

CARDIOVASCULAR SYSTEM

SUBJECT : Anatomy.

LEC NO. : lecture (2)

DONE BY : Rawan Alhindi

وَقُلْ رَبِّ زِدْنِي عِلْمًا



SCAN ME!



CVS....

Lecture (2)

Anatomy of the Heart

* في القلب
هي بين الفجوة القلبية
بين حيزي القلب

* الغشاء القلبي

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Assistant professor of Anatomy & Embryology

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.

internal feature of RA.

Interior of Right Atrium

الجزء الأمامي الخشن

A- Rough anterior part, show:

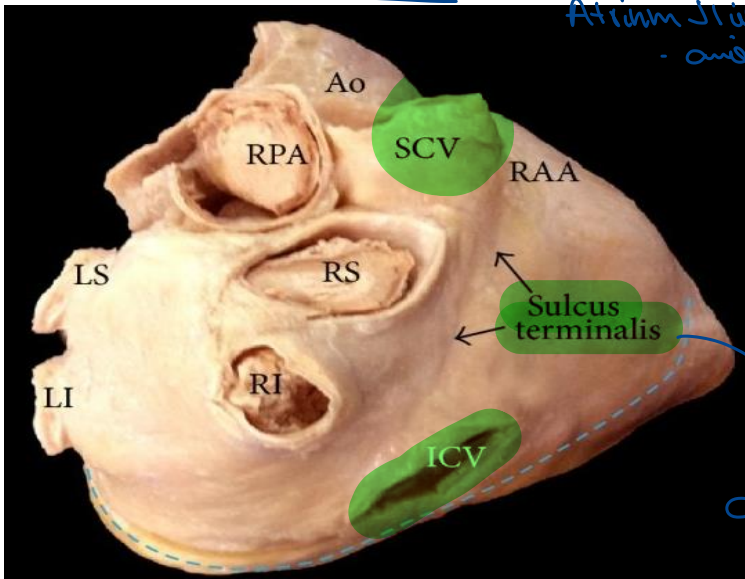
1- Openings of anterior cardiac veins. →

وهو من الشرايين التي تصب في القلب
Venous drainage
heart

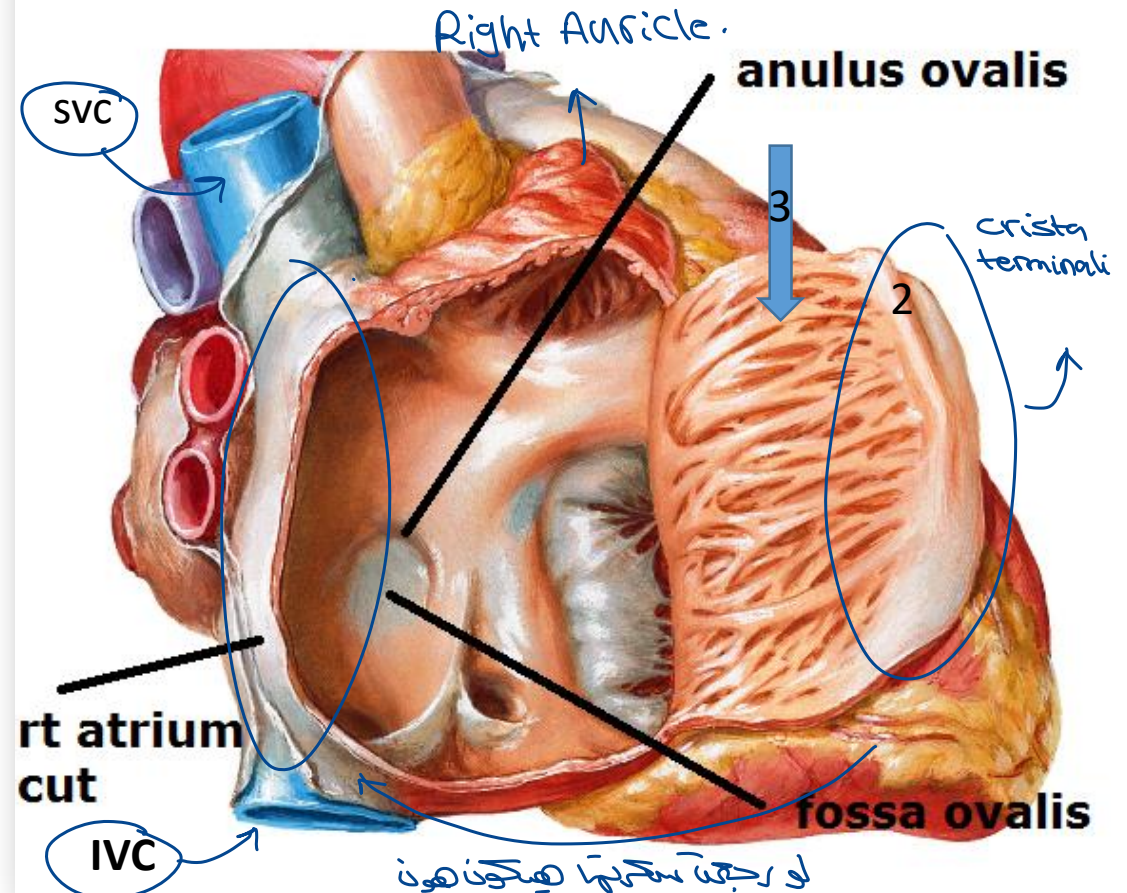
2- **Crista terminalis**: Vertical muscular ridge between **SVC & IVC**, separate anterior part from posterior part and represented externally by the **sulcus terminalis**.

3- **Musculi Pectinati**: Transverse muscular ridges from crista terminalis to the **right auricle**.

→ appendage
Atrium
- append



يقابل الـ Crista terminalis في الجزء الخلفي من القلب
Extend from SVC to opening of IVC ← نفس الـ



لو رجعت سكرتها ستكون هون
مكافئ

B- Smooth Posterior part, shows:

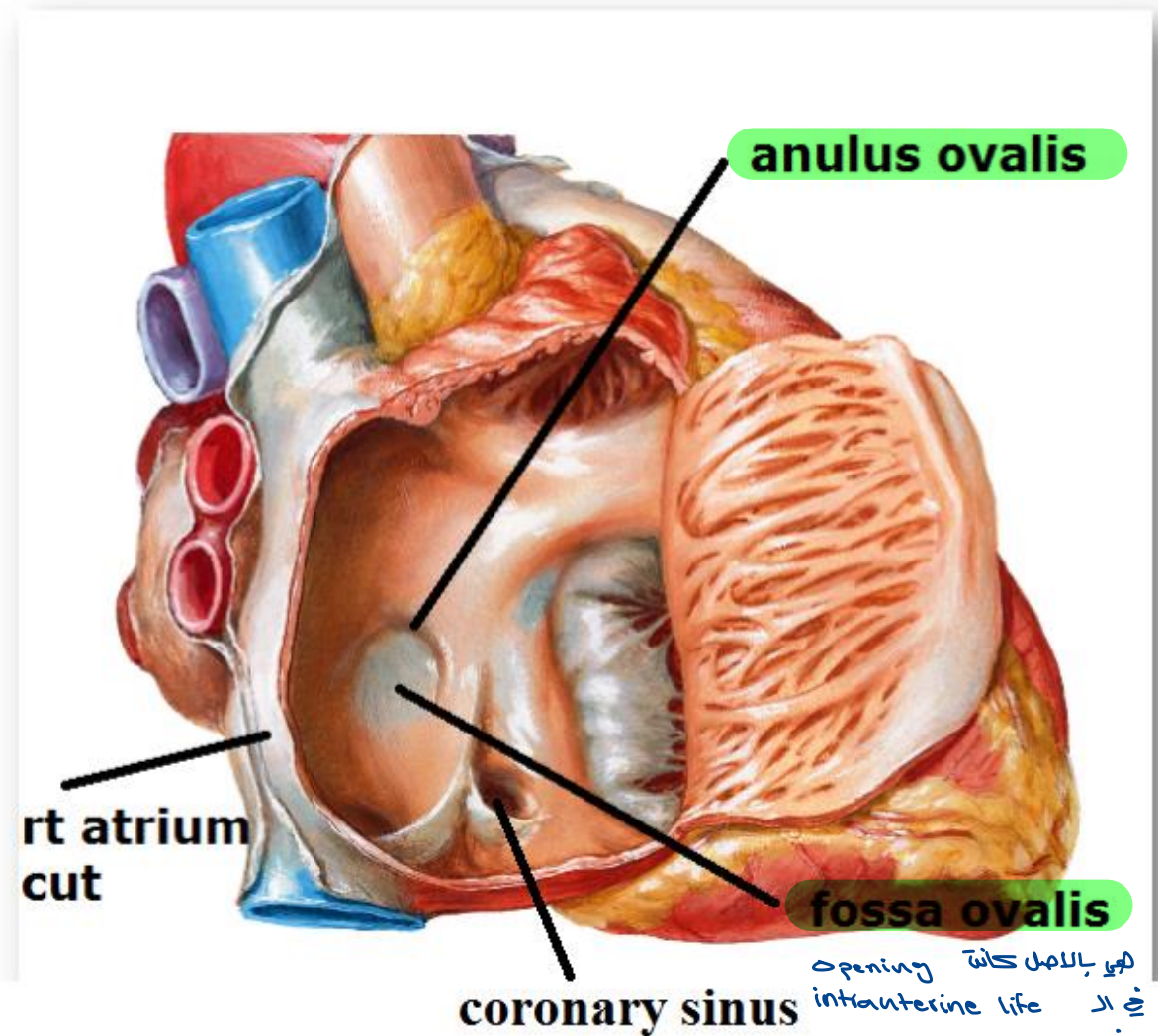
1. Openings of: S.V.C, I.V.C & coronary sinus.

2. Interatrial septum which has: fossa ovalis, limbus fossa ovalis.

- **Fossa ovalis:** shallow depression on interatrial septum.
- **Annulus ovalis:** Curved ridge that form upper & anterior boundaries of fossa ovalis.

C-Tricuspid opening:

- In lower anterior part of the right atrium.
- Guarded by tricuspid valve
- Admit three fingers.



هذا الفتحة كانت موجودة في الحياة الجنينية
في الـ RA والـ LA ولكنها تلتصق
والخلافة بصورتها الطبيعية.
* فتحة مفتوحة ← تشبه
Congenital Anomalies.

RA + LA
3:30

Interior of Left atrium

A- Rough anterior part:

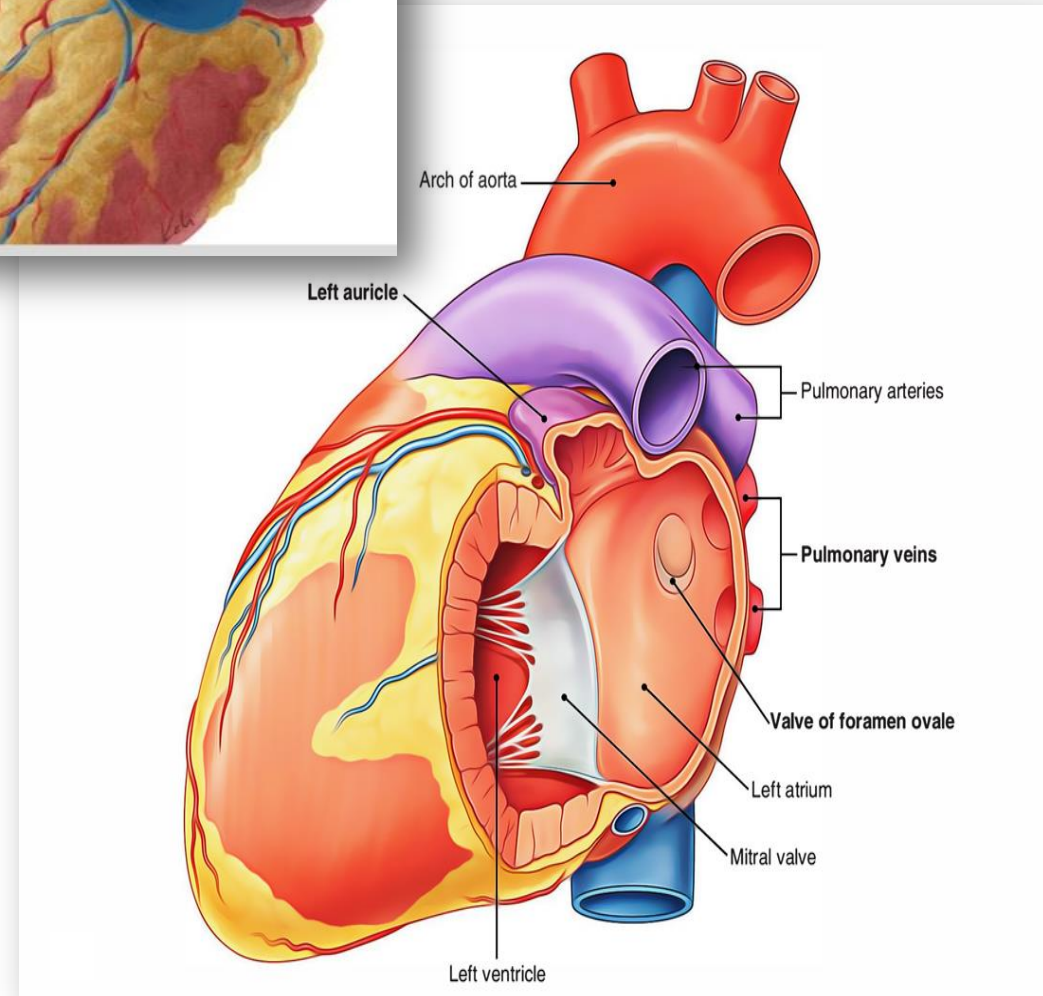
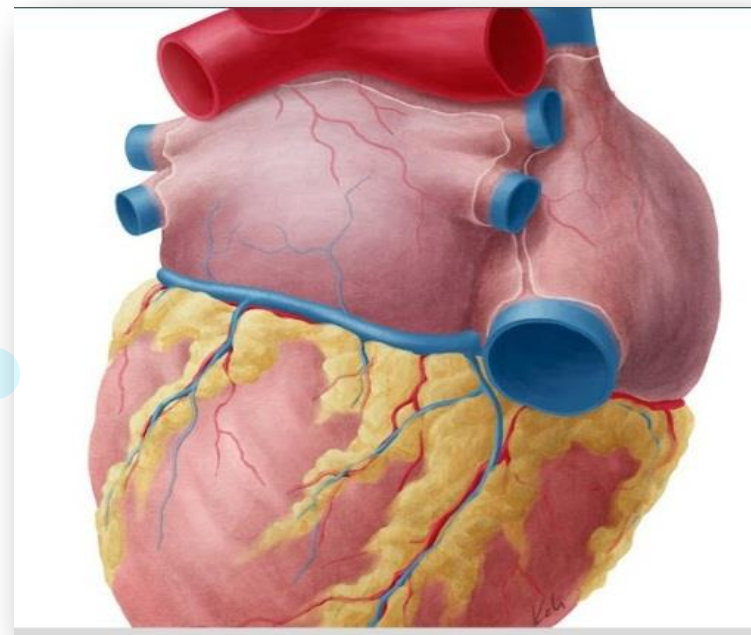
- Only its auricle that has muscoli pectinate.

B- Smooth posterior part shows:

- Openings of four pulmonary veins (Two at each side).

C- Mitral opening: → LA + L > 1/2 in

- Guarded by mitral valve.
- Admit two fingers.



Interior of the right ventricle

Cross section

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

A- Has 2 openings:

Tricuspid & Pulmonary.

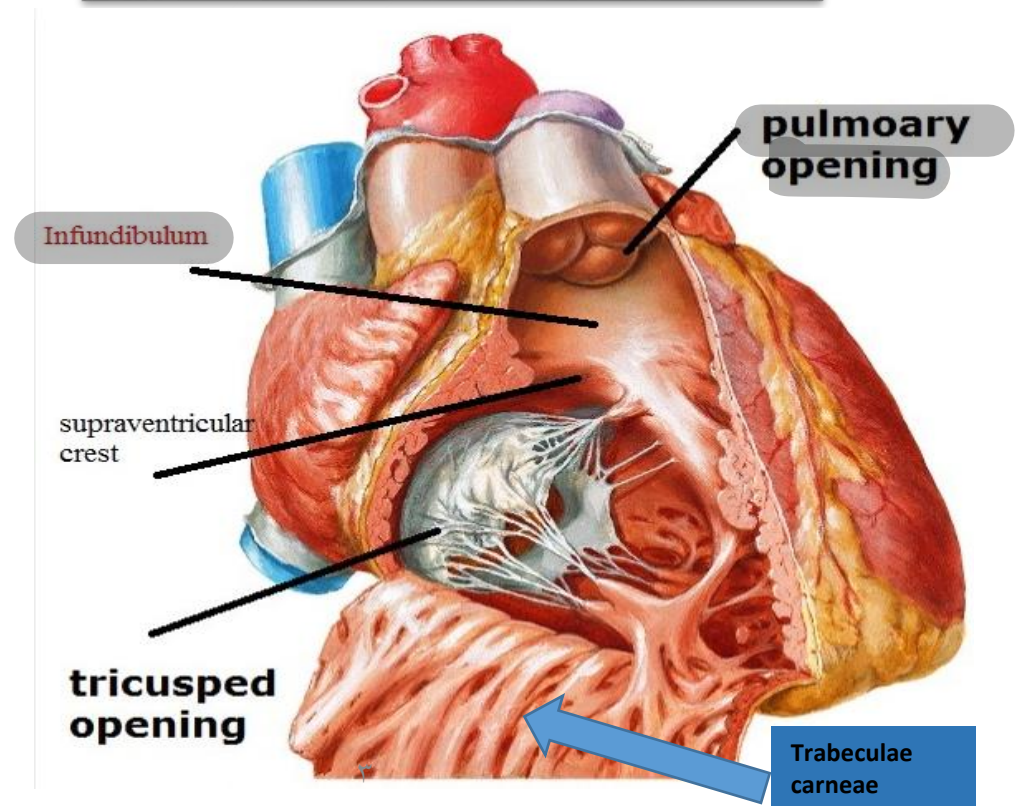
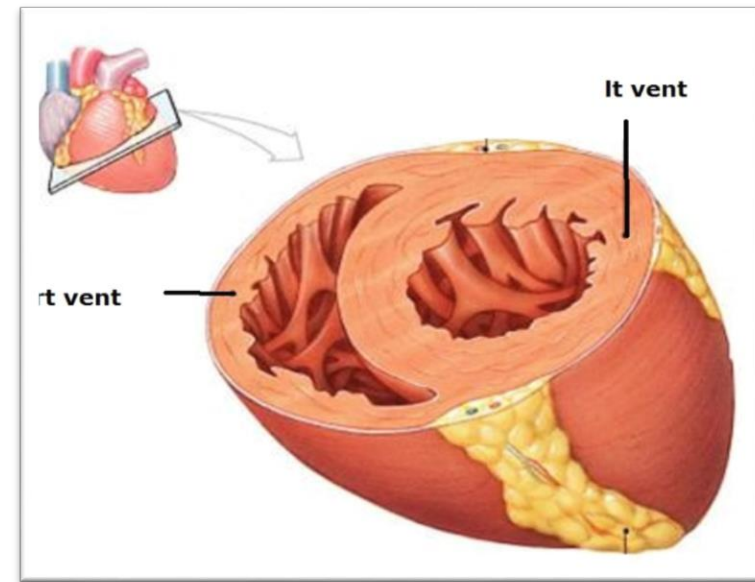
B- Has smooth (outflow) part:

- 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.



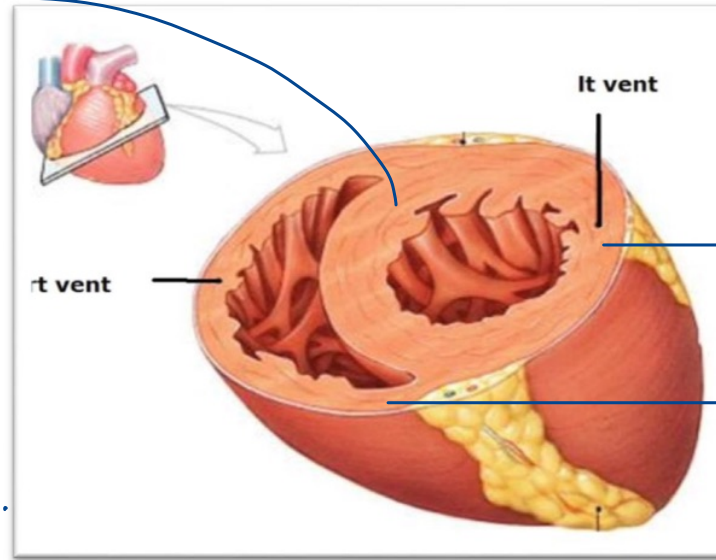
inter ventricular Septum

* muscular part \rightarrow $\frac{1}{3}$ thickness of LV

* Convex toward RV
Concave toward LV

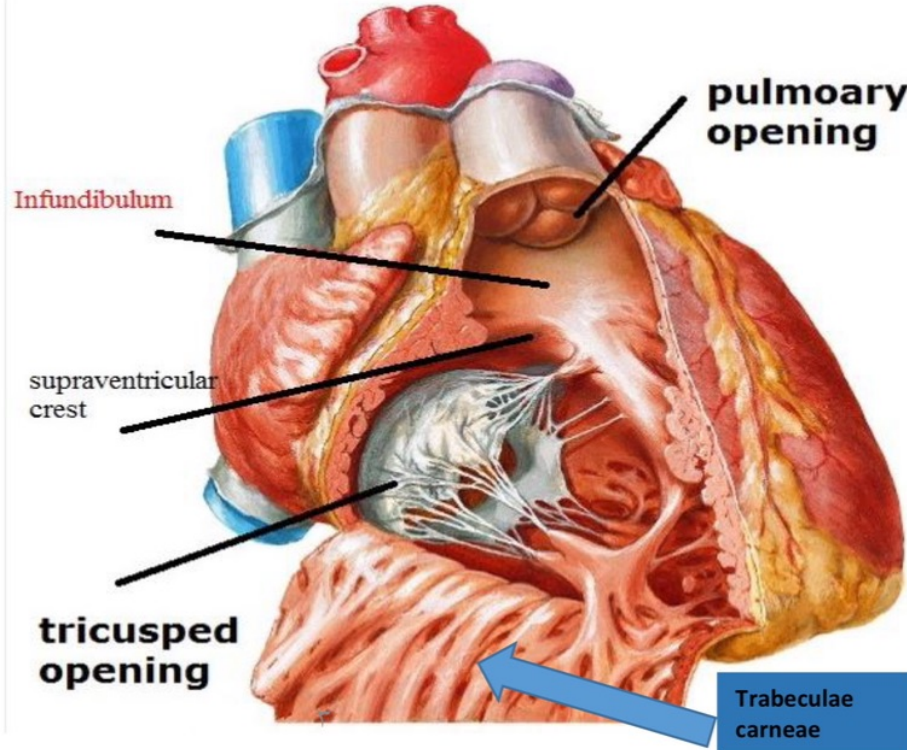


Cavity of RV = Semilunar in shape
cavity of LV = circular in shape.



thickness of RV = $\frac{1}{3}$ thickness of LV.

قوة عضلة البطين الأيمن = $\frac{1}{3}$ قوة عضلة البطين الأيسر
حجم البطين الأيمن = نصف حجم البطين الأيسر
مساحة البطين الأيمن = نصف مساحة البطين الأيسر



2-Papillary muscles: three in number

Anterior, posterior & septal papillary muscles

Shape: conical has:

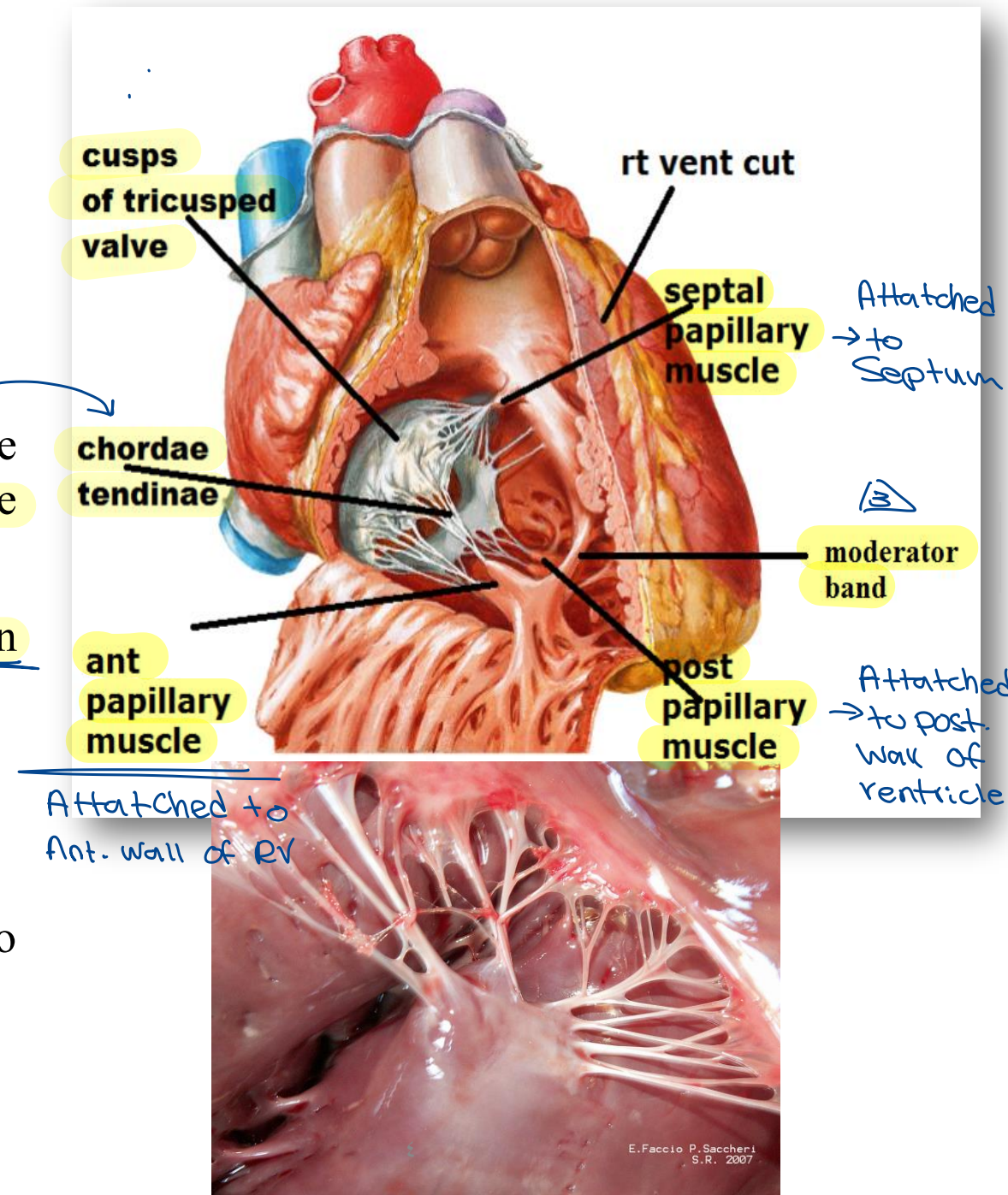
- **Base:** attached to the ventricular wall.
- **Apex:** gives chordae tendinae that attached to the margins & ventricular surface of cusps of the tricuspid valve.
- **Function:** they prevent prolapse of cusps (eversion to the atrium), holding them in a closed position.

ممكن بسبب ارتداد ال BP في ال RV
 عند ال Systole يطي ال cusps ليترجع
 Atrium -> eversion

3-Moderator band:

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

وحدة ال توصيل ال
 System of the heart.



Interior of the left Ventricle

Cross section:

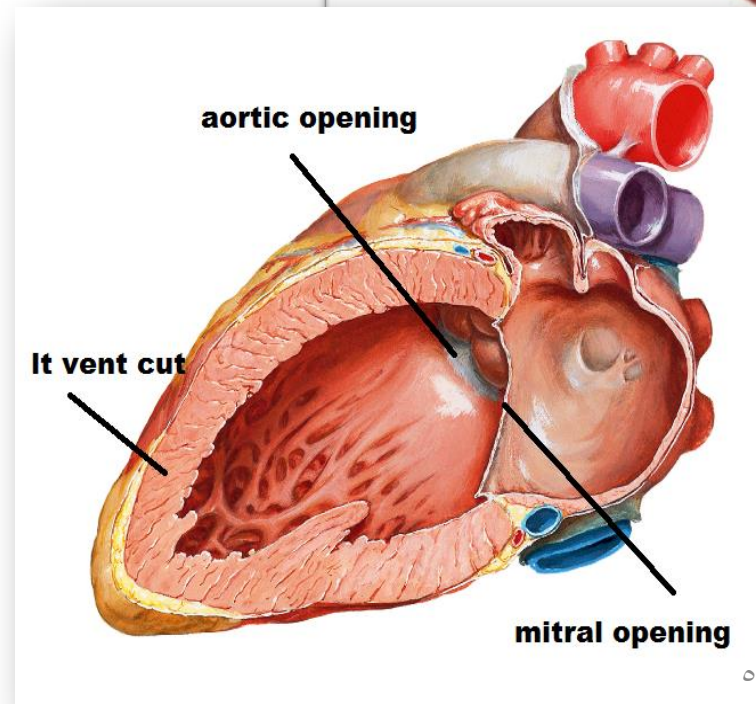
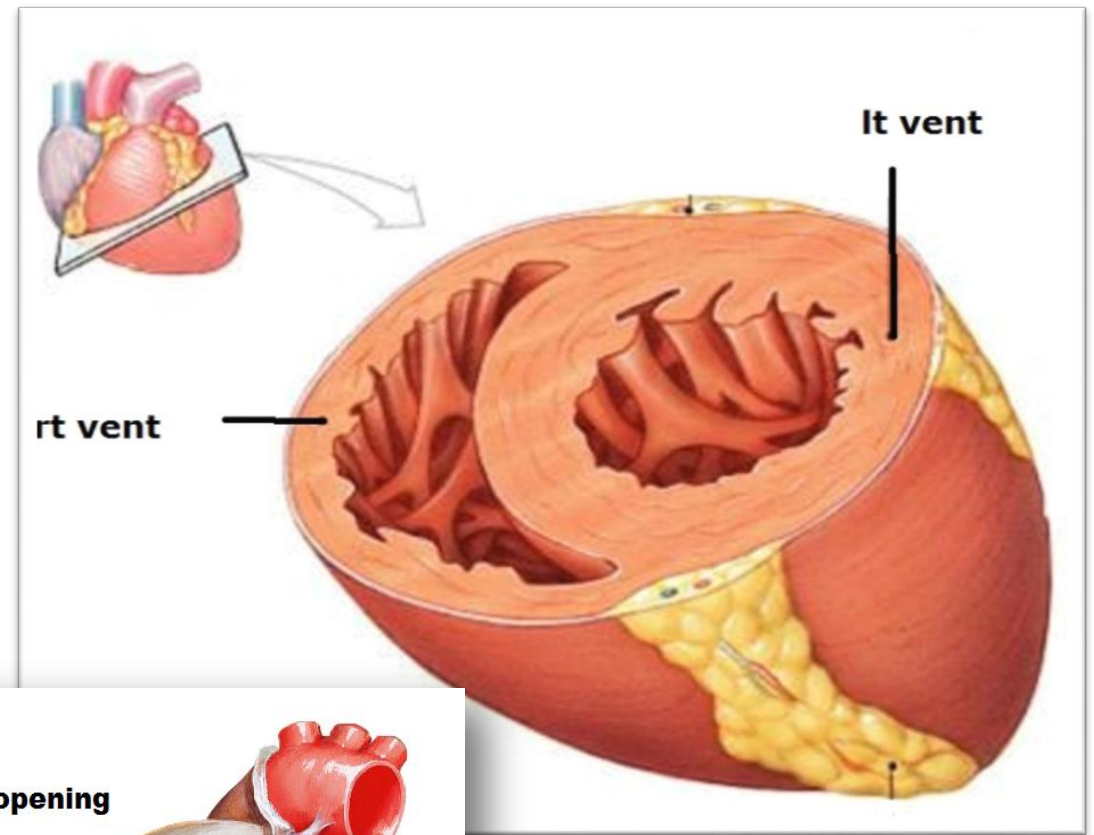
- Has circular cavity.
- Its wall: three times thickness of the wall of the right ventricle.

A- Has 2 openings:

Mitral & Aortic.

B- Smooth (outflow) part:

Aortic vestibule, below the aortic opening.



C- Rough (inflow) part, shows:

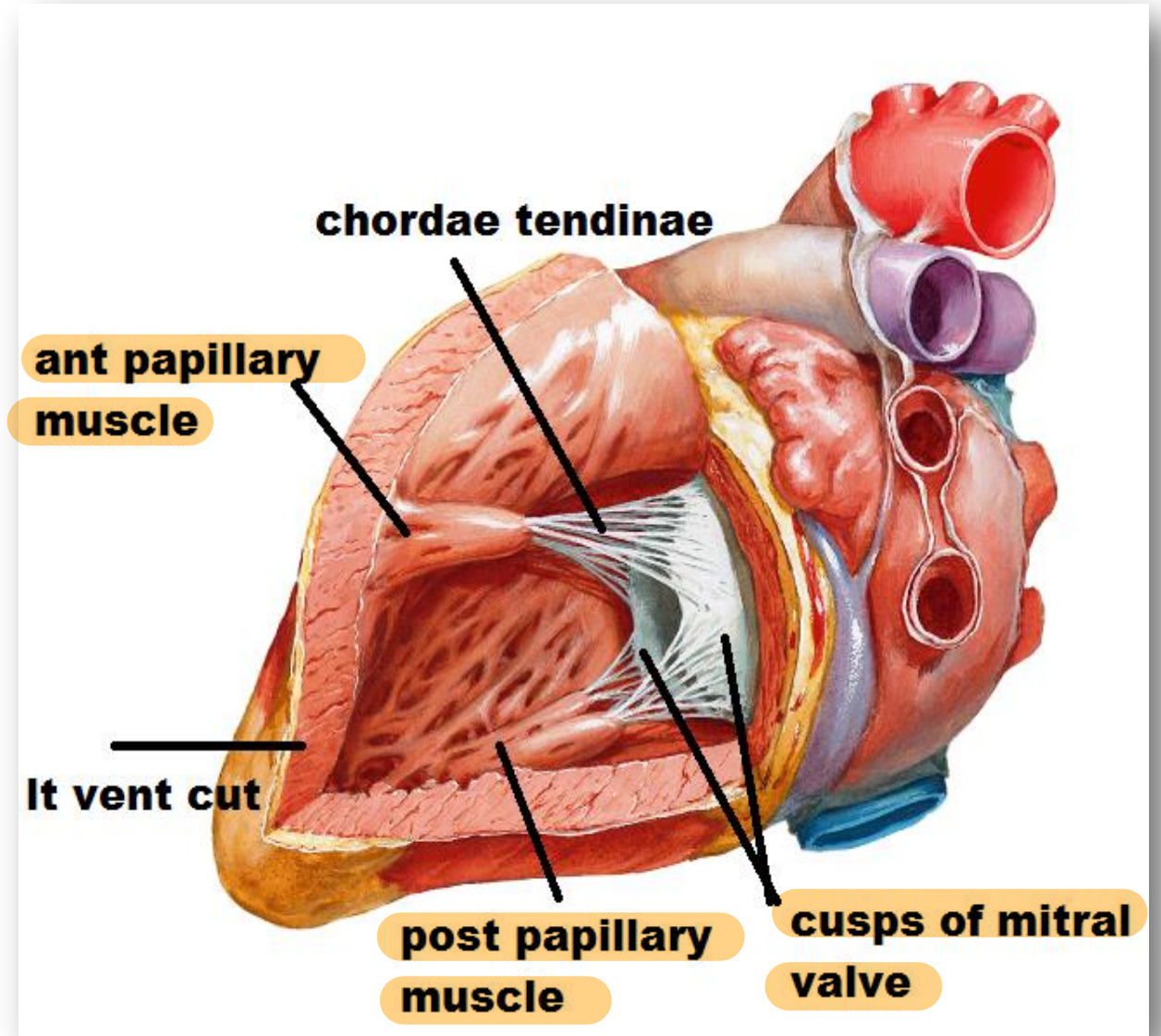
1-Trabeculae carnea.

2- Papillary muscles: two in number,

Anterior & posterior papillary muscles.

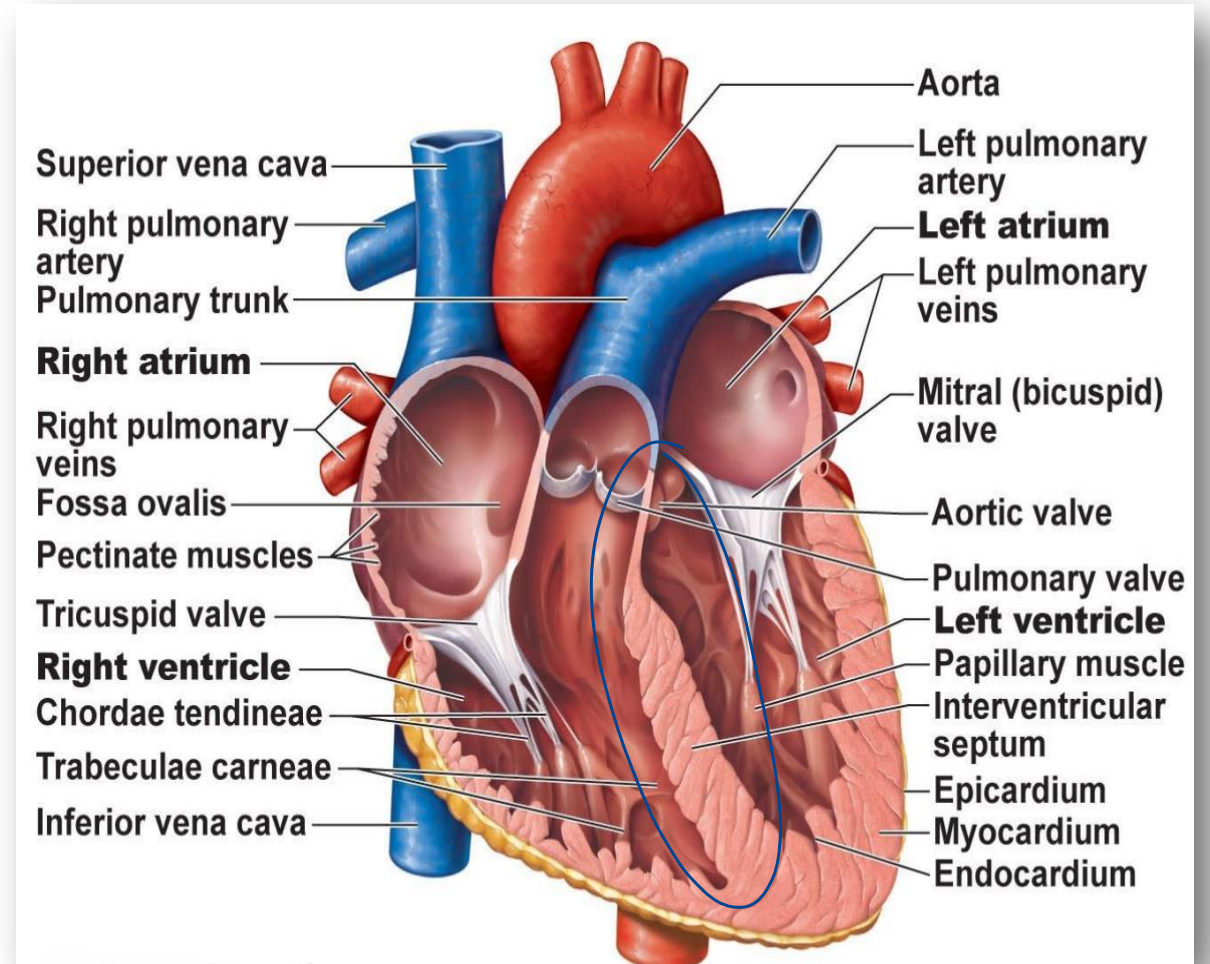
Shape: larger than that of the right ventricle, chordae tendinae are attached to margins & ventricular surface of cusps of the mitral valve.

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).



Fibrous skeleton of the heart

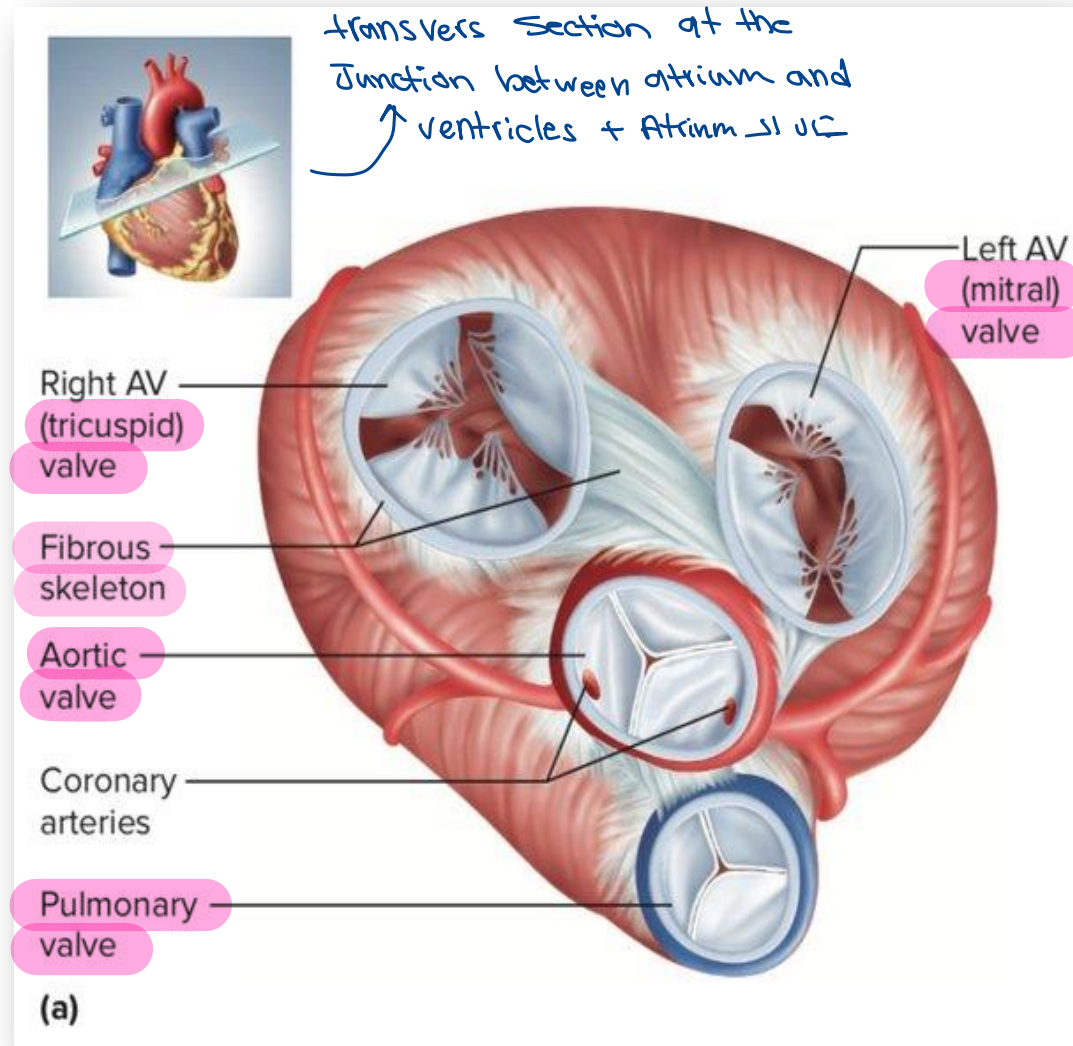
Definition: A rigid framework of dense regular connective tissue located between the atria and the ventricles.

Components:

- **Four fibrous rings.** 1-tricusped ring. 2-mitral ring. 3-aortic ring. 4-pulmonary ring.
- Right and left **fibrous trigones.**
- **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.**

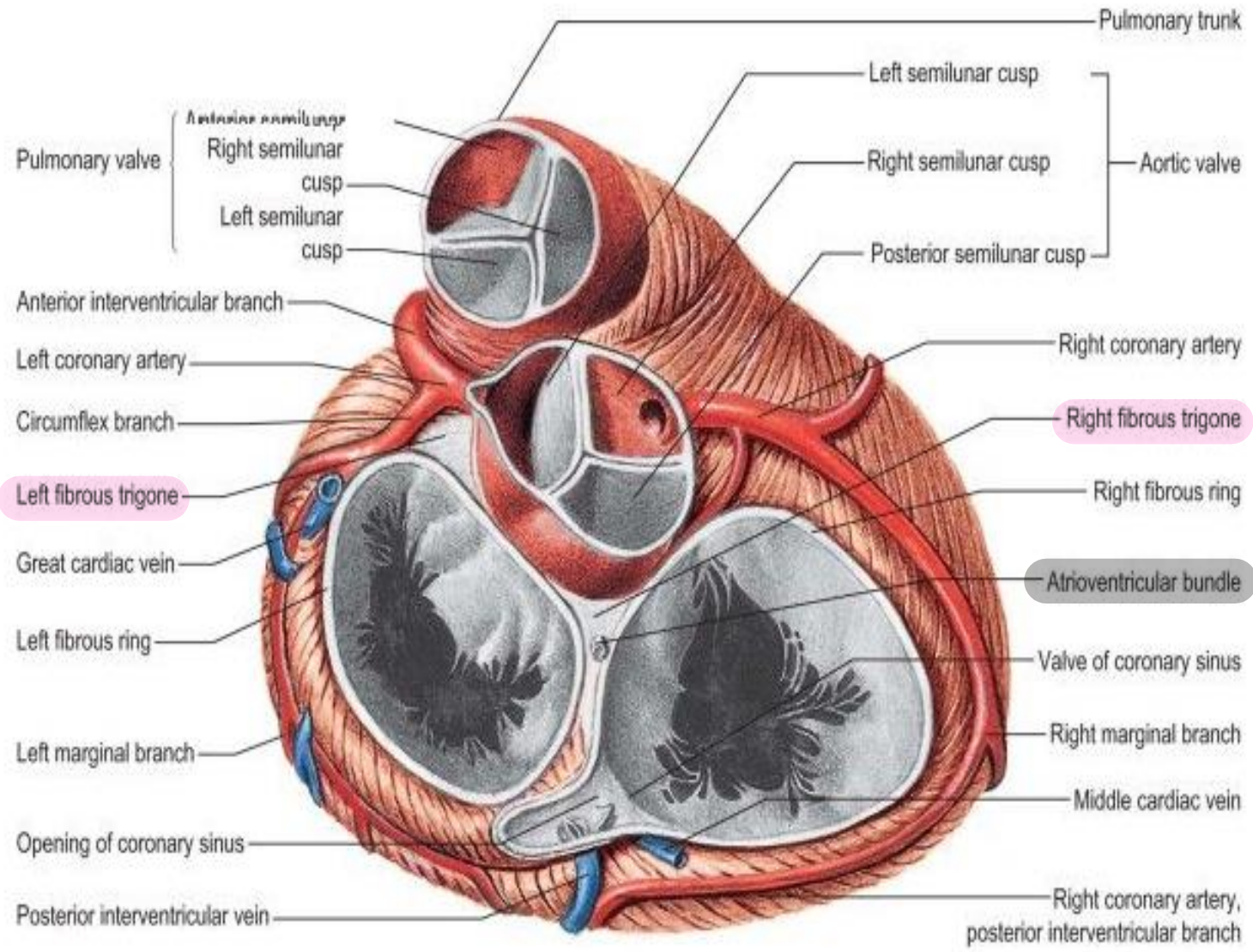


fibrous skeleton of the heart
myocardium of Atrium
Connection
is bundle in myocardium of ventricle
Atrio-ventricular bundle muscle fiber

Specialized cardiac muscle bundle
Conductive System

fibrous skeleton of the heart
myocardium of the ventricle / of the Atrium
muscle fiber
Atrio-ventricular bundle

Part of conductive system of the heart
fibrous skeleton of the heart



* من اجزاء الـ Conduction System of the heart
 * Specialized Cardiac muscle fiber
 الـ Fibrous skeleton
 الـ Bundle
 الـ Myocardium of the Atria
 الـ Myocardium of the ventricle.

Orifices at the right side of the heart

1-Right atrio-ventricular (inlet) orifice:

Tricuspid orifices:

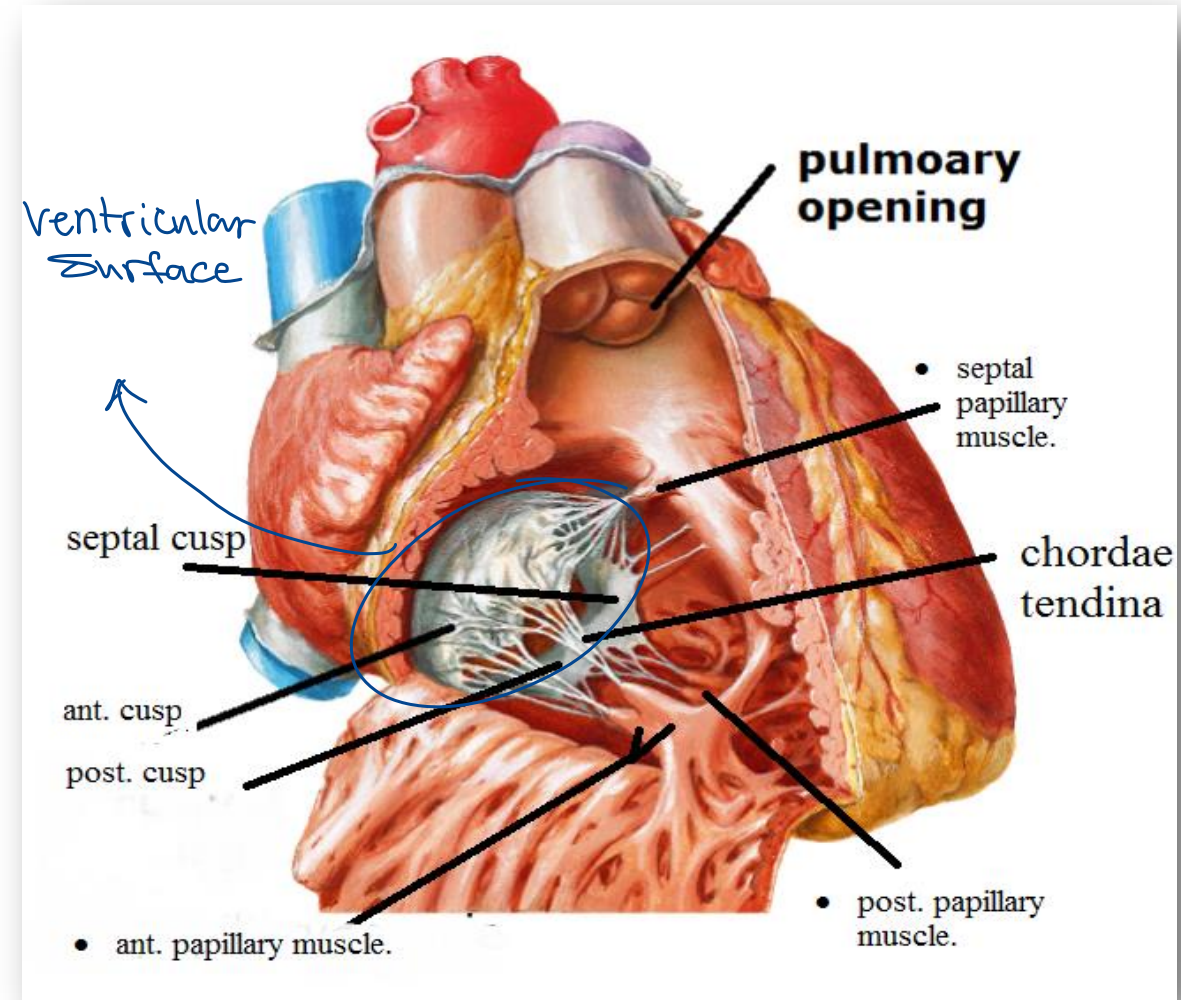
- Guarded by **Tricuspid Valve**.
- Surrounded by a fibrous ring, which gives attachment to **3 cusps (anterior, posterior & septal) of tricuspid valve**.
① ② ③

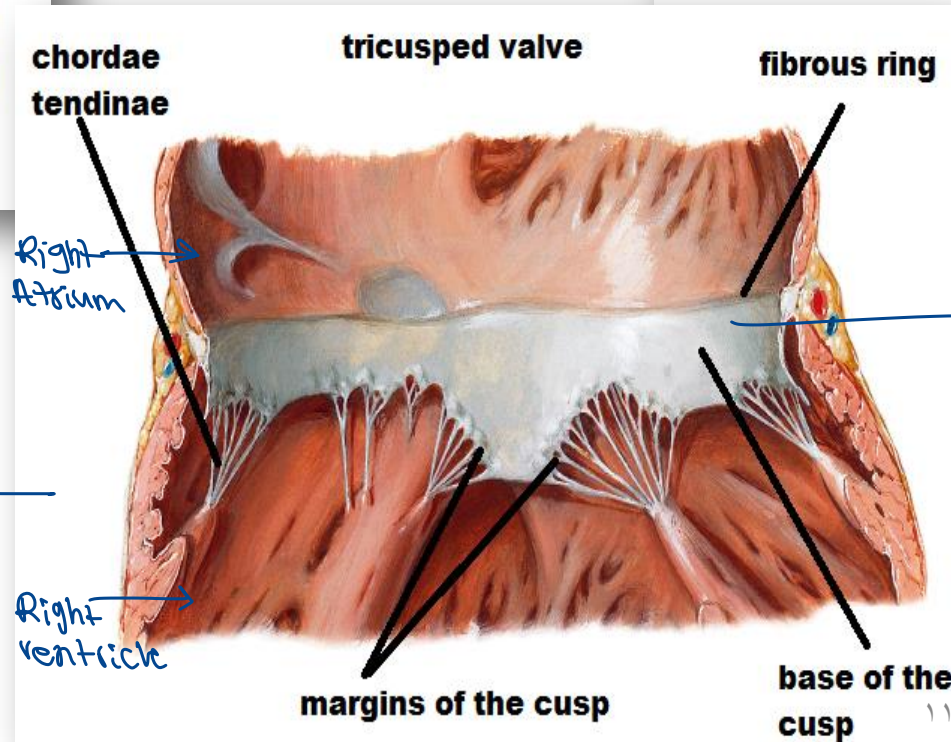
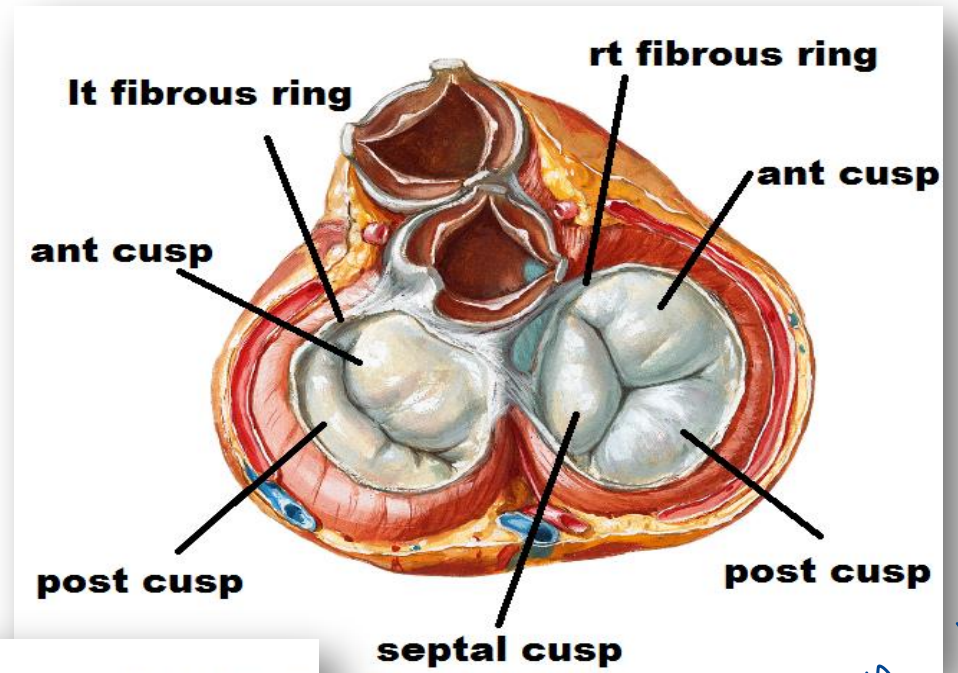
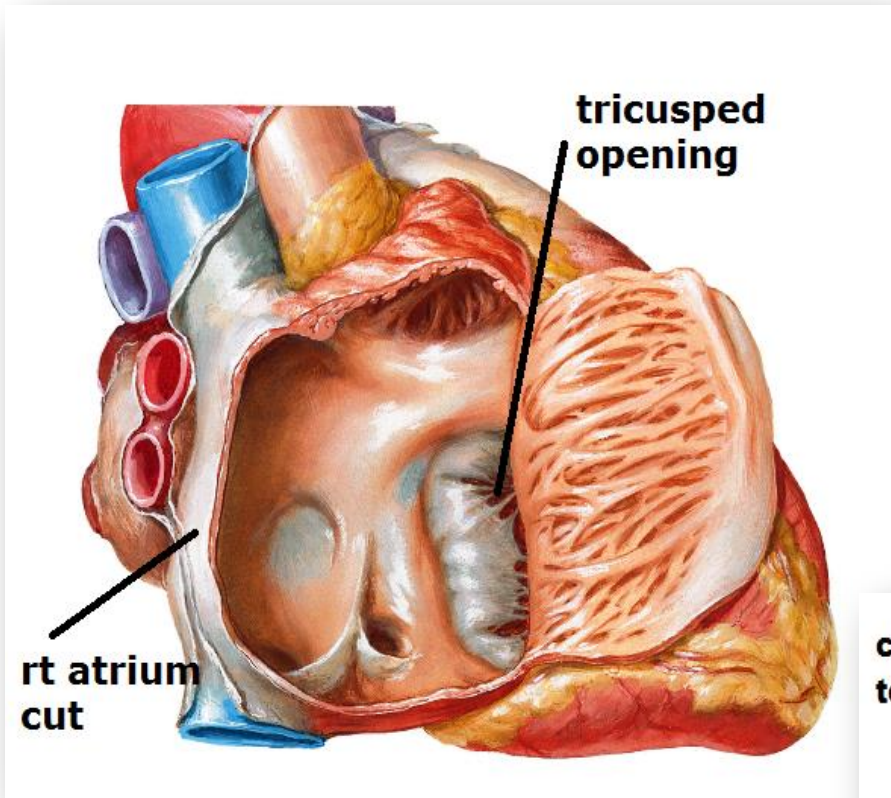
Each cusp; is a reduplication of endocardium. *Squamous Epithelium.*

Each cusp; is triangular in shape, has:

- **Two surfaces;** smooth atrial & rough ventricular.
- **Base;** attached to fibrous ring.
- **① Apex & ② margin;** **Chordae tendinae** attached to them.

*Also Chordae tendinae attached to ventricular surfac.
③ ↙





Right Side - اليمين
 left Side - الشمال
 wall - الجدار
 cut - مقطوع

Atrium - البطين

بالإضافة إلى حافة البطين
 Ring - الحلقة
 القردية

2-Outlet orifice of the right ventricle: Pulmonary orifice:

- Guarded by Semilunar (valve).
- Surrounded by a fibrous ring, which gives attachment to 3 semilunar cusps (anterior, right & left) of pulmonary valve.

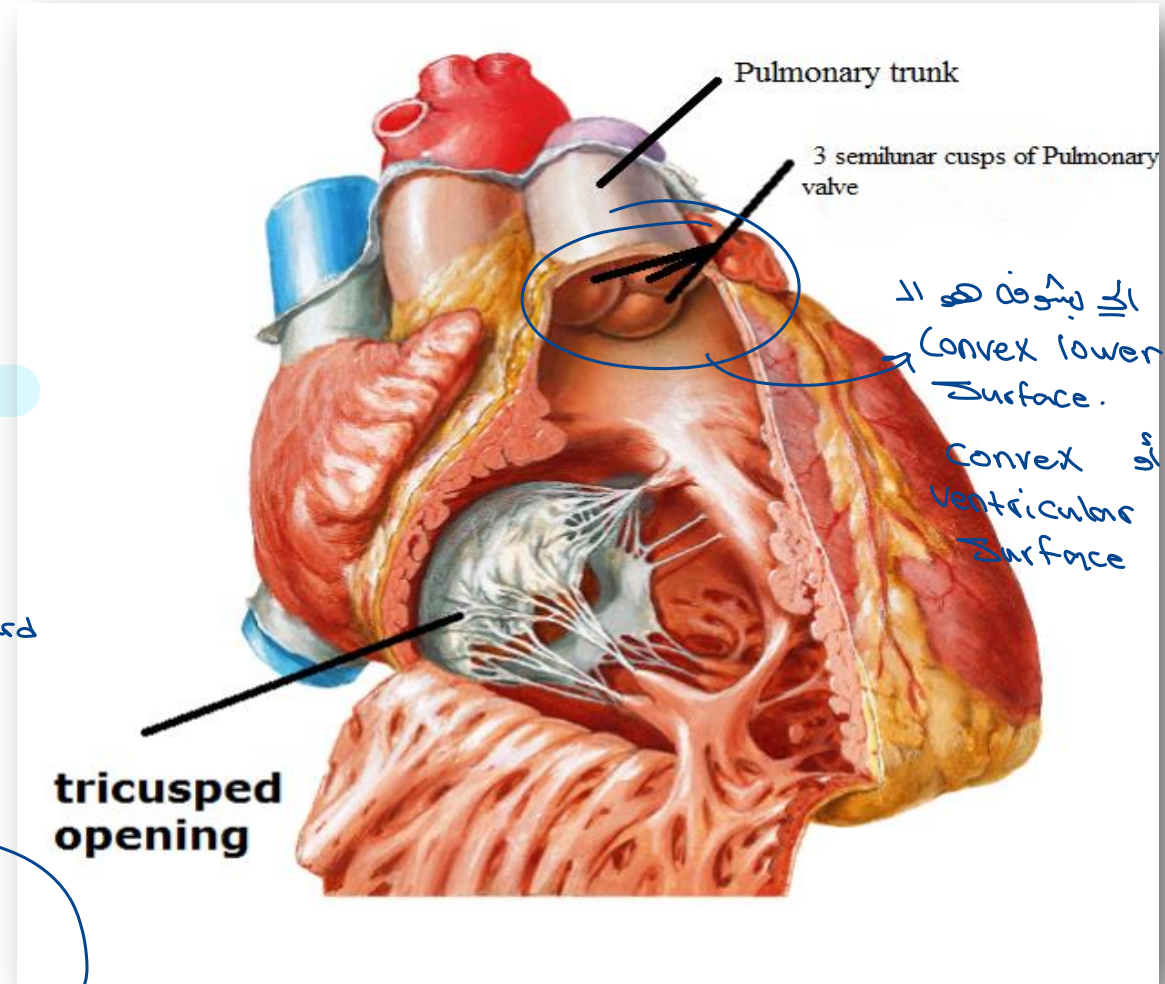
Each cusp: formed by folds (reduplication) of endocardium.

Each cusp: semilunar & has:

- Concave upper surface (open mouths) & convex lower (ventricular) surface.

- Upper margin (free); shows thickened nodule in the middle & thin lunule on the sides.

- Lower margins & sides; are attached to the arterial wall.

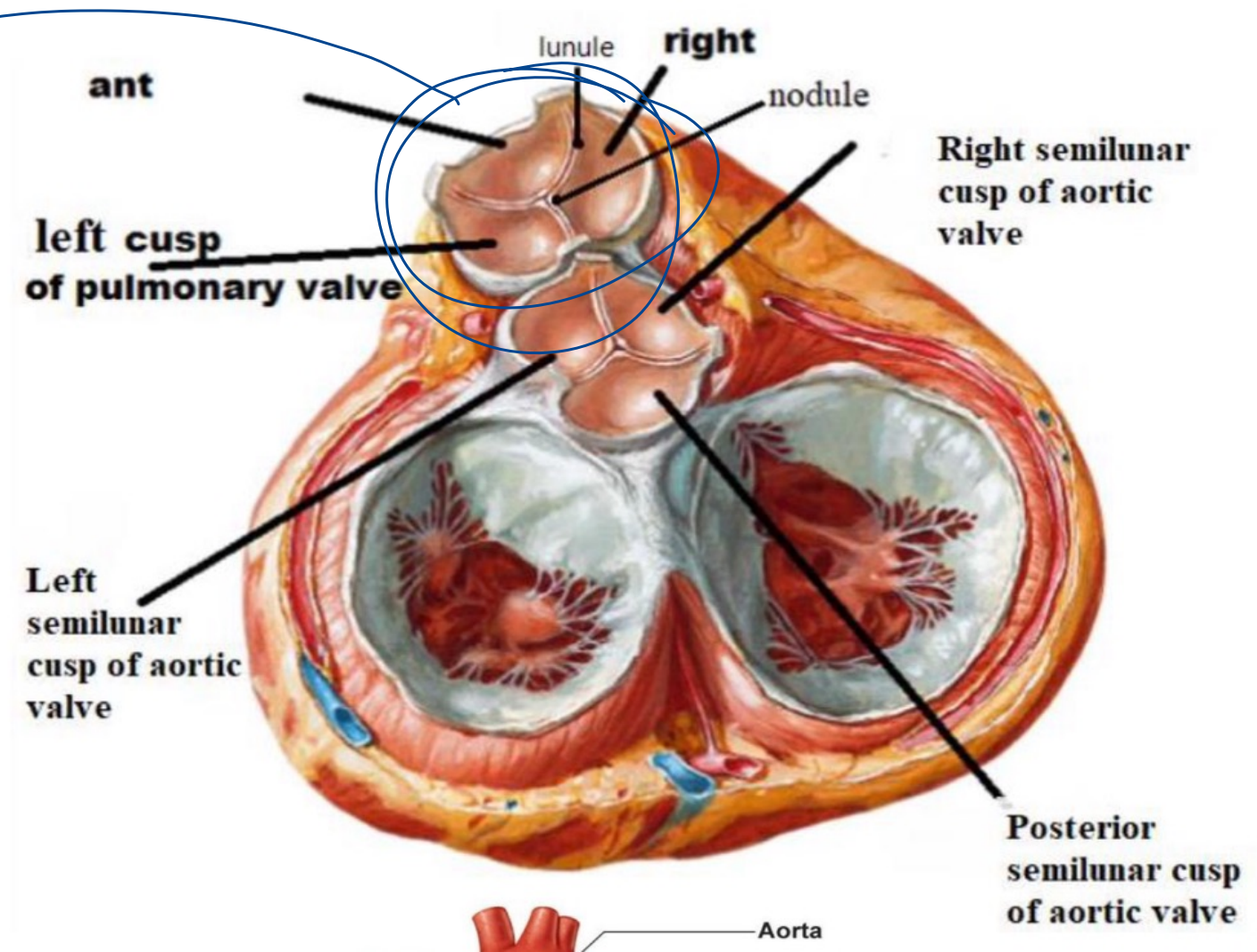


upper margin \rightarrow 11 & 16

ans \rightarrow free
 ans \rightarrow attached
 fibrous \rightarrow ring.

lunule
 \downarrow
 thin part

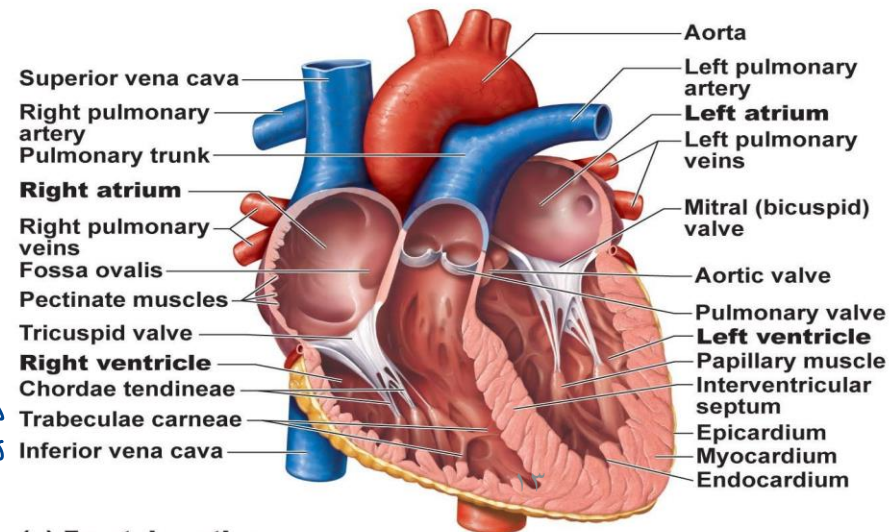
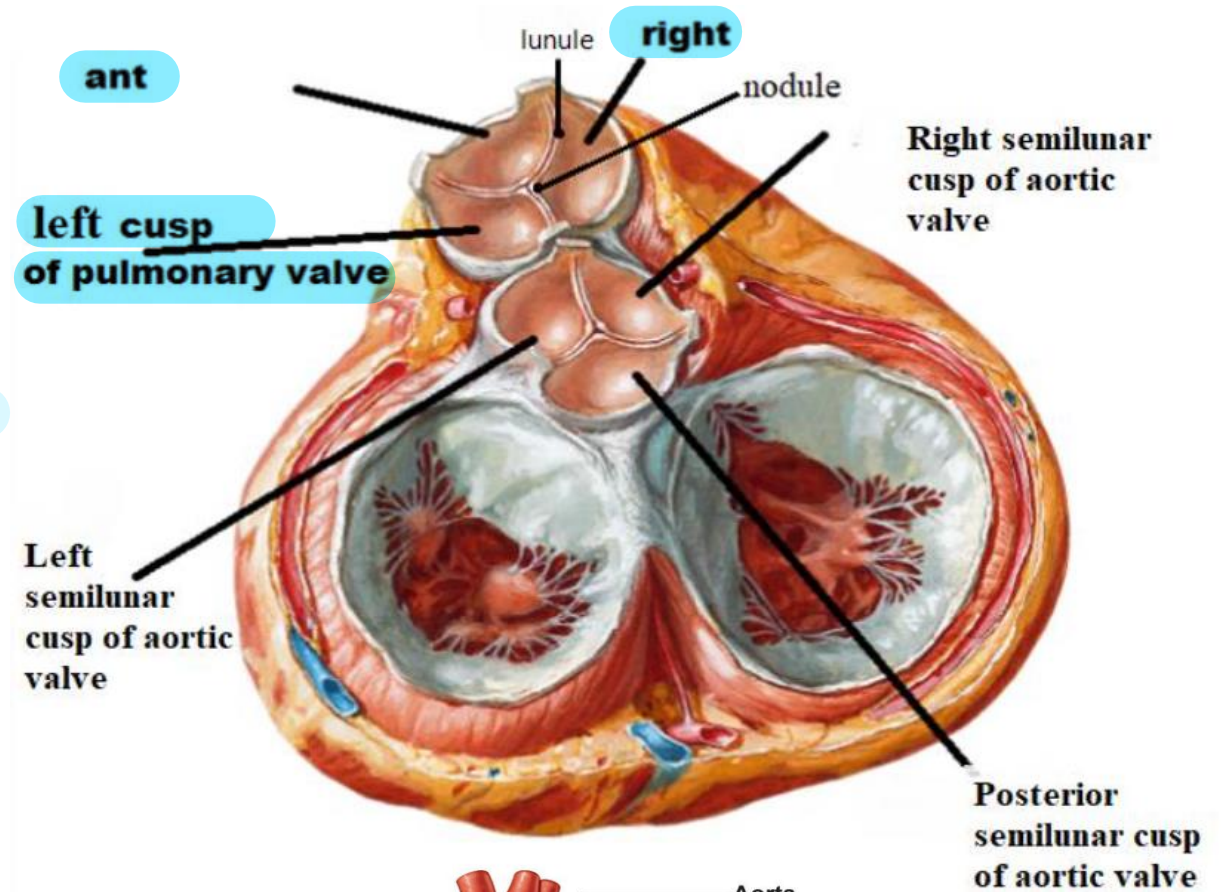
nodule
 \downarrow
 thick part.



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 ^{الانقباض} ventricular systole, the cusps of the valve are pressed against the wall of the pulmonary trunk by the out-rushing blood.
- During ^{الانبساط} 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.

من هنا يرجع الـ ventricle
 الـ Valve الـ يصره تسكين. كيف !! ← الـ Cusps يتسحب دم



(e) Frontal section

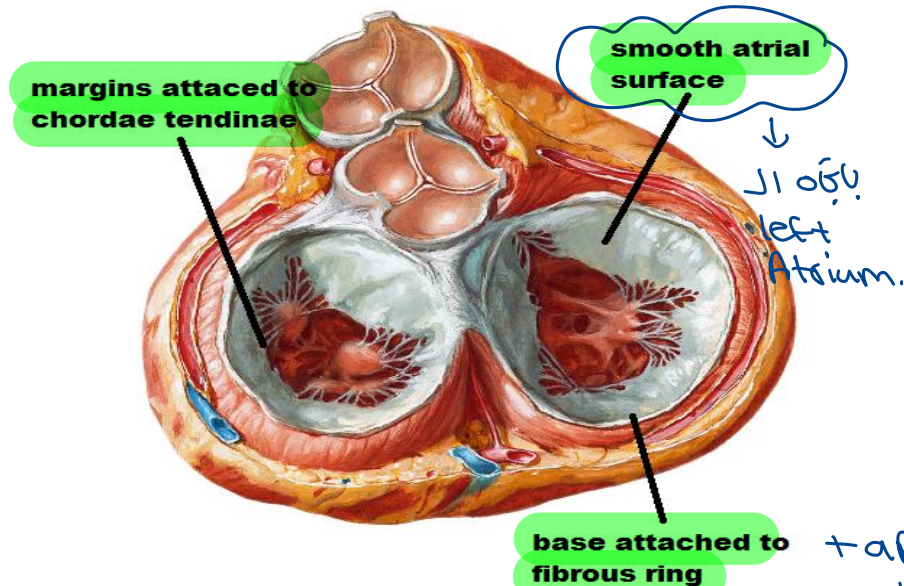
Orifices of the left ventricle

1-Left atrio-ventricular (inlet):

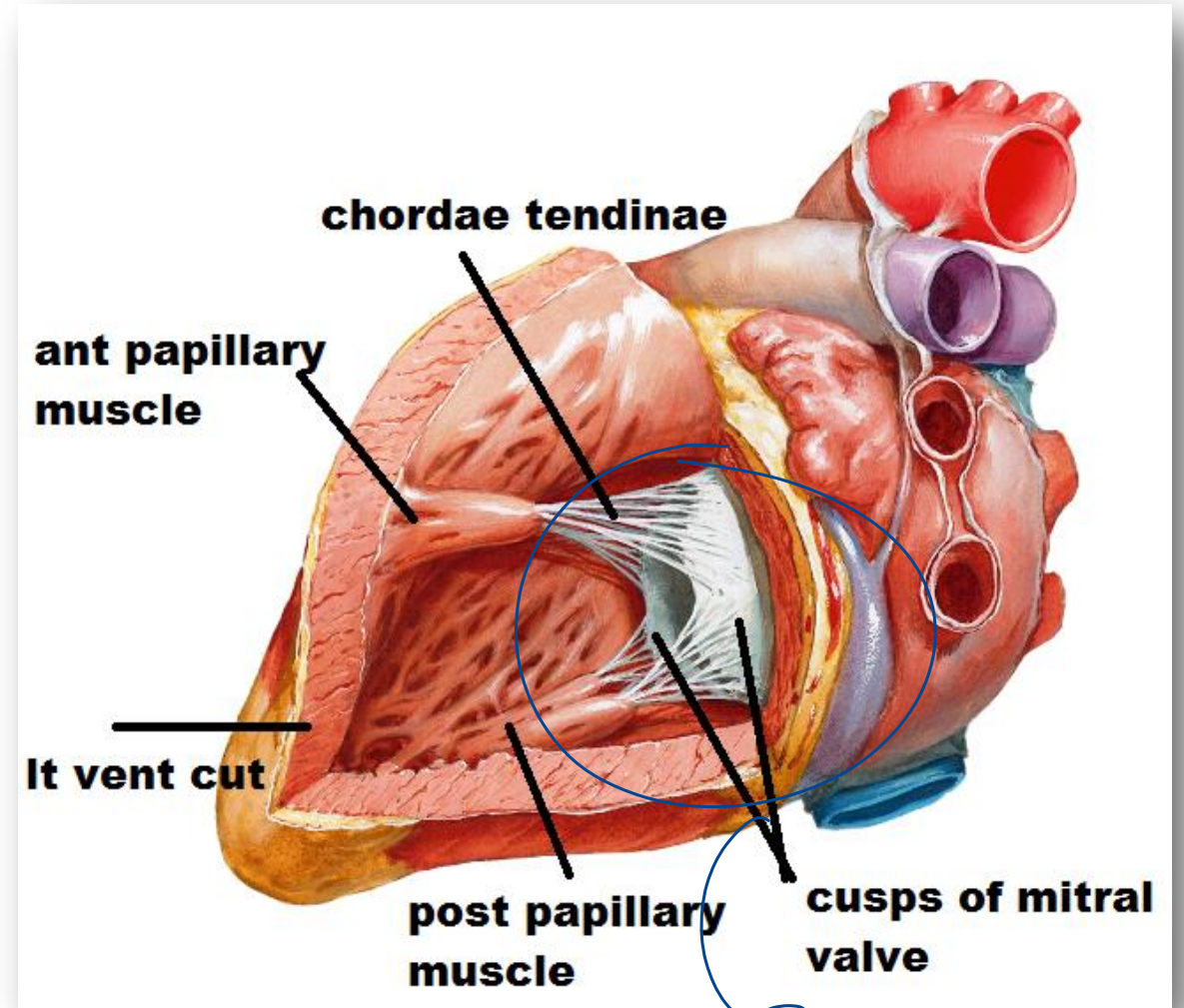
Mitral orifice → between LA + LV

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

The same description of the tricuspid cusps.



+ apex directed downward.



2-Outlet orifice; Aortic orifice.

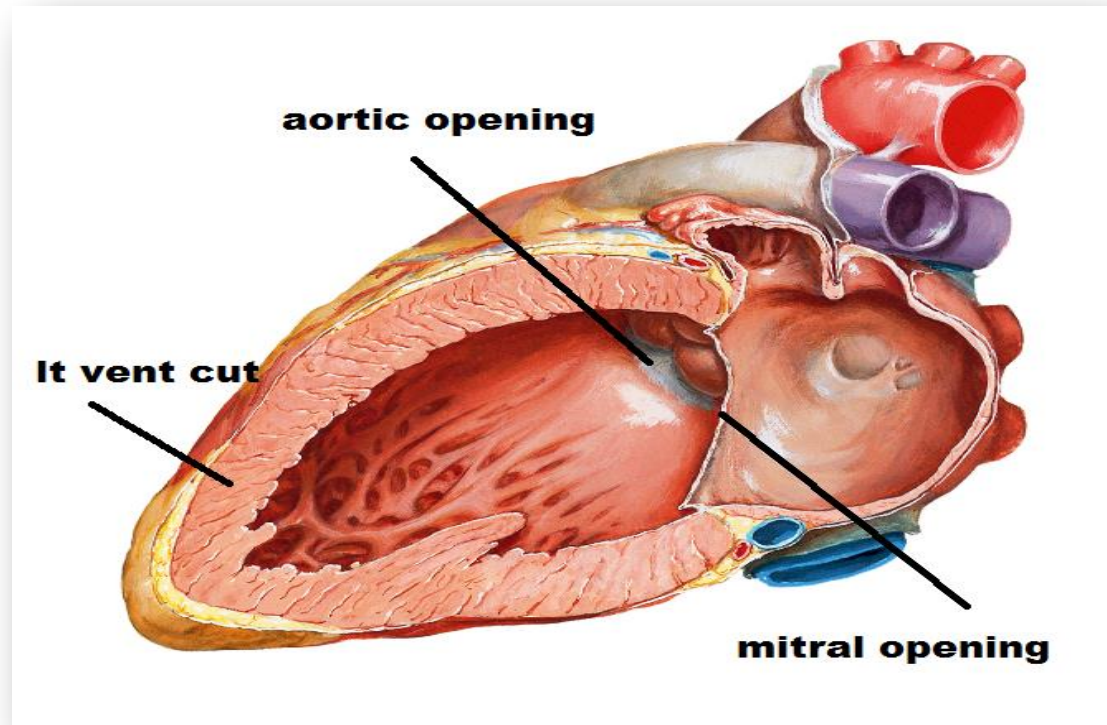
- Guarded by the semilunar valve.
- Surrounded by a fibrous ring, which gives attachment to **3 semilunar cusps (posterior, right & left)** of the aortic valve.

Each cusp: formed by folds of endocardium.

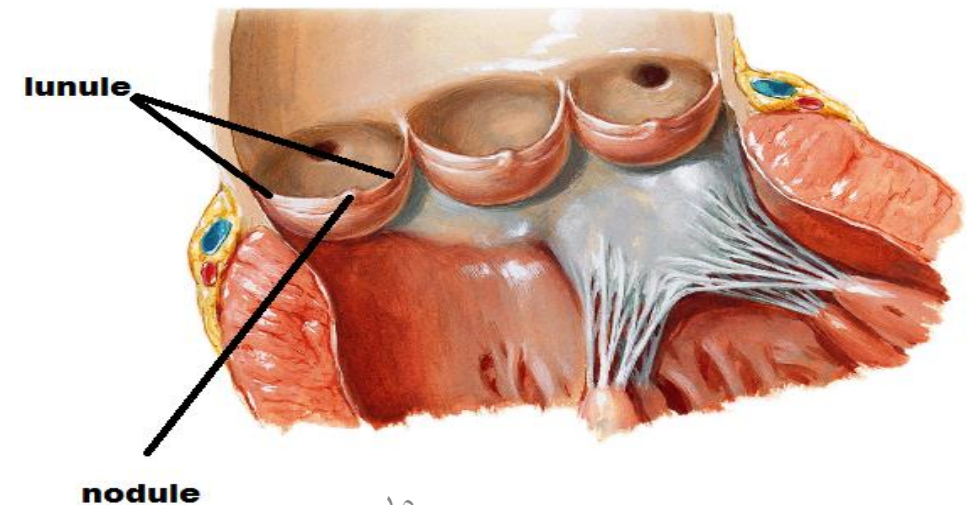
Each cusp: semilunar & has:

The same description of the pulmonary cusps.

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



aortic valve



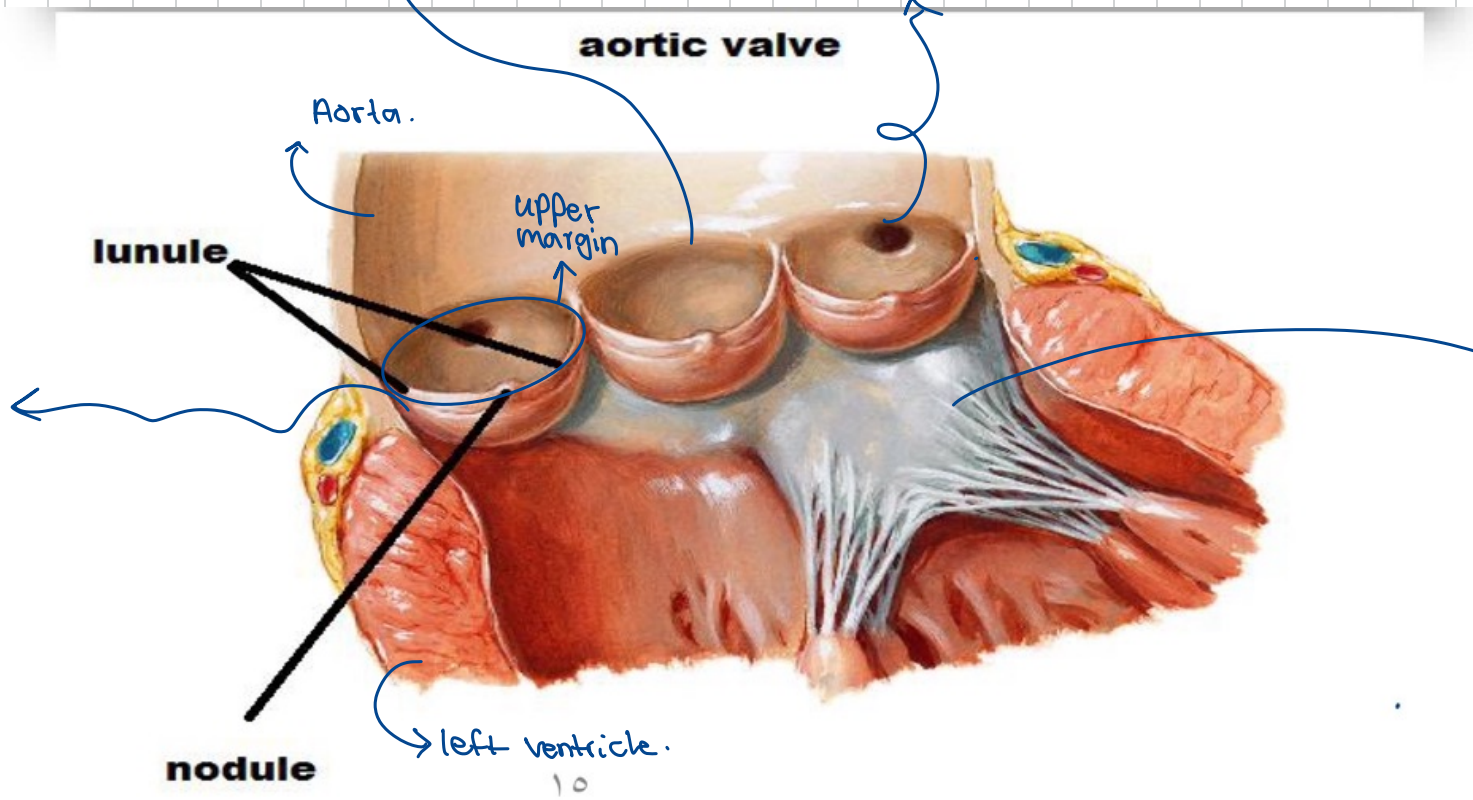
① Semilunar valve

- * Concave upper surface
Aorta
- * Convex lower surface
left ventricle

② upper margin
fibrous ring of Aortic Orifices
free side
thickened part at each side of nodule = lunule
thin part

③ Posterior coronary sinus of Aorta → non coronary sinus

④ Opening of Sinus

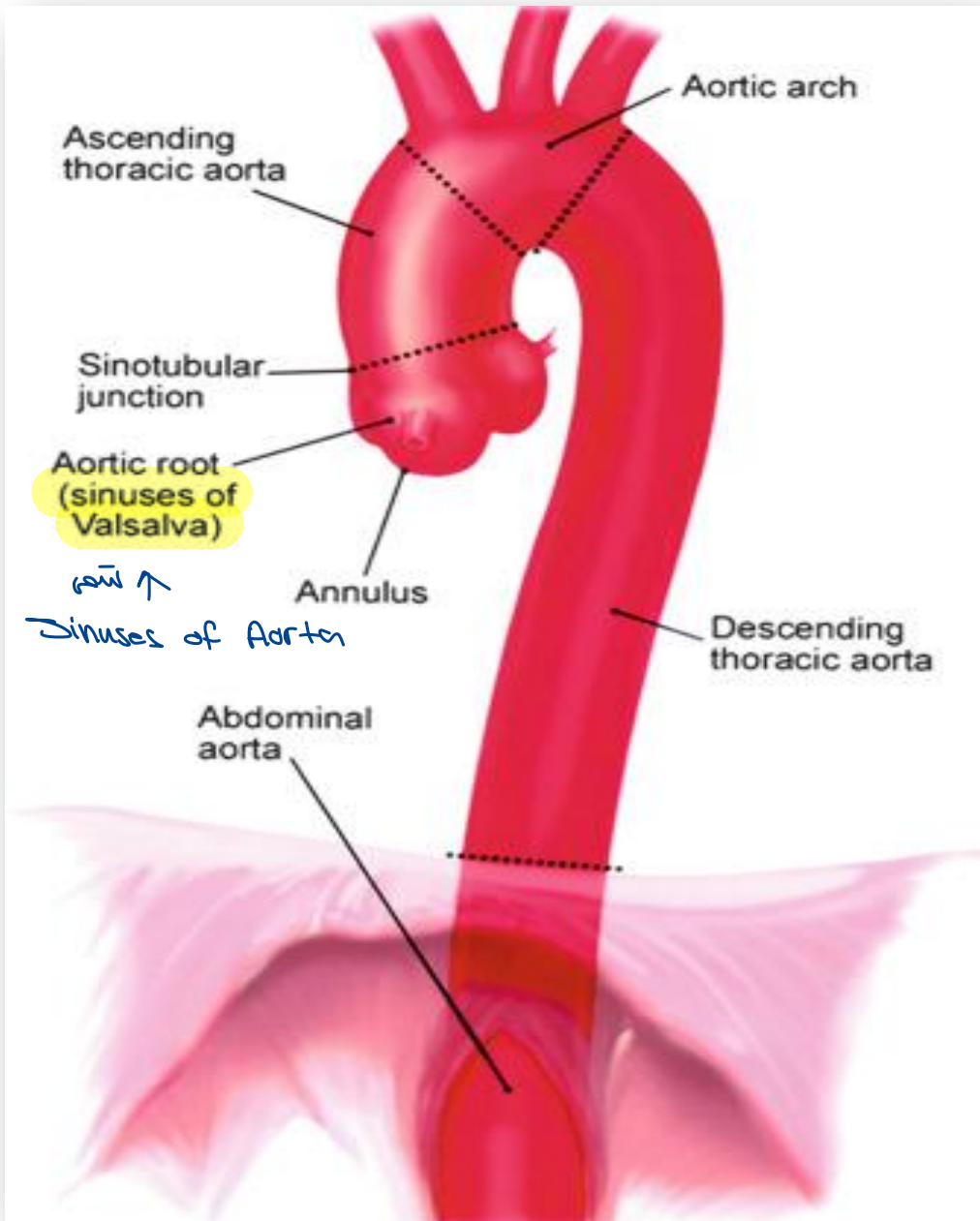
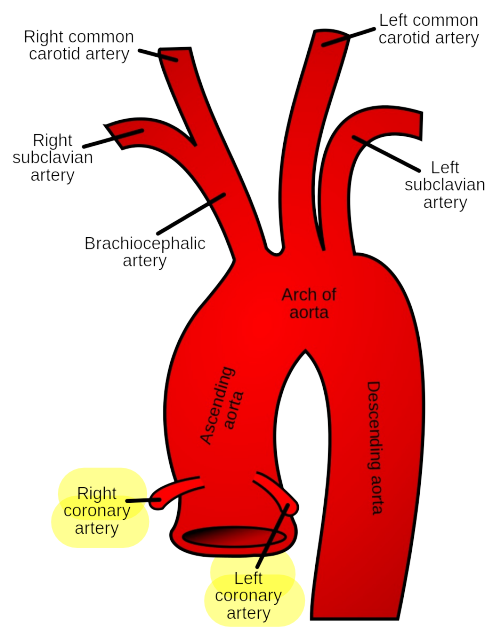


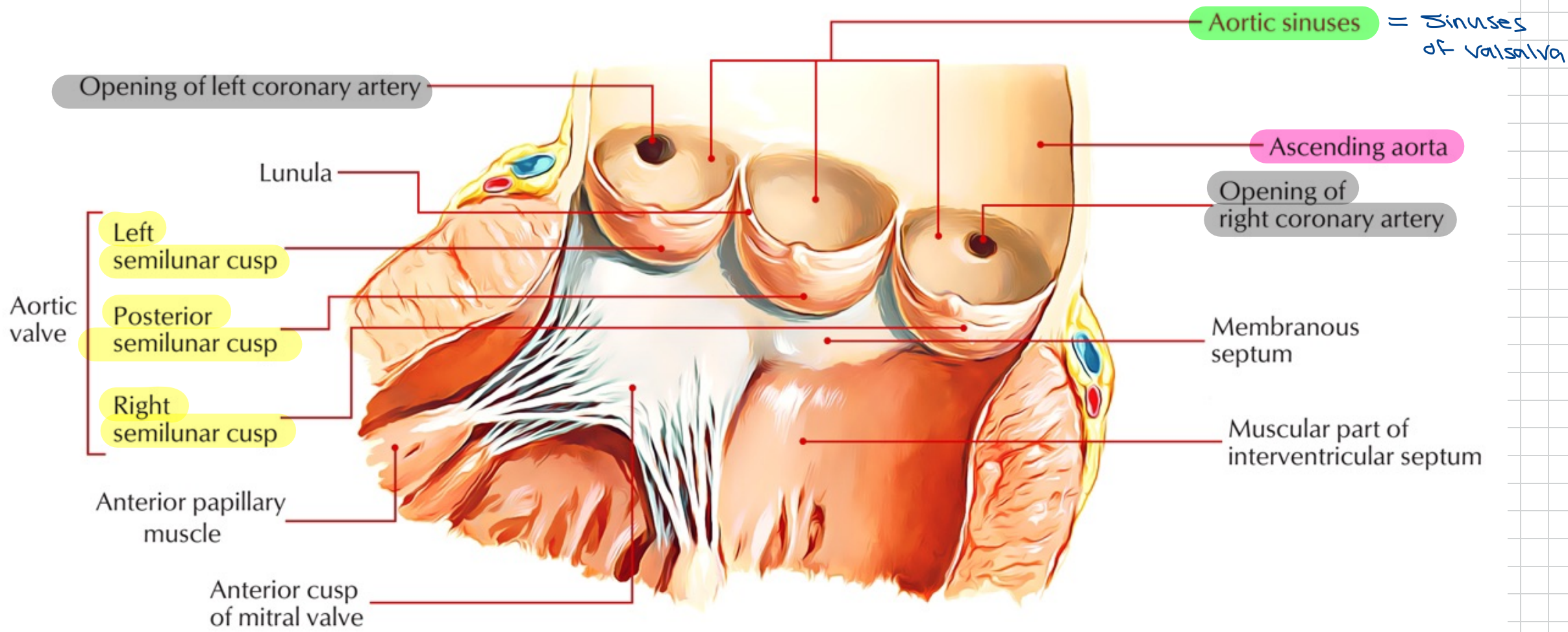
③ Chordae tendinae of papillary muscle of left ventricle
Anterior cusp of mitral orifices
Cusp of Aortic valve.

Cusps of Aortic valve.
Cusps of pulmonary valve
Not attached to chordae tendinae.

فصل من الكورة

فصل من الكورة





Surface anatomy of the valves of the heart

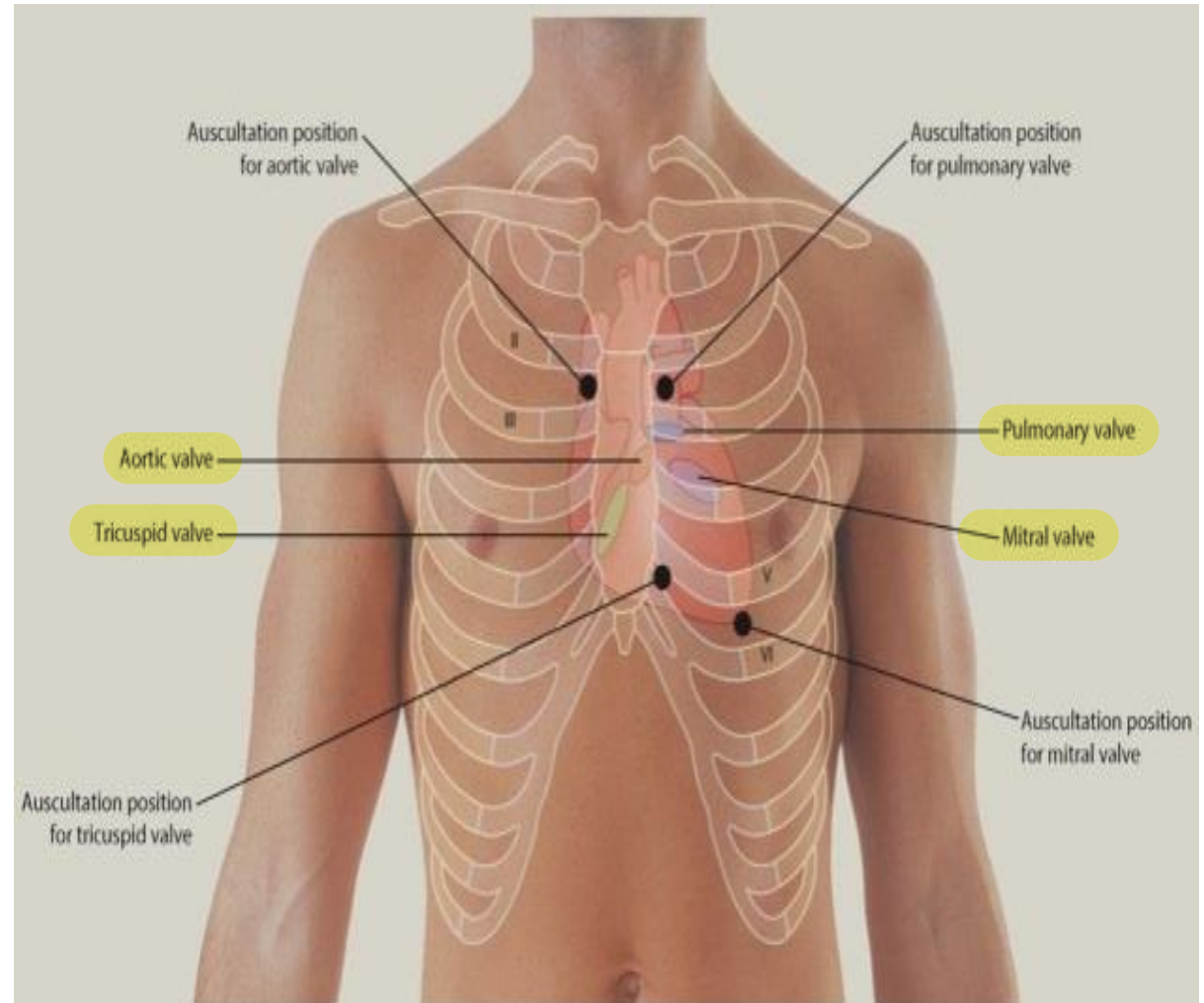
احفظهم بالترتيب عشاق تكون عارف ان
S ← S ← M ← M

Pulmonary valve: Left 3rd 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.



From Drake R et al. Gray's atlas of anatomy. 2nd ed. Philadelphia, PA: Churchill Livingstone/Elsevier; 2015.

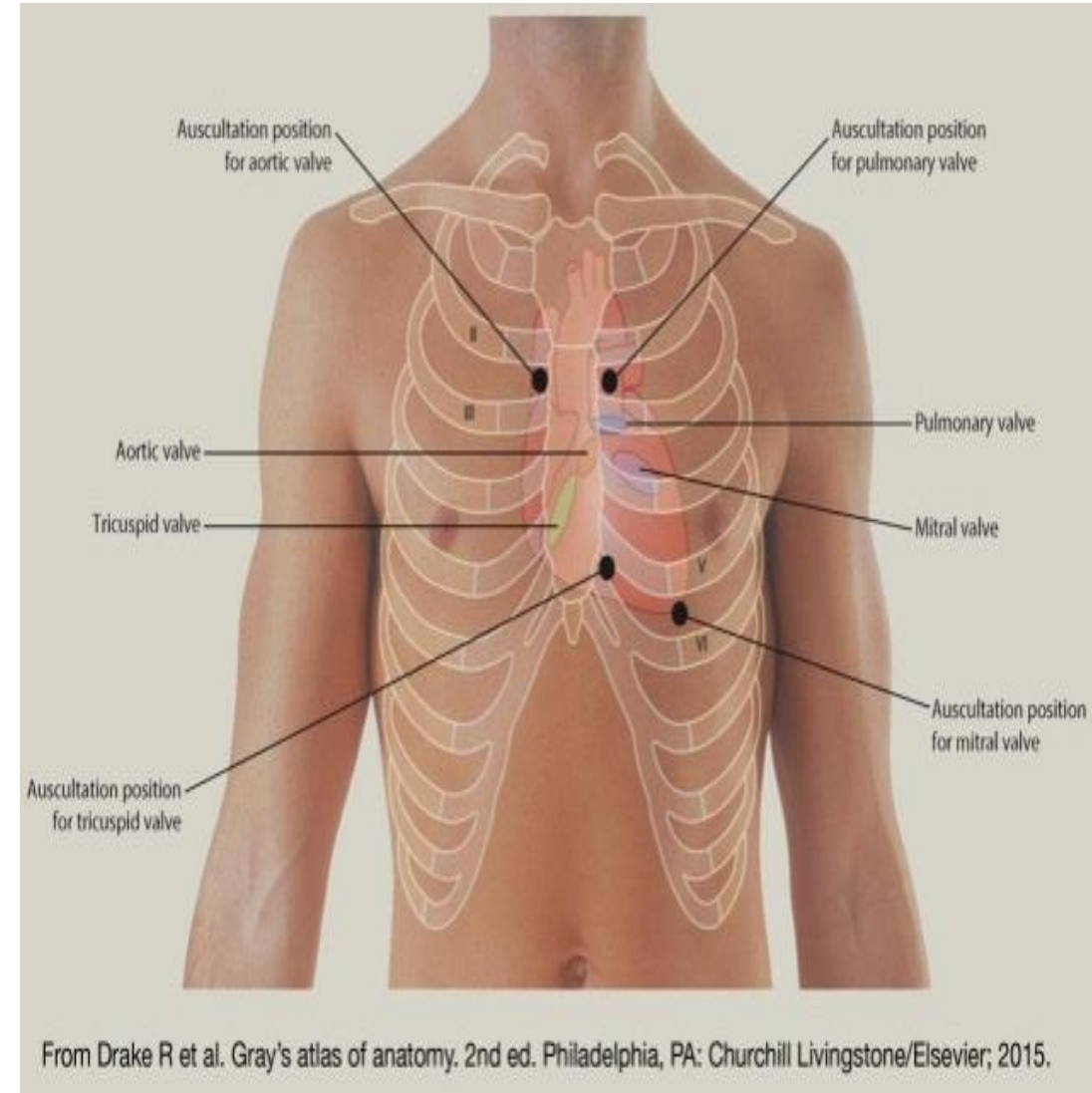
Auscultation of the valves of the heart

- There are two normal heart sounds, often described as a *lub* and a *dub* that occur in sequence with each heartbeat.

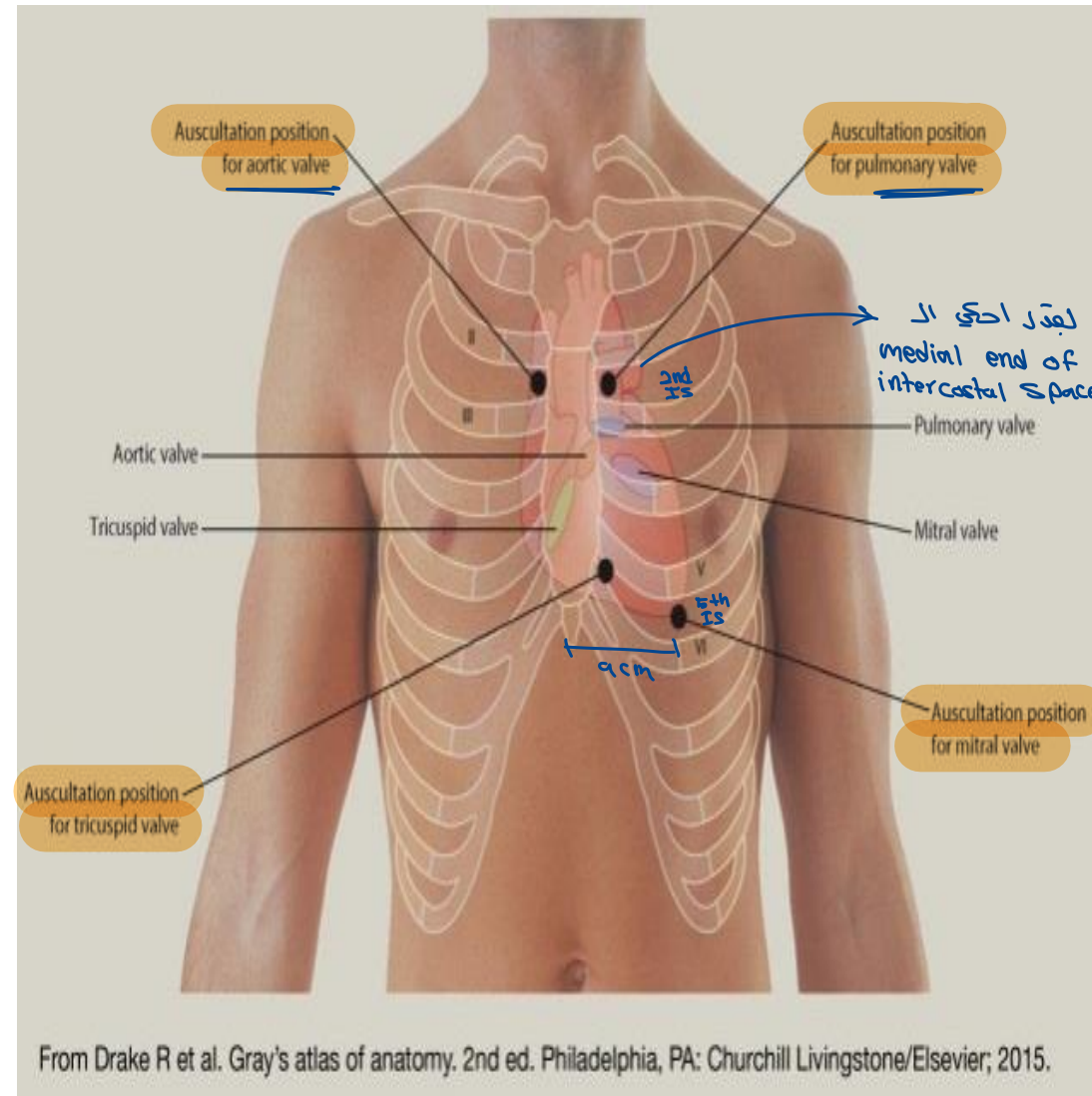
الصوت "لُب" **First heart sound (S_1)** produced by the closing of the atrioventricular valves.

الصوت "دُب" **Second heart sound (S_2)**, produced by the closing of the semilunar 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.

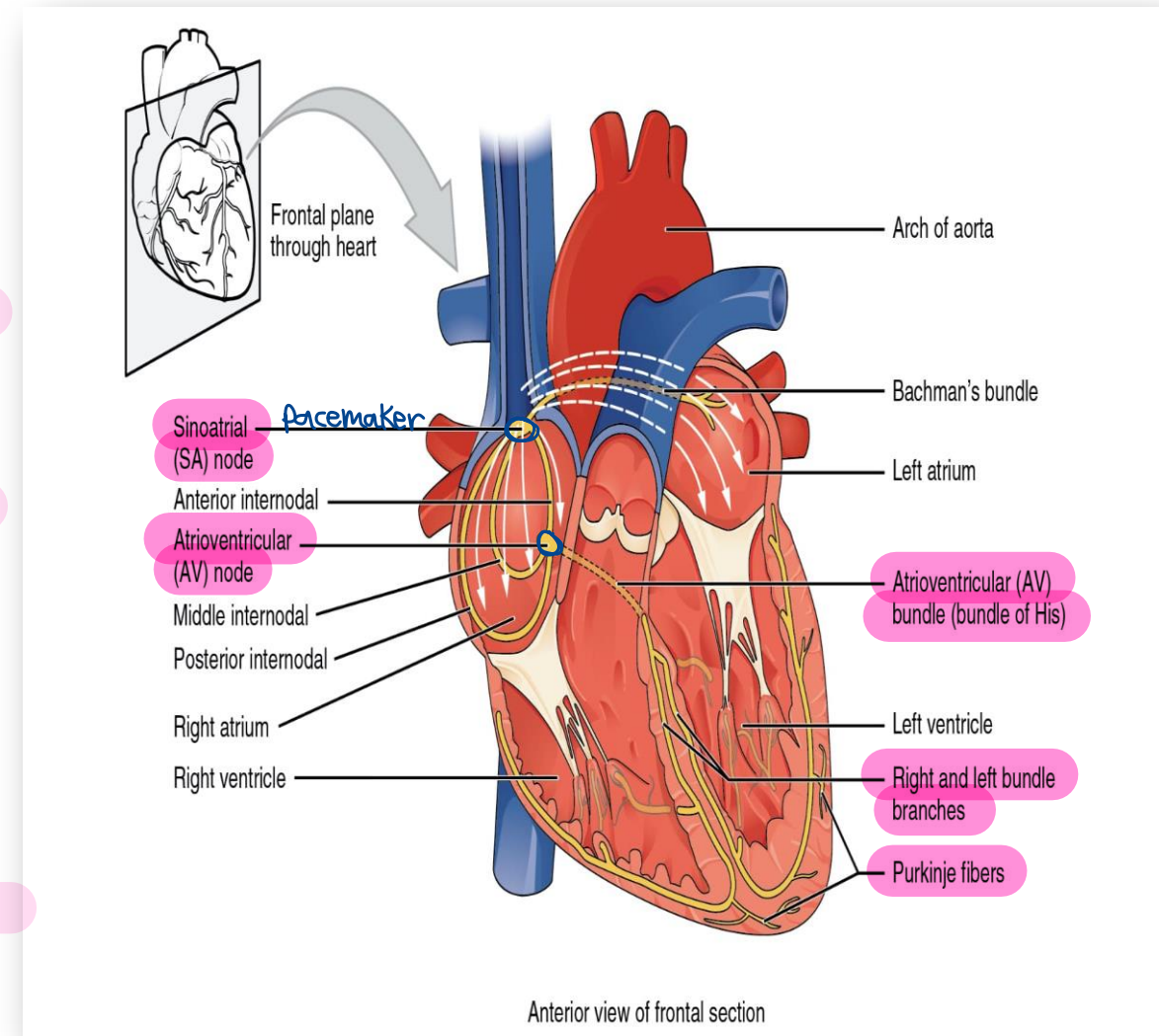


- }
2nd intercostal space
 ■ **Pulmonary valve area** is best heard over the **left second intercostal space**, near the sternal border.
- **Aortic valve area** is best heard over the **right second intercostal space**, near the sternal border.
- **Mitral valve area** is best heard **over the apex of the heart**.
- left 5th intercostal space
9cm from medial line.
 ■ **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.**

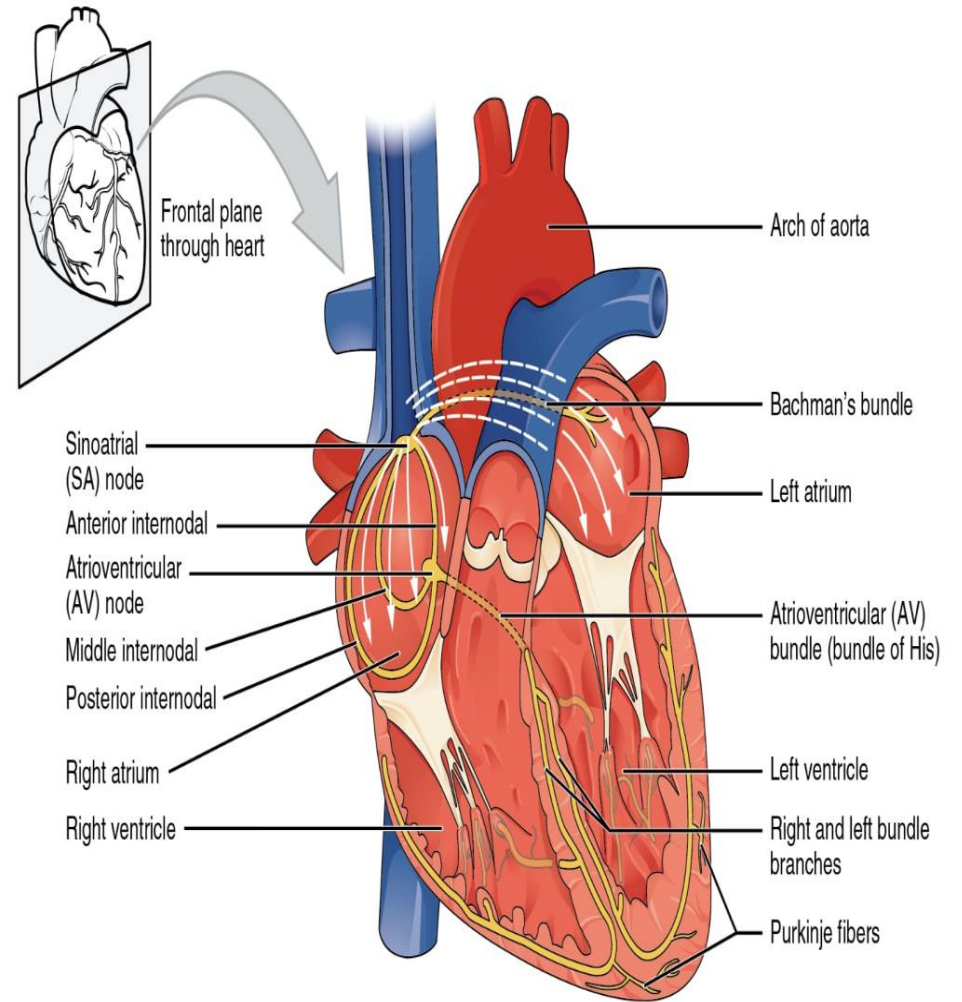


The specialized cardiac muscle fibers that form the conductive system of the heart, represented in:

- ① Sinuatrial node (SAN)
- ② Atrioventricular node (AVN)
- ③ Atrioventricular bundle and its right and left terminal branches.
- ④ Subendocardial plexus of Purkinje fibers.

Conductive System of the heart is specialized cardiac muscle fibers which are rhythmic contractile process. It is the contraction of Atrium which leads to contraction of ventricle.

Contraction of Atrium → contraction of ventricle

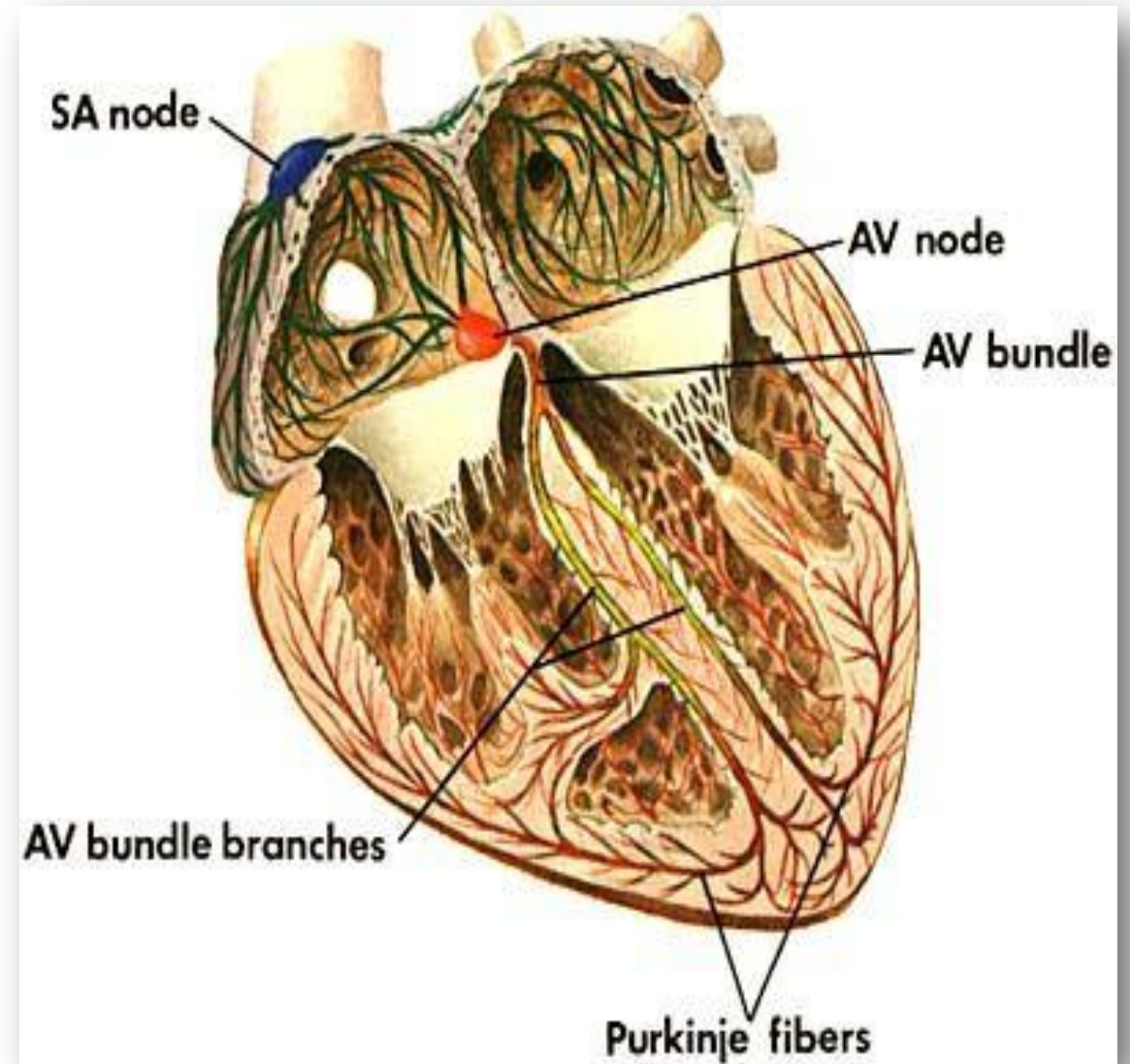


Anterior view of frontal section

① Sinoatrial node (SAN)

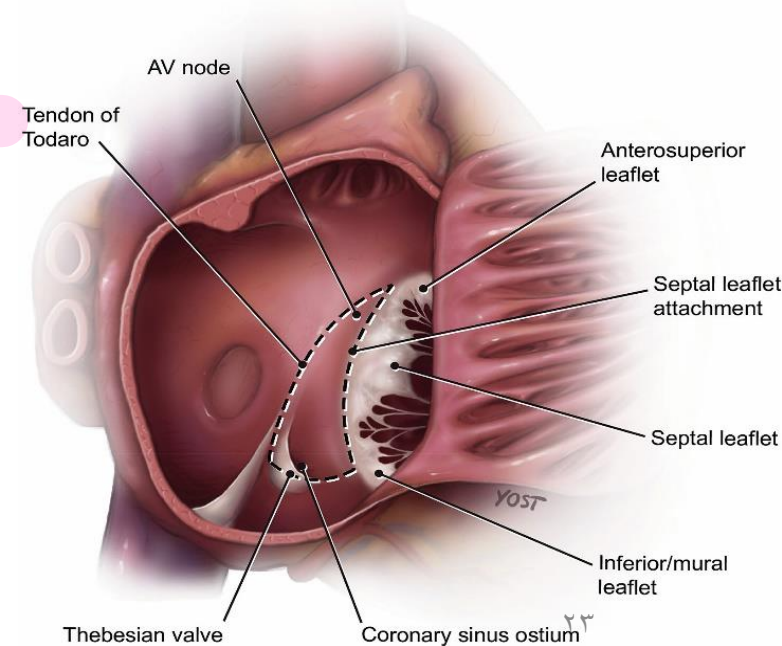
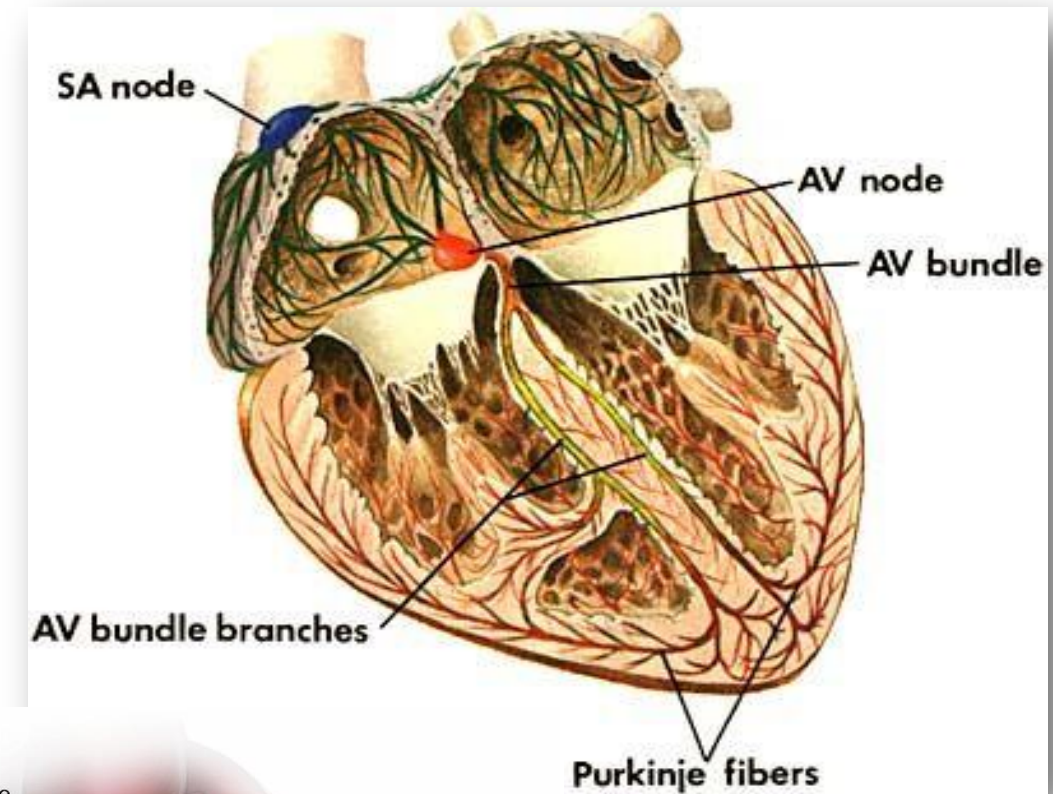
- It is the **pacemaker of the heart**, initiates the impulse of contraction.
- The sinoatrial node is an **elliptical structure, 10–20 mm long**.
- **Site:** is located in the wall of the right atrium in the upper part of the sulcus terminalis, subepicardially, just to the right of the opening of the 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.

Anterior of Right Atrium + Posterior wall of the Right Atrium



Atrioventricular Node (AVN)

- **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.

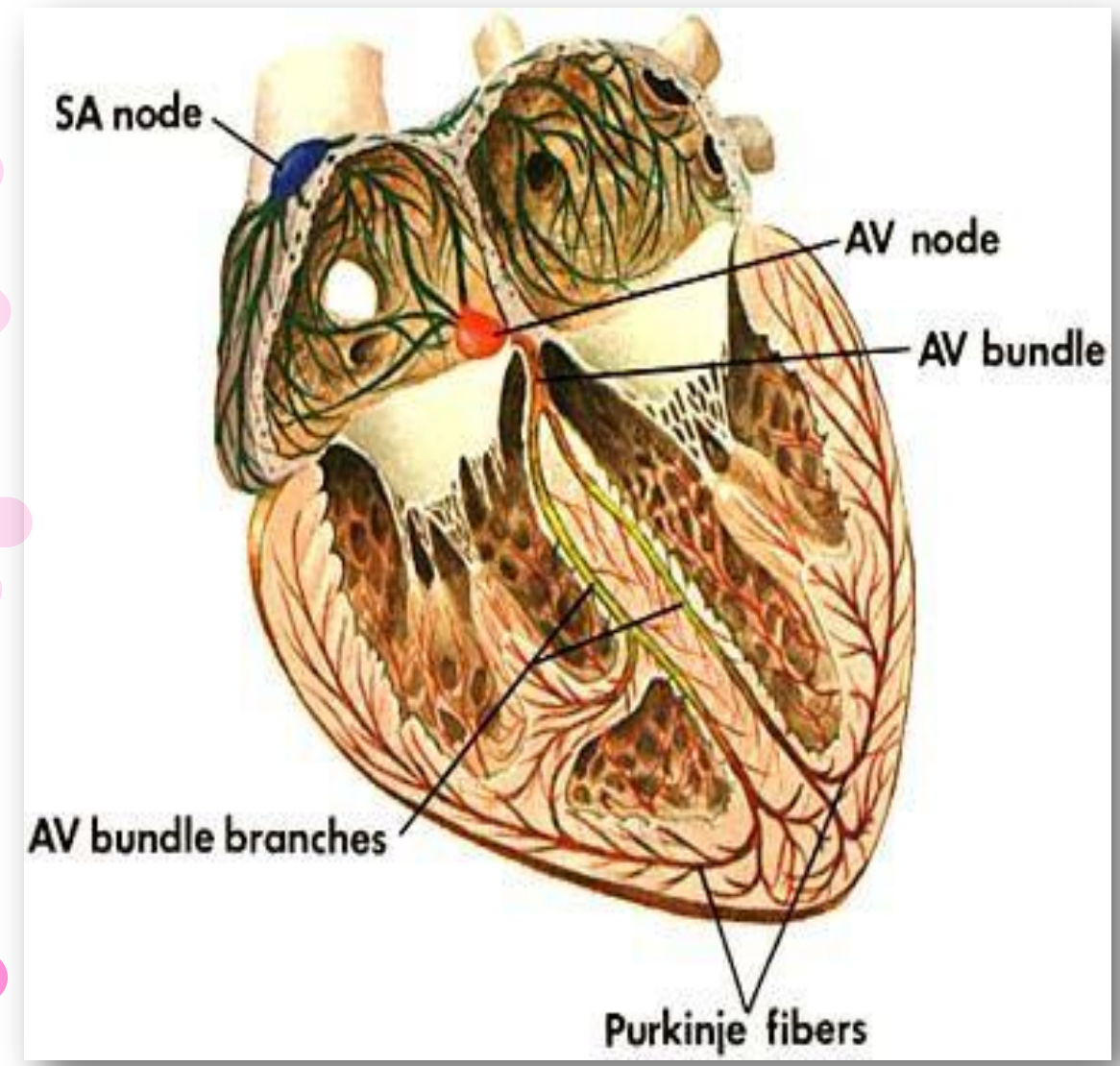


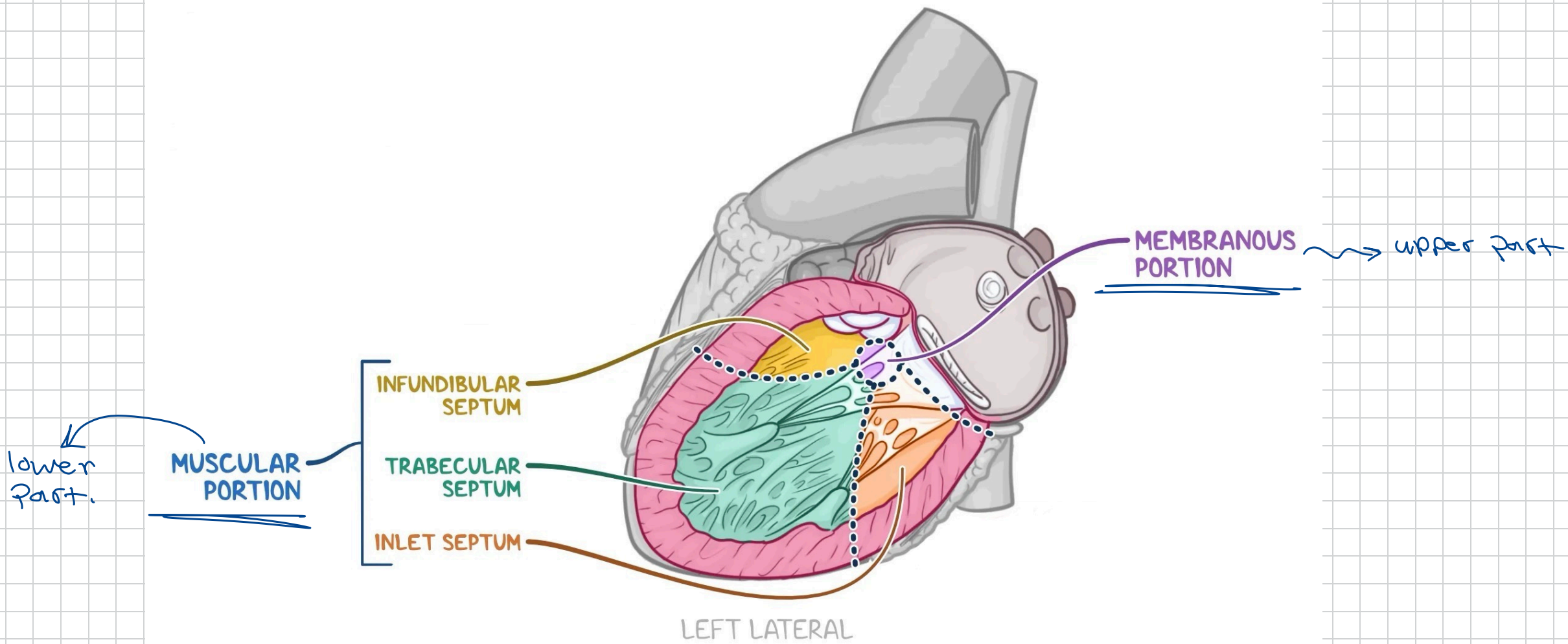
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منه في حيز
منه في حيز

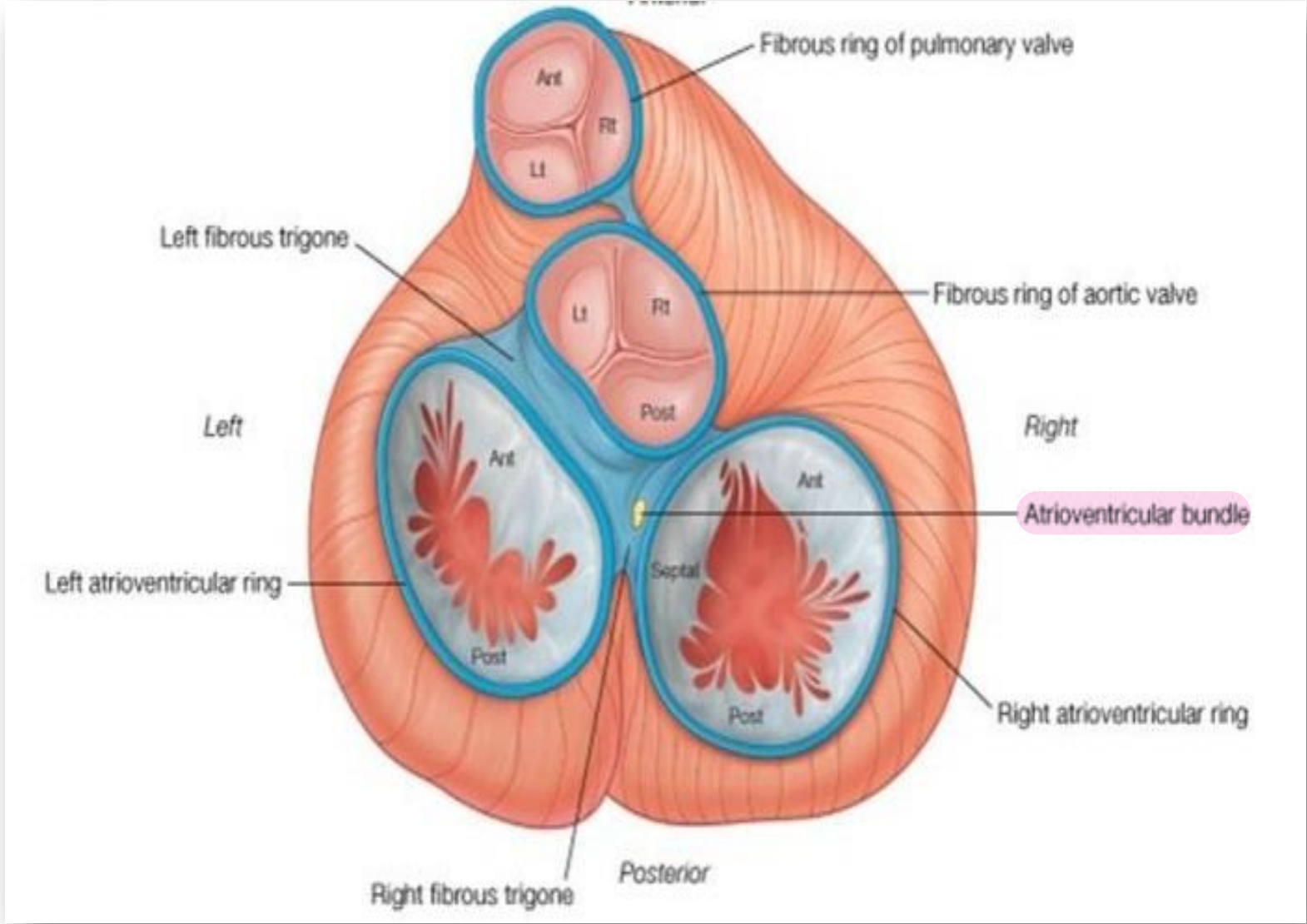
originate from Atrio-ventricular node
منه في حيز

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.**







The right bundle branch (RBB):

- It passes down on the right side of the interventricular septum beneath the endocardium.

"Sub endocardium"

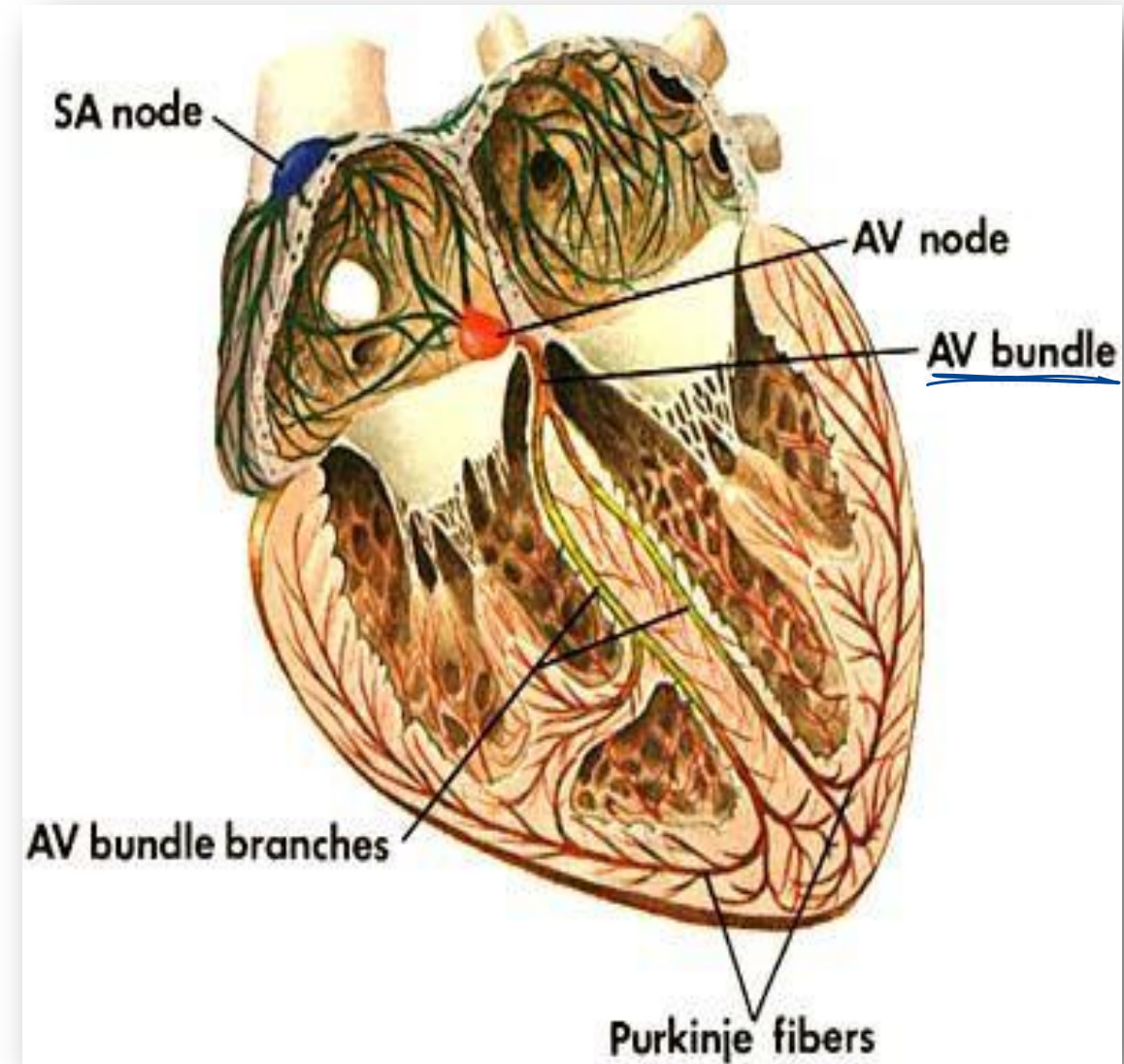
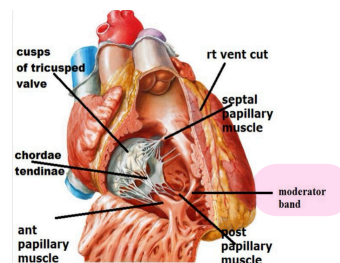
- It enters the moderator band, to reach the anterior papillary muscle of the right ventricle.

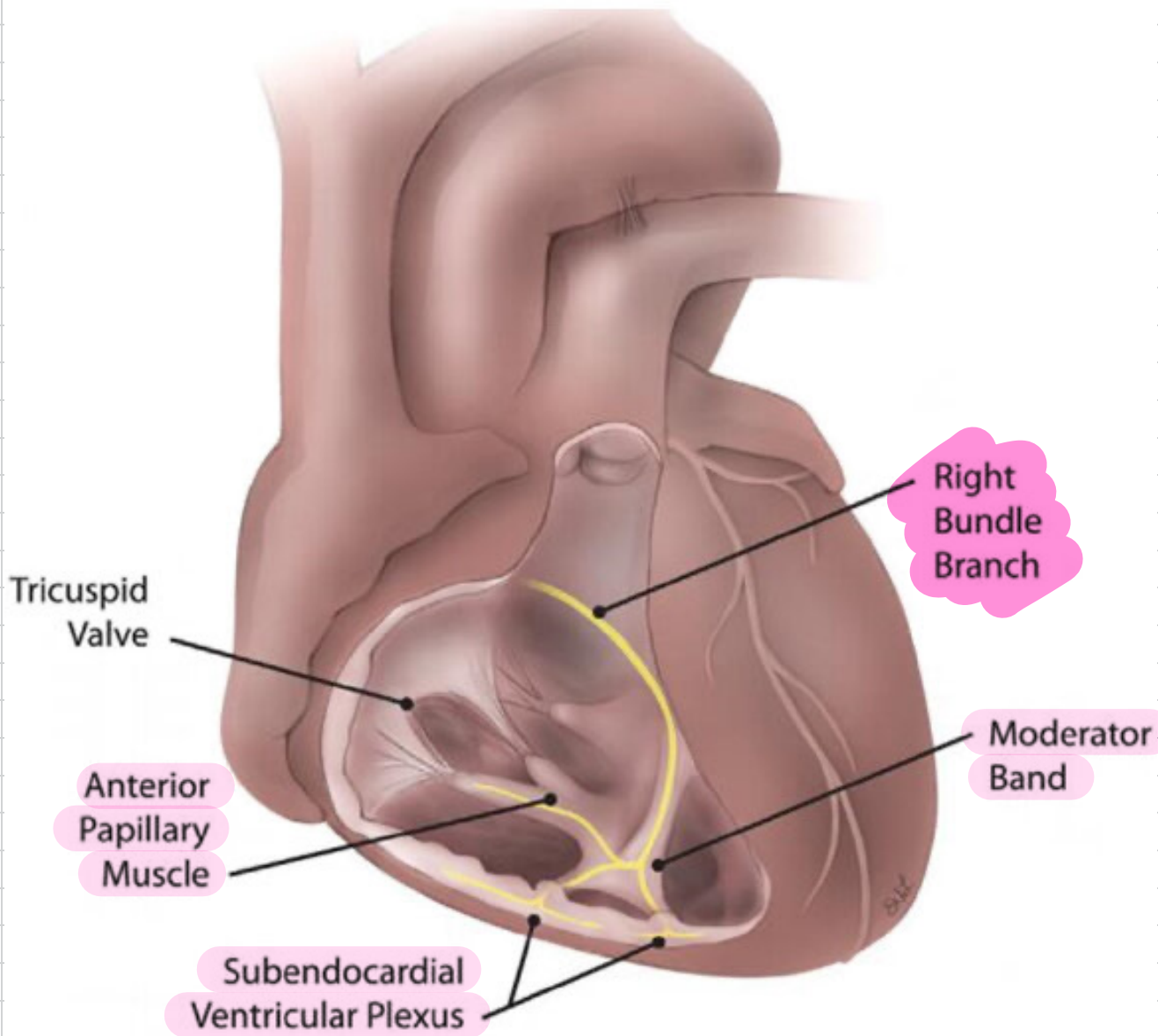
- Then it divides profusely into fine sub-endocardial branches that surround the papillary muscles and distributed to the remaining ventricular walls. Here it becomes continuous with the fibers of the Purkinje plexus of the right ventricle.

3-Moderator band:

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

Conductive system of the heart.





Atrio ventricular bundle بُجْلِيَّة *
 electrical impulse إشارة كهربائية
 Right ventricle and left ventricle
 Right & left bundle branch أغصان

Right bundle branch أغصان *
 Moderator بند is Right ventricle بعضة
 Papillary عضلة band عضلة
 muscle

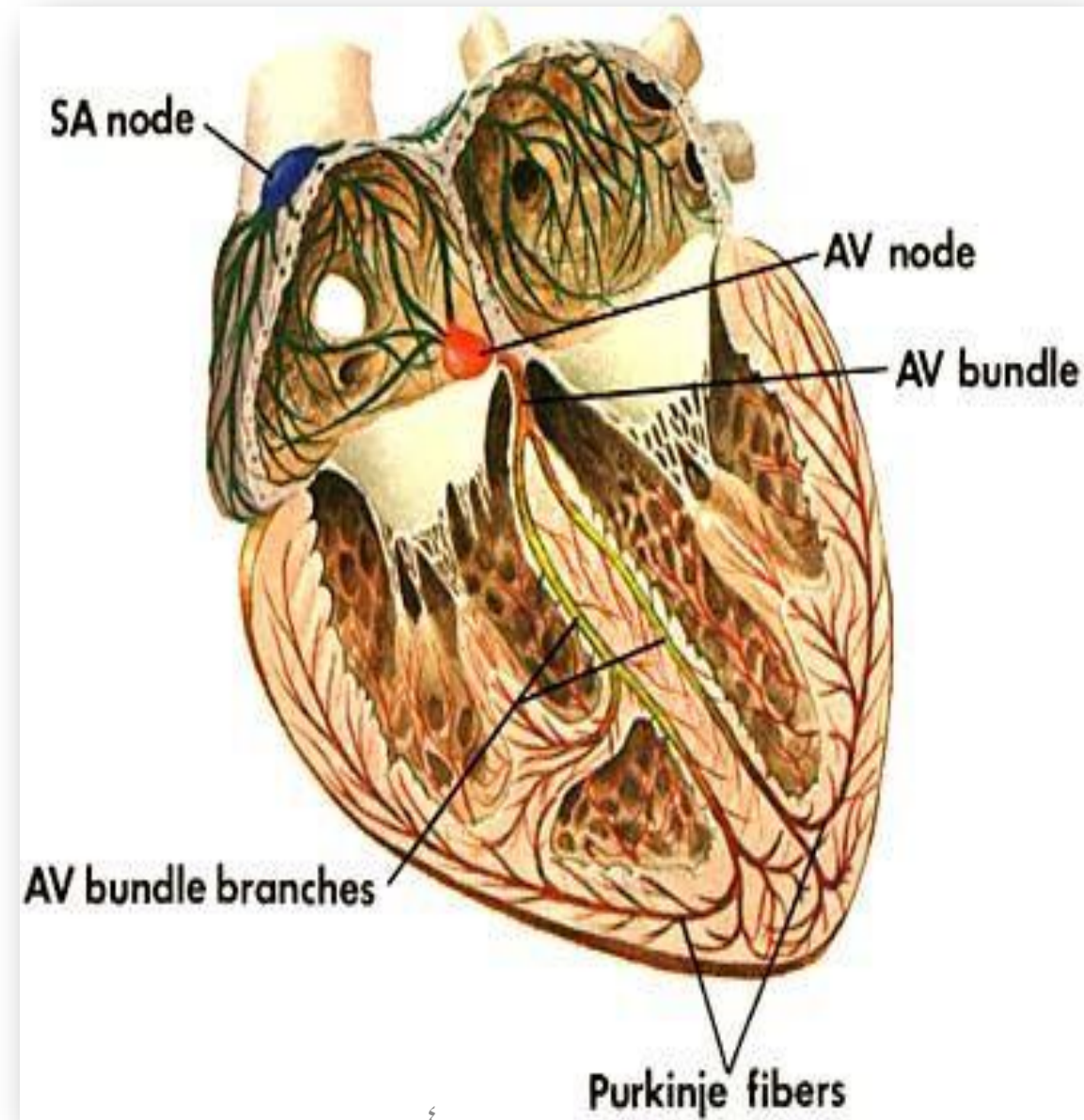
نقطة *
 Purkinje نقطة Conductive System نقطة
 Plexuses of Right ventricle

Contraction of papillary muscle *
 Papillary عضلة contraction of wall of ventricles.
 Mitral / tricuspid valve صمامات

Contraction of wall of ventricle عضلة بعضة pulmonary trunk or Aorta شرايين

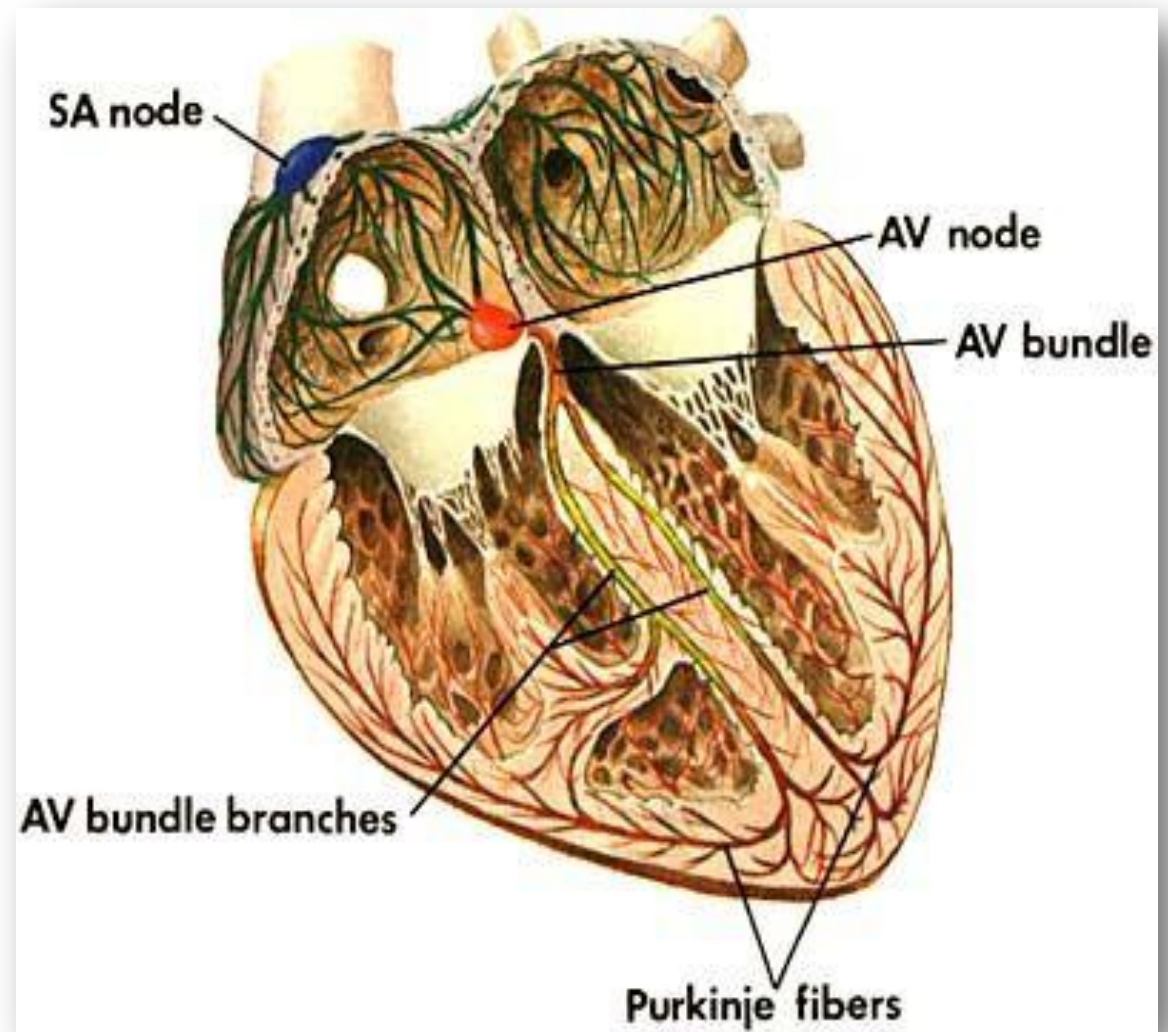
The left bundle branch (LBB):

- It passes down on left side of the interventricular septum beneath the endocardium.
- It divides profusely into fine sub-endocardial branches, which first surround the papillary muscles and distributed to all parts of the ventricle, which become continuous with the fibers of the Purkinje plexus of the left ventricle.



Purkinje fibers:

- Are **located in** ventricular walls of the heart, just **beneath the endocardium.**
- The Purkinje fibers are specialized conducting fibers **composed of electrically excitable cells.**
- Purkinje fibers **allow** the heart's conductive system **to create synchronized contractions of its ventricles.**



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
- (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

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- E) AV node, AV bundle, SA node, bundle branches