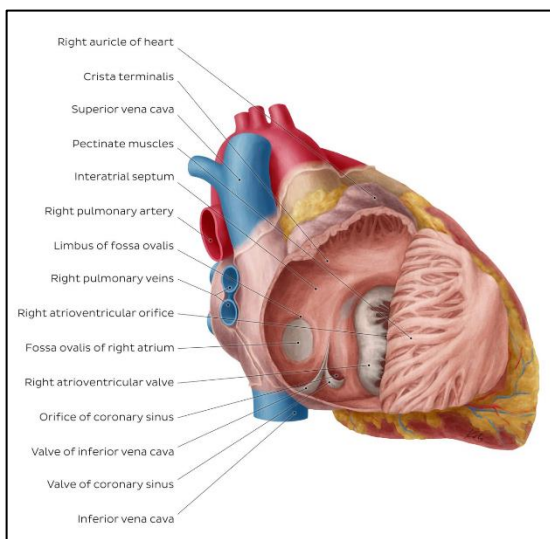
❖ Left Ventricle (LV)

- receives oxygenated blood from the LA
- pumps the blood to the aorta via (**Aortic valve**)
- forms the **apex** of the heart
- has the same features & structures of the RV

❖ Auricles of the heart

- the atria of the heart have extension pouches that represents the remnant of the fetal atria
- there are 2 auricles (Right & Left), one for each atrium
- their function is to increase the capacity of the atria, increasing the bloodflow sufficiency

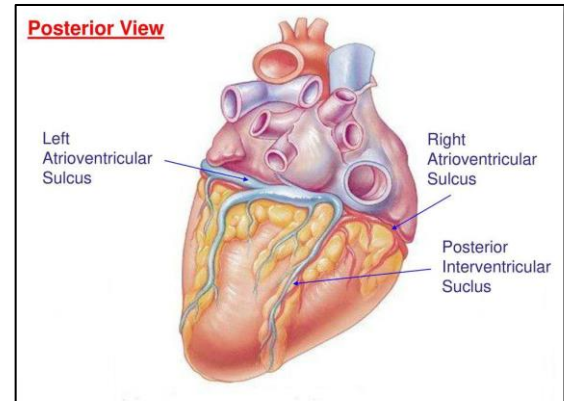
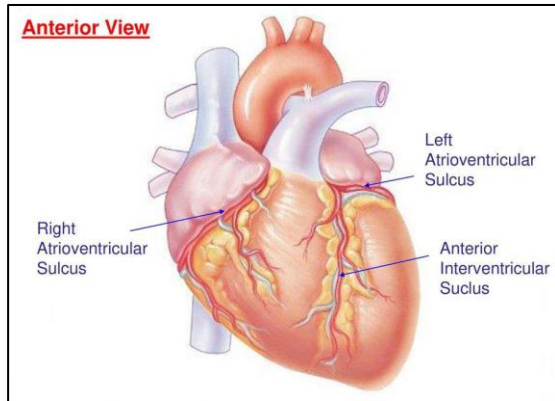
*****Note:** The function for both (**Foramen ovale & Ductus arteriosus**) is to shunt blood away from the pulmonary circulation; because **IT DOES NOT EXIST IN FETUS** (Fetal circulation discussed in the lecture - لانه الدكتور ما طلبها للامتحان)



Sulci of the Heart

▪ **Heart sulci:** grooves on the surface of the heart containing the coronary blood vessels, there are 3 main sulci:

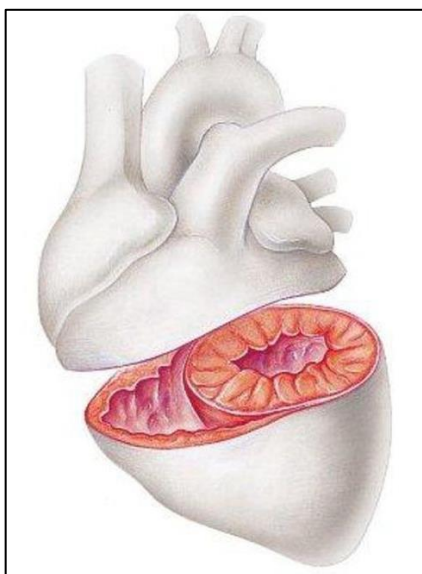
- (1) **Coronary (Atrioventricular) sulcus**, runs between the 2 atria and the 2 ventricles, composed of 2 small sulci (R&L)
- (2) **Anterior interventricular sulcus**, runs anteriorly between the 2 ventricles
- (3) **Posterior interventricular sulcus**, runs posteriorly between the 2 ventricles



Thickness of Myocardium

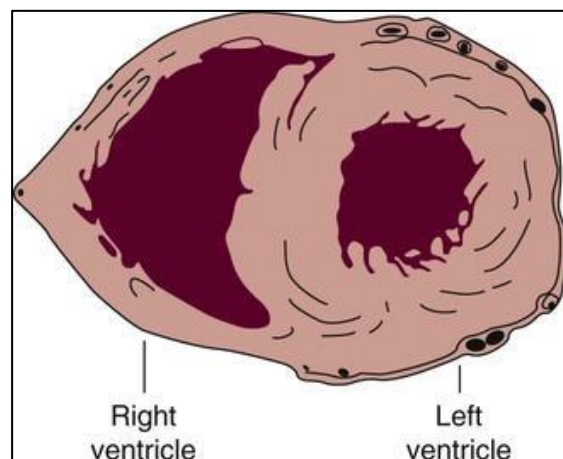
About the thickness of the heart chambers, they follow the following rules:

- ❶ the left side of the heart is **ALWAYS** thicker than the right side
- ❷ a ventricle **ALWAYS** has a thicker wall than an atrium at the same side of the heart; because ventricles pump blood to greater distances compared with the atria which pump blood to the adjacent ventricle
- ❸ The **thickest myocardium is the myocardium of the LV** and the thinnest are the RA & LA
- ❹ **LV is thicker than the RV**; because LV pumps blood to the whole body where the resistance to blood flow is greater than the resistance of blood flow in the pulmonary circulation, so it needs more power



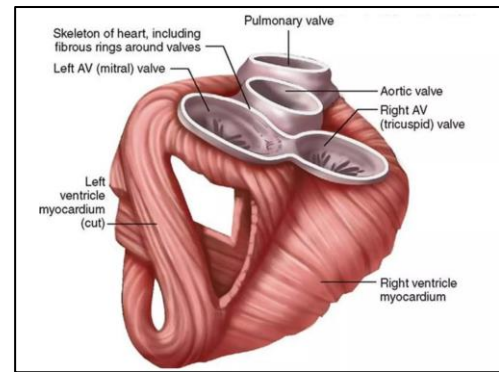
Right ventricle → Crescent shape

Left ventricle → Circular shape



Fibrous Skeleton

- this is the structural foundation of the heart valves & the insertion point for myocardial fibers
- acts as an electrical insulator between atria and ventricles; to allow the atria to contract completely before ventricles do
- composed of 4 dense CT rings:
 - ♦ **Right AV ring**
 - ♦ **Left AV ring**
 - ♦ **Pulmonary ring**
 - ♦ **Aortic ring**



Conducting System

- 1% of the cardiac muscle fibers become (**Authorhythmic**: can generate & propagate action potential)
- Conducting system of the heart is NOT composed of nerves but myocardial fibers
- the conducting system of the heart is composed:

➤ Sinoatrial node (SA node) (Pacemaker)

- located in the wall of the RA inferolateral to the opening of the SVC
- facilitates the contraction of both atria at the same time
- SA node is the fastest and the easiest point to generate AP

➤ Atrioventricular node (AV node)

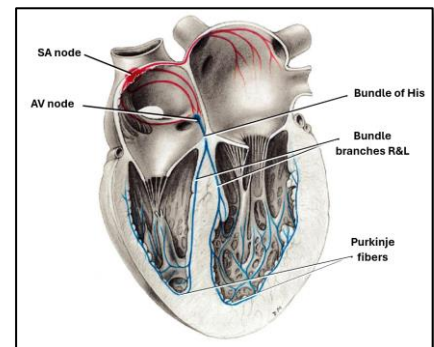
- located in the interatrial septum, anterior to the opening of coronary sinus
- it delays the electrical signal by (20 mS) until the atria are fully contracted

➤ Atrioventricular bundle (Bundle of His)

- located at the IV septum
- it is the only site where action potential can conduct from atria to ventricles; due to the absence of fibrous skeleton
- divides into R&L bundle branches that further divide into Purkinje

➤ Purkinje Fibers

- conducts the action potential to the myocardium of the ventricles
- have less myocardium but more mitochondria; to facilitate the conduction of action potential



Cardiac nerves

- **Cardiac plexus**, a network of nerves composed of:

- ❶ **Sympathetic nerves** (**Vagus nerve - CN X**) → increase heartbeat & dilate coronary arteries
- ❷ **Parasympathetic nerves** (**Upper thoracic sympathetic trunk**) → decrease heartbeat & constrict coronary arteries

❖ Clinical correlation: Arrhythmia (Dysrhythmia) ❖

The heart may beat irregularly, too quick, or too slow, these terms are called:

- ❶ **Bradycardia** → slow heartbeat (> 60 bpm)
- ❷ **Tachycardia** → rapid heartbeat (< 100 bpm)
- ❸ **Fibrillation** → rapid uncoordinated heartbeat; curable if in atria and fatal in ventricles

Blood circulations

Systemic circulation

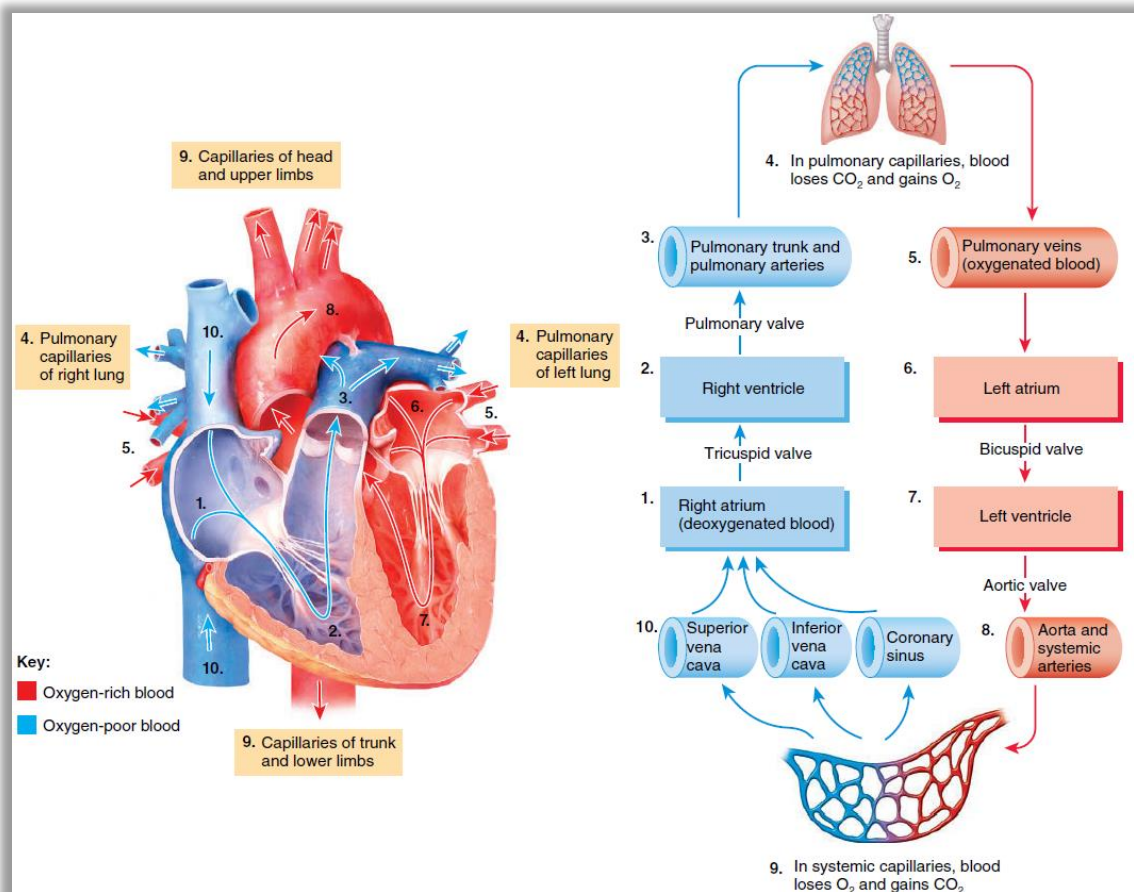
❖ It is the circulation of the oxygenated blood from the heart to all the body tissue, as the following order:

- ❶ LA receives the oxygenated blood from 4 pulmonary veins and pumps it to the LV through the bicuspid valve
- ❷ LV contracts to pump the blood to the aorta through the aortic valve
- ❸ the aorta will deliver the oxygenated blood to all the living cells in the human body
- ❹ the branches of the arterial system of the aorta will reach the capillaries where the venous system begins
- ❺ the venous part of the capillaries will deliver the deoxygenated blood from all the living cells of the body to the RA

Pulmonary circulation

❖ It is the circulation of the deoxygenated blood from the heart to the lungs for respiration and gas exchange to reoxygenate the blood, as the following order:

- ❶ RA receives the deoxygenated blood from the vena cava and pumps it to the RV through the tricuspid valve
- ❷ RV contracts to pump the blood to the pulmonary trunk to the 2 pulmonary arteries through the pulmonary valve
- ❸ the deoxygenated blood will travel to the alveoli of the lung to get reoxygenated by the process of respiration
- ❹ the oxygenated blood will return to the LA of the heart by the 4 pulmonary veins



Coronary circulation

❖ Coronary arteries

1) **Left coronary artery**, branches off the ascending aorta and runs deep/inferior to the left auricle, branches into:

A. Anterior interventricular (Left Anterior Descending - LAD) artery

- runs in the anterior interventricular sulcus
- **supplies:** RV & LV

B. Circumflex branch

- runs in the coronary sulcus
- **supplies:** LA & LV

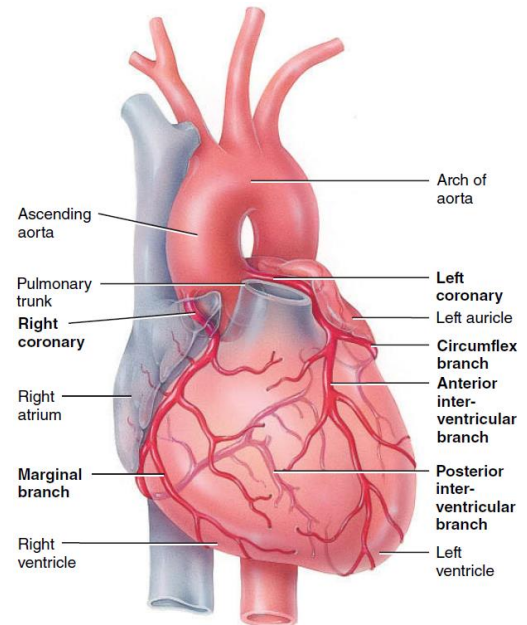
2) **Right coronary artery**, branches off the ascending aorta and runs deep/inferior beneath the right auricle, branches into:

A. Posterior interventricular artery

- runs in the posterior interventricular sulcus
- **supplies:** RV & LV

B. Marginal branch

- runs along the right margin of the heart
- **supplies:** RV



*****Note:** The marginal branch of the right coronary artery can be called (Right marginal branch) only if the individual has left marginal branch that branches off the left coronary artery, in some cases.

❖ Coronary veins

1) **Great cardiac vein**

- runs in the anterior IV sulcus
- **drains:** RV, LV, LA

2) **Middle cardiac vein**

- runs in the posterior IV sulcus
- **drains:** RV & LV

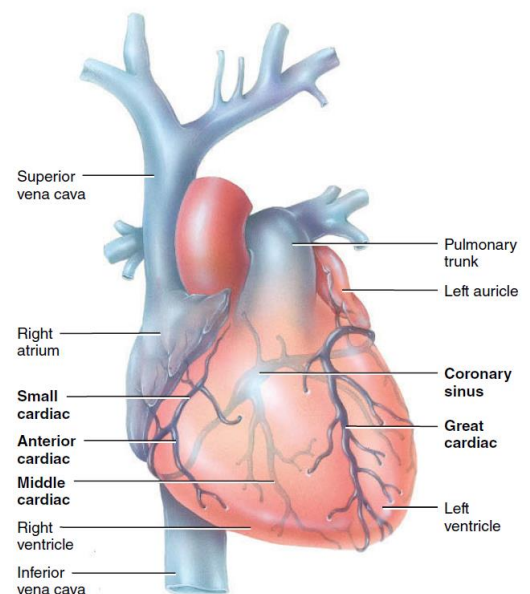
3) **Small cardiac vein**

- runs in the coronary sulcus
- **drains:** RA & RV

☼ The previous 3 veins drain into the **Coronary sinus**

4) **Anterior cardiac vein**

- opens directly into the RA
- **drains:** RV



▪ **Coronary sinus:** large venous sinus in the posterior surface of the heart that drains the greater, middle and small cardiac veins and empties directly in the RA

*****Note:** The myocardium contains many **Anastomoses** called (**Collateral circulation**), which means that the same area is supplied by more than one artery; to provide alternate routes if one artery becomes occluded