

Human Anatomy & Embryology

Lecture: Anatomy of Heart

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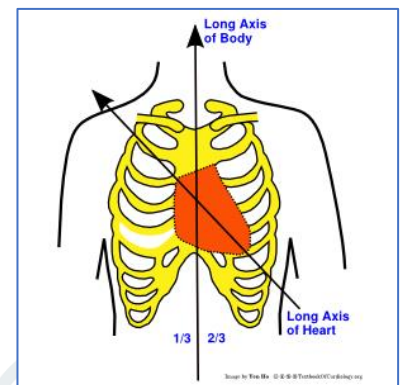


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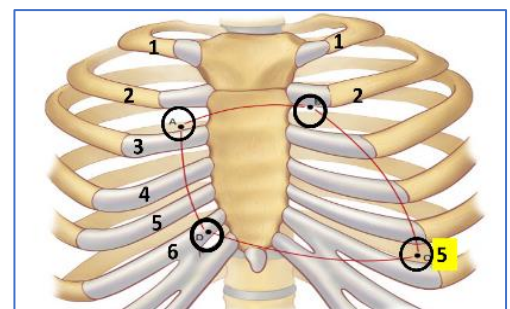
Anatomy of Heart

❖ Overview

- The Heart is hollow muscular organ. It is made of cardiac muscles and hollow means There is space inside it.
- Have 2 separate pumps:
 - **Left pump:** which start at left atrium which receives blood from the lungs then passes it to the left ventricle to pump into all parts of the body.
 - **Right pump:** right atrium receives blood from all part of the body passes the blood into right ventricle that pumps it to the lungs to be oxygenated.
- The Heart is lying between the 2 lungs and it is located in the **inferior part of mediastinum**.
- The inferior surface of Heart is attached to the central tendon of diaphragm.
- 1/3 of the heart in the right of midline and 2/3 in the left ->
- The Heart is posterior to the sternum and between 2 lungs and anterior to the vertebral column.
- The great vessels connected directly to the heart:
 - Superior + Inferior Venae Cavae (singular: vena cava).
 - Pulmonary trunk.
 - Aorta (greatest artery in the body).
- **4 superficial surface anatomy of where the heart is** (look at the image below):
 - 3 cm from the edge of sternum in the lower border of 2nd rib (Left).
 - 3 cm from the edge of sternum in the upper border of 3rd rib (right).
 - 3 cm from the edge of sternum in the 6th rib (right).
 - 9 cm from the edge of sternum below 5th rib "in the 5th intercostal space" (Left).

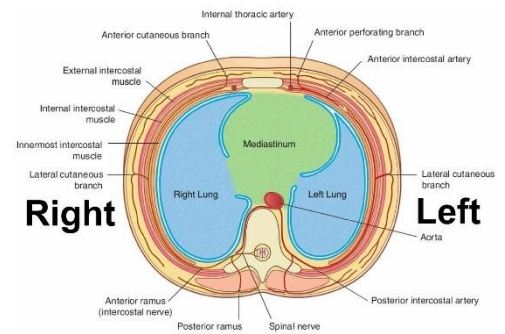


- There is white sheet covers the heart called **fibrous pericardium** (*pericardium fibrosum*).
- The heart is cone-shaped (has base and apex):
- The apex (the pointed end) is formed by left ventricle.
- The base is formed by left atrium.

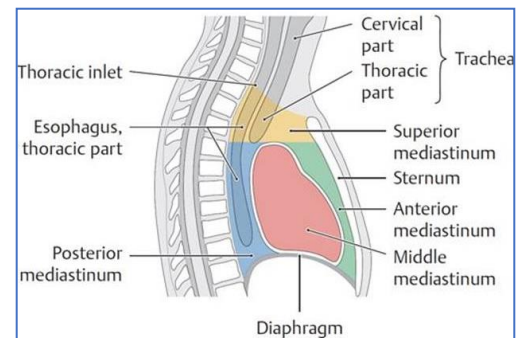


❖ Mediastinum

- an anatomical region that extends from the sternum to the vertebral column + from first rib to the diaphragm.
- [Mediastinum = thoracic cavity – pleural cavity (lungs)]. It is like a septum that divides the thoracic cavity into 2 parts right and left.
- It has many structures.
- We are going to divide mediastinum into superior mediastinum and inferior mediastinum by an imaginary plate that extends from sternal angle to the intervertebral disc between T4, T5.

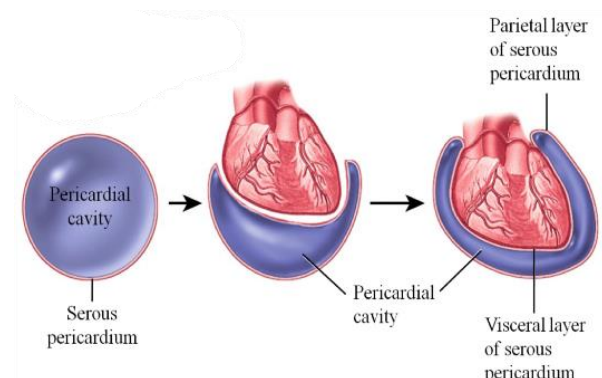


- Superior mediastinum (at level of T1 – T4):
 - ✓ connects to the neck through superior thoracic aperture.
 - ✓ it is at the level of T4-T5.
- Inferior mediastinum
 - Divided into 3 parts:
 - I. Anterior inferior mediastinum: narrow space posterior to the sternum and anterior to the pericardium.
 - II. Middle inferior mediastinum: the largest section and contains pericardium, heart and major vessels.
 - III. Posterior inferior mediastinum: small, long, and posterior to the pericardium, anterior to the 5th through 12th thoracic vertebrae and We found the esophagus in it.



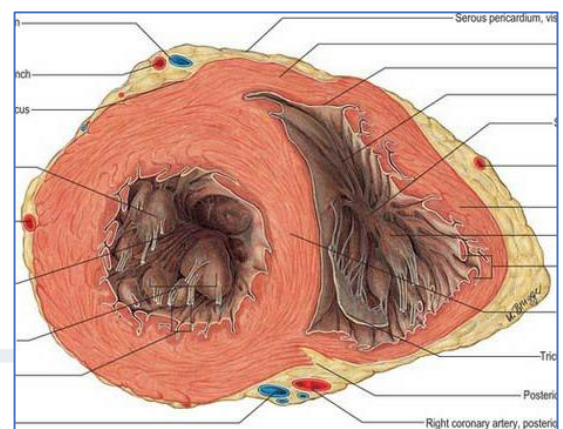
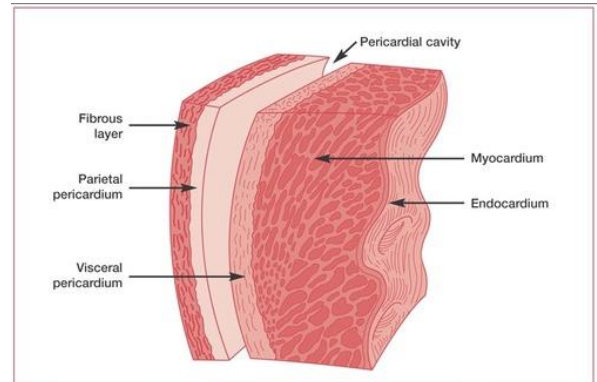
❖ Coverings of the Heart

- The Heart is covered by outer fibrous pericardium for protection and provide smooth surfaces (to remove friction when it contract).
- Outer **fibrous pericardium**: white sheath that covers the heart (single layer) and the smooth surface is provided by serous pericardium.
- **Serous pericardium**: serous: not connected to the outside and it has thin layer of fluid (the picture is important).
 - ✓ from the inferior side, it is a continuation of diaphragm's central tendon.
 - ✓ from the superior side, it is connected to the large vessels.



❖ Layers of the heart wall

- The heart chambers are lined with simple squamous epithelium called Endocardium (to provide smooth surface and prevent blood clotting).
 - Then myocardium.
 - Visceral pericardium (epicardium): simple squamous epithelium.
 - Pericardial cavity (contains fluid).
 - Parietal pericardium.
 - Fibrous pericardium.
-
- The thickness of the heart walls is Different, they are the thickest in the left ventricle "because the left ventricle pumping the blood into the whole body".
 - The right ventricle has thick walls but not as the thickness of the left one.
 - The right and left atrium has thin walls because they do not contract forcefully.
 - There is groove (sulcus) between the chambers, most evident (clear) between right and left ventricles.



❖ The four chambers of the Heart

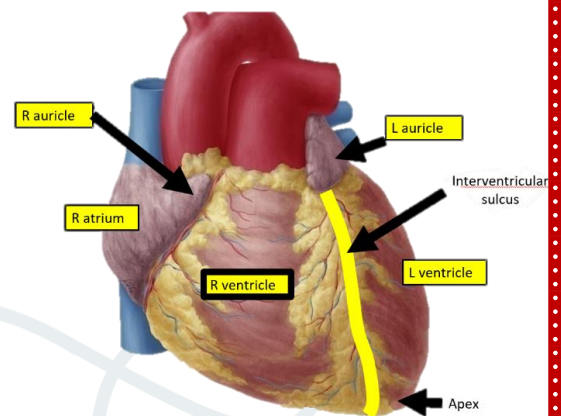
- **Right atrium:** receives blood from upper part of body through superior vena cava and from inferior part of body through inferior vena cava and it has thin wall.
- **Right ventricle:** has relatively thick wall.
- **Left atrium:** receives oxygenated blood from lungs through 4 large pulmonary veins (the ONLY veins having oxygenated blood) draining into, then it transfers this blood to left ventricle through bicuspid/mitral valve (will be talked about soon).
- **Left ventricle:** has the thickest wall and pumps oxygenated blood to the whole body.

❖ The right-pump of the Heart

- Pumps deoxygenated blood to the lungs.
- Consists of right atrium and right ventricle which are separated by tricuspid valve (will be talked about soon).
- Right atrium receives deoxygenated blood from the whole body through superior & inferior venae cavae, then pumps it through tricuspid valve into right ventricle, then right ventricle sends the blood into the lungs through pulmonary artery (trunk) which divides into 2 branches one on the left lung and one on the right lung to be oxygenated.
 - Any vessel come out of the Heart is an artery.
 - Any vessel come into the Heart is a vein.

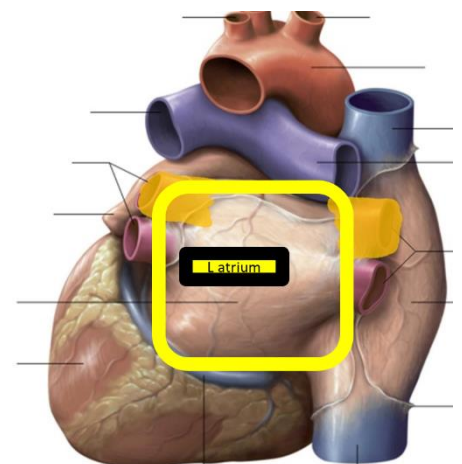
❖ The left-pump of the Heart

- Pumps oxygenated blood to the whole body.
- Consists of left atrium and a ventricle which are separated by bicuspid/mitral valve (will be talked about soon).
- The left atrium receives the oxygenated blood from 4 pulmonary veins and pumps it to the left ventricle through bicuspid valve "mitral valve" then left ventricle pumps it through aorta (largest artery in the body) going to branches to distribute oxygenated blood to all parts of the body.



❖ Surfaces of the Heart

- ✓ **In the anterior surface/view** We found: Right atrium, right auricle, right ventricle, interventricular sulcus, left ventricle, and left auricle (see the figure above).
- The right ventricle is the largest appearing structure in anterior surface/view.
- Left ventricle makes the left part of anterior surface of the heart.
- On the anterior surface of each atrium is a wrinkled pouchlike structure called **auricle**. It is an extra pocket of atrium that is closed at most time, but when the atrium is fulfilled and more additional blood comes to the atrium, it opens to accommodate this extra blood.

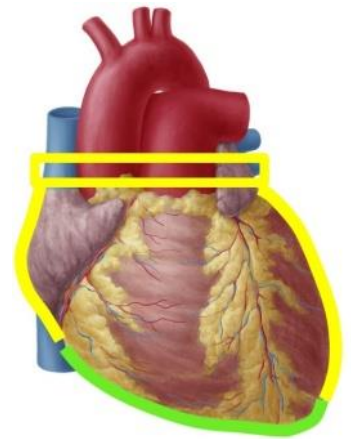


✓ **in the posterior surface/view:**

- The chamber that makes the posterior view of the heart is left atrium (the base of the cone).
- The inferior surface of the heart (which sit on the diaphragm) consist of right and left ventricles and interventricular groove separates the 2 ventricles.
- Left ventricle makes the majority of inferior surface of the heart.

❖ **Borders of the Heart**

- Superior border made by the great vessels that come in and out of the Heart.
- Right border made mainly by right atrium.
- Inferior border made by right ventricle and small part of left ventricle.
- Left border made basically of left ventricle and the upper part of small part of left auricle.



❖ **The Heart valves**

- There are 2 types of valves:
 - Semilunar valves: they Guard the beginning of the pulmonary trunk and the beginning of aorta.
 - Cuspid valves: they control blood movement between an atrium and its corresponding ventricle. According to the doctor, it is called 'cuspid' because it has different structures.

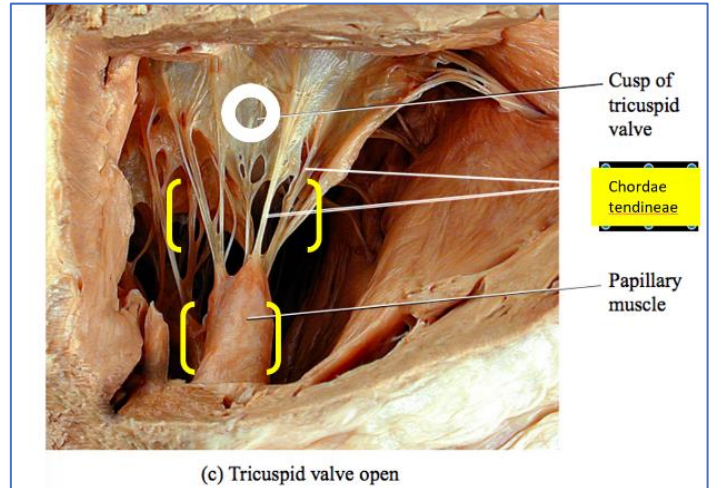
❖ **Semilunar valves**

- Are made up of 3 crescent moon-shaped leaflets, they form a pocket When a blood goes out of a ventricle these leaflets are stuck to the wall and blood will go out of the ventricles easily.
- When the blood tries to come into the heart back again the blood will fill these pockets and the valve closes.
- 3 Semilunar leaflets that have a nodule at its margin and There is a fibrous ring around these valves.

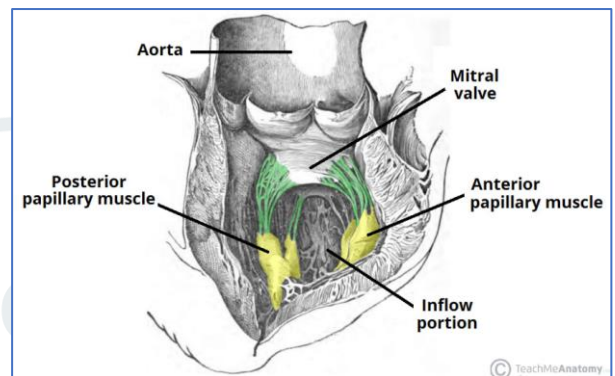
❖ **Cuspid valves**

- Also called atrioventricular (AV) valve, they are 2:
 - ✓ Tricuspid valve (right Atrioventricular valve; between right atrium and right ventricle): made of 3 leaflets (cusps).
 - ✓ Bicuspid valve (left Atrioventricular valve: between left atrium and left ventricle): made of 2 leaflets (cusps).

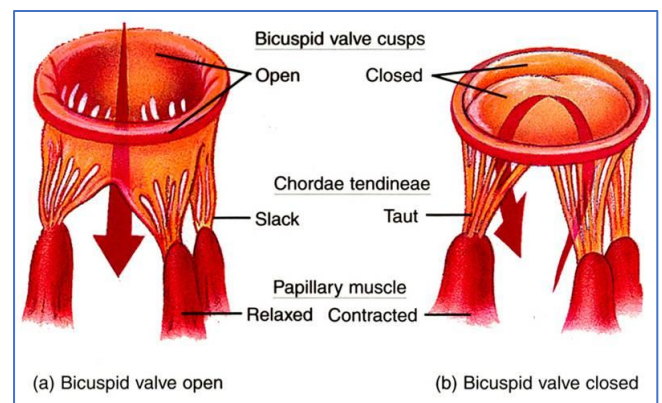
- Then the margins of the cusps are attached by thin strands of connective tissue called **chordae tendineae** that are attached to **papillary muscles**.
- **How it works:** Since the blood pressure in atria is much lower than that in the ventricles (during contraction of ventricles – systole), the flaps (leaflets/cusps, all ways deliver to roma) attempt to evert to the low-pressure regions. The chordae tendineae prevent this prolapse by becoming tense, which pulls on the flaps, holding them in closed position. This will not allow the blood to go back in an unphysiological direction.



This is an image of cuspid system where the opening and closing part called the cusp or leaflet, and in yellow color is papillary muscles which send strands of connective tissue (chordae tendineae, in green) connected to the margins of the leaflet.

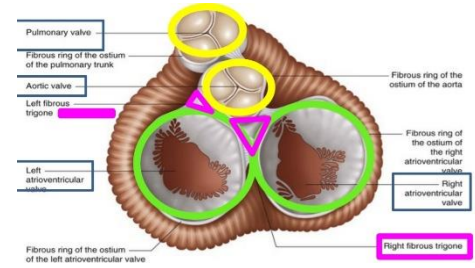


- The cuspid system is made up of fibrous ring, ring of collagen fibers that have very constant shape if This shape is destroyed then the blood will leak in an unphysiological upward direction.
- And chordae tendineae, the threads of connective tissue (can be considered as tendons) coming from the papillary muscles.
- And papillary muscles (study the image).



❖ Fibrous skeleton of the Heart

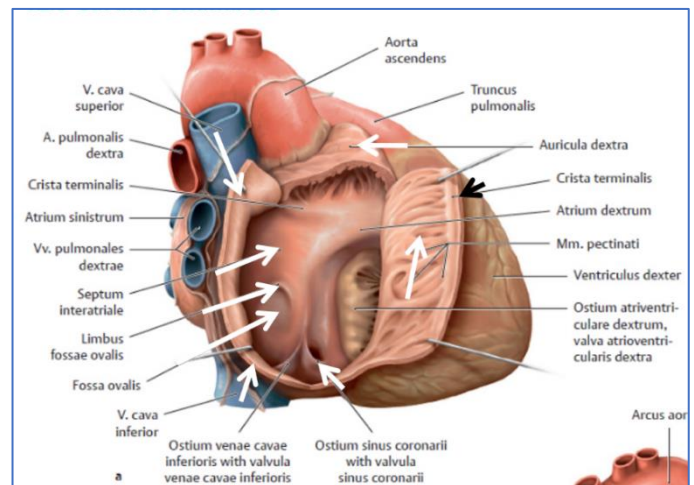
- The Heart is hollow muscular organ and it contracts, therefore it needs a point of insertion and This is What called fibrous skeleton of the Heart.
- The starting point of the fibrous skeleton of the Heart is the valves, each valve has fibrous ring of dense connective tissue.
- We have 4 valves, therefore we have 4 rings, these are the basic unit of fibrous skeleton of the Heart.
- If We look at areas between the rings of the valves, we can see white tissue, this is connective tissue in the form of triangles.
- There are 2 triangles in the Heart between the ring of the valves, this is a minor component of the skeleton of the Heart.



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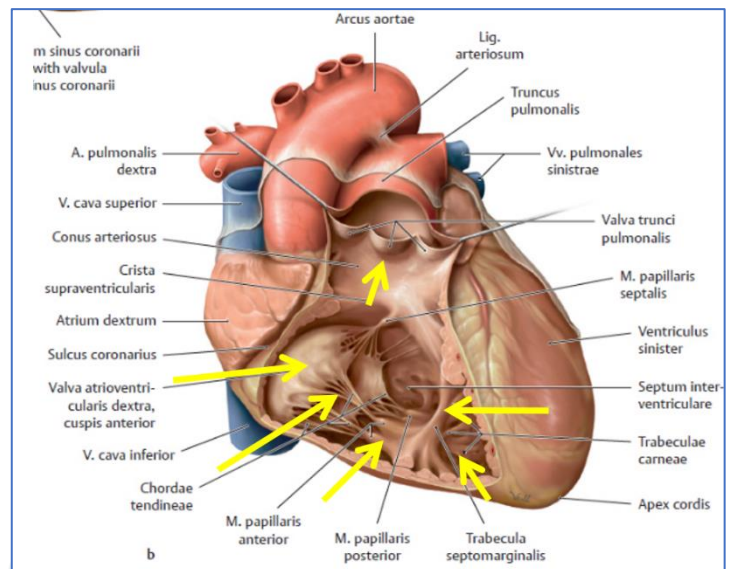
❖ Right atrium

- There is opening of superior vena cava and opening of inferior vena cava and small opening bringing the blood from the veins of the Heart itself.
- We can see smooth surface; this is the **interatrial septum** between right and left atria.
- We can see oval shape structure, this is made of 2 parts, a depression in the Middle called **fossa ovalis** was open so the blood will shift from right atrium the left atrium because the lungs are collapse as What happen in the fetus inside his mother womb.
- The margins of the fossa ovalis are raised they are not flat and called **limbus fossa ovalis**, so the fossa ovalis is in the interatrial septum.
- When we look to the right, we see a reflected part of wall of the right atrium, and the surface of This part is not smooth it has elevations coming from a structure called **crista terminalis**, that runs straight. and This is like the combed of the hair. then the cavity of right atrium has a little extensions called the auricles This is a spare space When the right atrium receive more blood than it can hold then This space is opened, so the auricle is extension of the atrial cavity, and inside the auricle is rough.



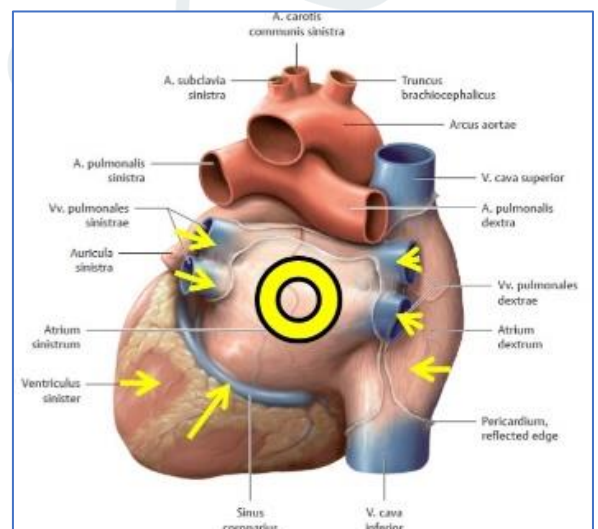
❖ Right ventricle

- The major structure in right ventricle is **valva atrioventricularis dextra**, another name for the **tricuspid valve** (valva: valve, atrioventricularis: related to atrium and ventricle together, dextra: right -in latin-), and the English name for this nomenclature is **right Atrioventricular (AV) valve**.
- Inside right ventricle is rough due to that the myocardium is not smooth, and we can see elevations and depressions called **trabeculae carneae**.
- moderator band** is an extension of trabeculae carneae, that extends from lateral wall of right ventricle through intraventricular space to attach to interventricular septum forming a bridge-like structure.
- Right ventricle is connected to the pulmonary trunk (pulmonary artery; the **ONLY** artery having deoxygenated blood) sending deoxygenated blood to the lungs through the pulmonary trunk. This route of this part is guarded by a semilunar valve.



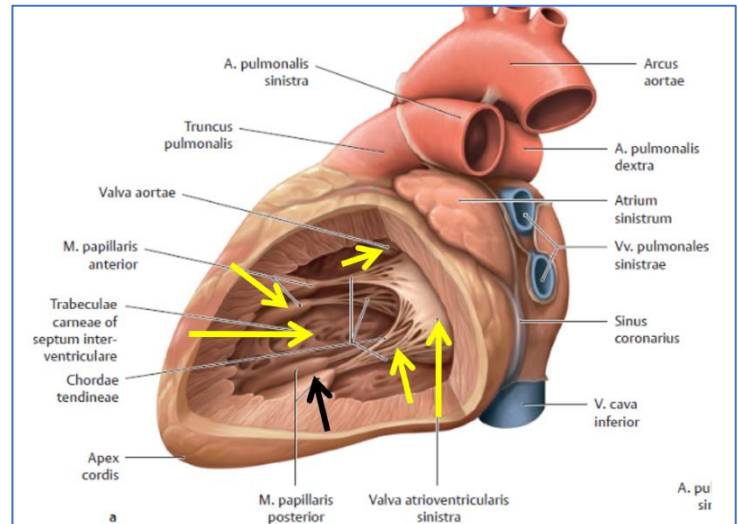
❖ Left atrium

- Receiving blood from the lungs.
- Making the base of the Heart facing the vertebral column and We can see that it receives the 4 pulmonary veins from the lungs. Between left atrium and left ventricle there is a large vein called the **coronary sinus** (we will talk about the coronary circulation later on), this vein collect blood from the heart itself to empty to the right atrium.



❖ Left ventricle

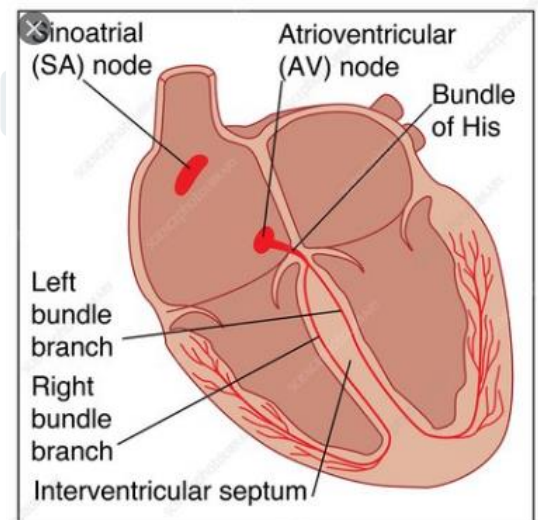
- There is leaflet of the valve between left atrium and left ventricle as a part of cuspid system (bicuspid/mitral valve here).
- There is chordae tendineae and papillary muscles which are part of myocardial tissue.
- Internal surface is rough because of the arrangement of the myocardium.



- The Heart is automatically programmed to contract unvoluntary, it has its own system, and it called the **Conduction system of the heart**.

❖ Cardiac conduction system

- The story of it, first We need pacemaker that mean a starting point where the electric impulses are generated, and This is **sinoatrial (SA) node**.
- SA node is in the wall of right atrium and it's very near to the opening of superior vena cava, then This is the place where impulse is generated.
- Where does this impulse go? (Remember: muscles are excitable tissue) when muscle fibers receives an excitable impulse it will take it will spread through it, so the electricity of the heart from the sinoatrial SA node is spreading throughout the 2 atria, which in turn response by contracting; pushing the blood to the ventricles.
- Then this electric impulse must be transferred to the ventricles to contract after the atria. now this electricity is prevented from going to the ventricles, why?



- because of skeleton of the heart makes the 2 atria electrically separated or insulated from the ventricles, we have in the interatrial septum: **atrioventricular (AV) node** that in turn picks up the impulse from atria, carry it through its extension **bundle of His** -carry impulse from interatrial septum to interventricular septum- and then this bundle of his is going to divide into two branches called **left bundle branch** going to the left ventricle and **right bundle Branch** going to the right ventricle.

- ✓ where do I find these branches of the bundle of His? in the interventricular septum.
- ✓ where do I find atrioventricular AV node? it is in the interatrial septum.
- ✓ where is sinoatrial SA node pacemaker is situated? it is in the wall of the right atrium near the opening of superior vena cava.

Summary: SA node → atria → AV node → bundle of His → right and left bundle branches → ventricles.

Good Luck

