

# CARDIOVASCULAR SYSTEM

SUBJECT : Anatomy of the Heart

LEC NO. : 2

DONE BY : Rama Alwraikat

وَقُلْ رَبِّ زِدْنِي عِلْمًا



SCAN ME!

# ILOS

1. To describe the internal features of each chamber of the heart.
2. To describe the fibrous skeleton of heart.
3. To identify papillary muscles and describe their locations and importance.
4. To describe the atrioventricular, semilunar (pulmonary and aortic) valves, their position, functional importance, surface marking and ideal sites for their auscultation.
5. To describe different parts of the conductive system of the heart.

# Interior of the right ventricle

Thickness of the wall of the Left Ventricle > Right Ventricle

## Cross section

- Has a semilunar cavity.
- Its wall: 1/3 thickness of the wall of the left ventricle.

or thickness of the Left ventricle is three times the thickness of the right ventricle because Left Ventricle pumps blood to all parts of the body through the Aorta so the it's force of contraction has to be more than Right Ventricle which only pumps blood to the lungs through the pulmonary trunk

## A- Has 2 openings:

Tricuspid & Pulmonary.

## B- Has smooth (outflow) part:

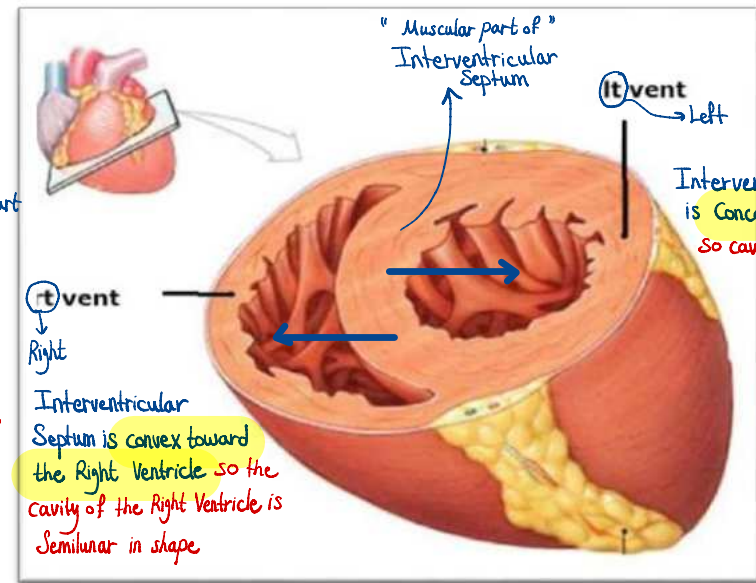
- Infundibulum of pulmonary trunk; funnel shaped part of right ventricle toward the pulmonary orifice, separated from inflow part by supraventricular crest.

## C- Rough (inflow) part: shows (3 features)

### 1-Trabeculae carneae:

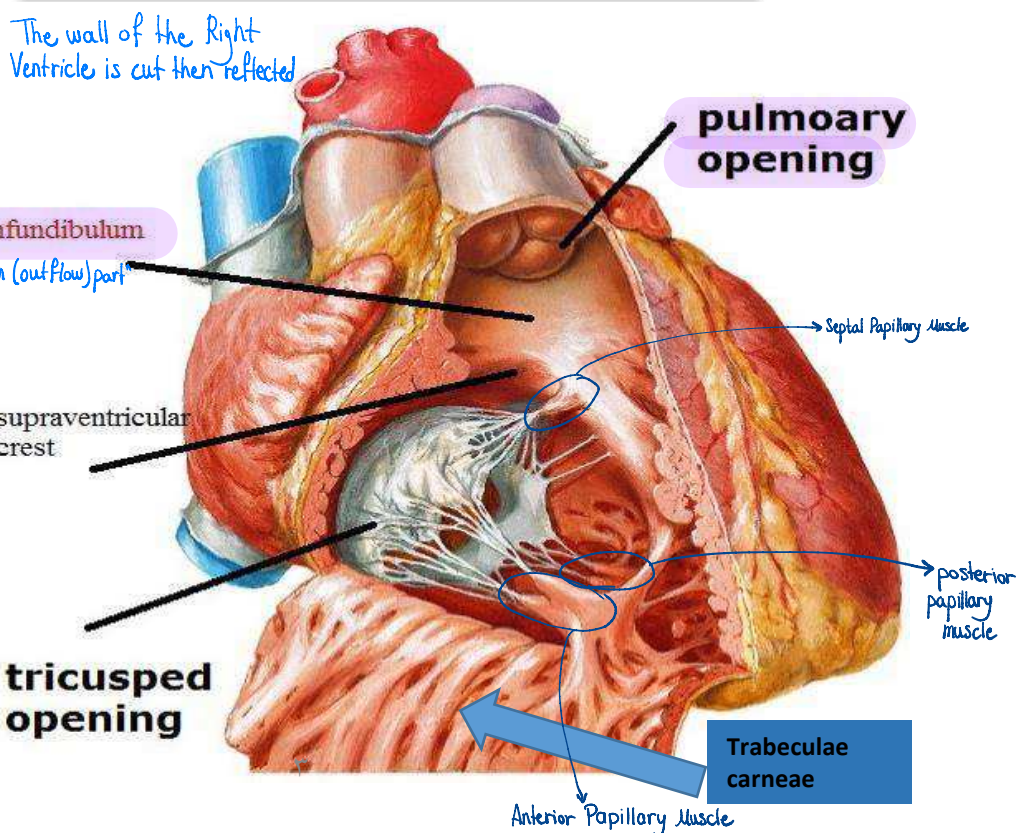
Muscular ridges that freely intercross. to form a meshwork

Interventricular Septum  
two parts  
Muscular Part  
Membranous Part



Interventricular Septum is Concave toward the Left Ventricle so cavity of Left Ventricle is Circular in shape

Cross or Transverse Section



Pulmonary Trunk يخرج منه الدم الى

مثل القمع

الجزء التي يوصله لدم من Right Atrium

مثل الشبكة

## 2-Papillary muscles: three in number

Anterior, posterior & septal papillary muscles

Shape: conical has:

- **Base:** attached to the ventricular wall.
- **Apex:** gives chordae tendinae that attached to the margins & ventricular surface of cusps of the tricuspid valve.

attached to the anterior wall of the right ventricle → Anterior Papillary Muscle  
or  
attached to Septum → Septal Papillary Muscle  
or  
attached to the posterior wall of the right ventricle → Posterior Papillary Muscle

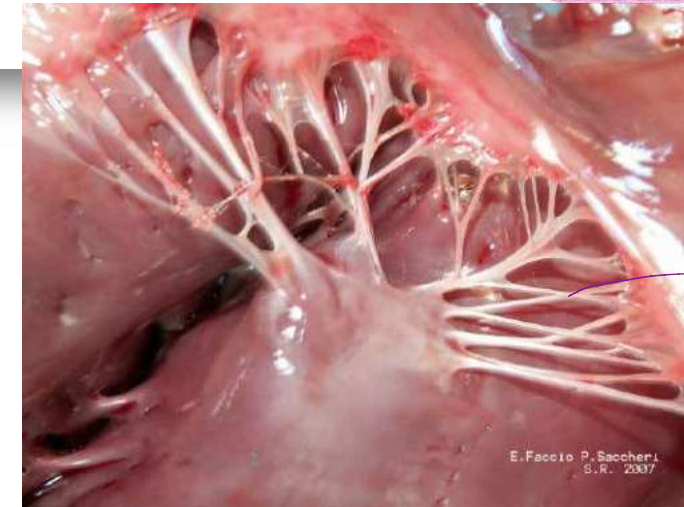
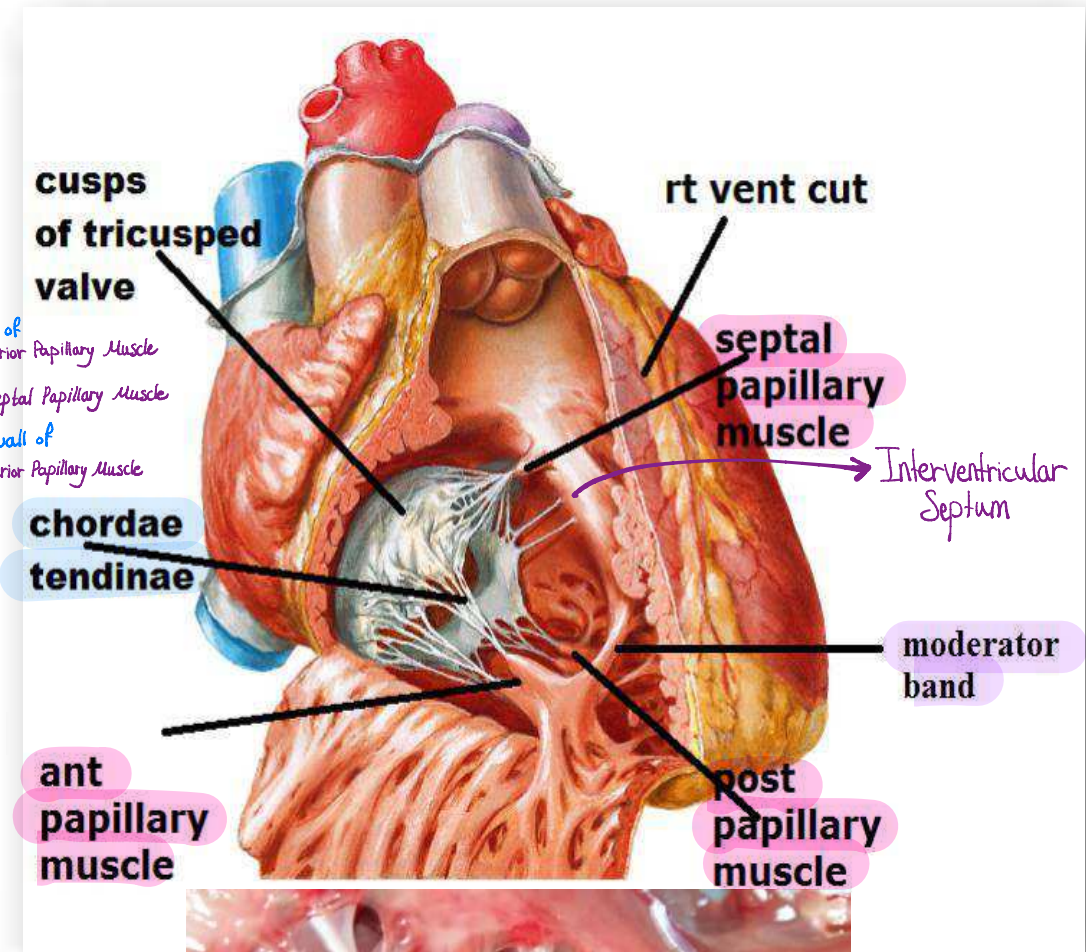
- **Function:** they prevent prolapse of cusps (eversion to the atrium), holding them in a closed position.

→ during ventricular <sup>انقباض</sup> systole, blood flows toward the pulmonary trunk without <sup>ارتداد</sup> regurgitation toward the right atrium by closure of the Tricuspid valve, so chordae tendinae hold the cusp in closed position & prevent eversion of the blood to the atrium due to high blood pressure in the right ventricle during ventricular systole

## 3-Moderator band:

- It is a trabecula from the interventricular septum to the base of anterior papillary muscle.
- **Function:** Transmits the right bundle branch.

→ a part of the conducting system of the heart



# Interior of the left Ventricle

## Cross section:

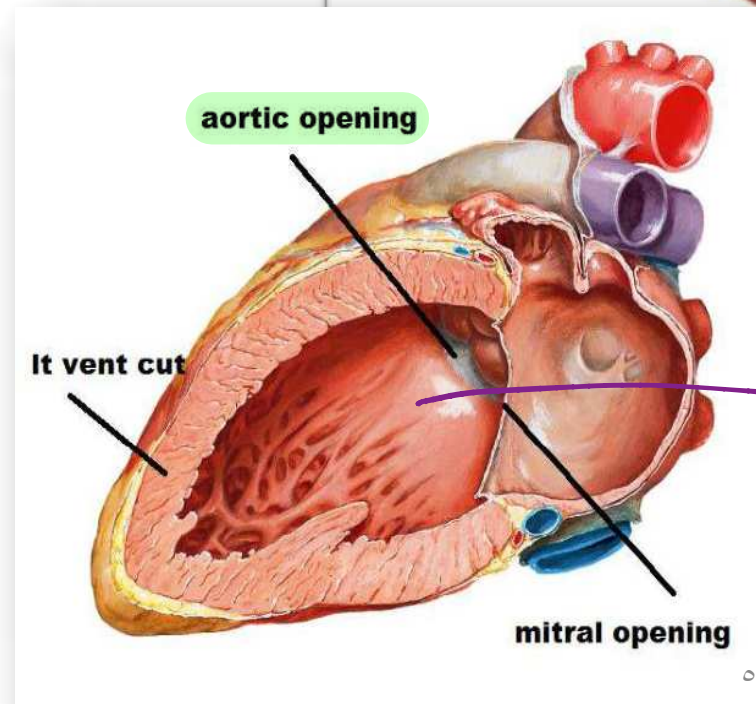
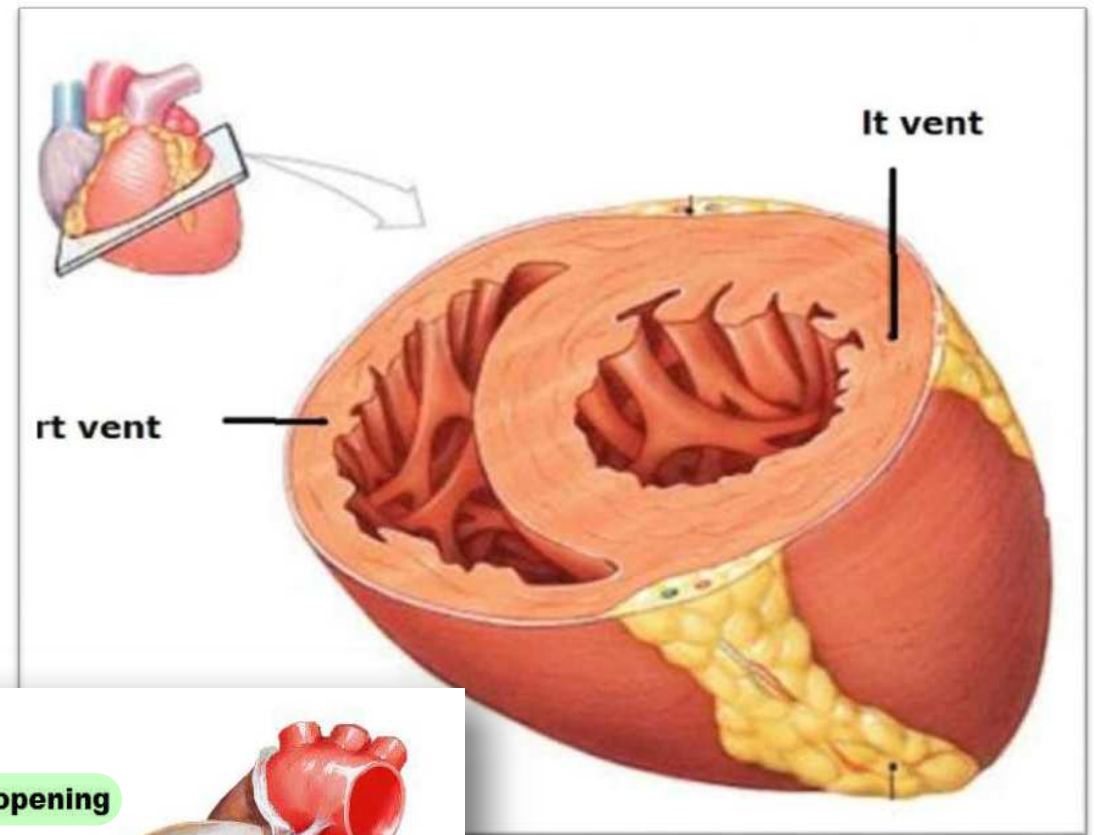
- Has **circular cavity**.
- **Its wall:** three times thickness of the wall of the right ventricle.

## **A- Has 2 openings:**

Mitral & Aortic.

## B- Smooth (outflow) part:

**Aortic vestibule**, below the aortic opening.



Aortic Vestibule  
"Smooth (outflow) part"

**C- Rough (inflow) part, shows:**

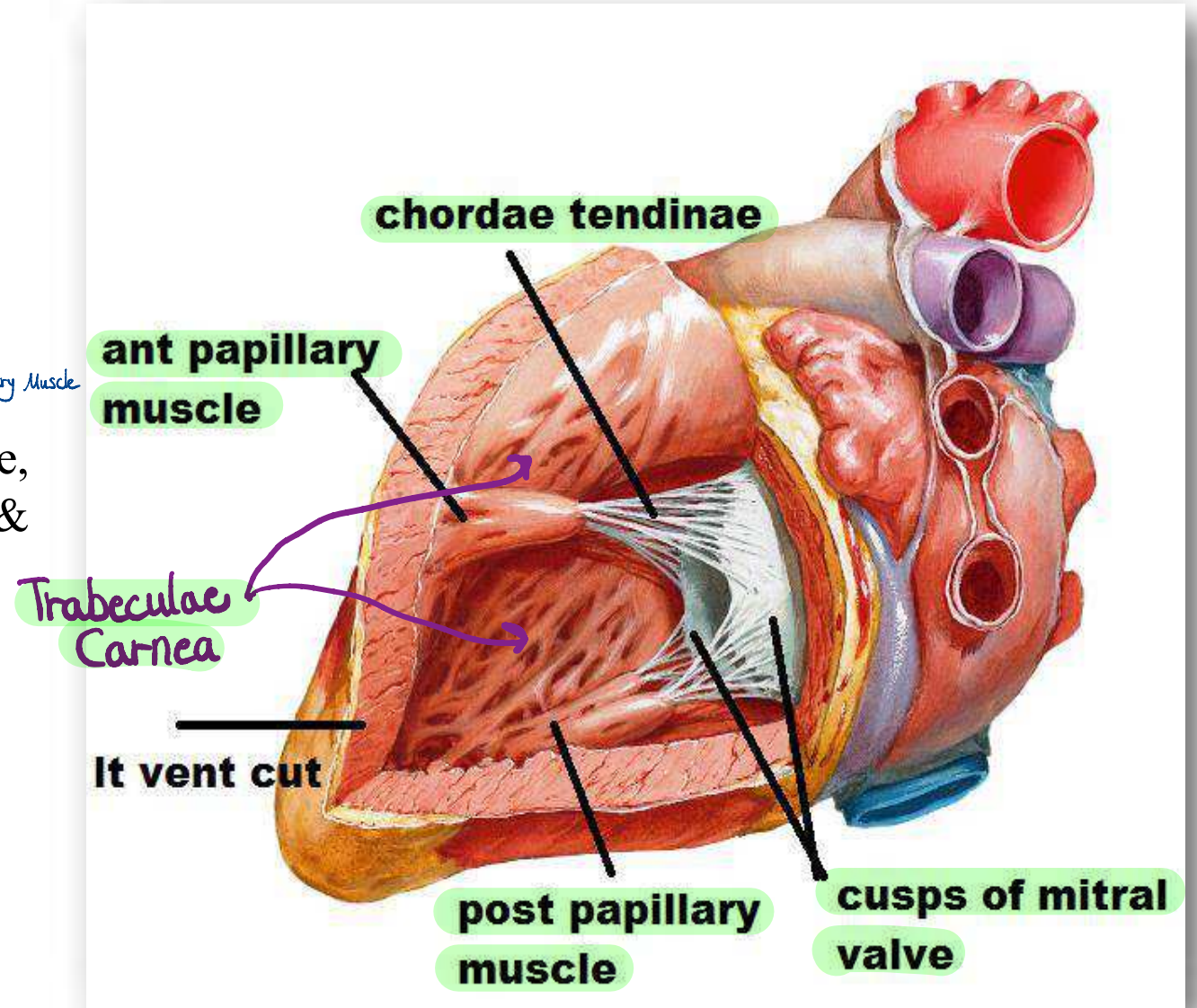
**1-Trabeculae carneae.**

**2- Papillary muscles:** two in number,

**Anterior & posterior** papillary muscles. *NO Septal Papillary Muscle*

**Shape:** larger than that of the right ventricle, chordae tendinae are attached to margins & ventricular surface of cusps of the mitral valve.

**3- Has no moderator band.**



# Interventricular septum

- The right ventricle is anterior & to the right of the septum.
- The left ventricle is posterior & to the left of the septum.
- The septum is convex towards the right ventricle.
- Consists of 2 parts (Lower muscular & upper membranous parts).

*because of Heart Rotation*

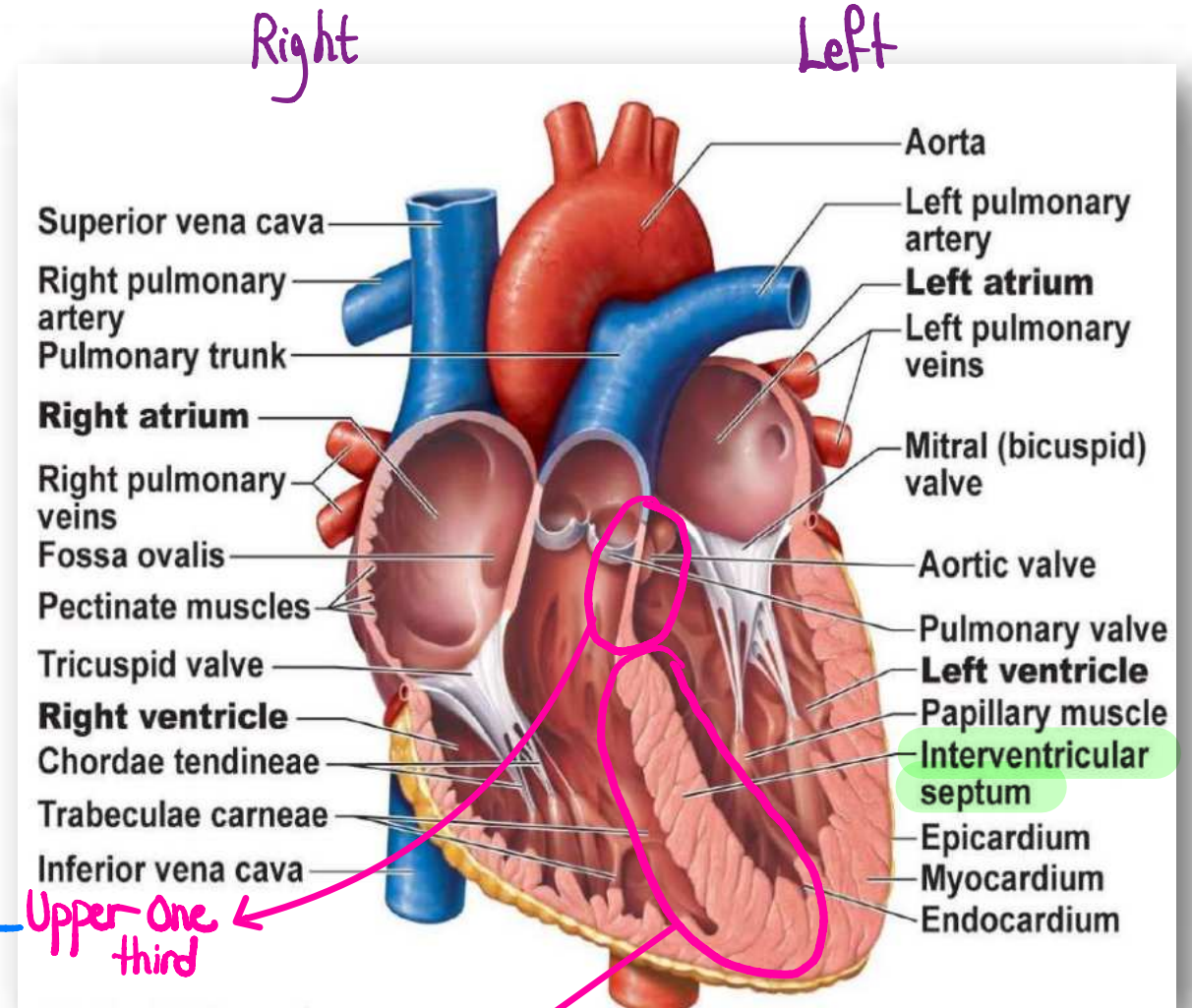
*one third*

*two thirds*

*Membranous Part*

*Upper one third*

*Muscular Part*



# Fibrous skeleton of the heart

**Definition:** A <sup>or firm</sup> rigid framework of <sup>↓ fibrous</sup> dense regular connective tissue located between the atria and the ventricles.

## Components:

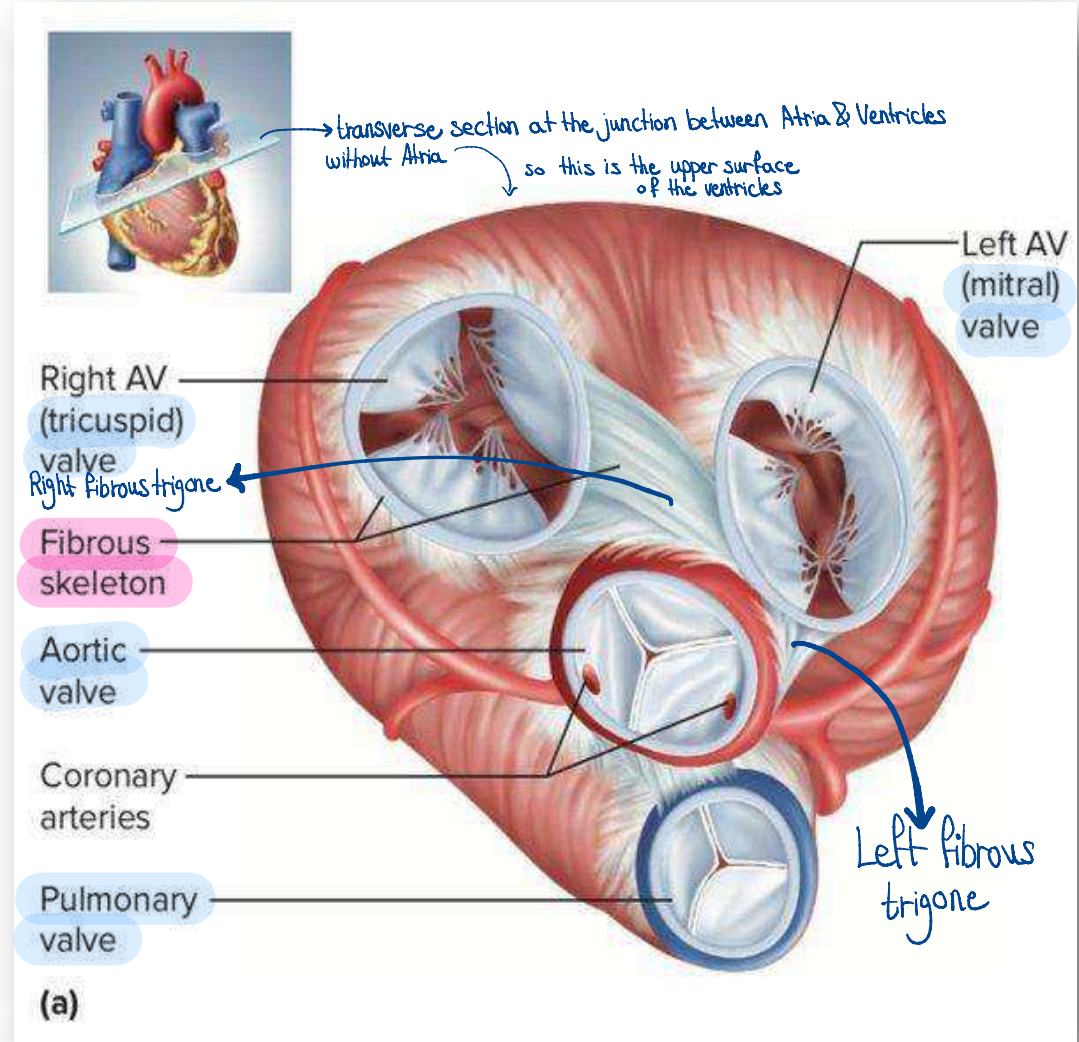
- **Four fibrous rings.** 1-tricuspid ring. 2-mitral ring. 3-aortic ring. 4-pulmonary ring.
  - related to the orifices*
  - or Bicuspid ring*
- Right and left **fibrous trigones.** *triangular in shape (two)*
- **Membranous parts** of the interatrial, interventricular septum.

## Functions:

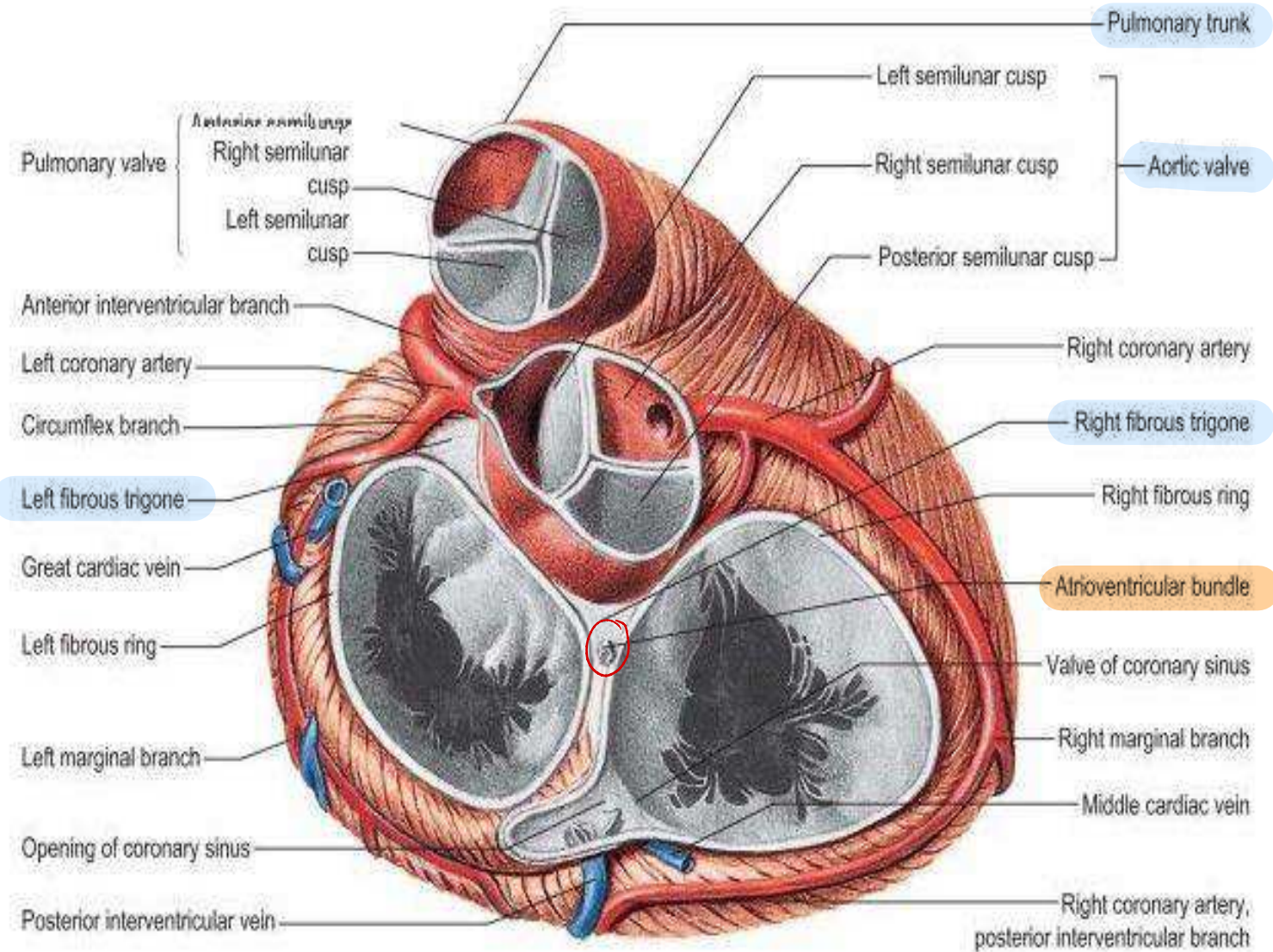
- Maintains **valve orifices open.**
- Provides **attachment** for valve cusps & myocardial fibers
- Acts as an **electrical insulator** between the atria and ventricles **except at the site of penetration of the atrioventricular bundle.** *(specialized cardiac muscle bundle & one part of the conducting system)*

*only site of connection between Atrial myocardium & Ventricular myocardium*

*↓ a group of fibers*







# Orifices at the right side of the heart

**1-Right atrio-ventricular (inlet) orifice:** → From Right Atrium to Right Ventricle

## Tricuspid orifices:

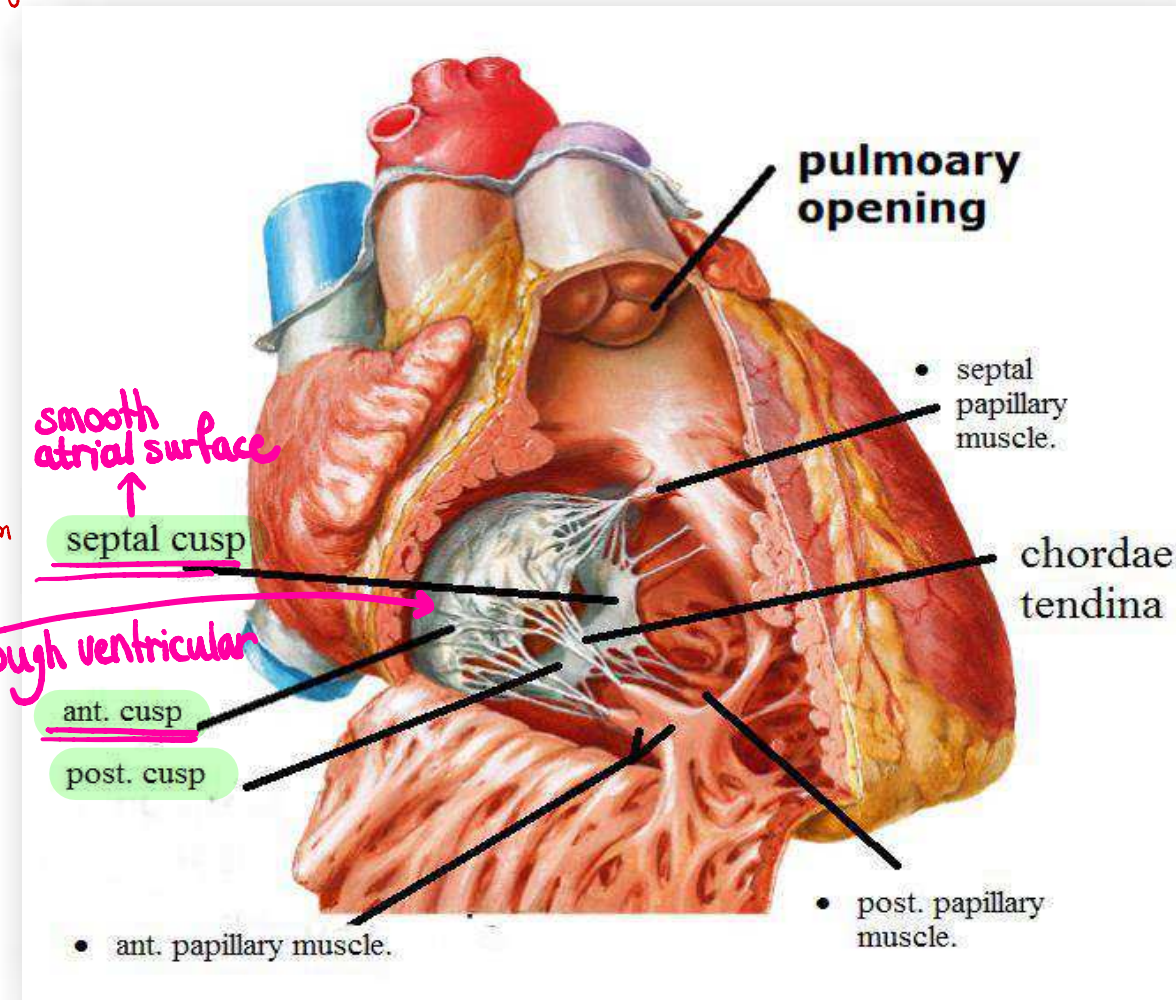
- Guarded by **Tricuspid Valve**.
- Surrounded by a **fibrous ring**, which gives attachment to **3 cusps (anterior, posterior & septal)** of tricuspid valve.

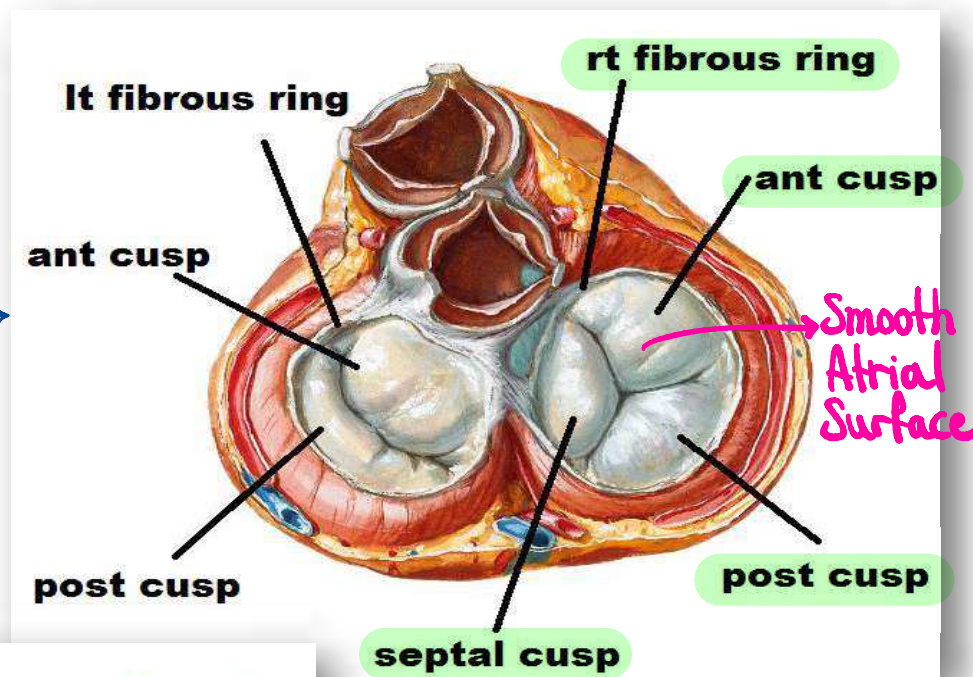
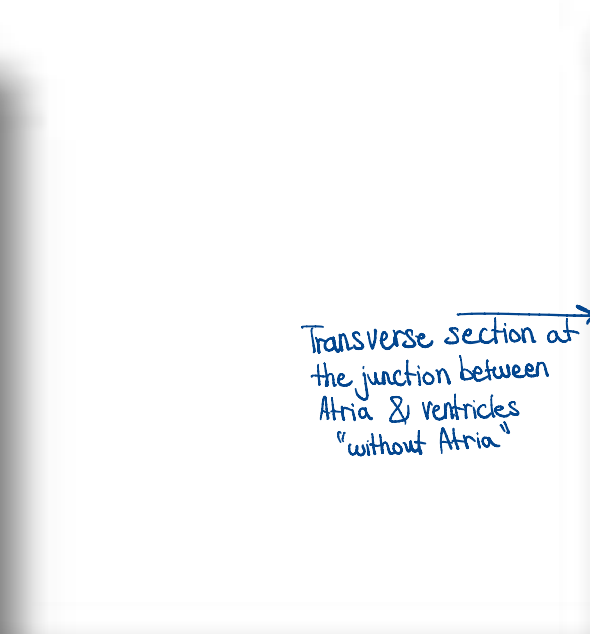
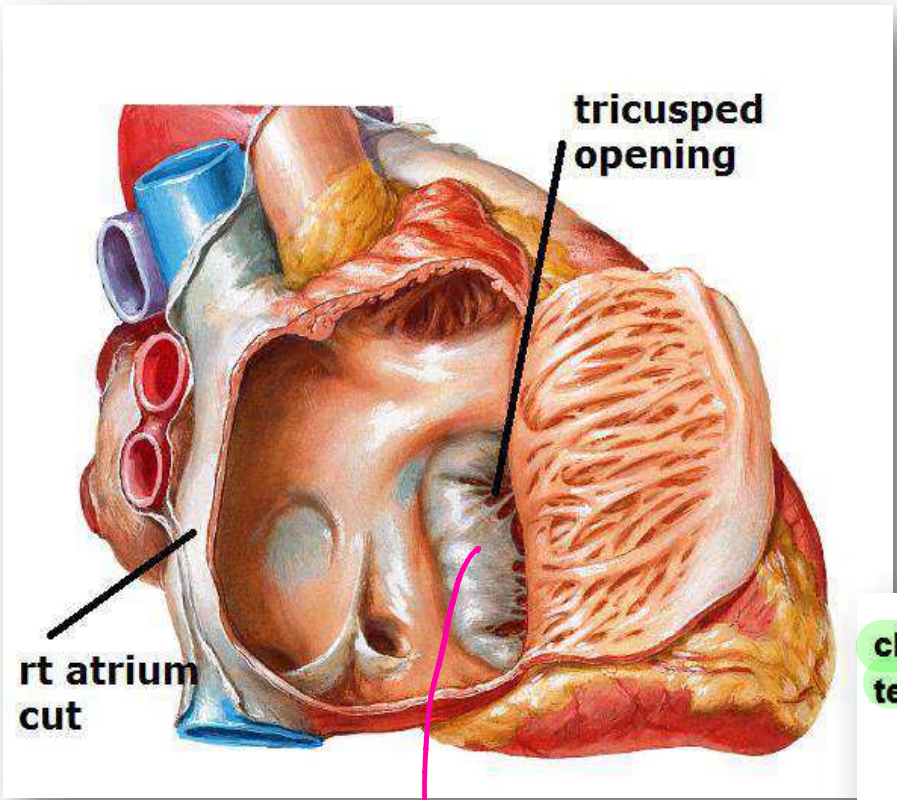
\* **Each cusp;** is a **reduplication of endocardium**.  
↓ *كلمة ثابت على ألب*  
Cusp  
or fold or double layer  
→ squamous epithelium like the endothelium of the blood vessels

Each cusp; is **triangular in shape**, has:

- **Two surfaces;** smooth atrial & rough ventricular.
- **Base;** attached to fibrous ring.
- **Apex & margin;** Chordae tendinae attached to them.  
↓ directed downward

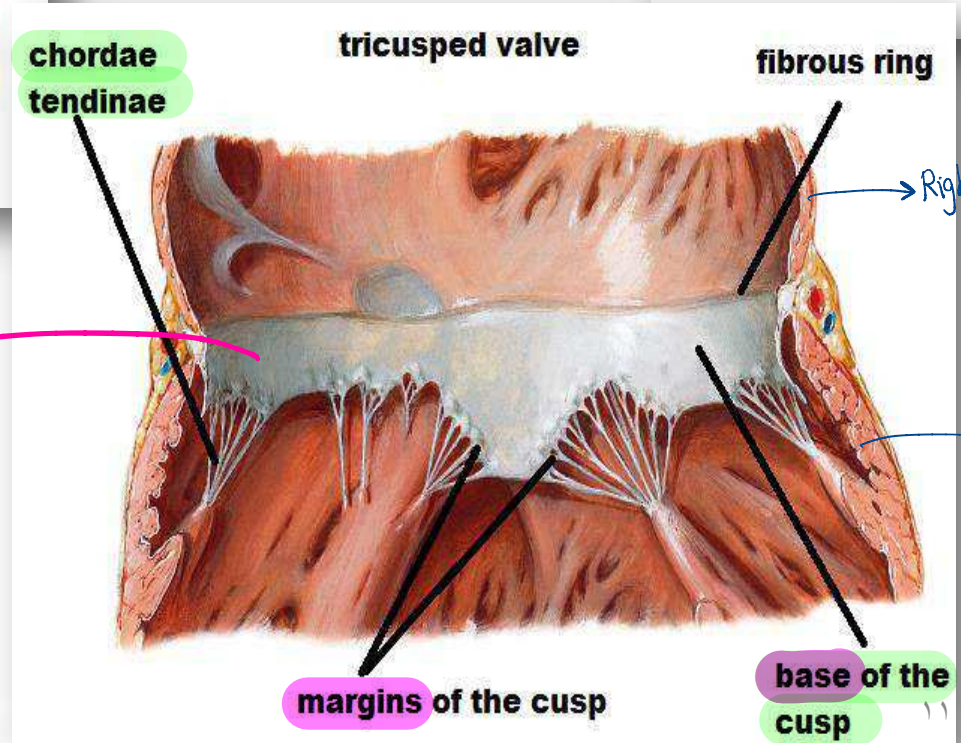
\* Also **Chordae tendinae** attached to **ventricular surfac**.





Smooth Atrial Surface

A pink handwritten label with an arrow pointing to the smooth atrial surface of the tricuspid valve in the top-left diagram.



Right atrium

A blue handwritten label with an arrow pointing to the right atrium in the bottom diagram.

Right Ventricle

A blue handwritten label with an arrow pointing to the right ventricle in the bottom diagram.

## 2-Outlet orifice of the right ventricle: Pulmonary orifice: → between Right Ventricle & Pulmonary Trunk

- Guarded by **Semilunar (valve)**: <sup>اسمه</sup> → Pulmonary Valve
- Surrounded by a fibrous ring, which gives attachment to **3 semilunar cusps (anterior, right & left)** of pulmonary valve.

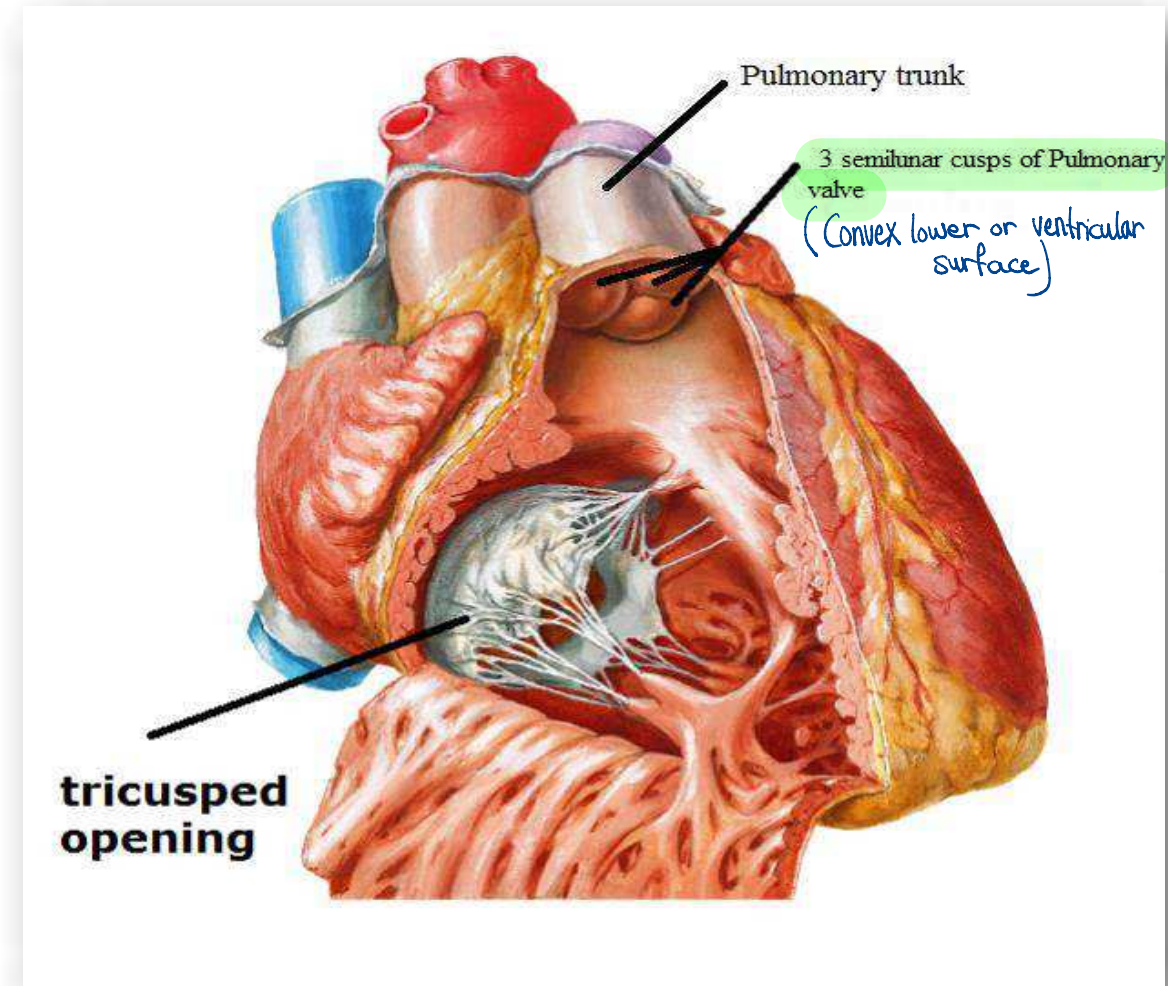
**Each cusp:** formed by folds (reduplication) of endocardium.

**Each cusp:** semilunar & has:

- **Concave** upper surface (open mouths) <sup>toward the pulmonary trunk</sup> & **convex** lower (ventricular) surface. <sup>toward the right ventricle</sup>
- **Upper margin (free)**; shows **thickened nodule** in the middle & **thin lunule** on the sides.
- **Lower margins & sides**; <sup>من الجدار</sup> are attached to the arterial wall.   
 to prevent prolapse into the right ventricle

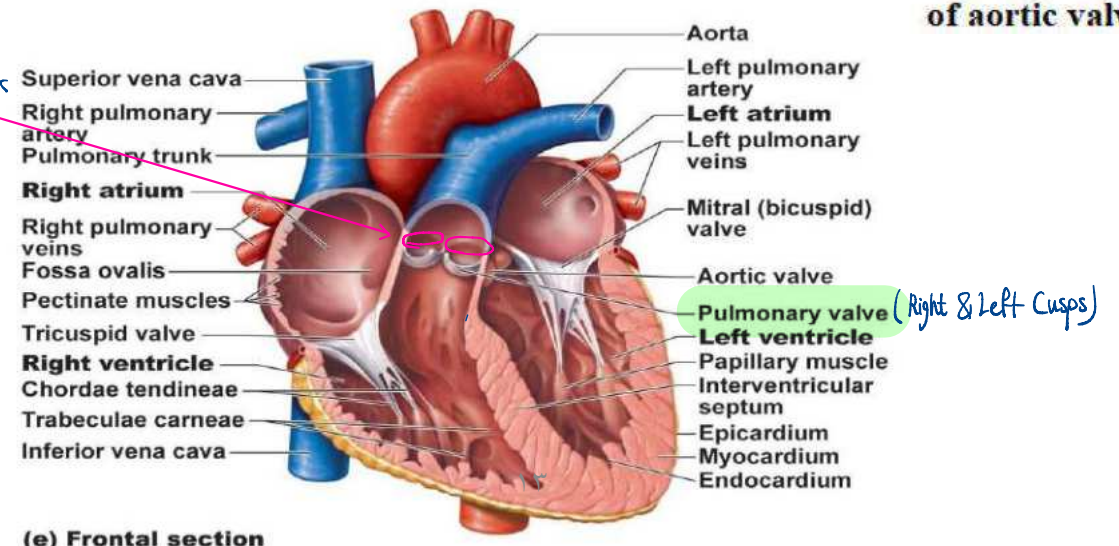
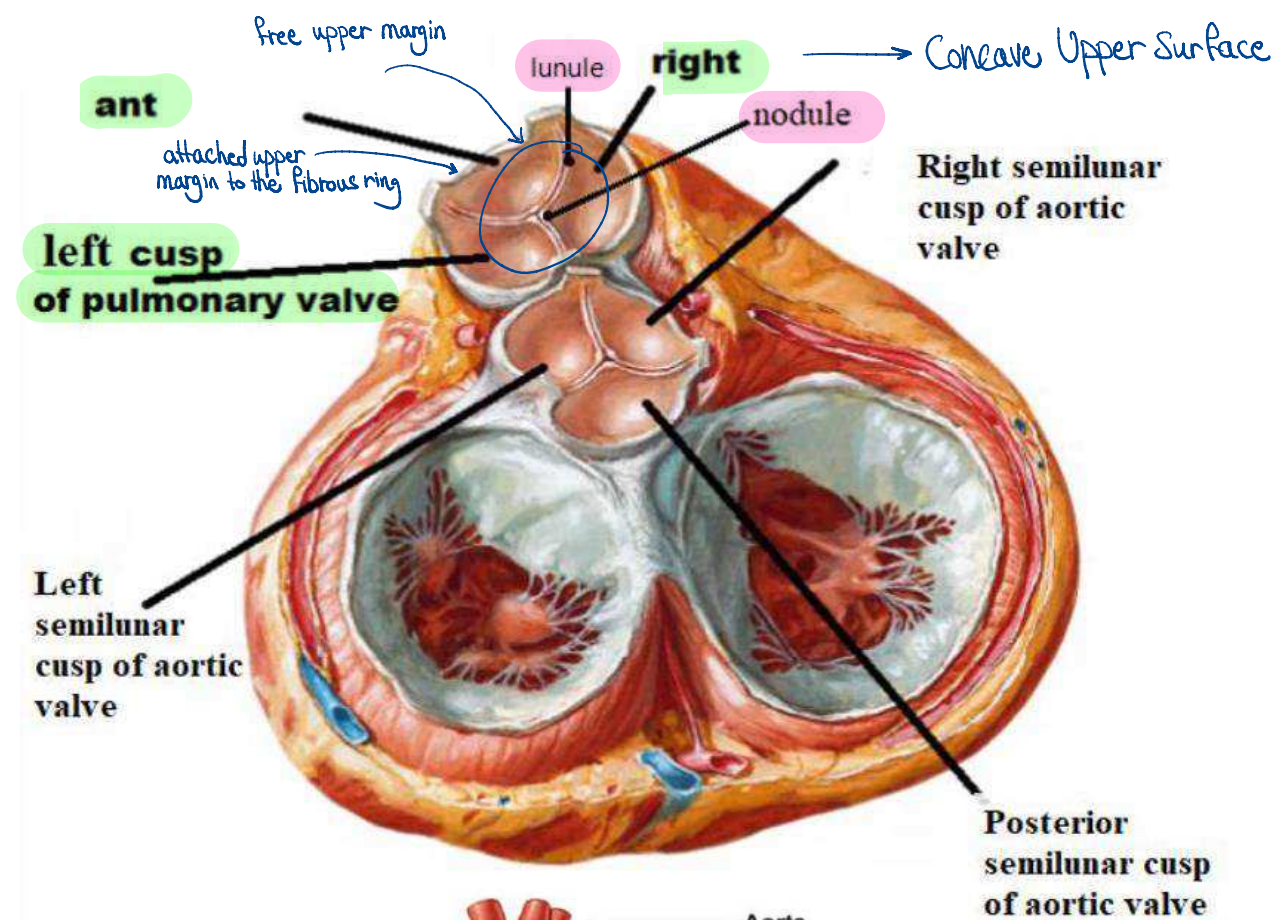
→ Free part → Nodule + Lunule

Attached part → attached to the fibrous ring



## Pulmonary valve:

- No chordae tendinae or papillary muscles are associated with these valve cusps.
- The attachments of the sides of the cusps to the arterial wall prevent the cusps from prolapsing into the ventricle.
- At the root of the pulmonary trunk are three dilatations called the sinuses.
- During the ventricular systole, the cusps of the valve are pressed against the wall of the pulmonary trunk by the out-rushing blood.
- During diastole, blood flows back toward the heart and enters the sinuses, the valve cusps fill and come into apposition in the center of the lumen, and close the pulmonary orifice.



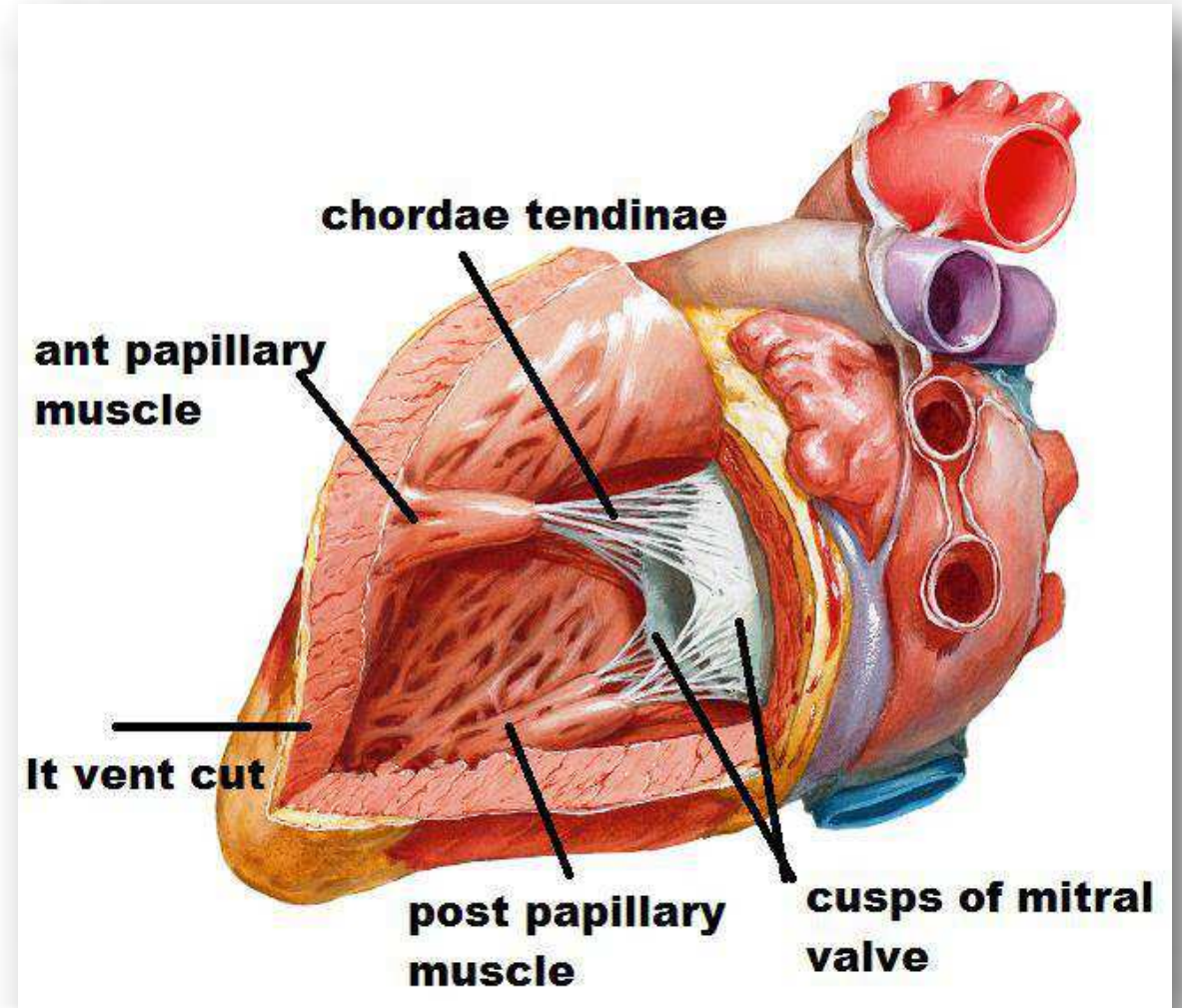
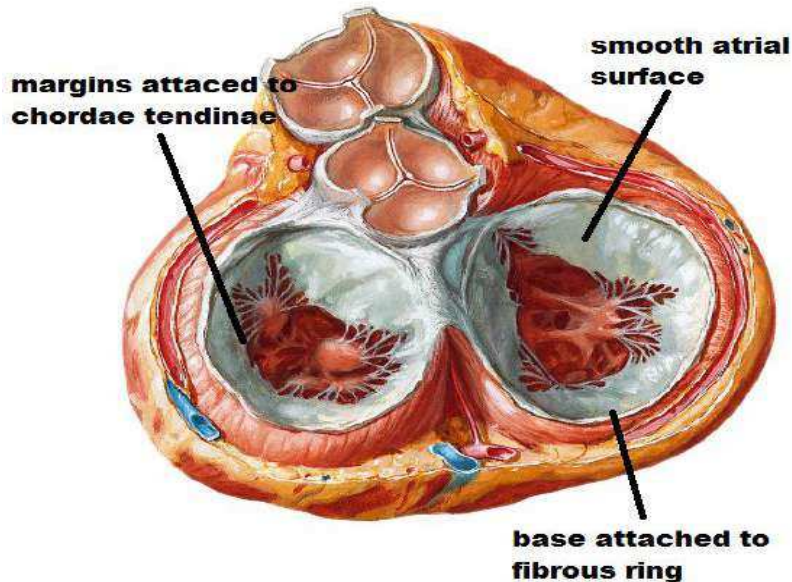
# Orifices of the left ventricle

## 1-Left atrio-ventricular (inlet):

**Mitral orifice** → between Left Atrium & Left Ventricle

- Guarded by the **Mitral Valve**. or *Bicuspid Valve*
- Surrounded by a fibrous ring, which gives attachment to **2 cusps (anterior & posterior)** of mitral valve.

**The same description of the tricuspid cusps.**



## 2- Outlet orifice; Aortic orifice. → between Aorta & Left Ventricle

- Guarded by the semilunar valve.
- Surrounded by a fibrous ring, which gives attachment to **3 semilunar cusps** (posterior, right & left) of the aortic valve.

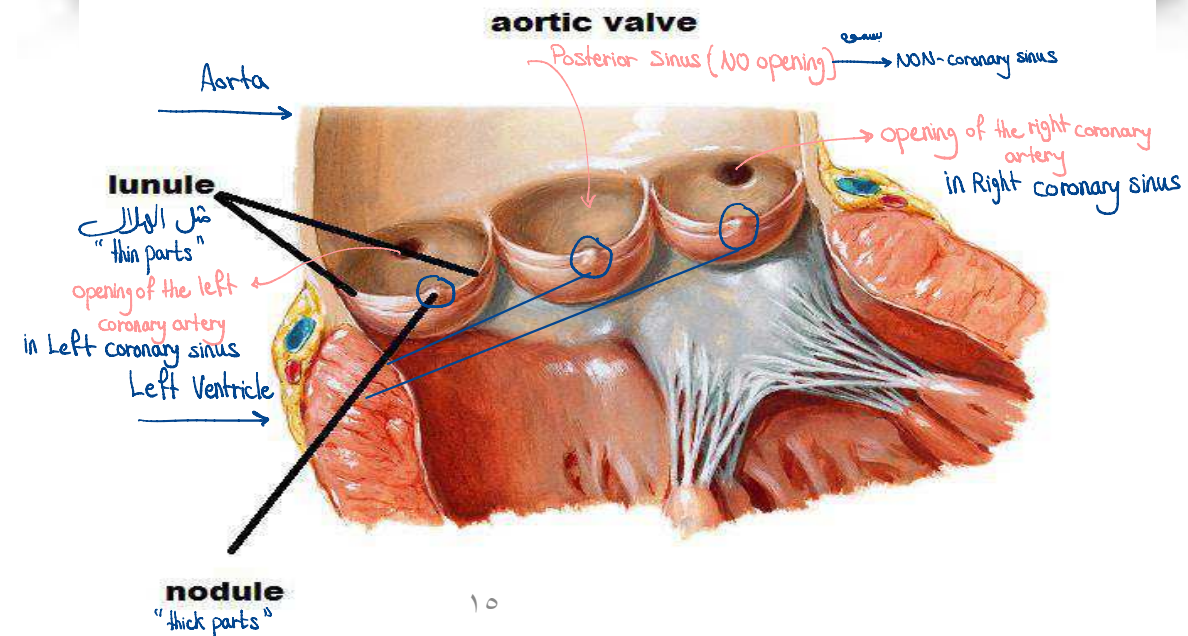
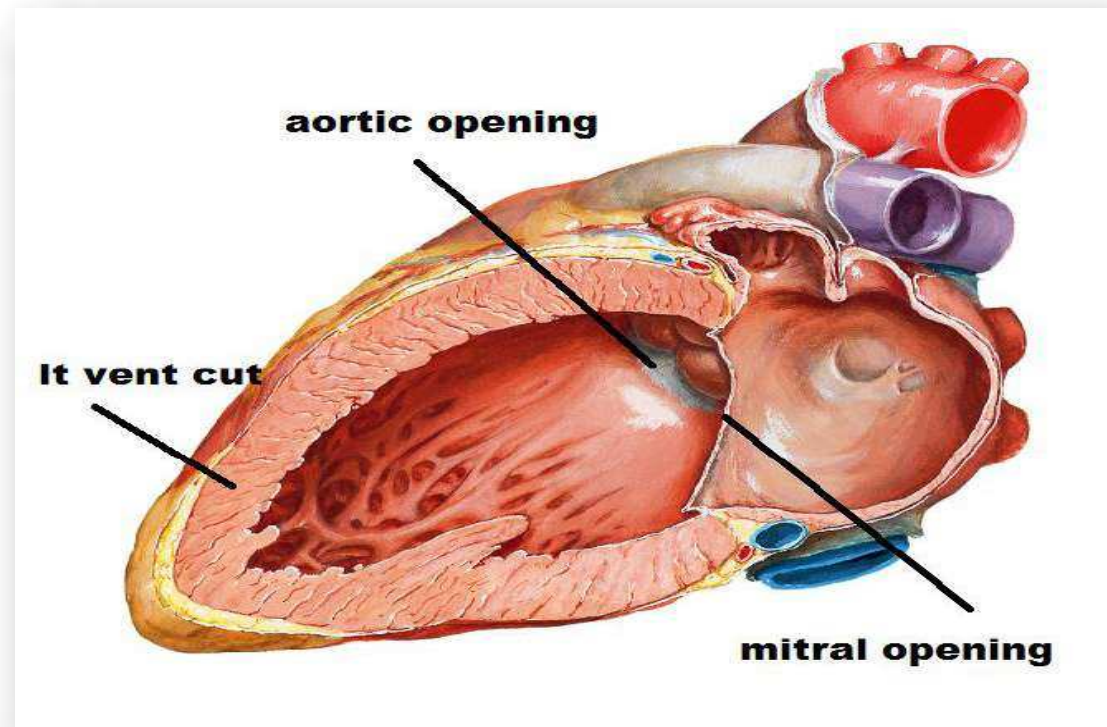
**Each cusp:** formed by folds of endocardium.

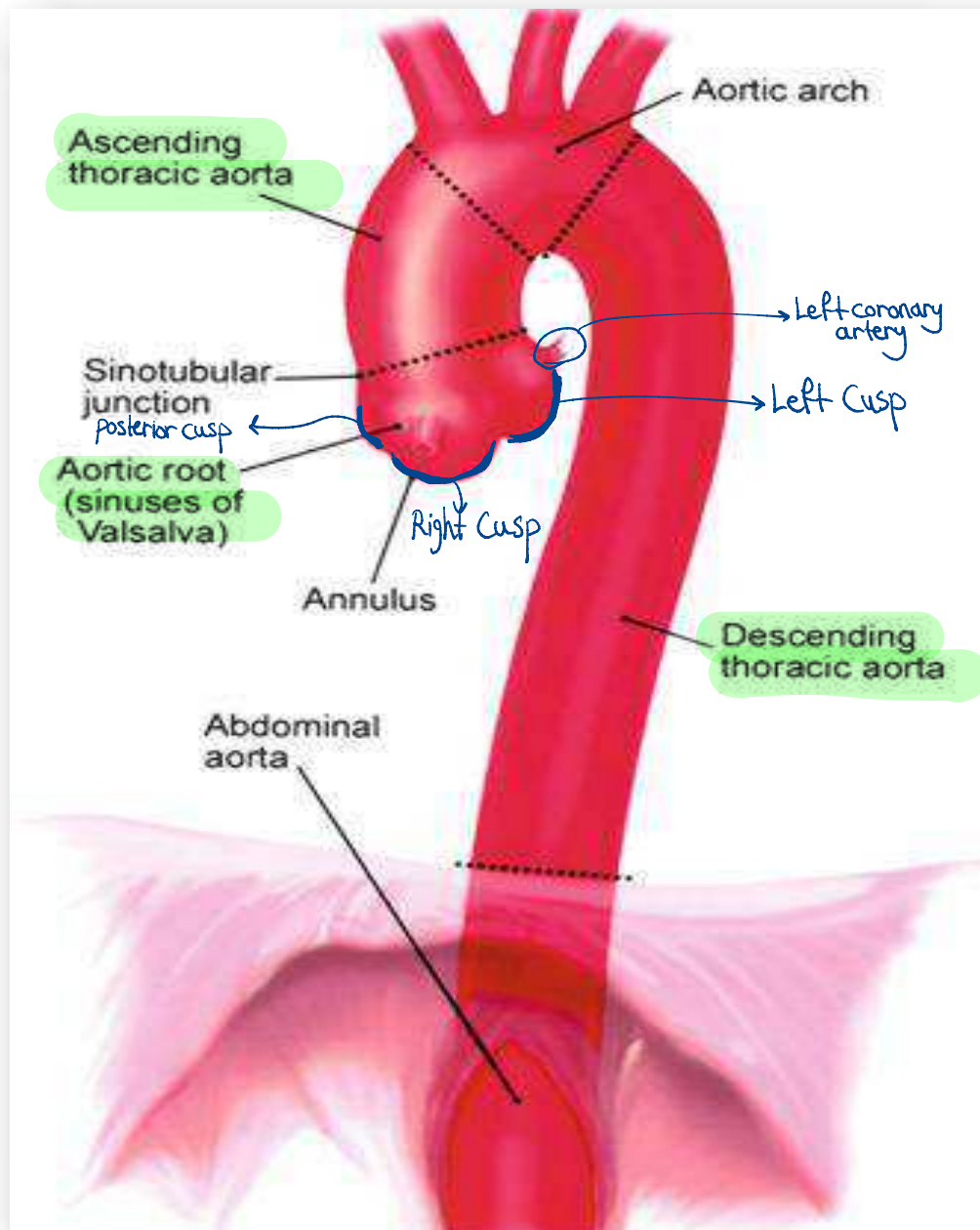
**Each cusp:** semilunar & has:

The same description of the pulmonary cusps.

- **Aortic Sinuses:** slight dilatation above each cusp.

سوس  
↓  
Sinuses of Valsalva







# Surface anatomy of the valves of the heart

ارسمهم على الرئتين

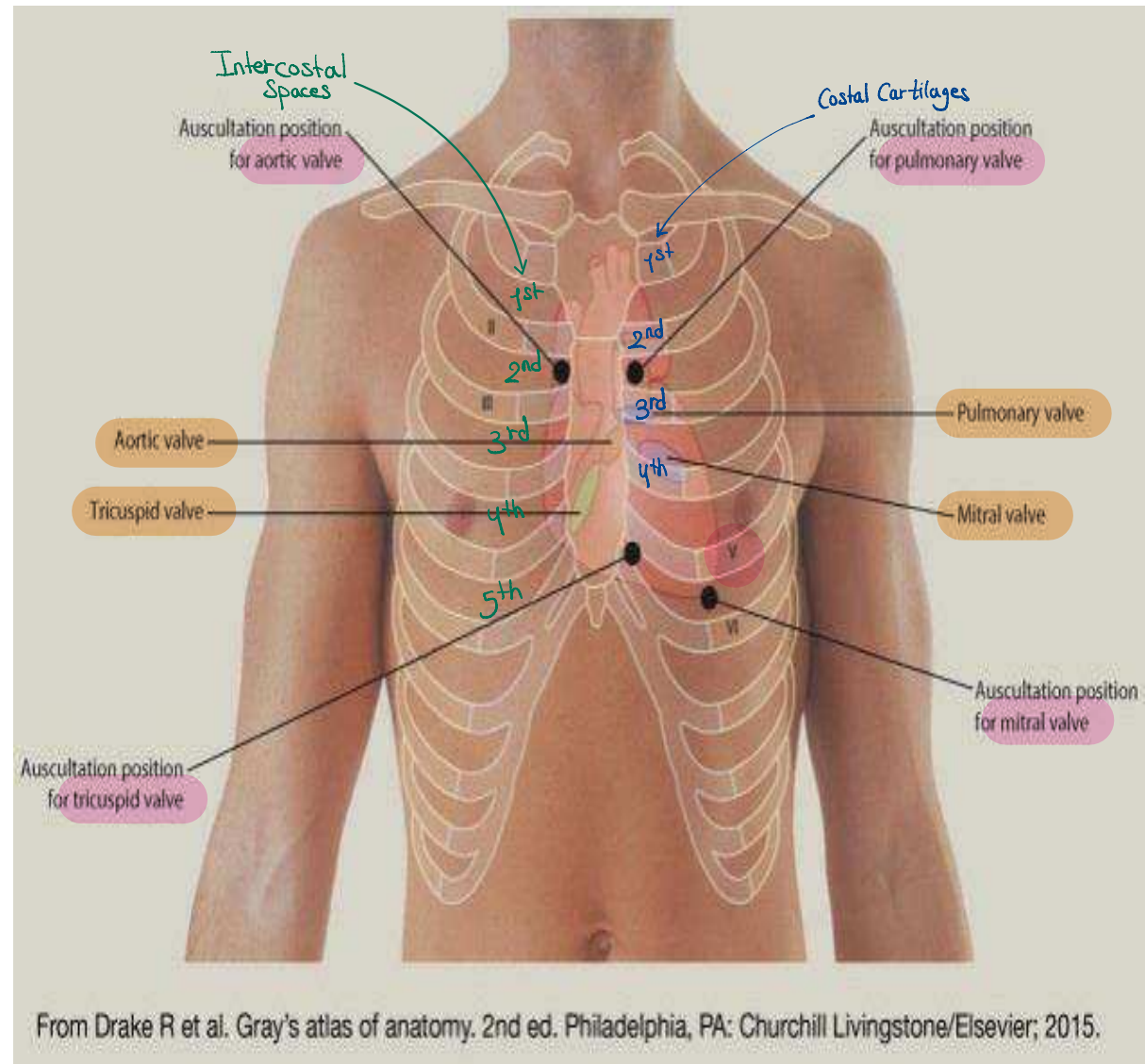
مرسوم بين الأضلاع  
"صدف الأضلاع"

**Pulmonary valve:** Left 3<sup>rd</sup> costal cartilage, close to the sternal margin.

**Aortic valve:** level of Left third intercostal space, behind the left 1/2 of sternum.

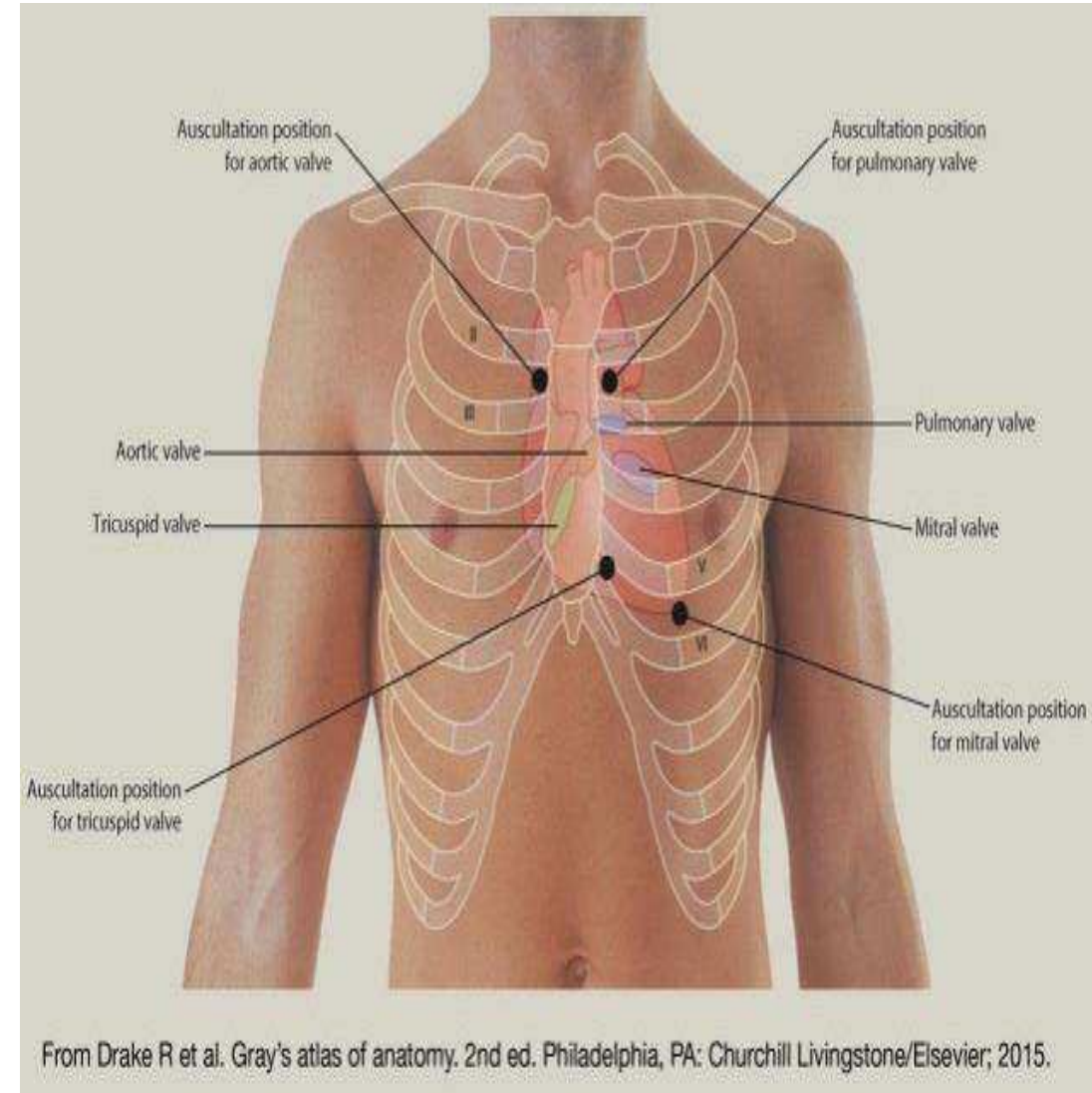
**Mitral valve:** Left fourth costal cartilage close to the sternal margin.

**Tricuspid valve:** level of fourth intercostal space, behind the right half of the sternum.

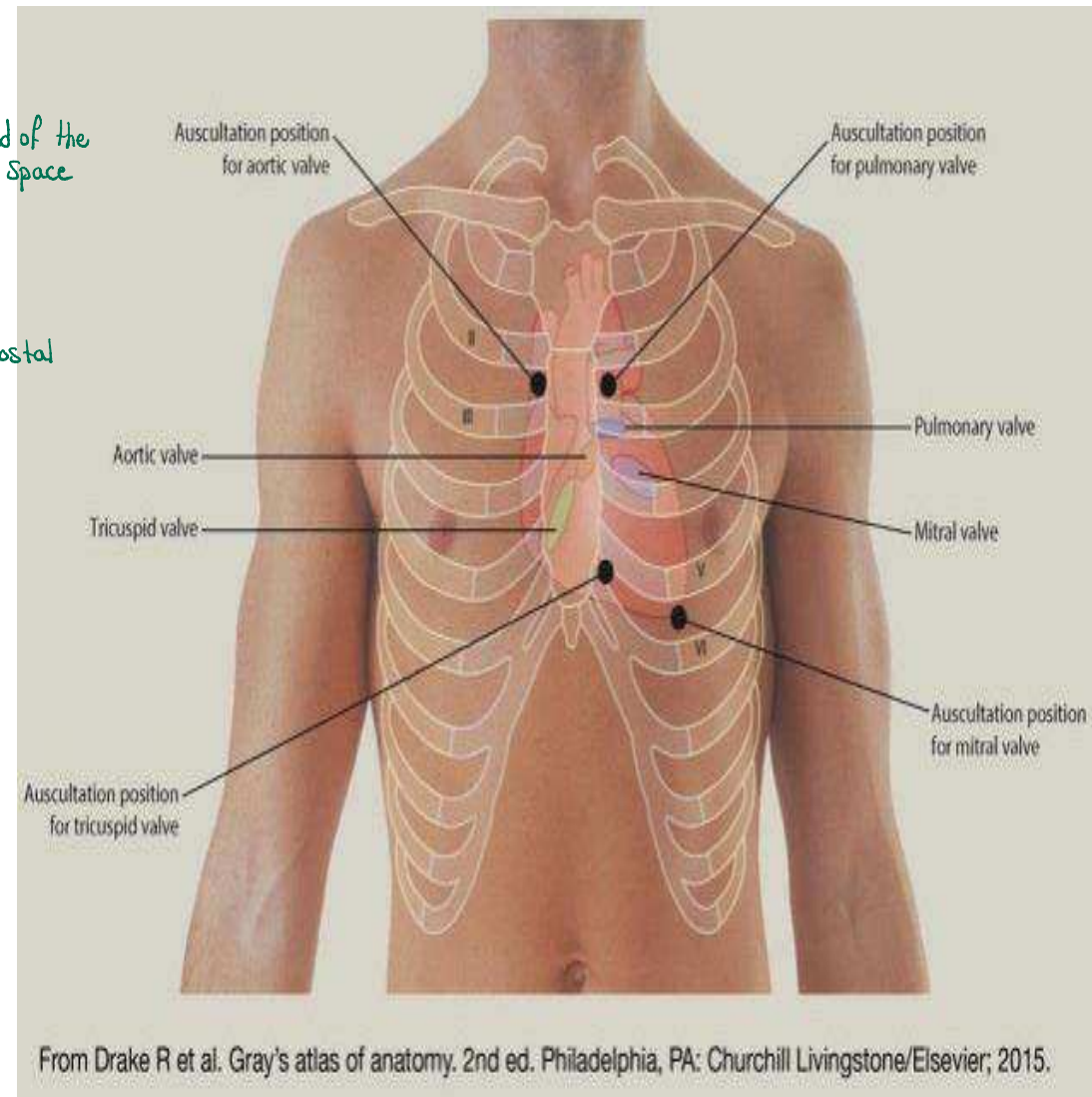


# Auscultation of the valves of the heart → NOT the same as surface anatomy "مخدين باهرى" of the valves

- There are two normal heart sounds, often described as a <sup>first</sup> lub and a <sup>second</sup> dub that occur in sequence with each heartbeat.
- First heart sound (S<sub>1</sub>)** produced by the closing of the atrioventricular valves.
- Second heart sound (S<sub>2</sub>)**, produced by the closing of the semilunar valves. (Aortic + Pulmonary Valves)
- It is important for a physician to know where to place the stethoscope on the chest wall to be able to hear sounds produced at each valve with the minimum of distraction. why? because the valve may be diseased or have stenosis (Narrowing) or the closure of the valve is insufficient which causes regurgitation of the blood



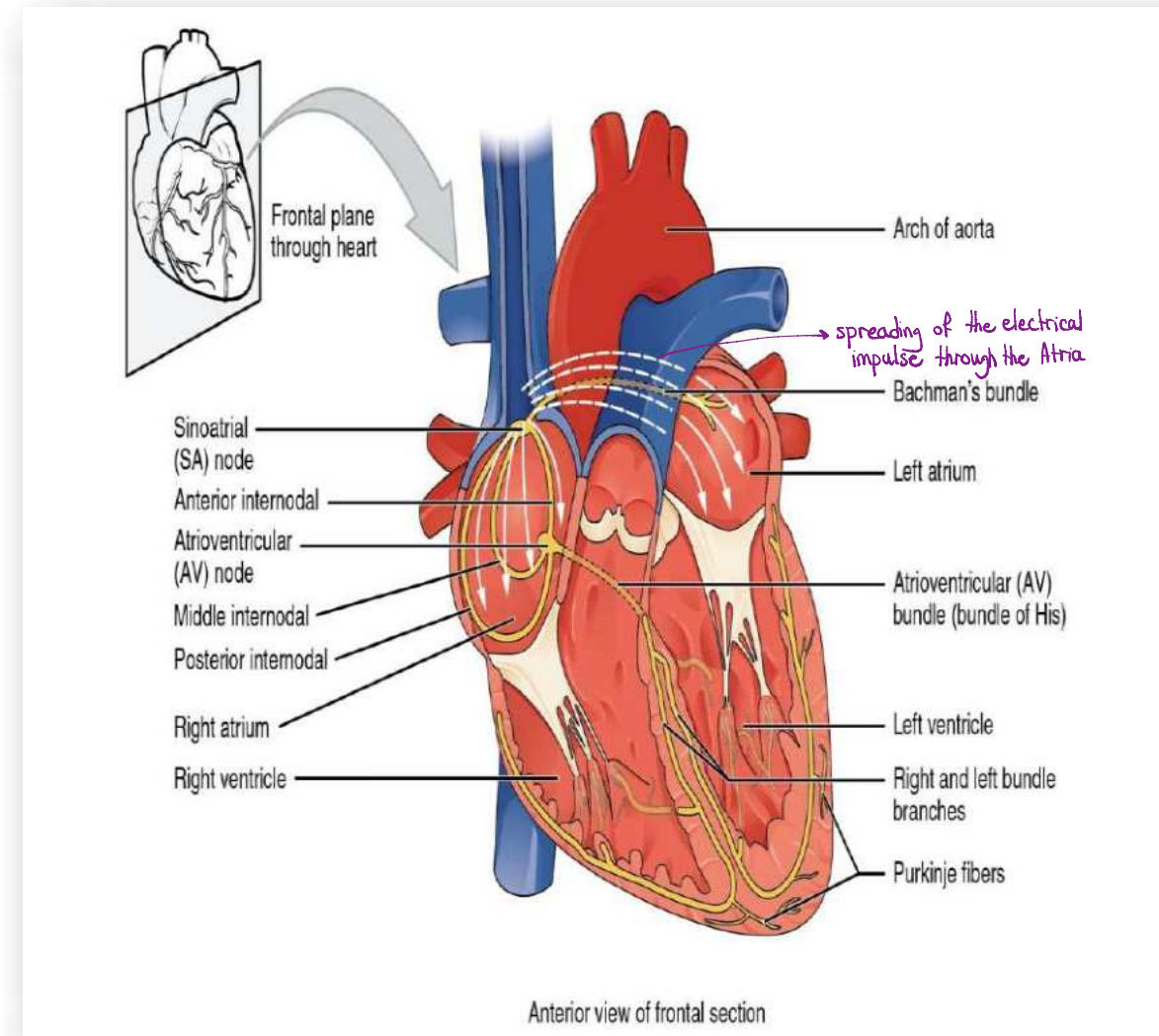
- **Pulmonary valve area** is best heard over the **left second intercostal space**, near the sternal border. *or Medial end of the Intercostal Space*
- **Aortic valve area** is best heard over the **right second intercostal space**, near the sternal border. *or Medial end of the Intercostal space*
- **Mitral valve area** is best heard **over the apex of the heart**. *→ Nine cm to the left from the Median Line in 5<sup>th</sup> Intercostal Space*
- **Tricuspid valve area** is at **fourth & fifth intercostal space**, near the left sternal border.



# Conductive System of the Heart

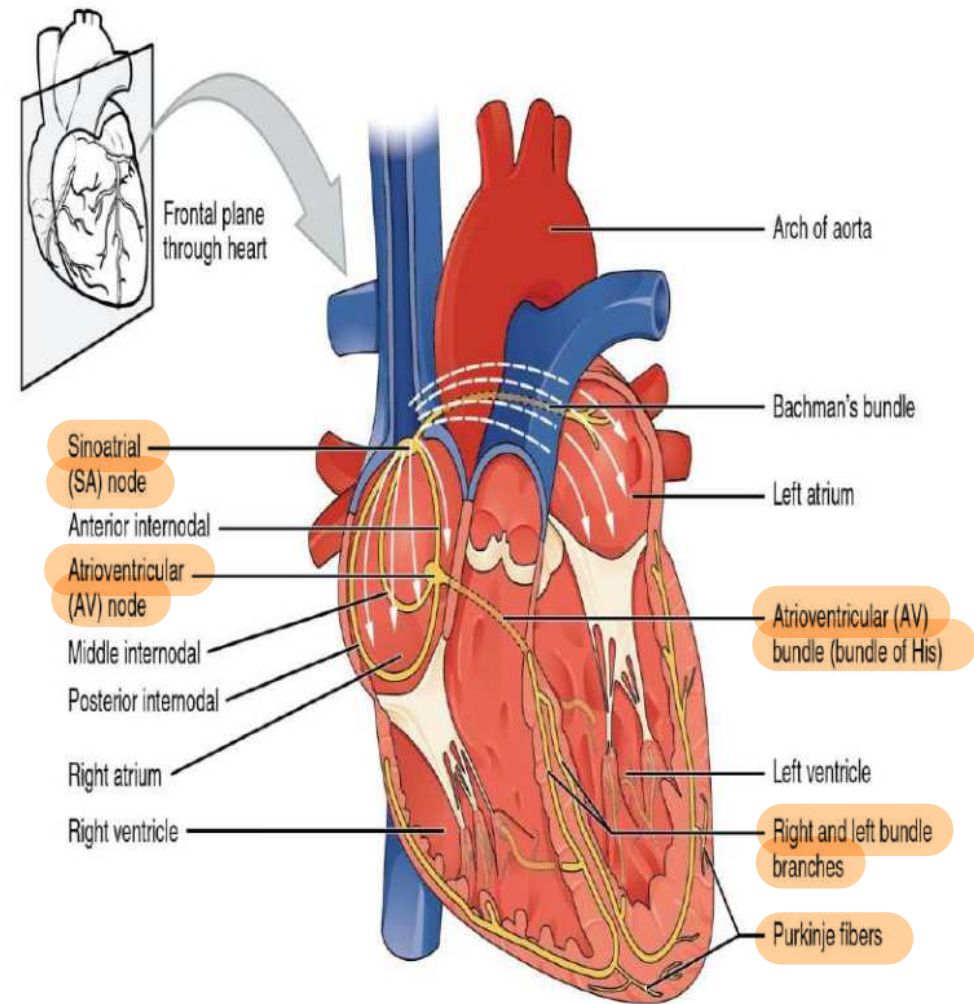
- The normal heart contracts rhythmically at about 70 to 90 beats/ minute in the resting adult.
- The **rhythmic contractile process** originates **spontaneously** in the conducting system and the impulse travels to different regions of the heart, so the atria contract first and together, to be followed later by the contractions of both ventricles together.
- The slight delay in the passage of the impulse from the atria to the ventricles allows time for the atria to empty their blood into the ventricles before the ventricles contract.

NOT at the same time



The specialized cardiac muscle fibers that form the conductive system of the heart, represented in:

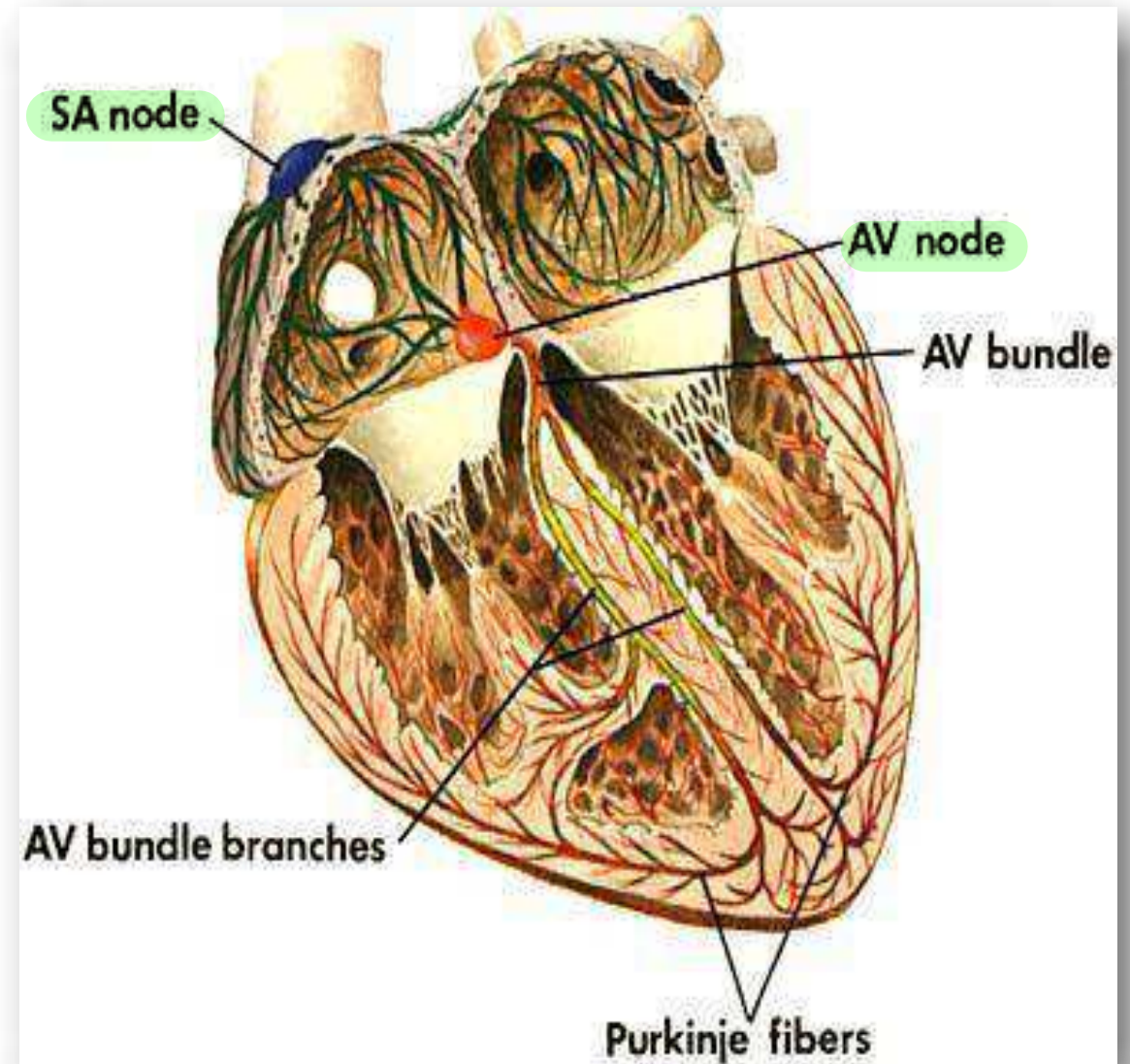
- Sinuatrial node (SAN) → Pacemaker of the Heart which initiate the electrical impulse
- Atrioventricular node (AVN) → NOT a pacemaker
- Atrioventricular bundle and its right and left terminal branches.
- Subendocardial plexus of Purkinje fibers.



Anterior view of frontal section

# Sinoatrial node (SAN)

- It is the **pacemaker of the heart**, initiates the impulse of contraction.
- The sinoatrial node is an **elliptical structure**, **10–20 mm long**.  
*بيضاوية الشكل*
- **Site:** is located in the wall of the right atrium in the upper part of the sulcus terminalis, subepicardially, just to the right of the opening of the superior vena cava
- The node **spontaneously gives origin** to rhythmic electrical impulses that spread in all directions through the cardiac muscle of the atria and **cause the muscles to contract**.



# Atrioventricular Node (AVN) → not a Pacemaker

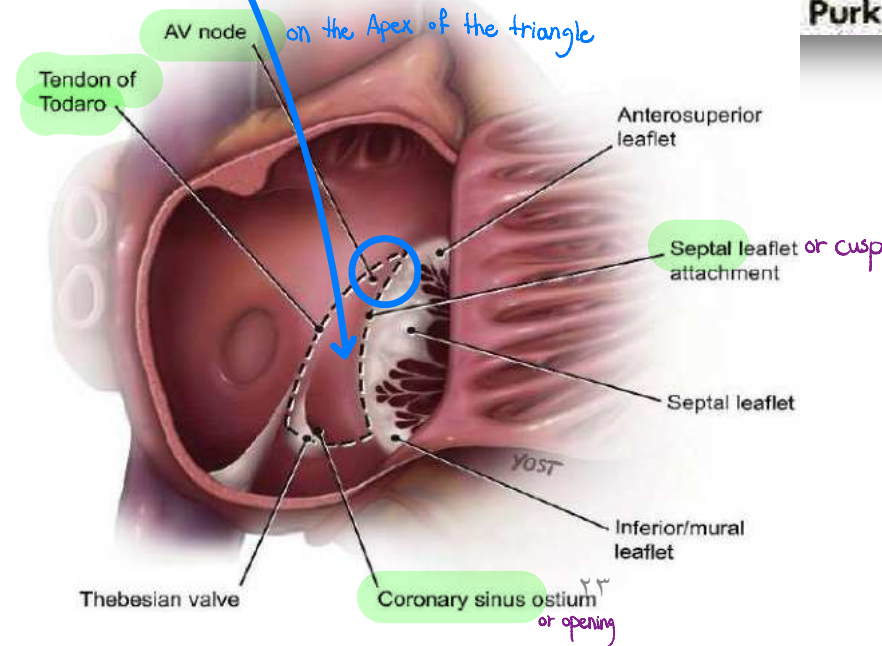
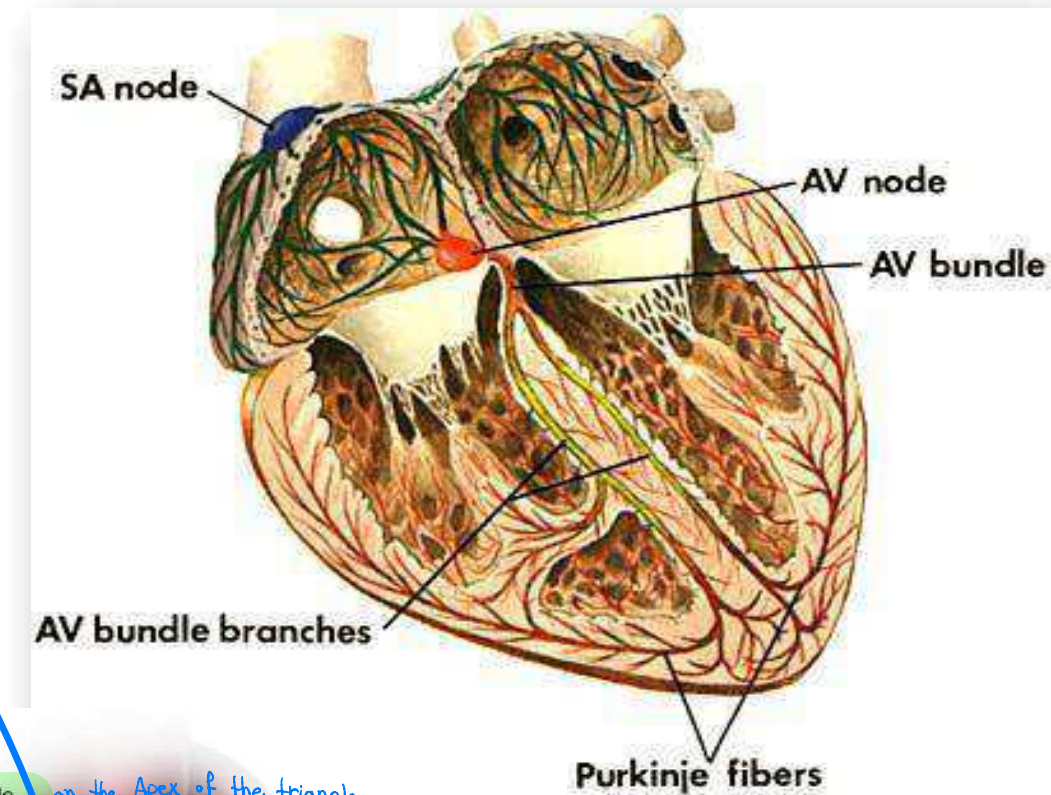
↓ in the Right Atrium

- **Site:** It is located within the **triangle of Koch** (at its apex)- above the attachment of the septal cusp of the tricuspid valve.

■ Triangle of Koch is a region located at the right atrium defined by the following landmarks: the coronary sinus ostium, tendon of Todaro (tT), and the septal leaflet of the tricuspid valve (TV).

- The atrioventricular node is **stimulated by** the excitation waves as it pass through the atrial myocardium.

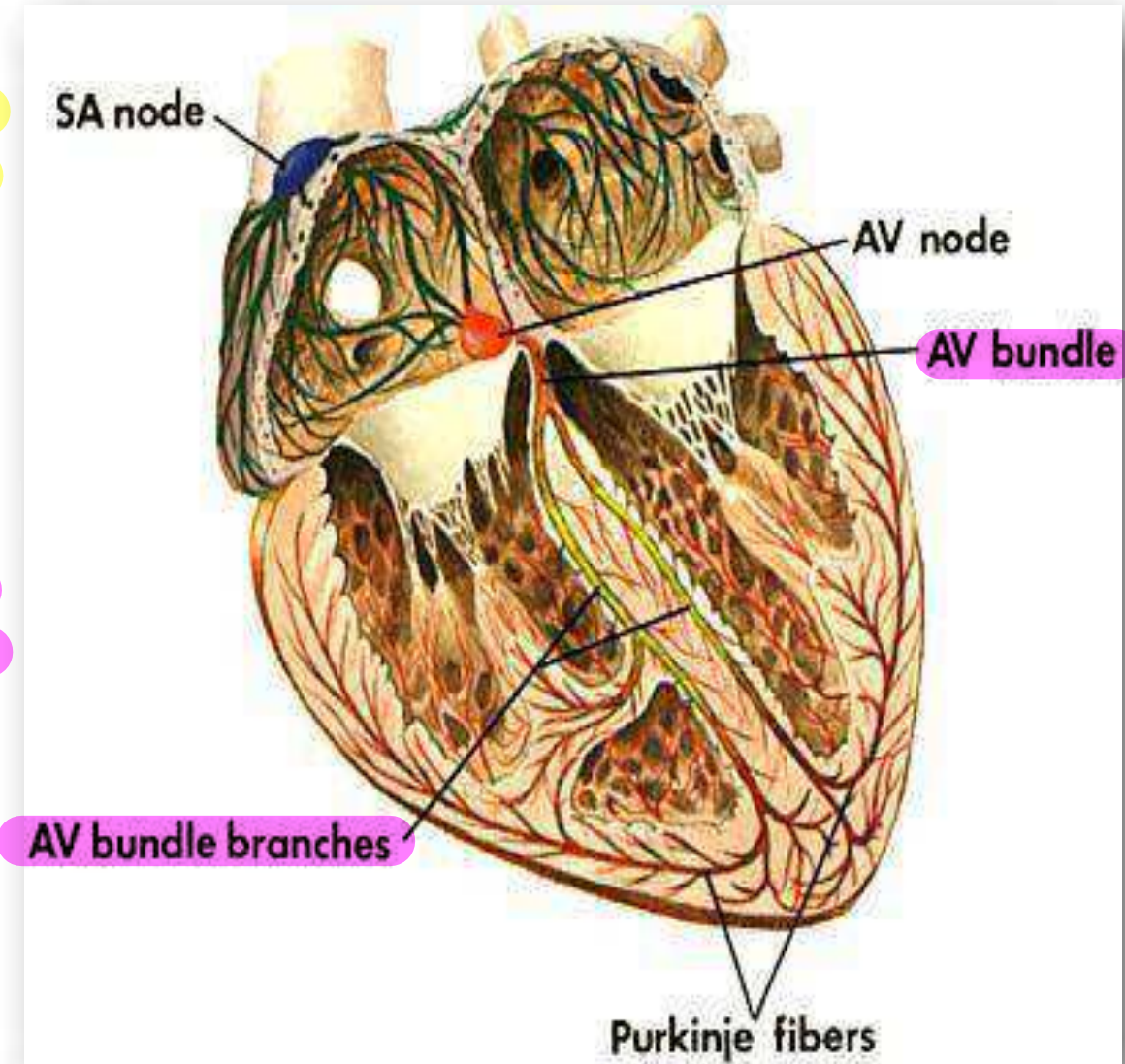
- **From it** the cardiac impulse is **conducted to the ventricles** by the atrioventricular bundle.



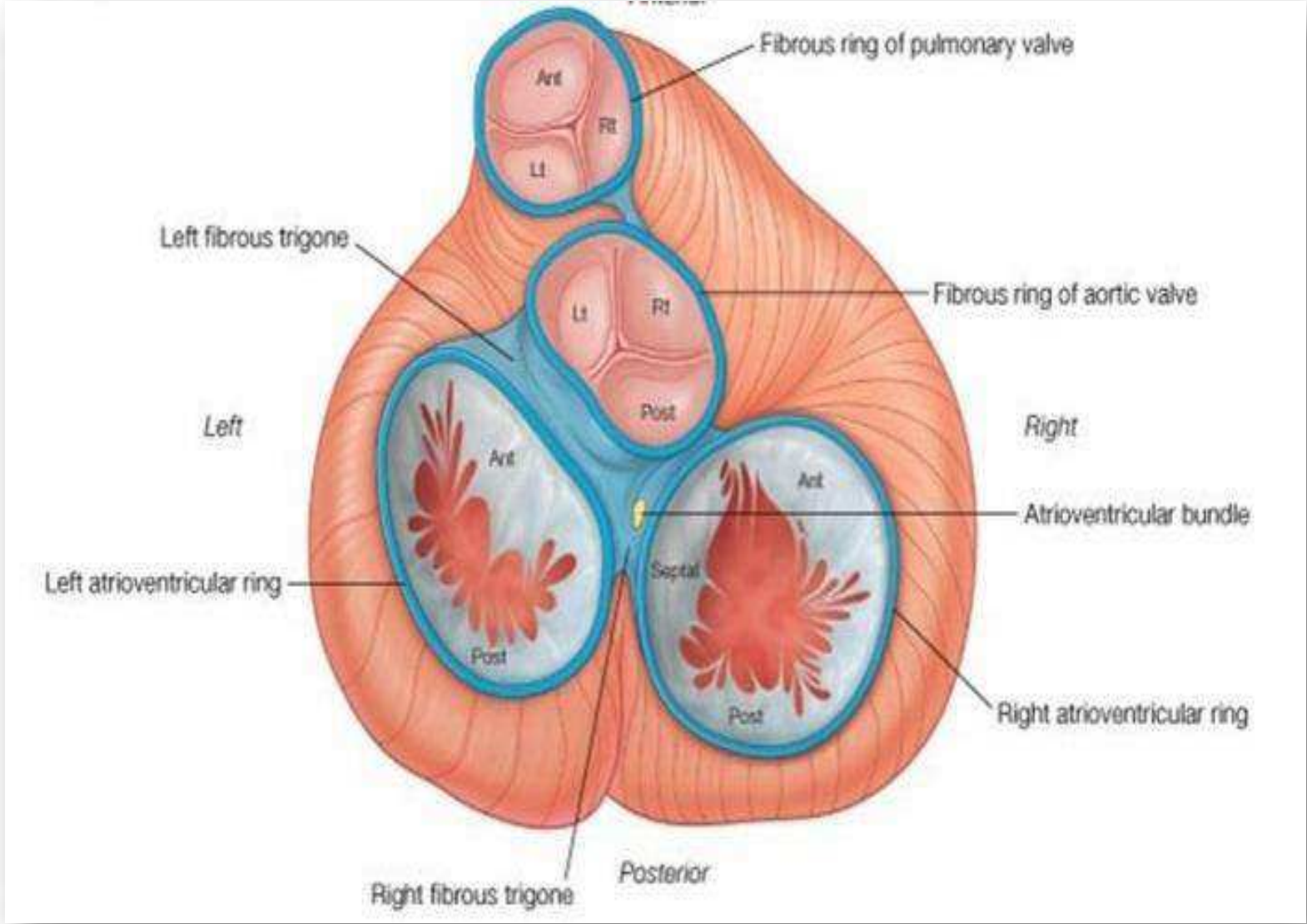
المثلث من فضاء وعين  
مخروط  
Boundaries of  
Triangle of Koch

## Atrioventricular Bundle: → originate from the Atrioventricular Bundle

- The atrioventricular bundle (**bundle of His**) it is the only bundle of cardiac muscle that **connects** the myocardium of the atria and the myocardium of the ventricles.
- So it is thus the **only route** along which the cardiac impulse can travel from the atria to the ventricles.
- **Course:** The bundle **descends** through the fibrous skeleton of the heart, **then descends** behind the septal cusp of the tricuspid valve to reach the membranous part of the ventricular septum.
- **End:** At the upper border of the muscular part of the ventricular septum **it divides into** two branches, one for each ventricle, **Right & left bundle branches.** → bundle for each ventricle







# Quiz

A 57-year-old patient has a heart murmur resulting from the inability to maintain constant tension on the cusps of the atrioventricular (AV) valve. Which of the following structures is most likely damaged?

- (A) Crista terminalis
- (B) Moderator band.
- (C) Chordae tendineae → it is responsible to close the cusps sufficiently
- (D) Pectinate muscle.

Which of the following sequences correctly represents the conduction of an impulse through the heart?

- (A) SA node, AV node, AV bundle, bundle branches
- B) SA node, AV bundle, AV node, bundle branches
- C) AV node, SA node, AV bundle, bundle branches
- D) SA node, bundle branches, AV node, AV bundle
- E) AV node, AV bundle, SA node, bundle branches