



LECTURE No. 4

# **PERICARDIUM HEART VESSELS AND NERVES OF THE THORAX**

Assoc. Prof. ALINA ȘIȘU MD, PhD.

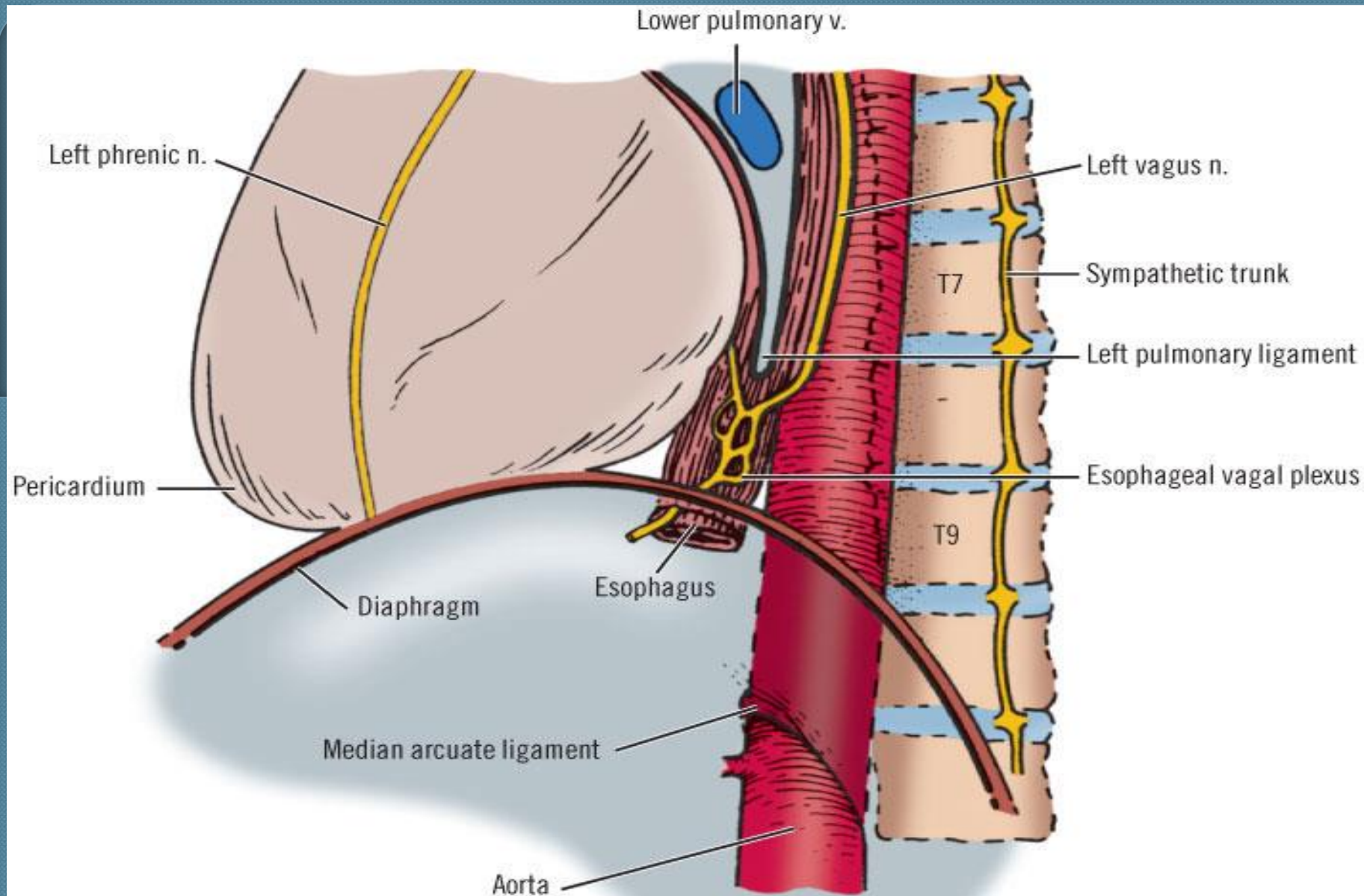


## The Pericardium

The pericardium is a conical fibro-serous sac, in which the heart and the roots of the great vessels are contained.

It is placed behind the sternum and the cartilages of the third, fourth, fifth, sixth, and seventh ribs of the left side, in the mediastinal cavity.

- anterior: anterior wall of the thorax, the lungs and pleuræ, the sternum and the medial ends of the cartilages of the fourth and fifth ribs;
- Posterior : the bronchi, the oesophagus, the descending thoracic aorta, and the posterior part of the mediastinal surface of each lung.
- Laterally, it is covered by the pleuræ, and is in relation with the mediastinal surfaces of the lungs; the phrenic nerve, with its accompanying vessels, descends between the pericardium and pleura on either side.





## Structure of the Pericardium

Although the pericardium is usually described as a single sac, an examination of its structure shows that it consists essentially of two sacs intimately connected with one another, but totally different in structure.

The outer sac, known as **the fibrous pericardium**, consists of fibrous tissue.

The inner sac, or **serous pericardium**, is a delicate membrane which lies within the fibrous sac and lines its walls; it is composed of a single layer of flattened cells resting on loose connective tissue.

The heart invaginates the wall of the serous sac from above and behind, and practically obliterates its cavity, the space being merely a potential one.



**The fibrous pericardium** forms a flask-shaped bag, the neck of which is closed by its fusion with the external coats of the greater vessels, while its base is attached to the central tendon and to the muscular fibers of the left side of the diaphragm.

- Superior: is continuous with the pretracheal layer of the deep cervical fascia.

By means of these upper and lower connections it is securely anchored within the thoracic cavity.

It is also attached to the posterior surface of the sternum by **the superior and inferior sternopericardiac ligaments**; the upper passing to the manubrium, and the lower to the xiphoid process.

The vessels receiving fibrous prolongations from this membrane are: the aorta, the superior vena cava, the right and left pulmonary arteries, and the four pulmonary veins.

**The inferior vena cava enters the pericardium through the central tendon of the diaphragm, and receives no covering from the fibrous layer!!!!**



**The serous pericardium** is a closed sac which lines the fibrous pericardium and is invaginated by the heart; it therefore consists of a visceral and a parietal portion.

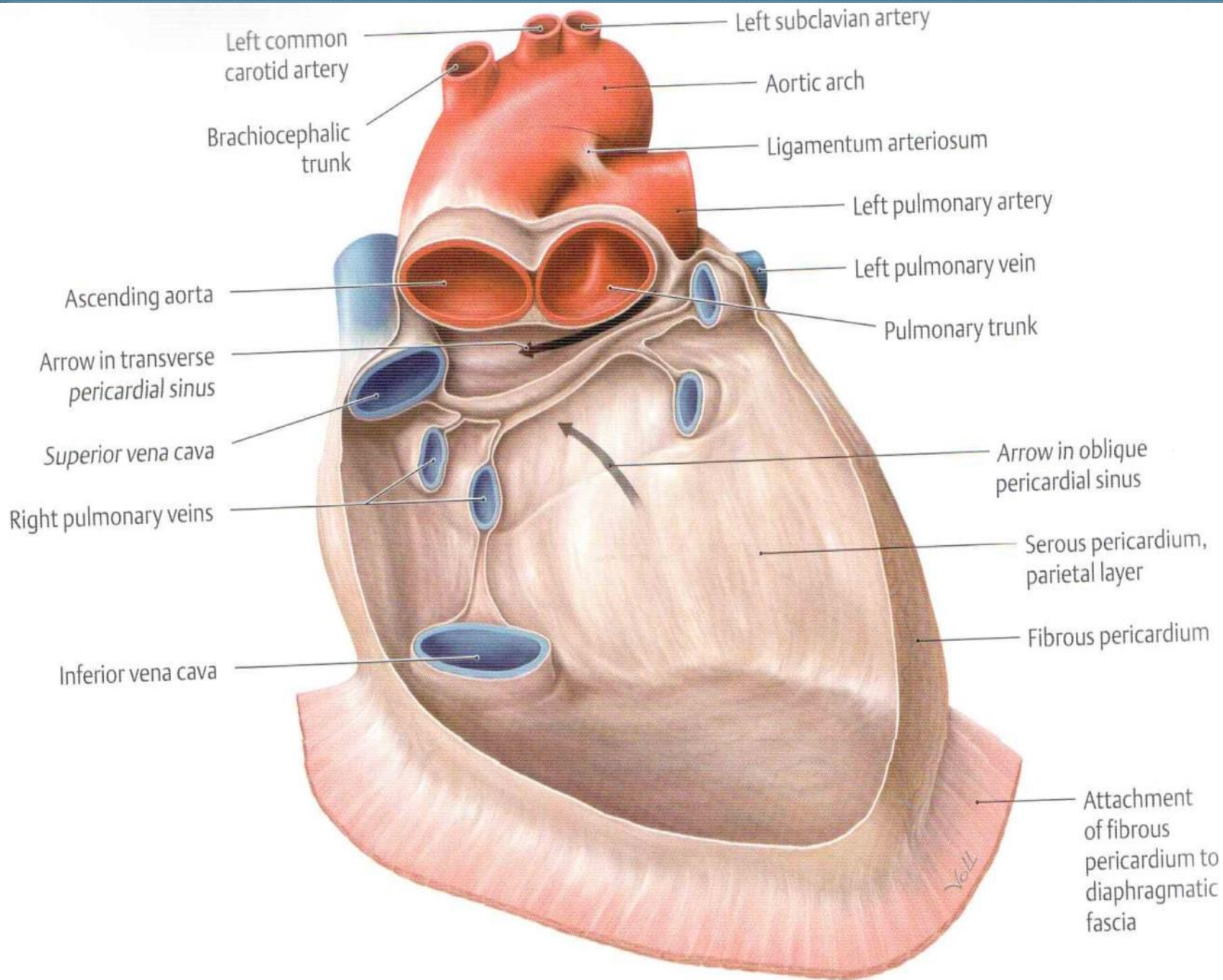
**The visceral portion, or epicardium**, covers the heart and the great vessels, and from the latter is continuous with the parietal layer which lines the fibrous pericardium.

The portion which covers the vessels is arranged in the form of two tubes. The aorta and pulmonary artery are enclosed in one tube, **the arterial mesocardium**.

The superior and inferior venæ cavæ and the four pulmonary veins are enclosed in a second tube, **the venous mesocardium**, the attachment of which to the parietal layer presents the shape of an inverted U.

The cul-de-sac enclosed between the limbs of the U lies behind the left atrium and is known as **the oblique sinus**, while the passage between the venous and arterial mesocardia—, between the aorta and pulmonary artery in front and the atria behind—is termed **the transverse sinus**.



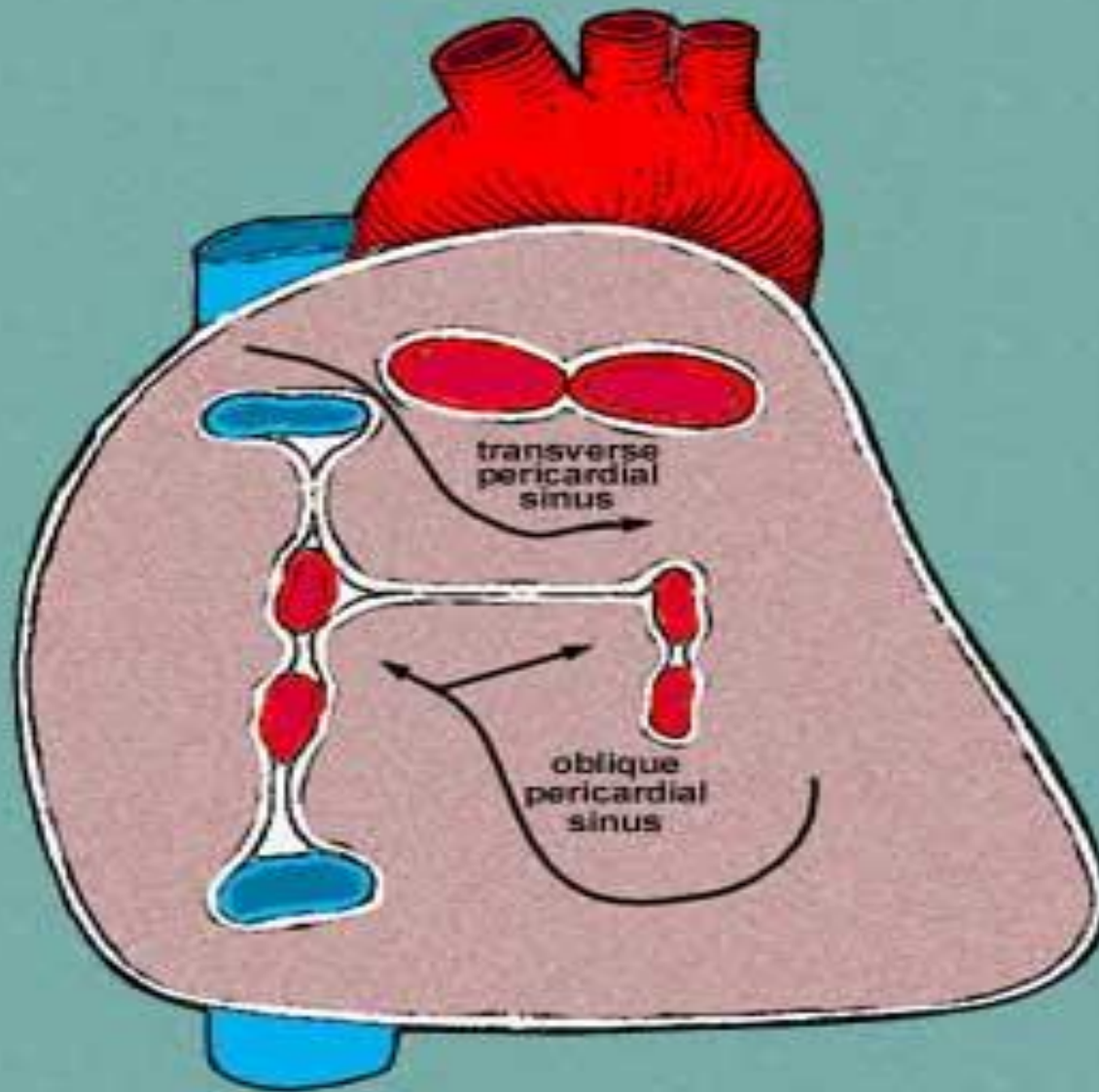




# Pericardial Sinuses

- The pericardial sinuses:
- transverse pericardial sinus
- oblique pericardial sinus
- the transverse pericardial sinus can easily be reached by sticking a finger between the superior vena cava and the ascending aorta and pulmonary trunk.
- This sinus is a left over from heart development in the embryo.

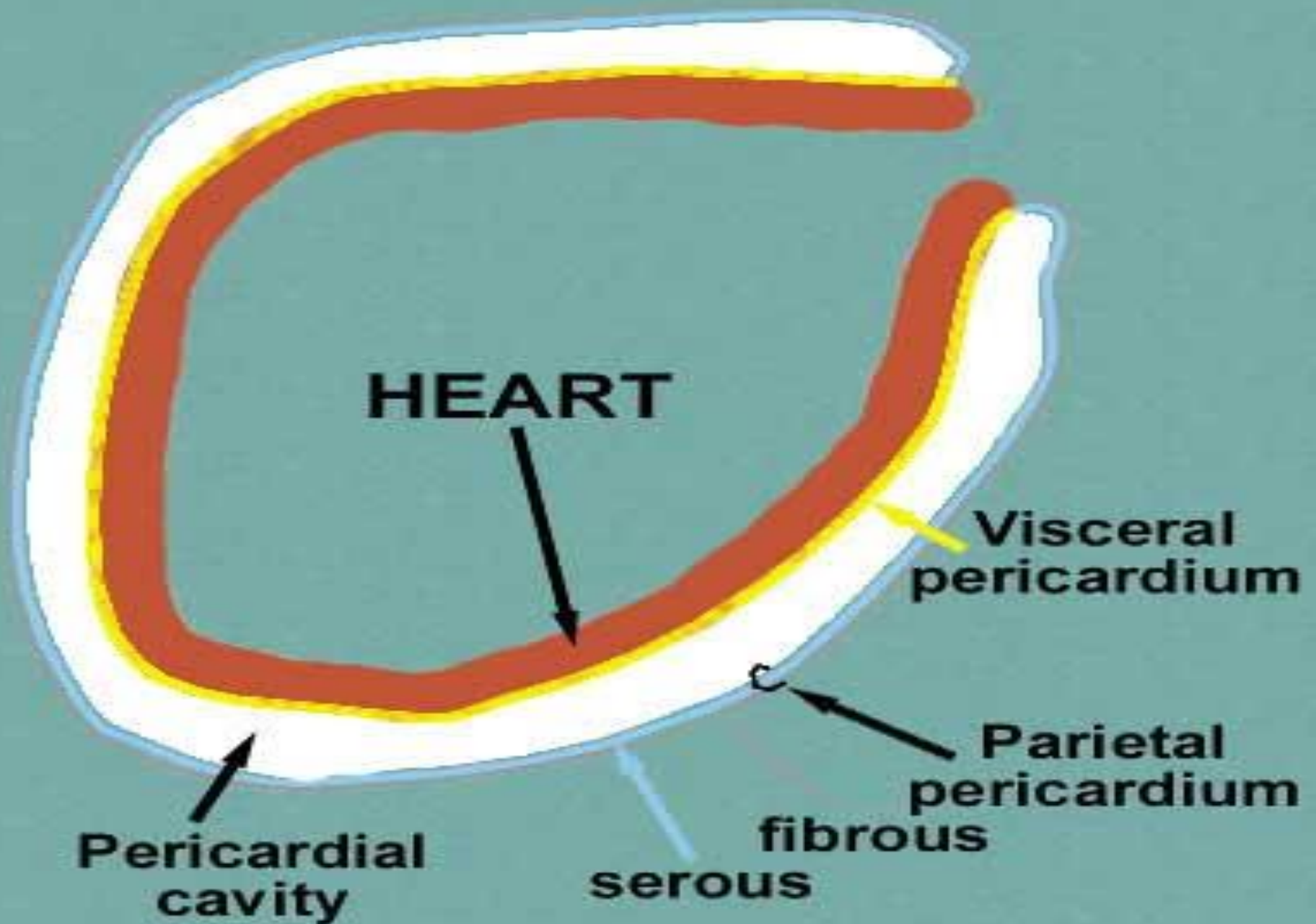






- The heart and its pericardium make up the contents of the middle mediastinum.
- The left and right phrenic nerves and their adjacent arteries (pericardiophrenic) lie to the left and right of the pericardium and anterior to the roots of the lungs.



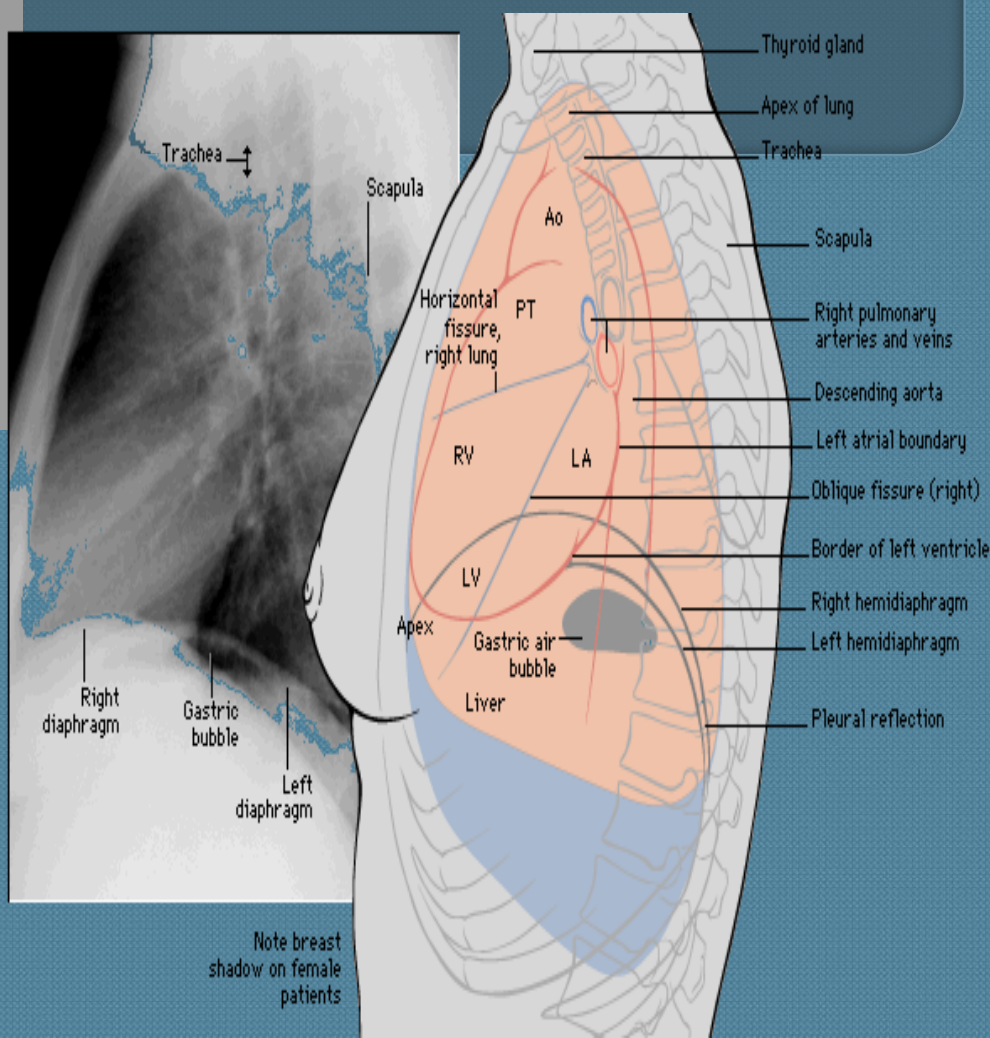
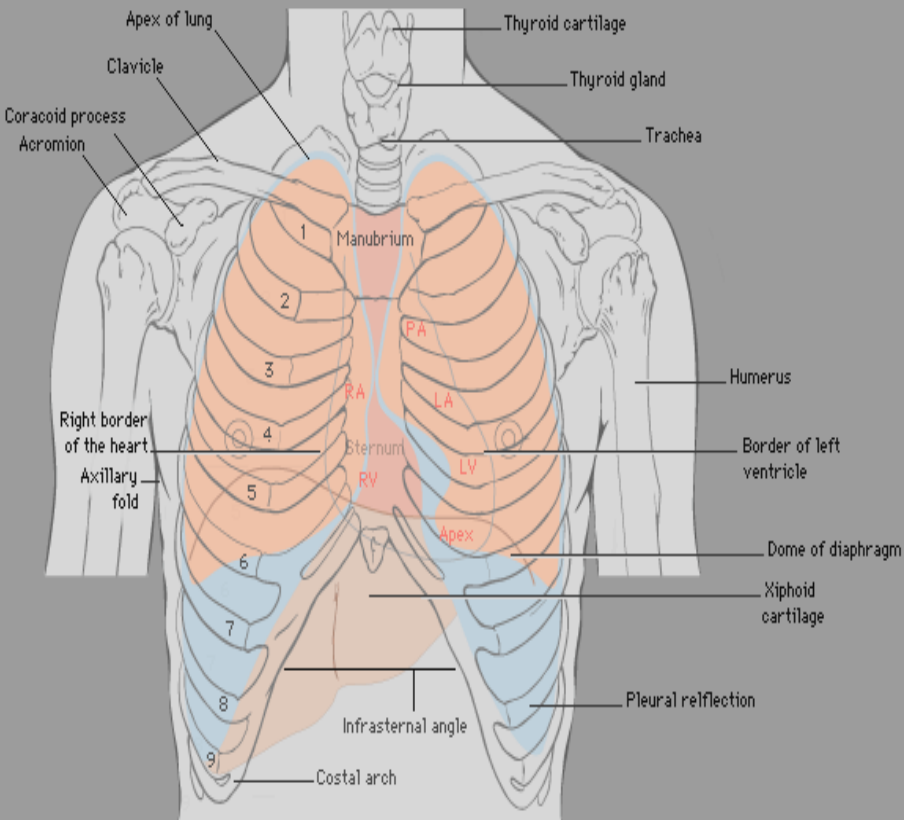






# THE HEART





Note breast shadow on female patients



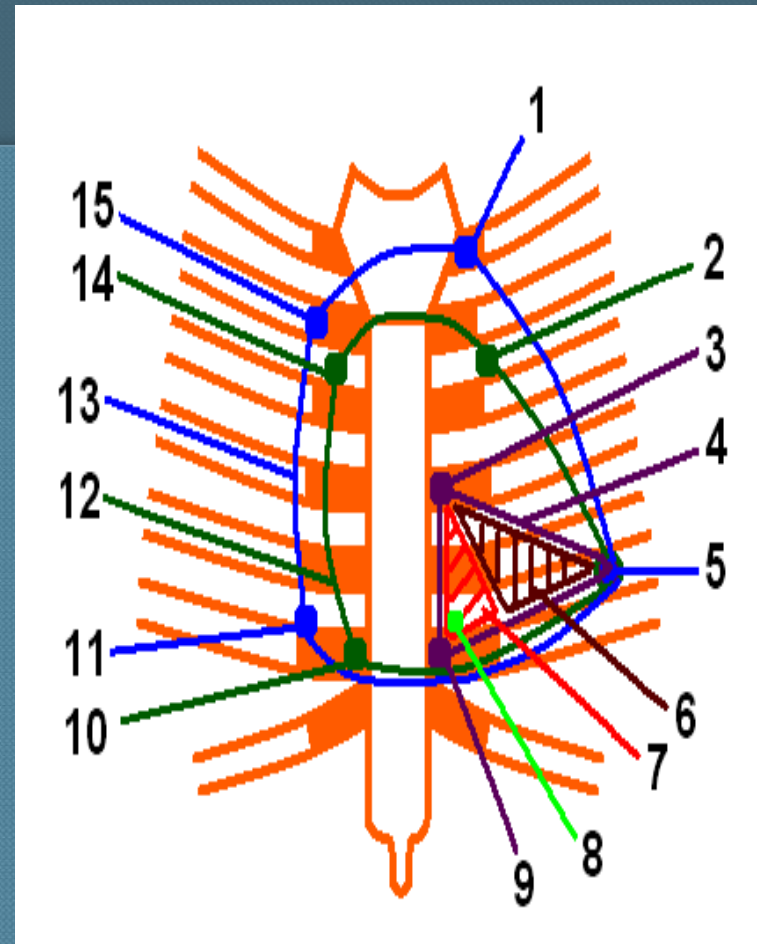
# Thoracic-cardio-pericardic topography

## Heart and pericardium projections

The heart is projecting in two areas:

- relative dullness area;
- absolute dullness area;

- Left sterno – chondral joint.
- Second intercostal space- 1,5 cm from sternum.
- VIth left sterno – chondral joint.
- **The absolute heart dullness projection**
- The Vth left intercostal space – 7 cm from the sternum on the medio-clavicular line
- Complementary space of Gerhard (lateral triangle).
- Delorme's triangle (medial triangle).
- Pericardic punction
- VIth left sterno-chondral joint.
- VIth right sterno-chondral joint.
- Superior margin of the VIth right rib – 2 cm away from the sternum.
- **Relative heart dullness area projection.**
- Pericardium projection
- The 2nd right intercostal space – 1 cm from the sternum.
- IInd right rib – 2 cm from the sternum.



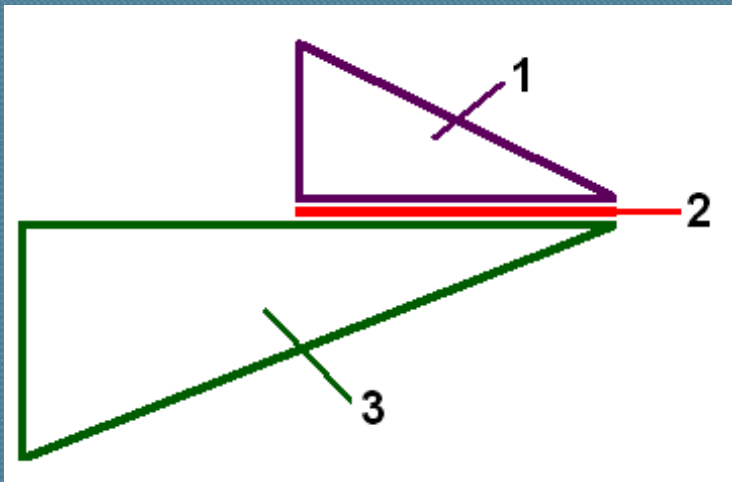


Into the relative dullness area , between the thoracic wall and the heart the lung and the pleura interpose.

In the absolute dullness area there are two triangles:

- **Laterally** , the complementary space of Gerhard, where the pleura interposes between the heart and the thoracic wall.
- **Medially**, the triangle of Delorme, where the heart and the thoracic wall are conected.

**The pericardic puncture** is realized in the Vth left intercostal space (in the area of the Delorme triangle), right next to the left margin of the sternum, in order not to injure the internal thoracic vessels that pass 1 cm para-sternal.



1. Absolute dullness area of the heart.
2. Cassaet's line (separating the two dullness).
3. Hepatic dullness area.



# THE HEART

-Musculo – cavitary organ, part of the circulatory apparatus, where it plays a pumping role (Benninghoff), ensuring the blood circulation.

Disposition : situated in the inferior floor of the anterior mediastinum (in the pericardic compartment), right above the diaphragm, between the two lungs, 1/3 on the right and 2/3 on the left side of the median line.

Color: reddish;

Consistency : firm;

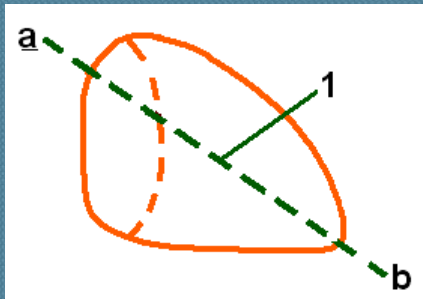
Capacity: 500 – 600 cm<sup>3</sup>;

Weight : 270 – 300 g;

Dimensions :

- longitudinal diameter = 133 mm;
- transverse diameter = 103mm

Shape : cone-like, with its axis obliquely oriented from right to left, from superior to inferior and from posterior to anterior.



1. Heart axis;
  - a. Right, posterior and superior
  - b. Left, anterior and inferior



## External morphology - relations

Presents a cone-shape with a base, an apex, 2 surfaces and 2 borders

### **BASE of the heart**

- Oriented toward right, posterior and superior.
- Presents 2 segments : a right and a left one.

**The right segment presents** superiorly – superior vena cava orifice and  
- inferiorly – inferior vena cava orifice.

Between the lateral extremities of the two cava veins orifices lies the terminal sulcus corresponding to the terminal crest of Hiss.

It corresponds to the right atrium and presents relations with:

- a. right mediastinal pleura
- b. mediastinal surface of the right lung.
- c. right phrenic nerve.
- d. right superior phrenic vessels.



**The left segment** presents the four pulmonary veins orifices, two right (superior and inferior ) and two left (superior and inferior).

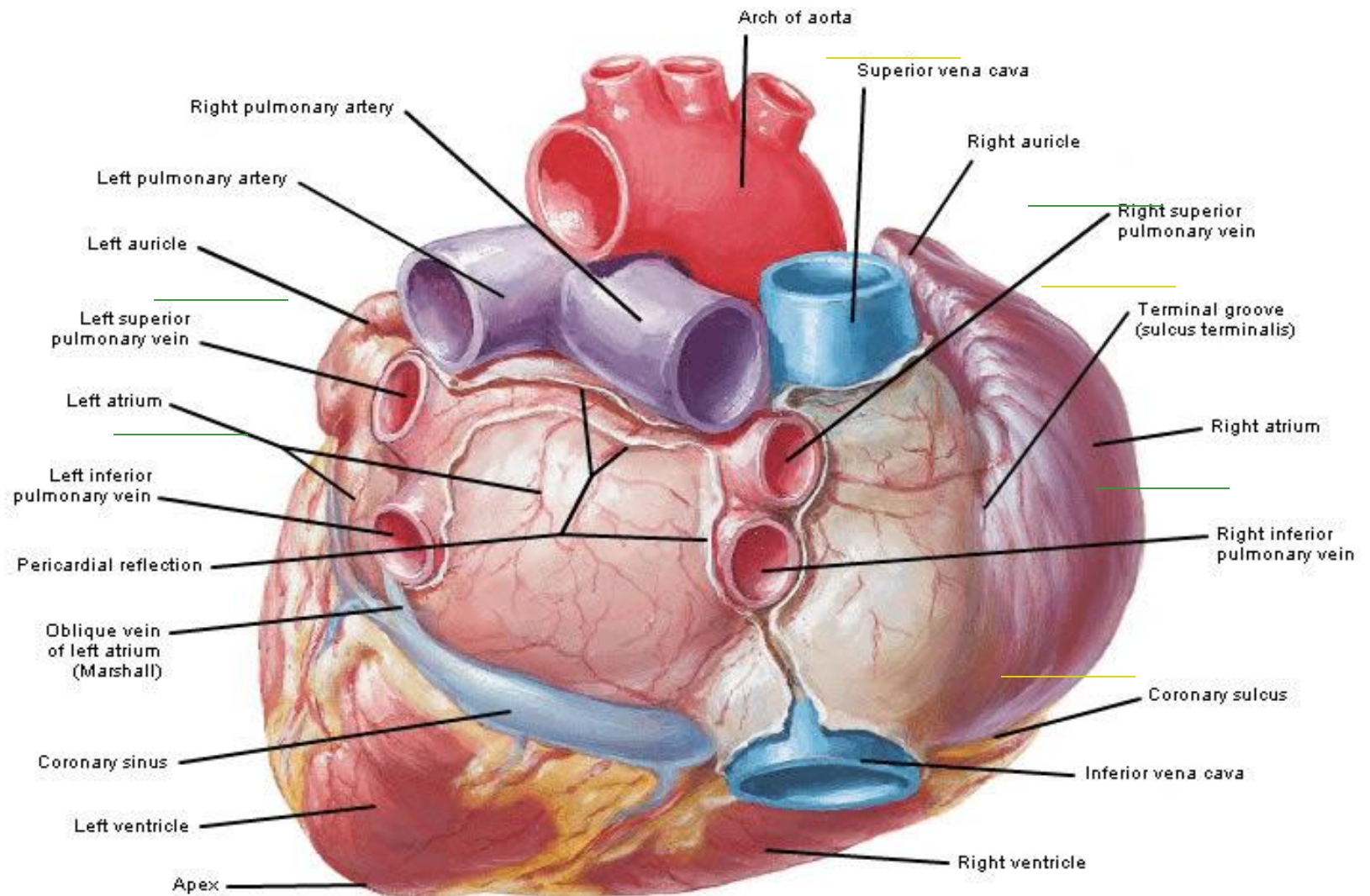
•Corresponds to the left atrium and comes in rapport with :

- a.Oesophagus
- b. Vagal nerves.
- c. Thoracic aorta.
- d. Azygos veins and inferior hemiazygos.
- e. Thoracic duct.
- f. Sympathetic thoracic chain.
- g. Preesophageal pleural recesses .
- h. Retroesophageal pleural recesses.
- i. Posterior costo-mediastinal recesses.
- j. Interpleural ligament of Morosow.



# Base of Heart

## Posterior View





## HEART APEX

- Oriented to the left, anterior and inferior.
- Comes in relation with the Vth left intercostal space and the intercostal muscle, with the corresponding vessels and nerves.
- Corresponds to the Vth left intercostal space on the left medio-clavicular line, 7 cm from the sternum, where we can observe the apical shock.

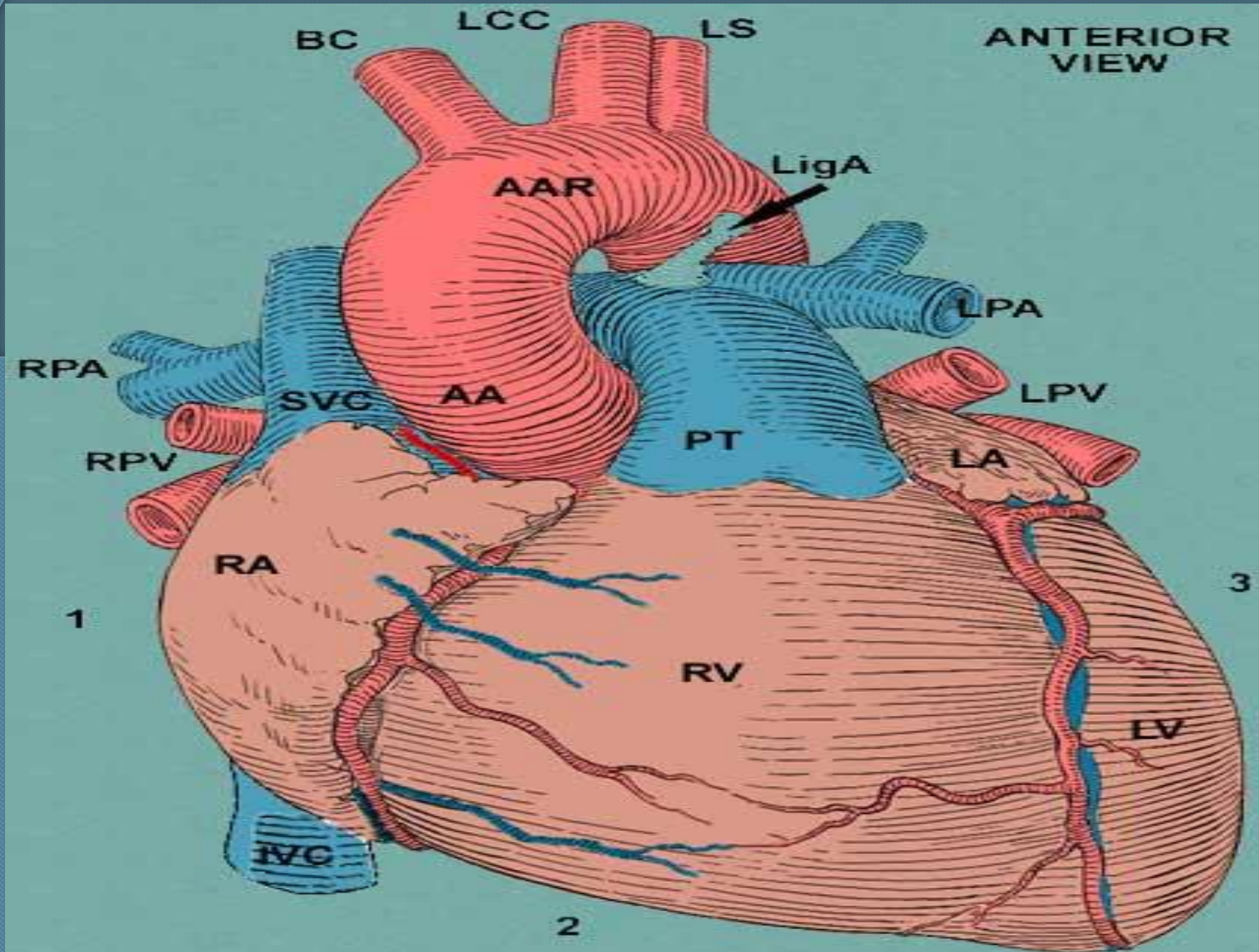
Right next to the apex of the heart, on the right side we can find the heart apex incisure, where the anterior and posterior interventricular grooves meet.



# The Heart

- The anterior surface of the heart is also known as the sternocostal surface for obvious reasons.
- Notice the ruffled edges of the left (LA) and right (RA) atria.
- These are the ones to use for orientation.







- Note that the anterior surface shows parts of each of the four chambers of the heart:

- right atrium (RA)
- left atrium (LA)
- right ventricle (RV)
- left ventricle (LV)



- Also note the three borders of the heart:
- right border (1) made up of the right atrium
- left border (3) made up of the left ventricle
  - superior and inferior venae cavae
  - pulmonary trunk and left and right branches
  - pulmonary veins (usually 4 in number but this can vary)
  - ascending aorta



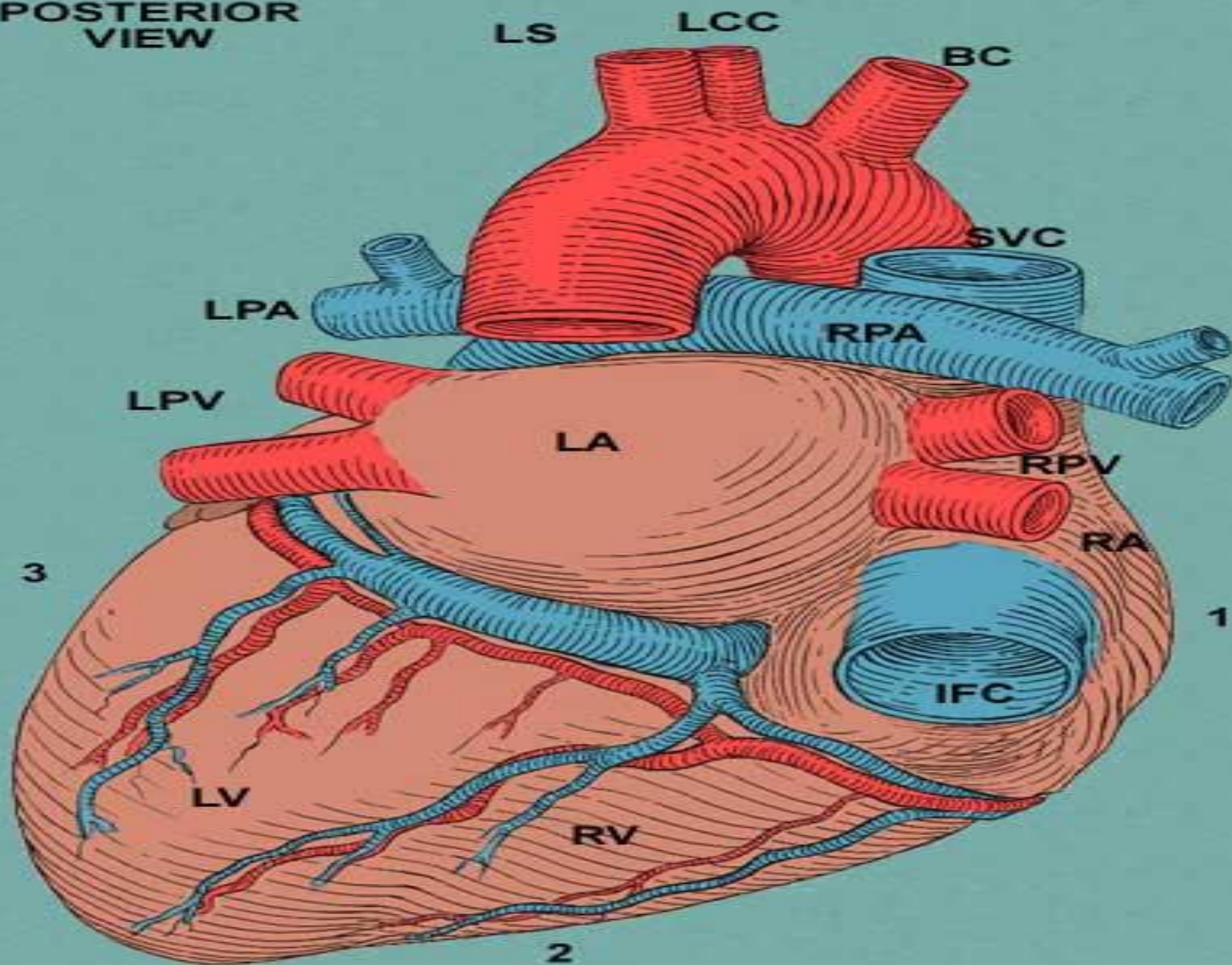
- The last item to identify is the remains of the embryonic connection between the pulmonary trunk and aortic arch, the *ligamentum arteriosum*.
- At one stage in development, the lungs were not functional so the blood was shunted into the arterial system at this site.
- Oxygen exchange in the embryo occurred at the placenta and not the lungs.



- The adjacent figure shows the posterior aspect of the heart.
- Its identifiable features include:
  - right atrium (RA)
  - left atrium (LA)
  - right ventricle (RV)
  - left ventricle (LV).



**POSTERIOR  
VIEW**

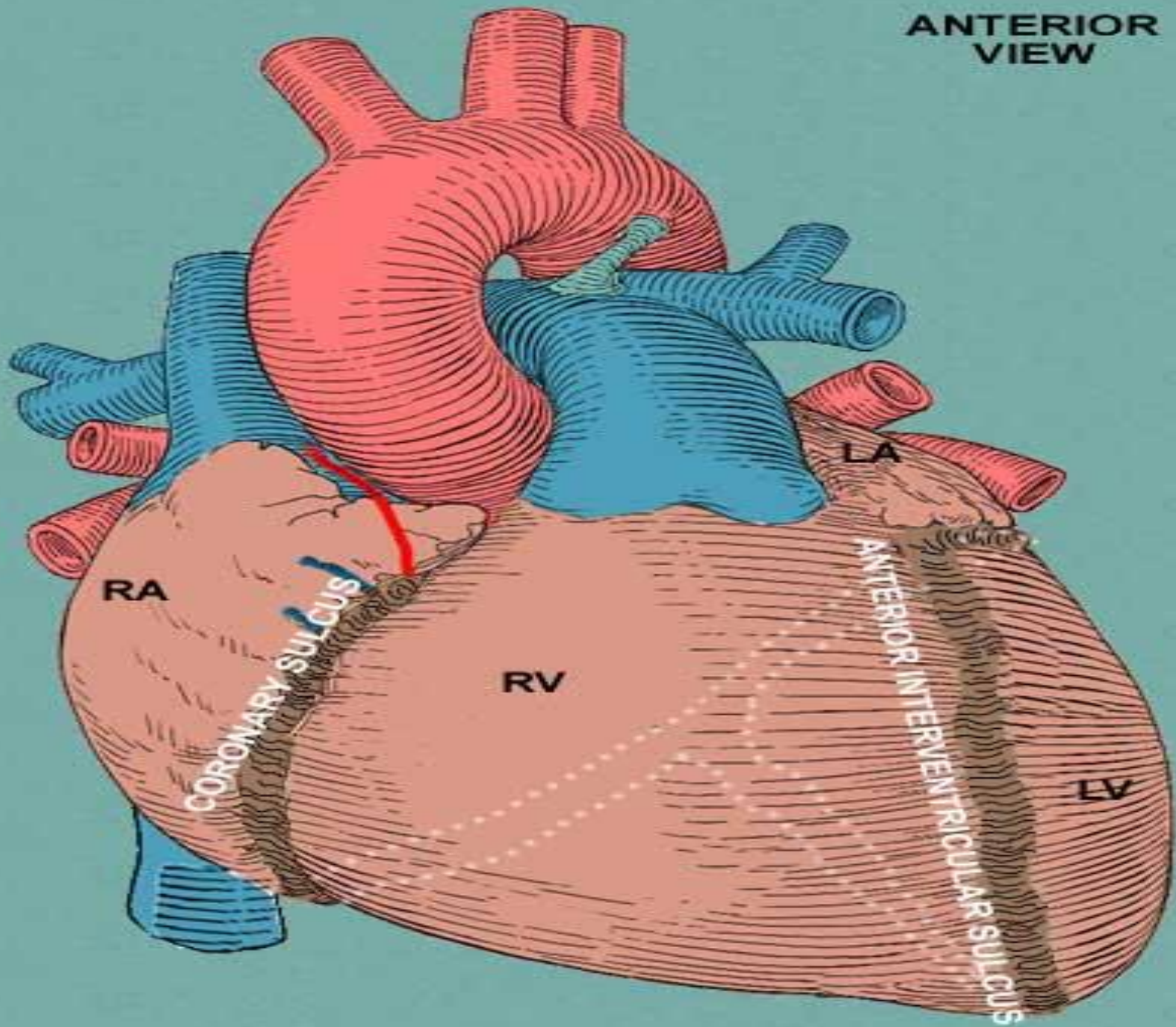




- From the anterior view of the heart, the anterior interventricular and coronary sulci can be seen (the darker brown areas).
- The anterior interventricular sulcus separates the right and left ventricles.
- The anterior part of the coronary sulcus separates the right atrium from the right ventricle.



# ANTERIOR VIEW

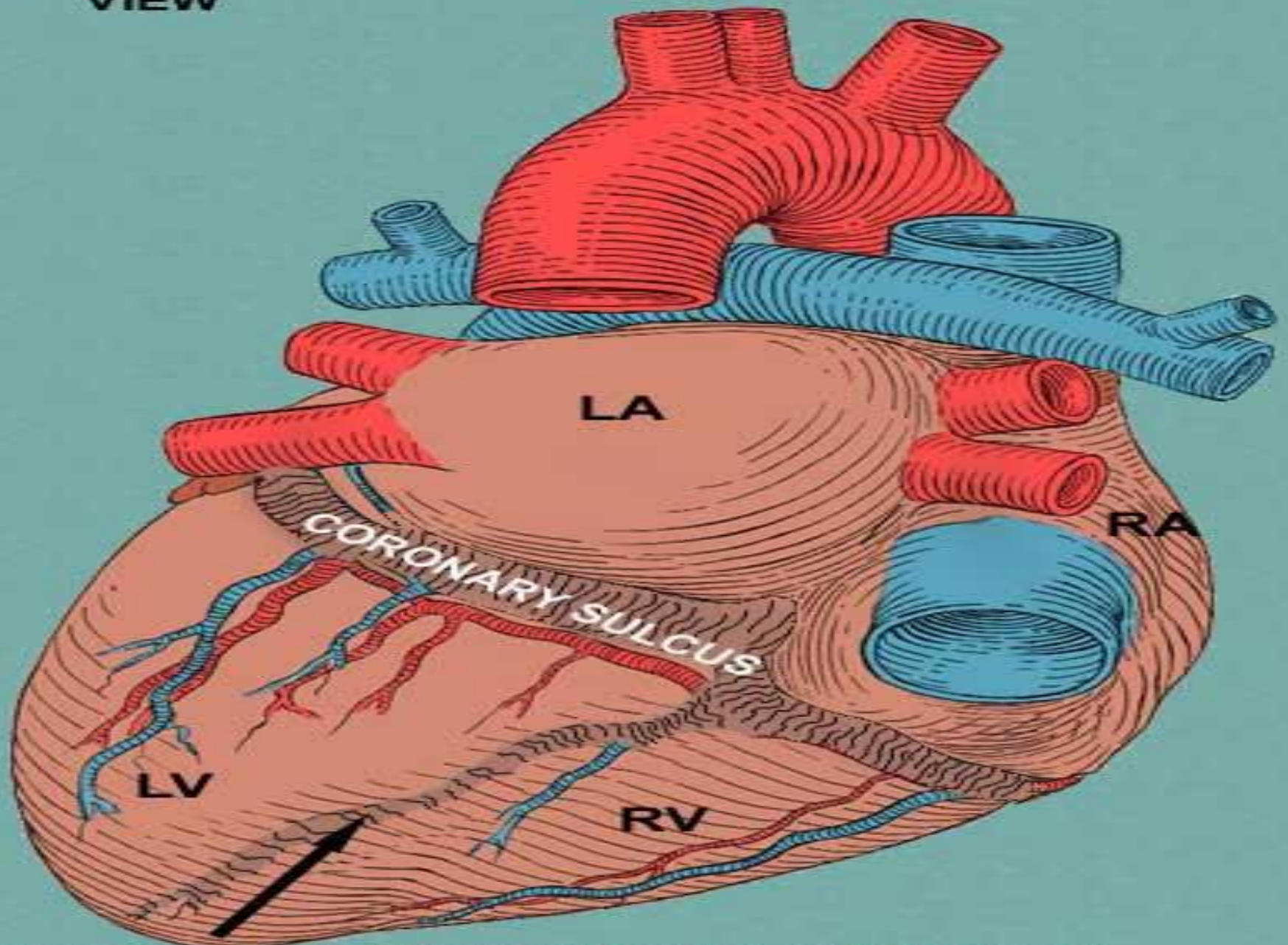




- From the posterior view of the heart, the posterior part of the coronary sulcus and the posterior interventricular sulcus can be seen.
- From this view, the coronary sulcus can be seen to separate the left and right atria from the left and right ventricles.
- The posterior interventricular sulcus separated the right ventricle from the left ventricle and if followed inferiorly, it can be seen to be almost continuous with the anterior interventricular sulcus.



**POSTERIOR  
VIEW**

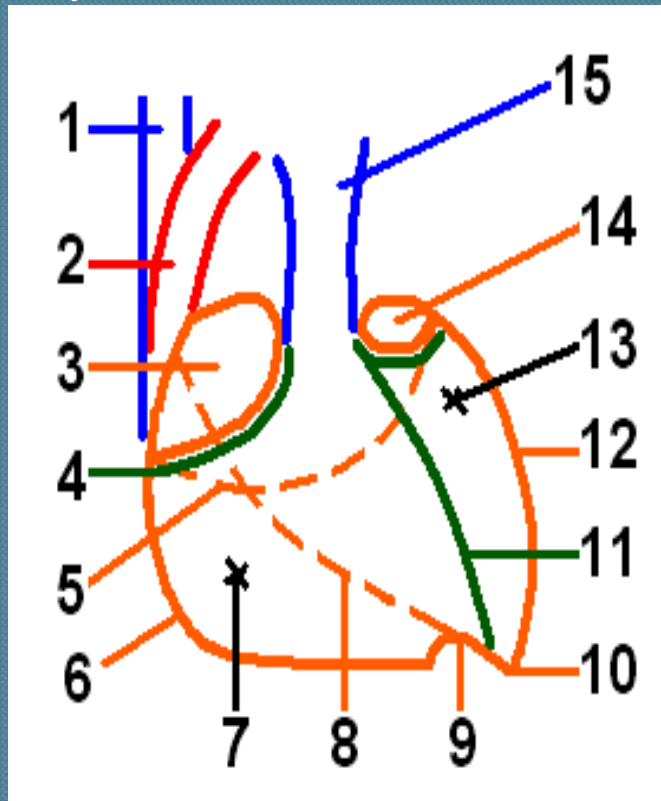


**POSTERIOR INTERVENTRICULAR SULCUS**



## THE STERNO COSTAL SURFACE (anterior) of the heart

- Anteriorly oriented.
- Presents two segments : superior and inferior.
- Separated by a transverse groove, the coronary or anterior atrio-ventricular groove. It is interrupted in its middle region by the pulmonary artery.



1. Aorta
2. Right auricle
3. Coronary or atrio-ventricular groove.
4. Posterior coronary groove.
5. Right margin.
6. Right surface.
7. Posterior interventricular groove.
8. Apical incisure.
9. Heart apex.
10. Anterior interventricular groove.
11. Left margin
12. Left surface
13. Left auricle
14. Pulmonary artery
15. Superior vena cava



Sterno – costal surface presents the following relations:

- a. With Sternum, chondro-sternal joints, costal cartilages, chondro-costal joints, ribs and intercostal spaces, intercostal muscles, vessels and nerves.
- b. Transverse muscle of the thorax.
- c. Internal thoracic vessels with their lymphatic nodes.
- d. Anterior costo-mediastinal recesses and the anterior borders of the lungs.

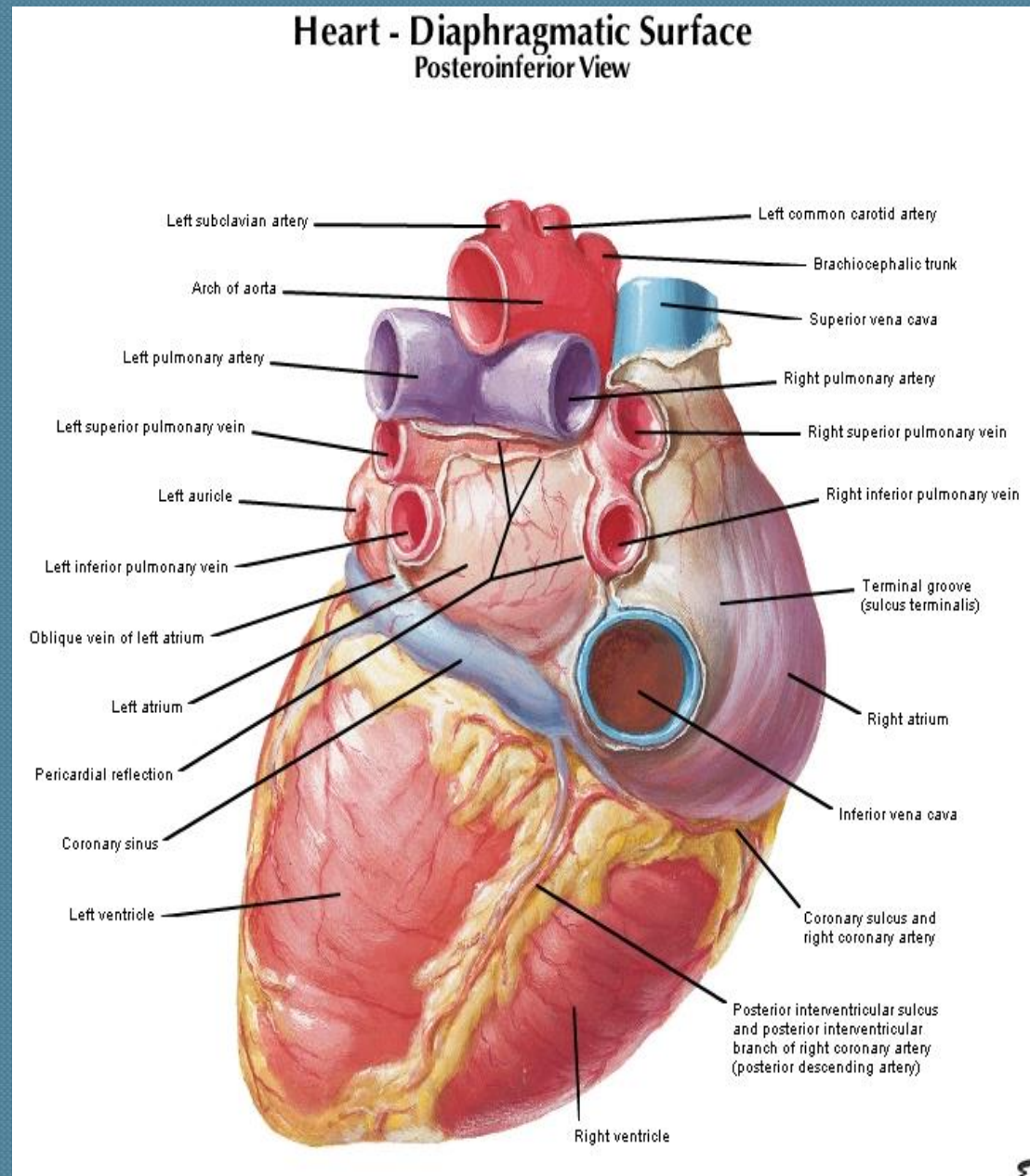


## Diaphragmatic surface of heart

-Oriented inferiorly and posteriorly.

-At the limit between the diaphragmatic surface and the base of the heart there is a transverse groove, the posterior coronary groove (atrio-ventricular), travelled by the coronary sinus.

-Presents relations with the supramesocolic abdominal organs – the liver and the stomach.





## HEART borders

- The **Left border** is rounded and broadened
    - It presents relations with:
      - Left mediastinal pleura.
      - Mediastinal surface of the left lung
      - Left phrenic nerve.
      - Left superior phrenic vessels.
  - The **right border** is sharp, presenting a vertical and a horizontal portion, forming an angle, giving the name **of angular border of the heart**.
- In the close vicinity of the heart apex, on its right border there is **the apical incisure**.

**Anterior and posterior coronary grooves (atrio-ventricular)** are continuously with each other at the heart margins.

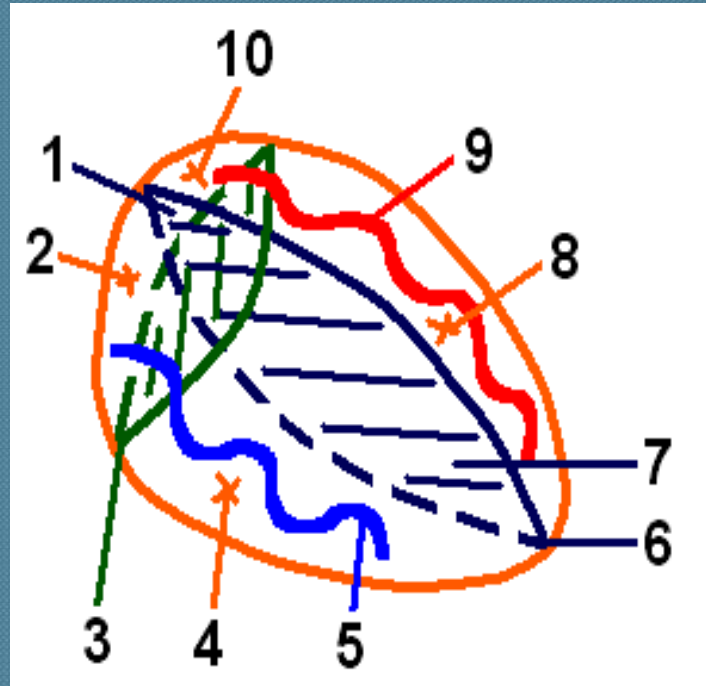
**Anterior and posterior interventricular groove** are continuously at the heart apical incisure.

The coronary and interventricular grooves are travelled by the coronary vessels.



# Internal morphology

The heart is divided into two halves – right heart (venous) and left heart (arterial), by a longitudinal septum, corresponding to the interventricular grooves externally.



1. Interatrial septum.
2. Right atrium.
3. Transverse or atrio-ventricular septum.
4. Right ventricle.
5. Right venous heart.
6. Longitudinal septum.
7. Interventricular septum.
8. Left ventricle.
9. Left arterial heart.
10. Left atrium.

Each half is divided by a **transverse or atrio-ventricular septum**, corresponding on the exterior to the coronary (atrio-ventricular) grooves, with the atrium toward the base of the heart and the ventricle toward the apex of the heart.

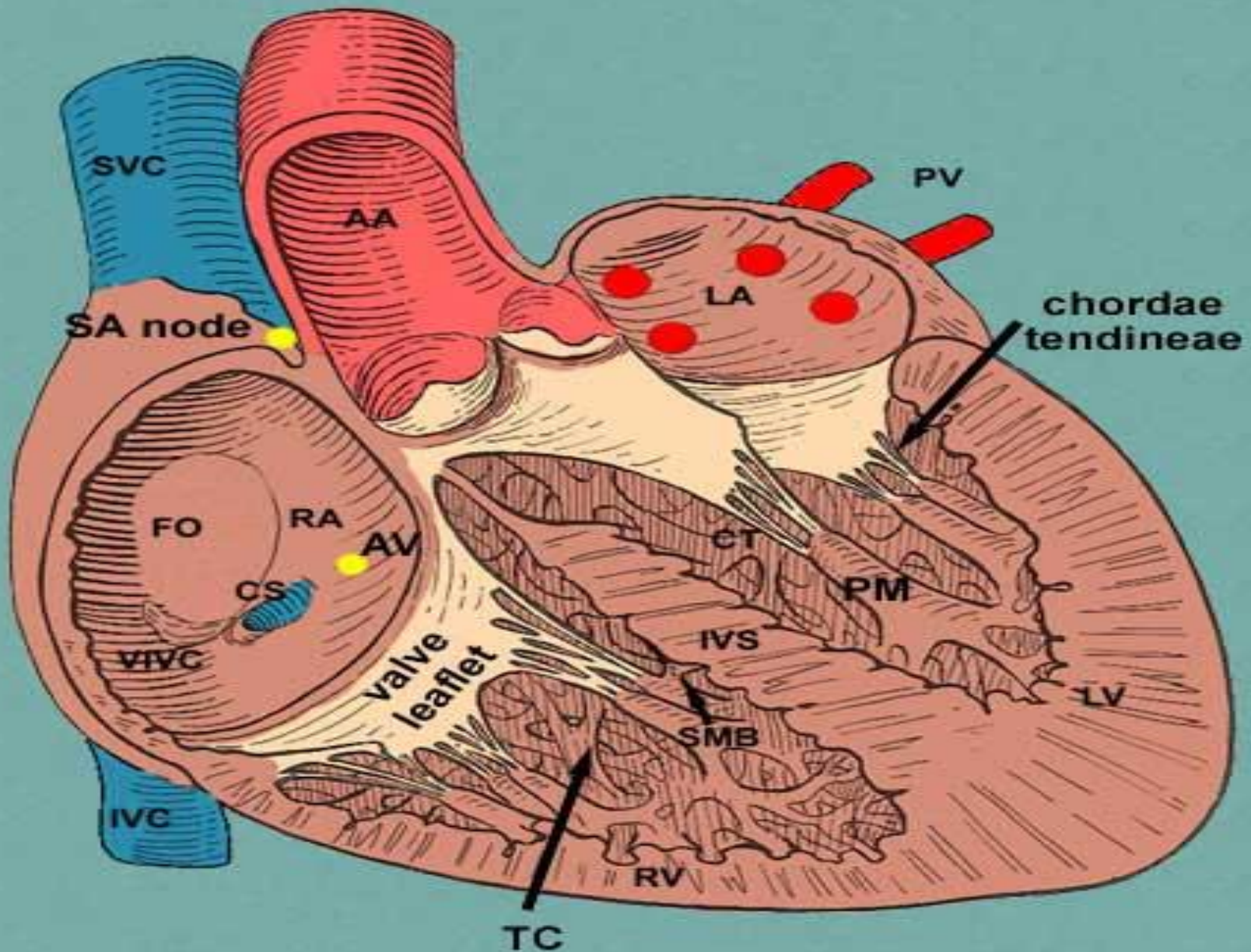
The longitudinal septum portion between the atria is called interatrial septum and the one separating the ventricles is called the interventricular septum.



# Internal structure of the heart

- The right atrium has a forward extension into its auricle.
- This space is lined by ridges of muscle called **pectinate muscles** and are not shown in the diagram.
- Starting with the right atrium, the internal structures are:
  - *fossa ovalis*
  - openings of the superior (SVC) and inferior (IVC) venae cavae and the coronary sinus opening (CS)
- The entrance of the inferior vena cava and coronary sinus may be covered with small valve leaflets (valve of the inferior vena cava and valve of coronary sinus).
- The SA node is located at the junction of the superior vena cava with the right atrium.
- The AV node is located in the lower part of the interatrial septum near the opening of the coronary sinus.







- The right atrium and right ventricle communicate with each other by way of the tricuspid valve.
- As the name implies, it has three leaflets.
- **chordae tendineae**, attaching the free border of the valve cusps (leaflets) to either papillary muscles (PM) or directly to the wall of the heart chamber.
- **Papillary muscles are only found in the ventricles of the heart!!!!!!!!!!!!!!!!!!!!!!!!!!!!**
- the rough lining of the ventricular wall is called **trabeculae carneae**, because of their meaty appearance
- the anterior papillary that has an attachment to the interventricular wall known as **the septomarginal trabecula or the moderator band**.



Blood leaves the right ventricle and passes through the pulmonary trunk to the lungs.

Oxygenated blood returns to the left atrium of the heart from the lung through the pulmonary veins.

The left atrium communicates with the left ventricle **through the mitral or bicuspid valve**.

Just as in the right ventricle, the valve cusps or leaflets connect to the papillary muscles (PM) by way of *chordae tendineae*.

The inner walls of the left ventricle is thrown into folds of trabeculae carneae just as in the right ventricle.

Note, in particular that the left ventricular has a much thicker wall than the right ventricle.

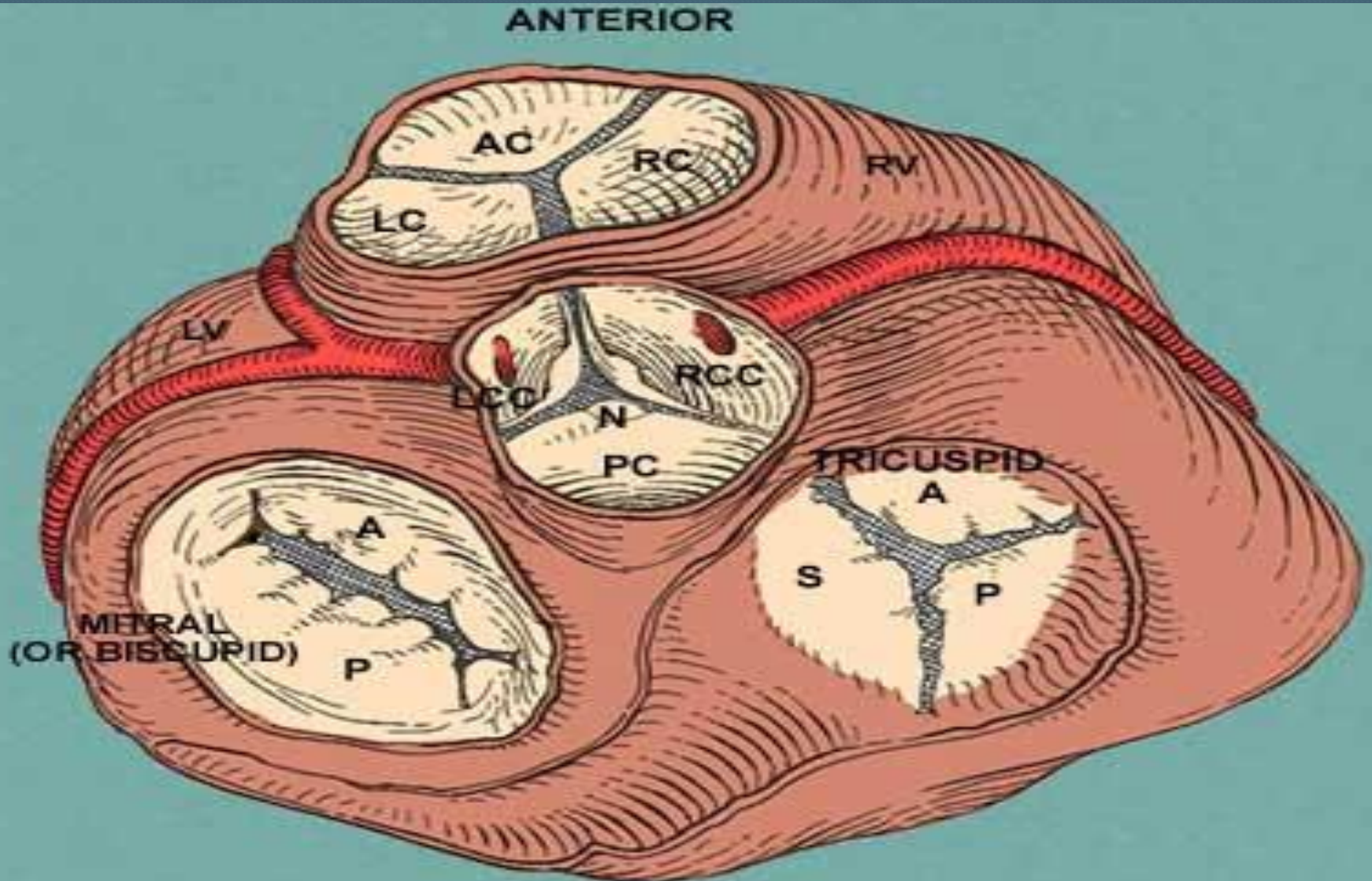
If the heart is not too diseased, this is how you can tell the difference between the two ventricles.

Note the interventricular septum (IVS) between the two ventricles.

Blood leaves the left ventricle through the ascending aorta and is then sent to body organs and tissues.



# Heart Valve Positions





- This diagram is a special dissection that shows the four heart valves and their relationship to one another.
- The view is from the top after the left and right atria have been removed.
- the right atrioventricular valve (tricuspid valve).
- It has an anterior (A), posterior (P) and septal (S) cusp.
- The left atrioventricular valve (mitral valve) has an anterior (A) and a posterior (P) cusp.
- The pulmonary and aortic valves are both tricuspid.
- During embryonic development, these two vessels were one.
- With rotation of the heart and a separation of the single channel, the pulmonary trunk ends up anterior and the ascending aorta ends up posterior.



The original contained four primitive valve cusps, an anterior, left and right and a posterior.

The left and right valves were divided during the separation so that a left and right ended up in both the pulmonary (or anterior channel) and the ascending aorta (or posterior channel).

In the adult, this development results in an anterior displaced pulmonary trunk with an anterior and a left and right cusp, while the posterior displaced ascending aorta has a left and right coronary cusp and a posterior cusp.

The coronary cusps are named because the origins of the left and right coronary arteries are found lateral to these cusps.



# THE ATRIA

The atria are situated toward the base of the heart, separated by the ventricles through the atrio-ventricular septum; the atria are separated with each other by the interatrial septum.

The walls of the atria are very thin, because of the minor importance of the atrial myocardium.

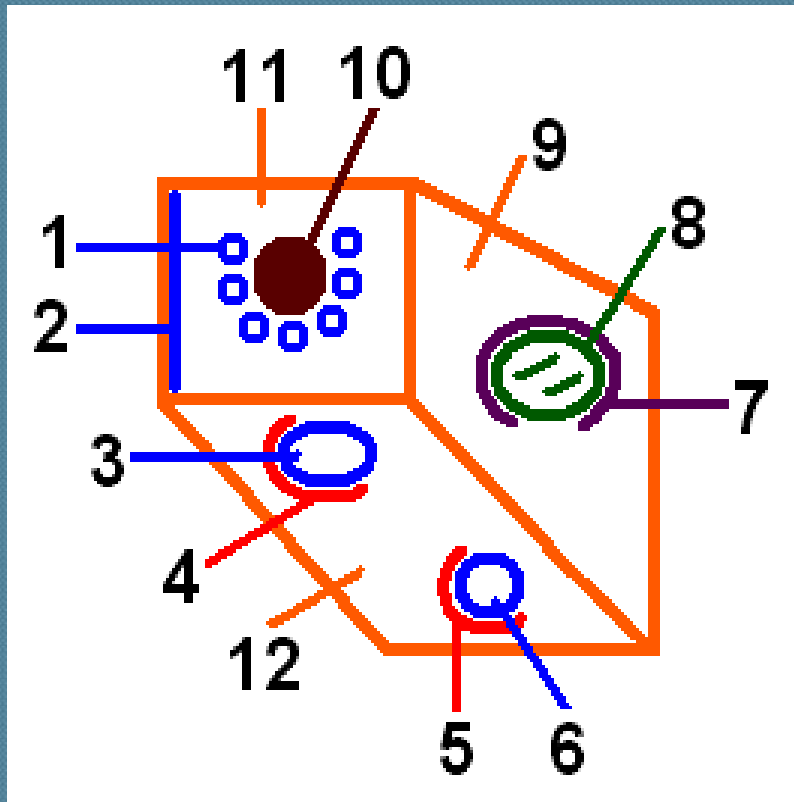
They present a cubic shape, with 6 walls. Each atrium presents a pocket-like structure, called **auricle**.

## The right atrium

Presents 6 walls:

1. posterior.
2. intern (septal).
3. inferior.





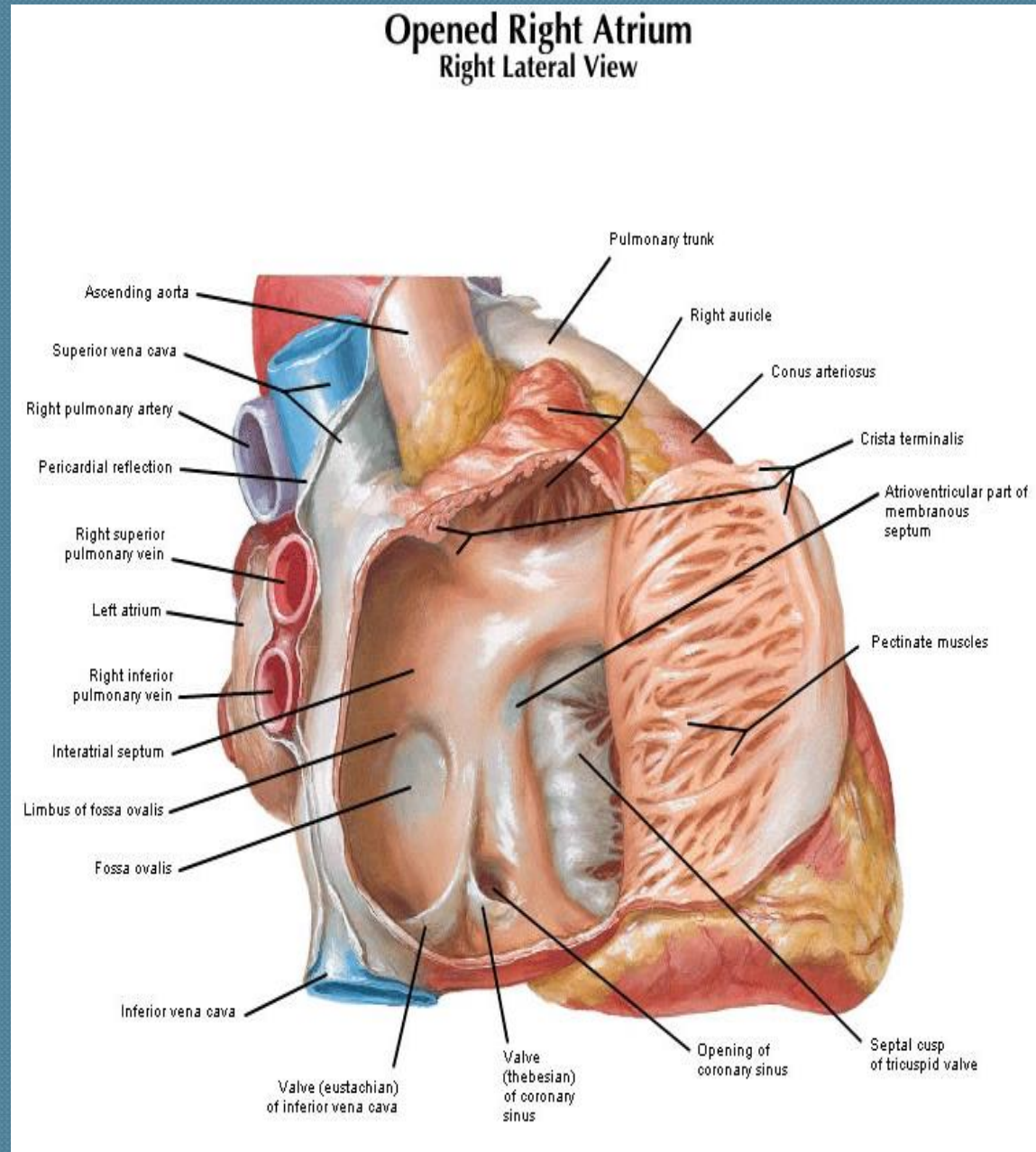
1. Accessory cardiac veins orifices.
2. Terminal crest of Hiss.
3. Inferior vena cava orifice.
4. Eustachio's valve.
5. Thebesius's valve.
6. Coronary sinus orifice.
7. Vieussens's ring.
8. Oval fossa.
9. Interior or septal wall.
10. Intercaval tubercle of Lower.
11. Posterior wall.
12. Inferior wall.

1. **The posterior wall** presents numerous little orifices of the accessory cardiac veins and present in its middle portion a small prominence – the intercaval tubercle of Lower, which has the role of reflecting the blood flow toward the interior of the atrium.  
At the meeting point of the posterior with the external wall we can find the terminal crest of Hiss.



2. The internal or septal wall corresponds to the interatrial septum. In its middle portion we can find the oval fossa, surrounded by an incomplete ring – the ring of Vieussens. In the prenatal period, the oval fossa corresponds to the foramen of Botal, through which the two atria communicate with each other.

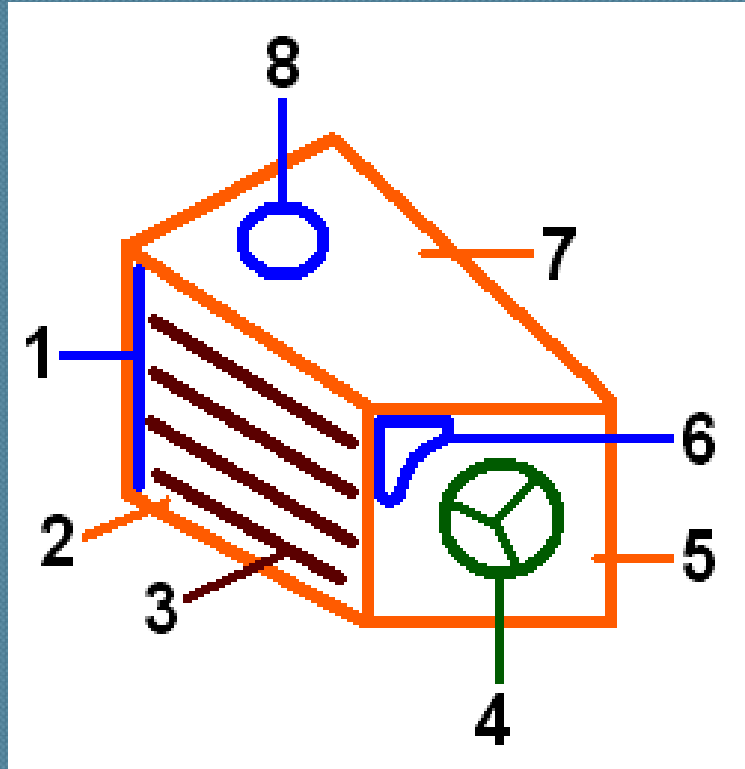
3. The inferior wall presents in its posterior portion the vena cava orifice, bounded by the Eustachio valve. Anterior to it, toward the septal wall, we can find the coronary sinus, covered by the Thebesius valve.





## Walls

4. superior
5. external
6. anterior



1. creasta terminală a lui Hiss;
2. peretele extern;
3. mușchii pectinați;
4. orificiul atrio-ventricular drept cu valvula tricuspidă;
5. peretele anterior;
6. orificiul de comunicare cu auriculul drept;
7. peretele superior;
8. orificiul venei cave superioare.
9. Terminal crest of Hiss.
10. External wall,
11. Pectinate muscles.
12. Right atrio-ventricular orifice with tricuspid valve.
13. Anterior wall.
14. Communication with right

**4. Superior wall** presents posteriorly the superior vena cava and the

**5. External wall** presents the terminal crest of Hiss at the intersection with the posterior wall; the pectinate muscles run toward the terminal crest.

## 6. Anterior wall presents two orifices :

- right atrio – ventricular orifice , presenting the tricuspid valve.
- comunication orifice with the right auricle , situated between the anterior, external and superior walls.



# THE LEFT ATRIUM

Presents six walls.

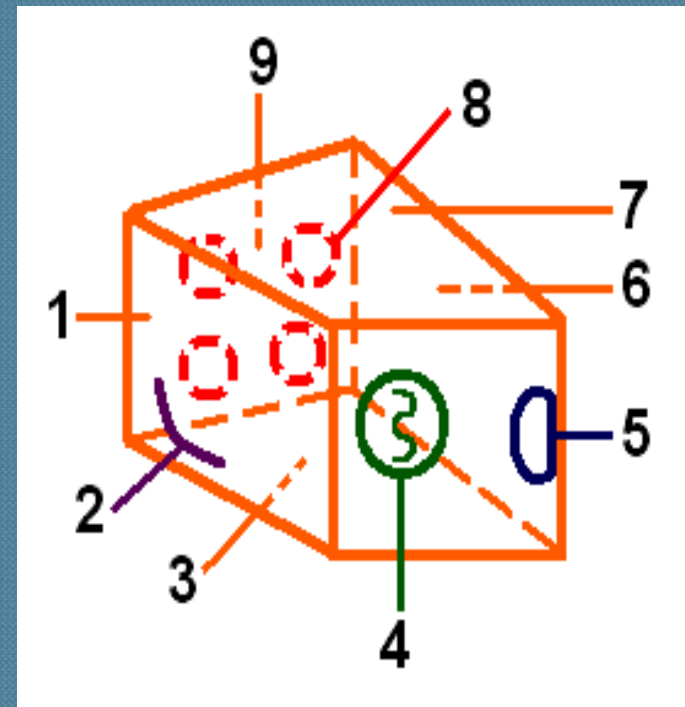
Superior, external and inferior wall are smooth.

4. **Posterior wall** presents the four pulmonary veins orifices, two right (superior and inferior) and two left (superior and inferior).

5. **Internal or septal wall** corresponds to the interatrial septum. Postero-inferiorly it presents a semilunar fold, also known as falx septim corresponding to the postero-inferior limit of the oval fossa from the septal wall of right atrium.

6. **Anterior wall** presents two orifices:  
Left atrio-ventricular orifice – presenting a mitral valve.

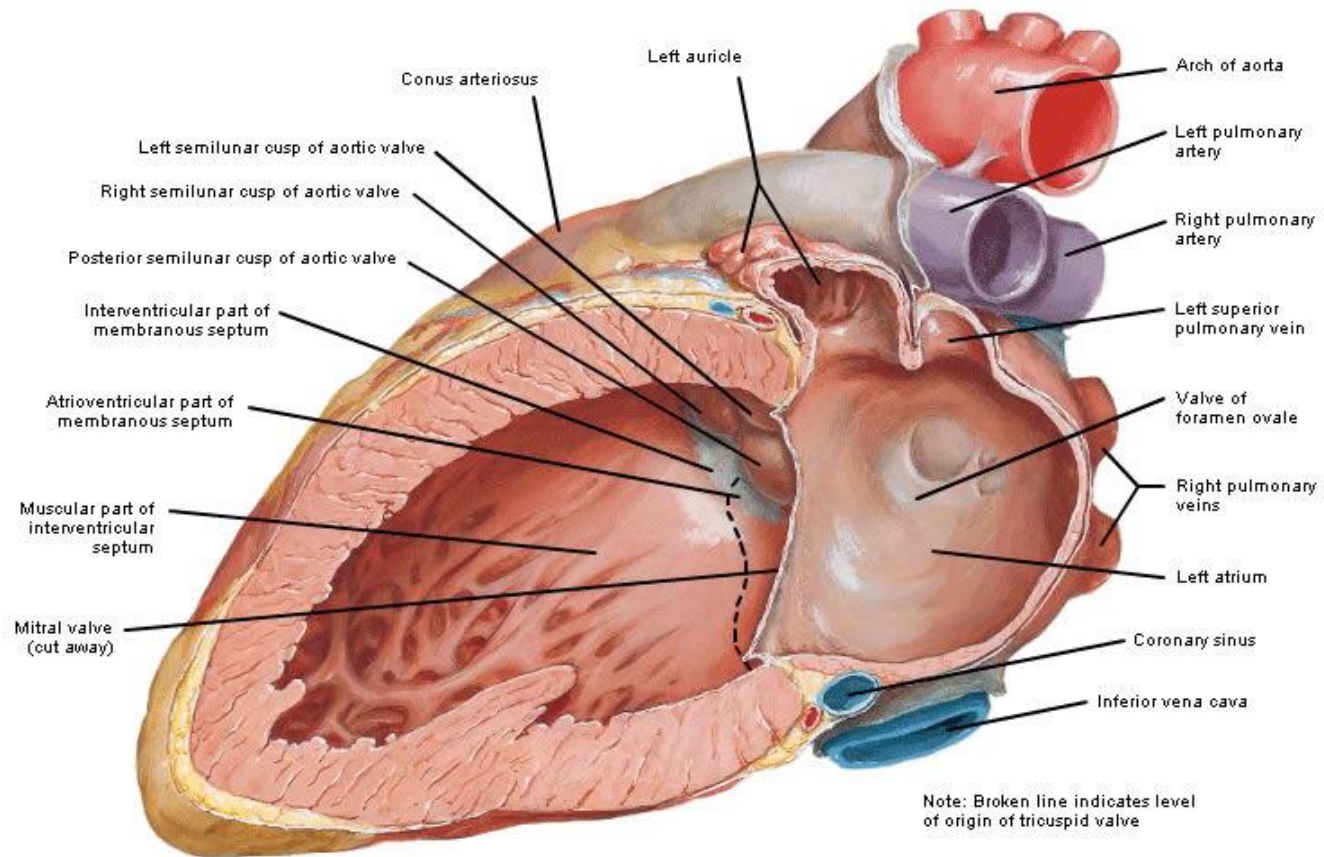
Communication orifice with the left auricle, at the intersection between the anterior and external walls.



1. Internal or septal wall.
2. Falx septi.
3. Inferior wall.
4. Left atrio-ventricular orifice with mitral valve.
5. Communication orifice with the left auricle.
6. External wall.
7. Superior wall.
8. Pulmonary veins orifices.
9. Posterior wall.



## Left Atrium and Ventricle Sectioned with Mitral Valve Cut Away





# THE VENTRICLES

Are situated with their base toward the atrio-ventricular septum, which separates the ventricles from the atria and with its tip toward the apex of the heart.

They are separated by the interventricular septum , which presents :

- a small membranous portion situated at the intersection between the interventricular and atrio-ventricular septum and
- A broad muscular portion .

The walls of the ventricles are thicker than the atrial walls, with the myocardium as the motive power of the heart.



At the base of each ventricle there are two orifices:

- atrio-ventricular , a communication between the atrium and the ventricle.
- Arterial (pulmonary artery on the right side and aorta on the left side), through which the blood is pushed into circulation.

Inside the ventricles one can notice numerous muscular columns, also known as *trabeculae carneae*, grouped as it follows:

1. The first degree trabeculae, presenting a conical shape, with the base at the ventricular wall and the tip oriented toward the interior of the ventricle, connected to the atrio – ventricular valve through *chordae tendinae*, *papillary muscles*.
  2. The second degree trabeculae, presenting *as muscular arches*, adherent to the ventricular wall.
  3. The third degree trabeculae, adhering to the ventricle wall, *muscular belts*.
- At the heart apex we can find a conglomerate of first and second degree trabeculae, also known as *the cavernous zone*.



# THE RIGHT VENTRICLE

Has a triangular pyramidal shape, with its base at the atrio-ventricular septum and the tip toward the apex of the heart and presents three walls.

**The base** presents inferiorly the right atrio-ventricular orifice with the tricuspid valve and superiorly the pulmonary artery orifice, surrounded by three semilunar valves.

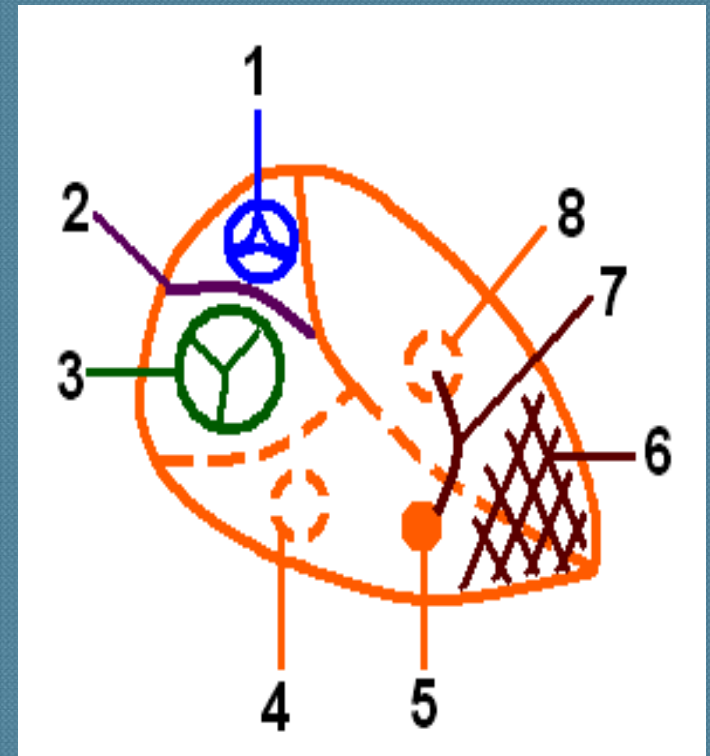
Between the two orifices we can find a prominence, the supraventricular crest or Wolff's spur.

**The tip** is found immediately at the right side of the heart apex, presenting the cavernous area.

**The anterior wall**, concave toward the ventricle's interior, presents the anterior papillary muscle.

**The inferior wall**, concave toward interior, presents the inferior papillary muscle.

**The internal or septal wall** : convex, corresponding to the interventricular septum, presents the internal papillary or septal muscle.



1. Pulmonary artery orifice with three semilunar valve.
2. Supraventricular crest.
3. Right atrio-ventricular orifice with the tricuspid valve.
4. Inferior papillary muscle.
5. Anterior papillary muscle.
6. Cavernous zone.
7. Septo-marginal trabeculae.
8. Internal papillary or septal muscle.



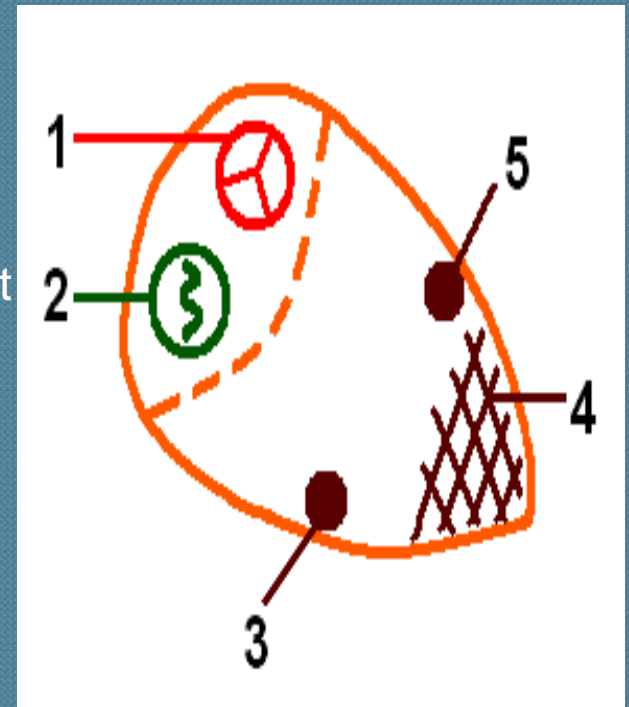
# THE LEFT VENTRICLE

Has a cone-shape transversally flattened, with a base at the atrio-ventricular septum, a tip and two walls.

The base presents the aortic orifice superiorly, with three semilunar valves and the left atrio-ventricular orifice inferiorly, presenting the mitral valve.

The tip corresponds to the heart apex, presenting the cavernous area.

The interior or septal and the external walls are both concave. At the meeting point of the two walls the papillary muscles are found, one anterior and one posterior, stronger than the ones found in the right ventricle.

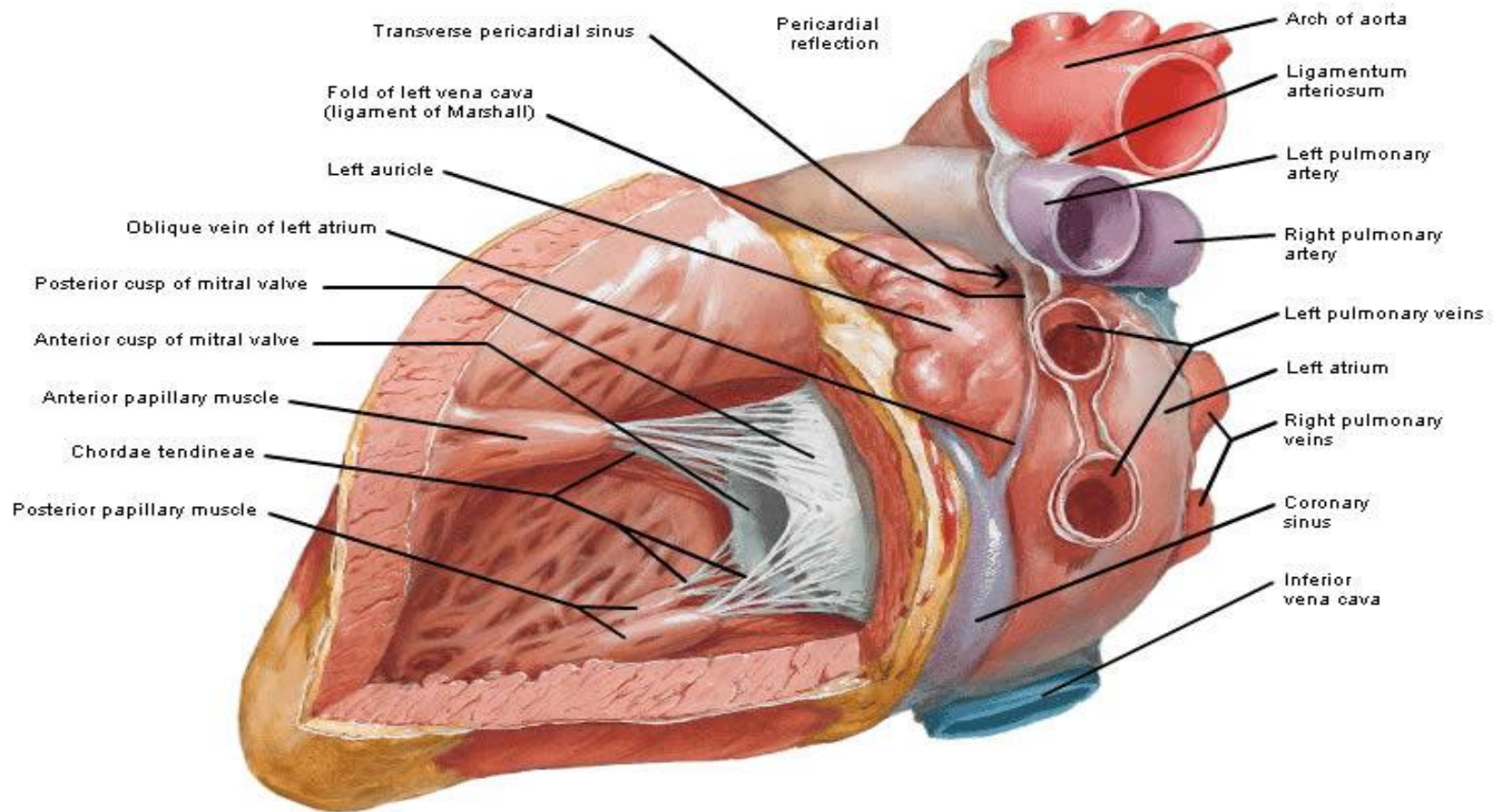


1. Aortic orifice presenting three semilunar valves.
2. Left atrio-ventricular orifice presenting the mitral valve.
3. Posterior papillary muscle.
4. Cavernous zone.
5. Anterior papillary muscle.



# Left Ventricle

## Flap Opened in Posterolateral Wall





# THE FIBROUS SKELETON AND VALVULAR HEART APPARATUS

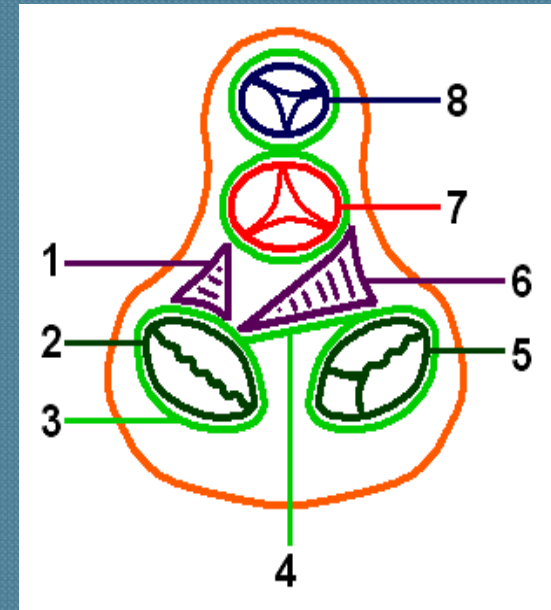
The fibrous skeleton corresponds to the atrio-ventricular septum.

It is an insertion point for the valvular apparatus of the heart and myocardium.

The fibrous wall of the heart presents four fibrous rings of Lower, circumscribing the arterial orifices (pulmonary and aortic) and atrio-ventricular orifices (right and left).

The atrio-ventricular orifices present atrio-ventricular valves, the tricuspid on the right side and the mitral valve on the left side.

The arterial orifices present 3 semilunar valves and two fibrous trigones.



1. Left fibrous trigone.
2. Left atrio-ventricular orifice with the mitral valve.
3. Lower fibrous ring.
4. Interventricular septum membranous part
5. Right atrio-ventricular orifice with tricuspid valve.
6. Right fibrous trigone.
7. Aortic orifice with three semilunar valve.
8. Pulmonary orifice with three semilunar valve.

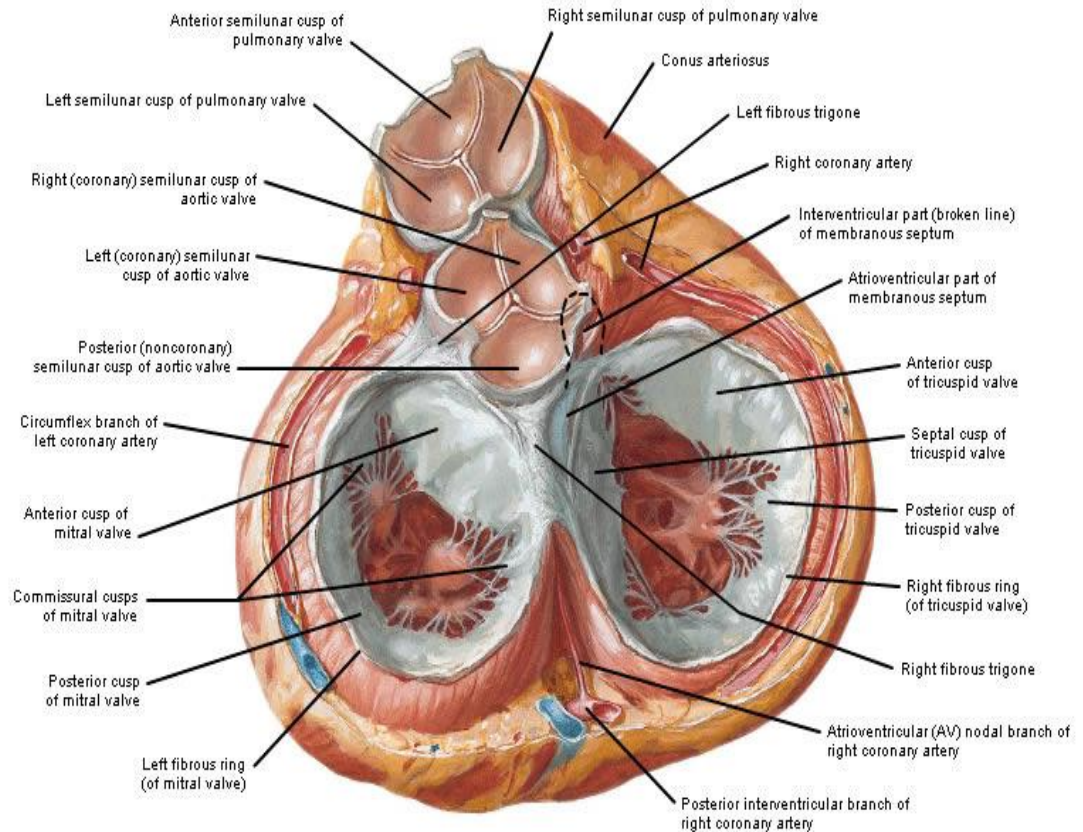


It is represented by the atrio-ventricular valves and the semilunar valves, having the role of regulating the direction of blood flow.

The atrio-ventricular valves permit the passage of the blood from the atria to the ventricles, and the semilunar valves only permit the blood passage from the ventricles to the arteries.

Pathological state of the valvular apparatus may lead to stenosis (mitral) and insufficiency(aortic).

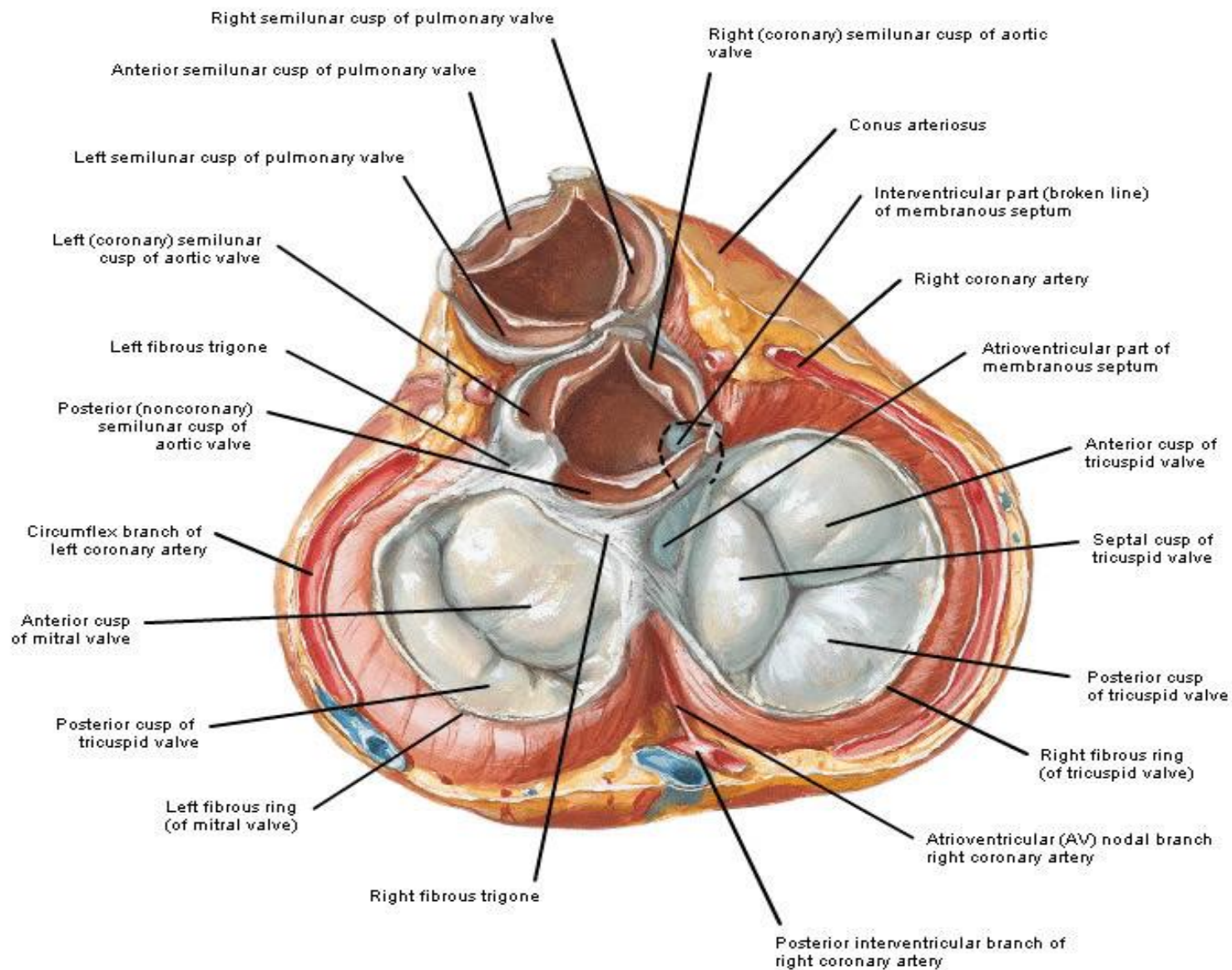
## Valves of Heart in Diastole



Viewed from base with atria removed



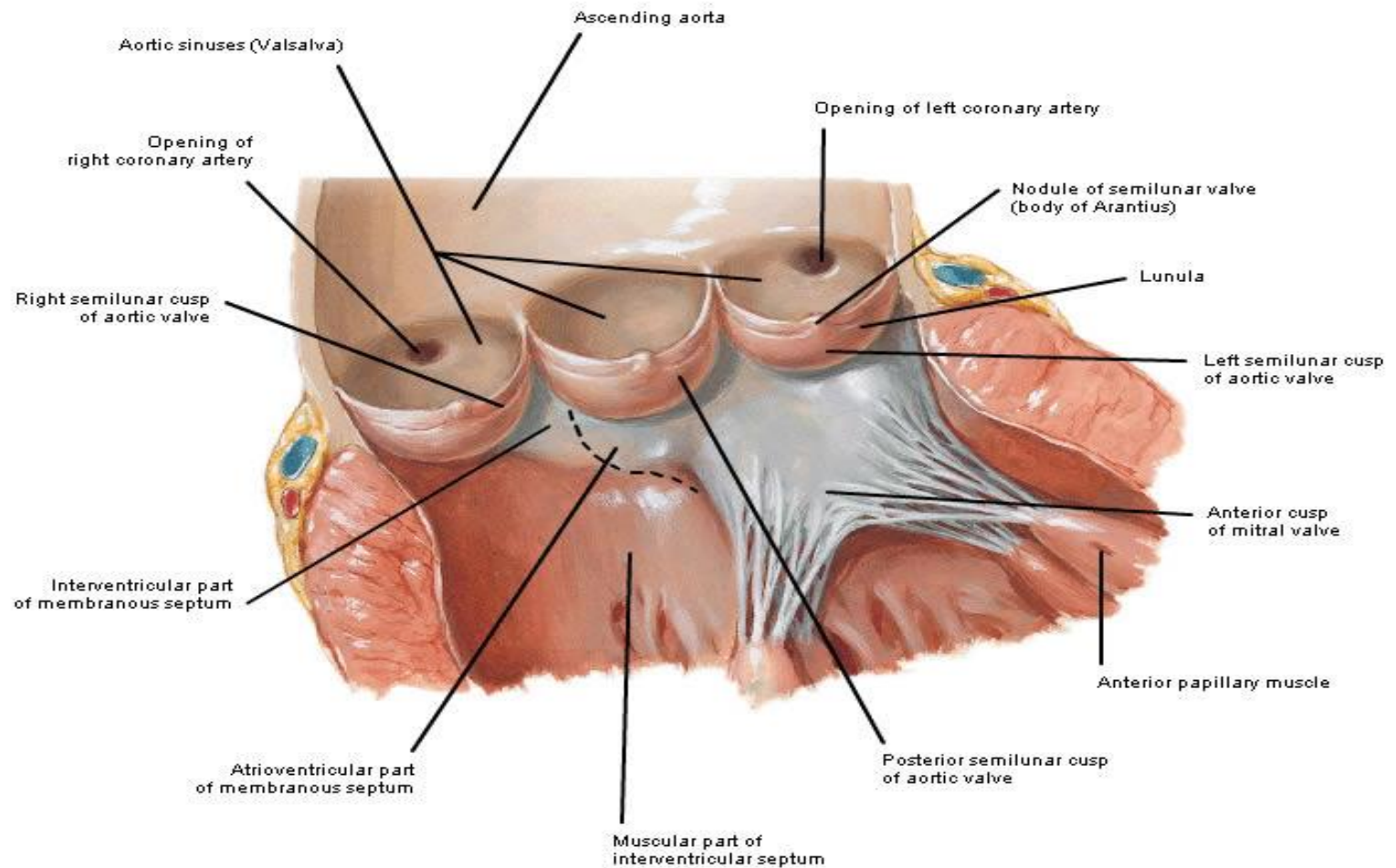
# Valves of Heart in Systole



Viewed from base with atria removed



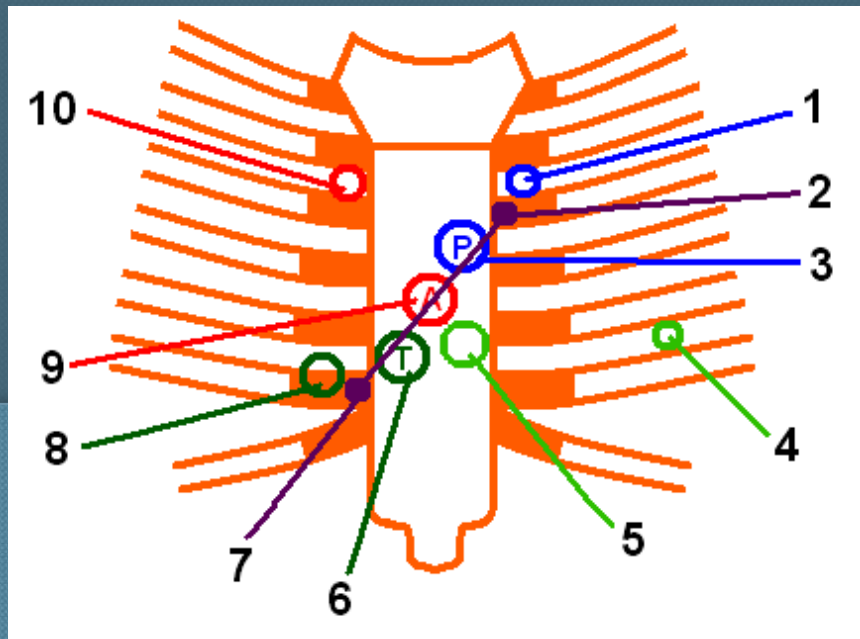
# Aortic Valve



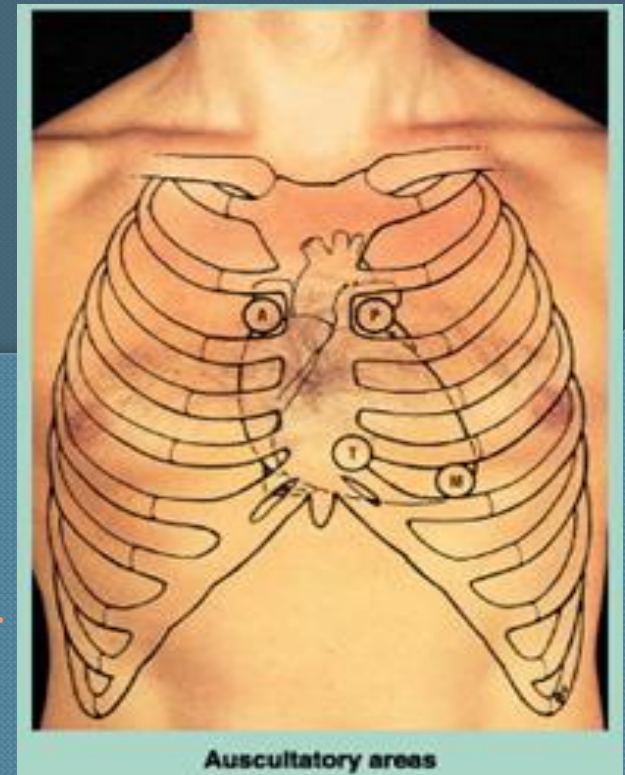
Broken line indicating level of origin of tricuspid valve on opposite side of septum



# The heart orifices and the auscultation sites.

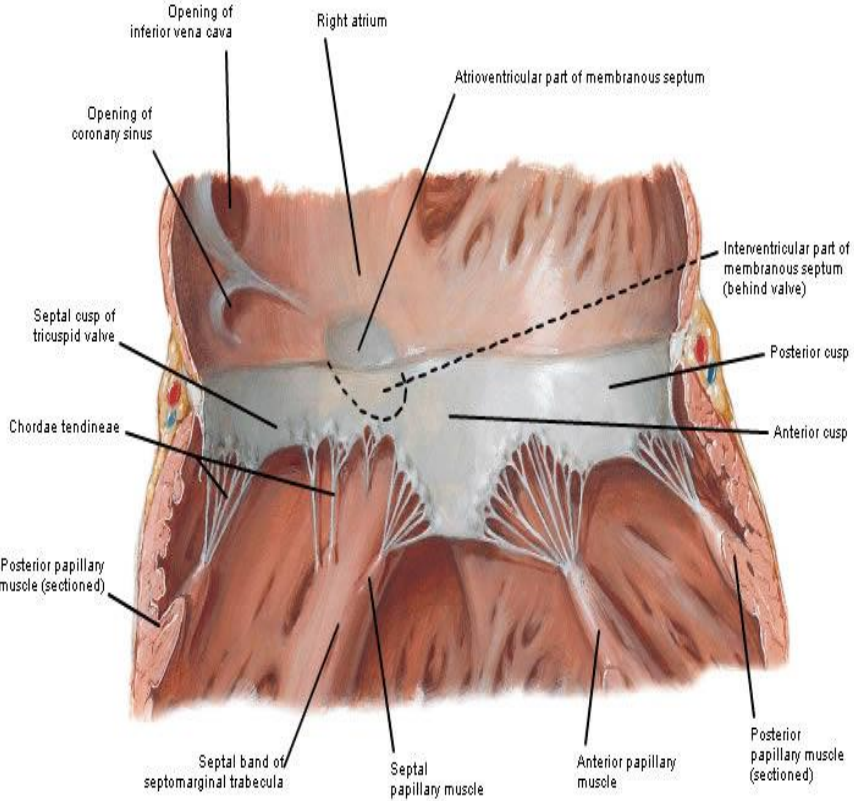


1. The pulmonary artery site in the II<sup>nd</sup> left intercostal space near the sternum.
2. 3<sup>rd</sup> left sterno-chondral joint.
3. Pulmonary artery's orrifice projection
4. Bicuspid site or mitral in the V<sup>th</sup> left intercostal space – 7 cm from the sternum on the left medio-clavicular line.
5. The mitral or bicuspid orifice projection (left atrio-ventricular).
6. Tricuspid orifice projection (right atrio-ventricular).
7. VI<sup>th</sup> right sterno-chondral joint;
8. Tricuspid site (V<sup>th</sup> right intercostal space and VI right costal cartilage)
9. Aortic orifice projection.
10. Aortic site in the II<sup>nd</sup> right intercostal space, next to the sternum.

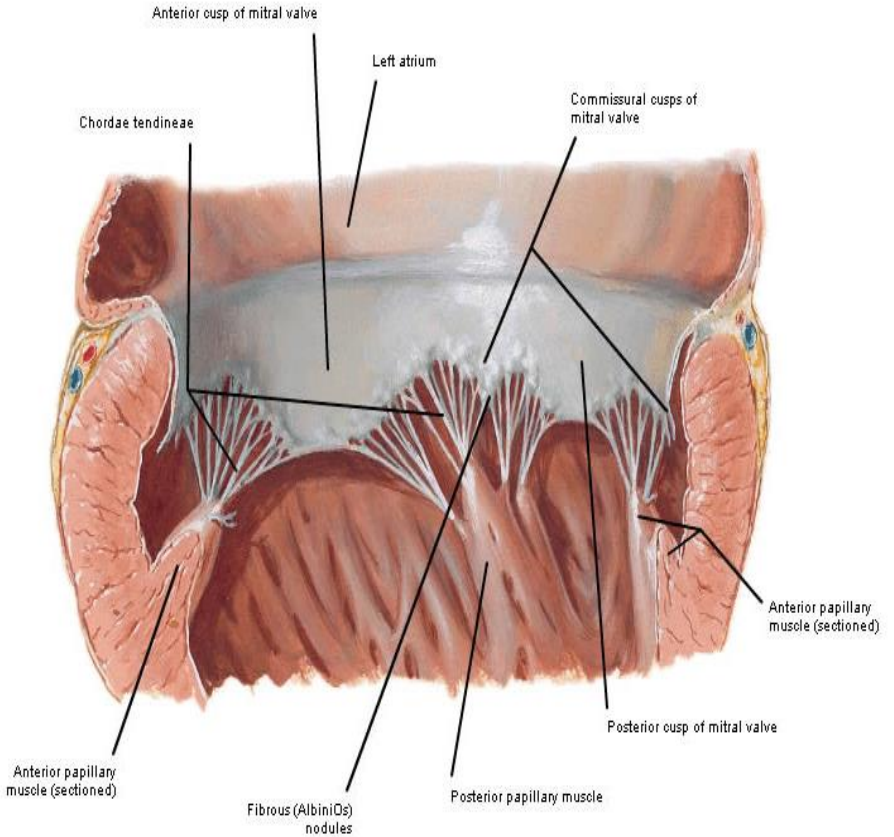




## Tricuspid (Right Atrioventricular) Valve



## Mitral (Left Atrioventricular) Valve





# THE MIOCARDIUM

The miocardium forms the heart's wall.

It is covered by the epicardium (the visceral layer of the serous pericardium) and it is lined with endocardium, which continues with the vascular endothelium at the great vessel's emergence.

The pathological state is called endocarditis.

There is an atrial and a ventricular miocardium, separated by the atrio-ventricular septum, which is the fibrous skeleton of the heart.

This separation permits the isolated contraction of the atria from the ventricles.



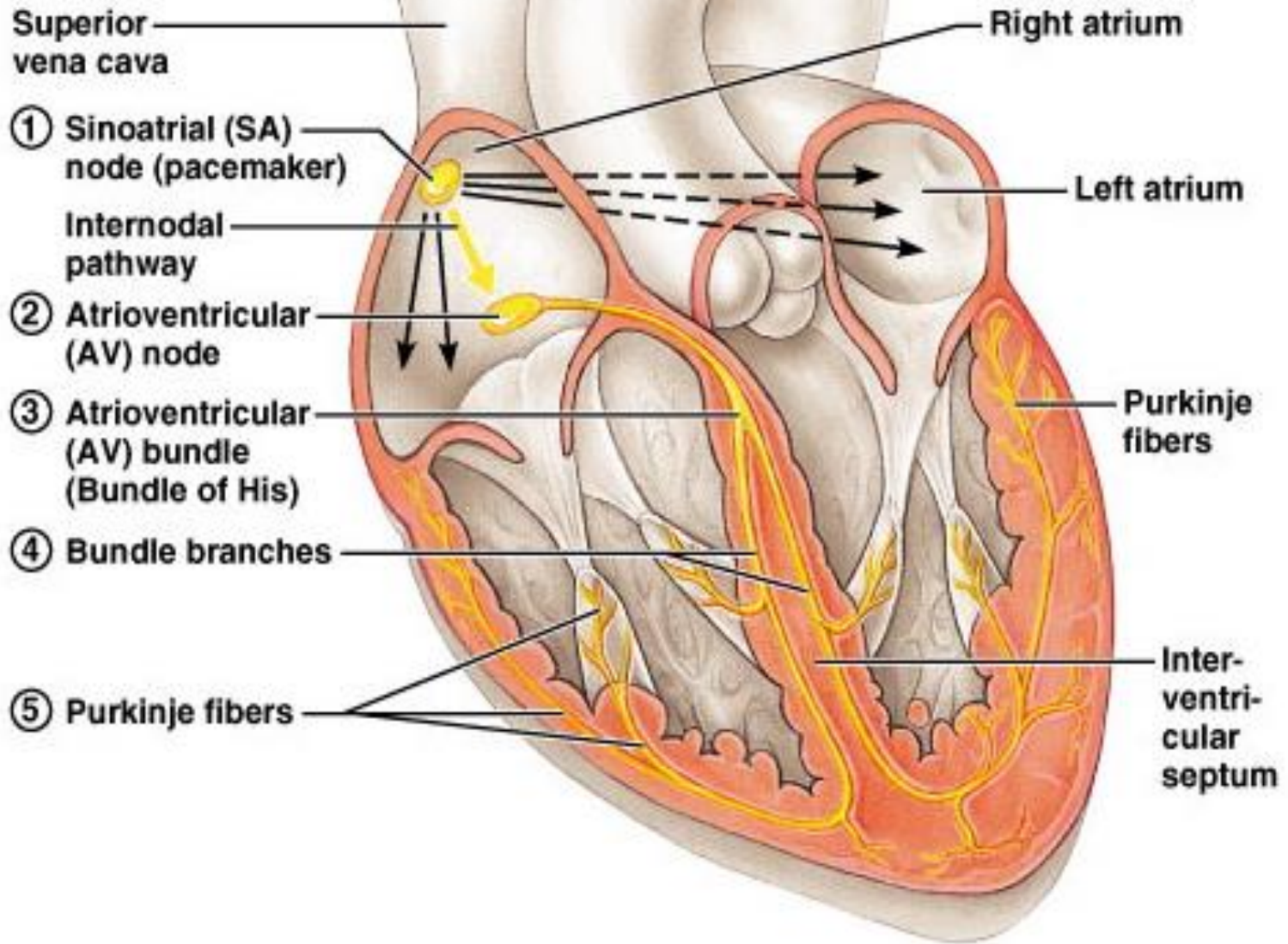
**The embryonic myocardium** constitutes the excito-conducting system which generates and transmits the nervous influxes of the heart (intrinsic innervation of the heart); it is composed of fiber trunks forming nodules, fascicles and networks.

**Sino-atrial node of Keith-Flack** is situated in the right atrium wall, between the orifices of the two cava veins, superior and inferior, closer to the superior vena cava orifice.

**Atrio-ventricular node of Ashoff-Tawara** presents two parts: an atrial one, represented by **Zahn's nodule** and a ventricular one, **the head of His's fascicle**, where the atrio-ventricular and interventricular septum meet.

His (Kent) fascicle starts in the atrio-ventricular node of Aschoff-Tawara, descends into the interventricular septum, continues with the muscular portion, bifurcates and gives birth to two branches for the two ventricles, which ramify in order to form **the Purkinje network**.







**Atrial miocardium** – the fibers of the atrial miocardium present a double architecture – the first one is common to each atrium and the other one is common to both atria.

Proper fibers of the right and left atrium – circular fibers of the two atria, playing a sphincter role.

Common fibers of the atria – ansiforme and transverse.

The ansiforme fibers straddle the atria. At the level of interatrial septum there is an ansiforme fibers condensation, forming the interatrial ansiforme fascicle.

The transverse fibers diverge at the level of the auricles, surrounding them.



**Ventricular myocardium** – plays a major role in the heart's dynamic.

It presents : external and internal spiral fibers, as well as circular fibers.

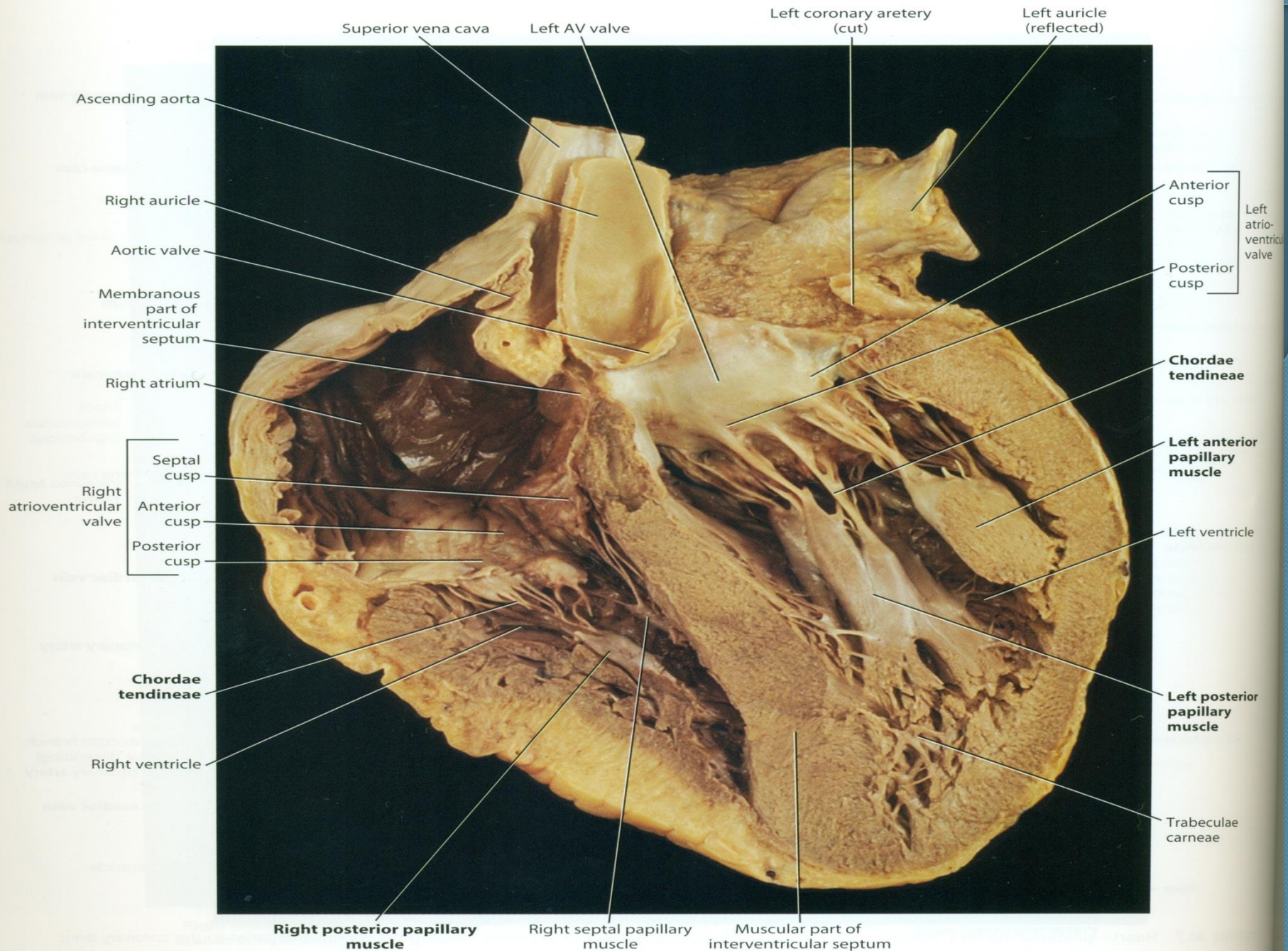
External proper ventricular spiral fibers start from the fibrous skeleton of each ventricle, present a spiral trajectory, then pass to the apex of the heart and end in the fibrous skeleton of the ventricle, but on the opposite side of the starting point.

External common ventricular spiral fibers have their origin from the fibrous skeleton of a ventricle, present a spiral trajectory and end on the fibrous skeleton on the other ventricle.

Internal spiral fibers start from the apex of the heart, from the external spiral fibers. They penetrate the interventricular septum, as the septal fibers. Between the external and internal spiral fibers there is a “V” forming, with its tip toward the heart apex, encompassing the circular fibers.

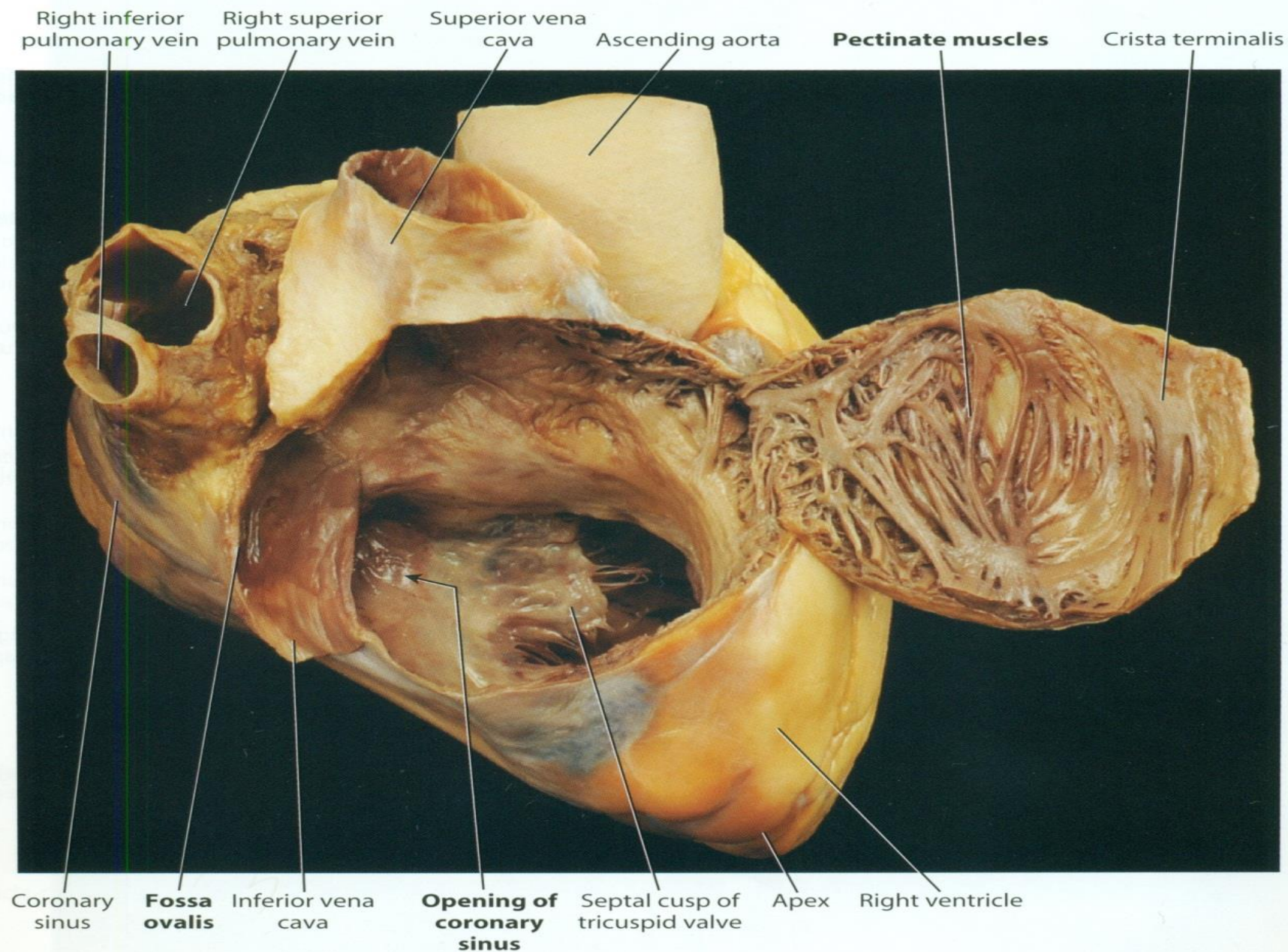
The circular fibers represent the true motive power of the heart. They are proper to each ventricle. In systole, the spiral fibers pull the atrio-ventricular septum toward the apex of the heart and then the circular fibers compress the ventricle, pushing the blood into circulation.





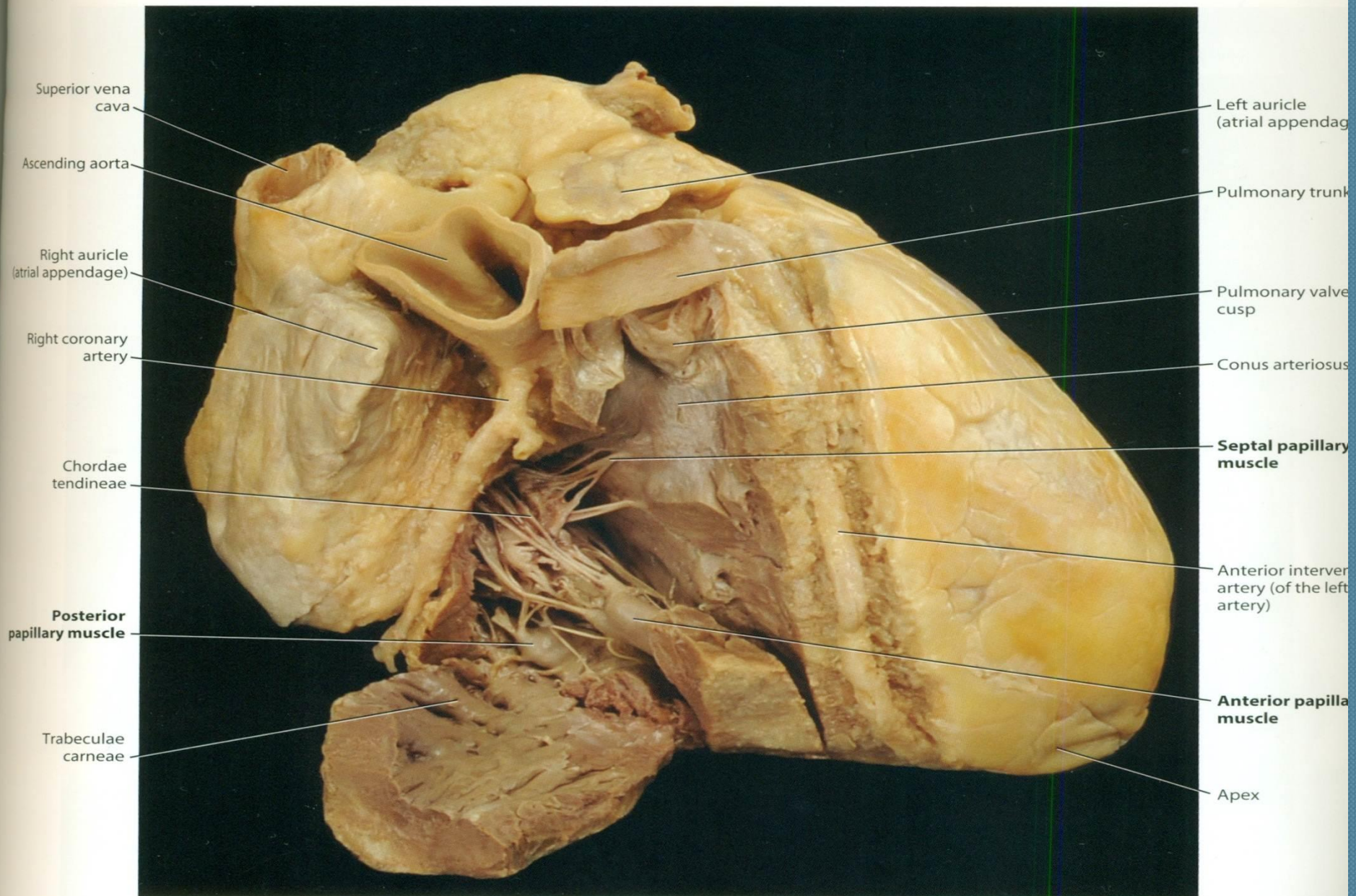
**FIGURE 30.8** Heart—posterior half. Anterior view of the posterior half of the heart showing the papillary muscles with their chordae tendineae.





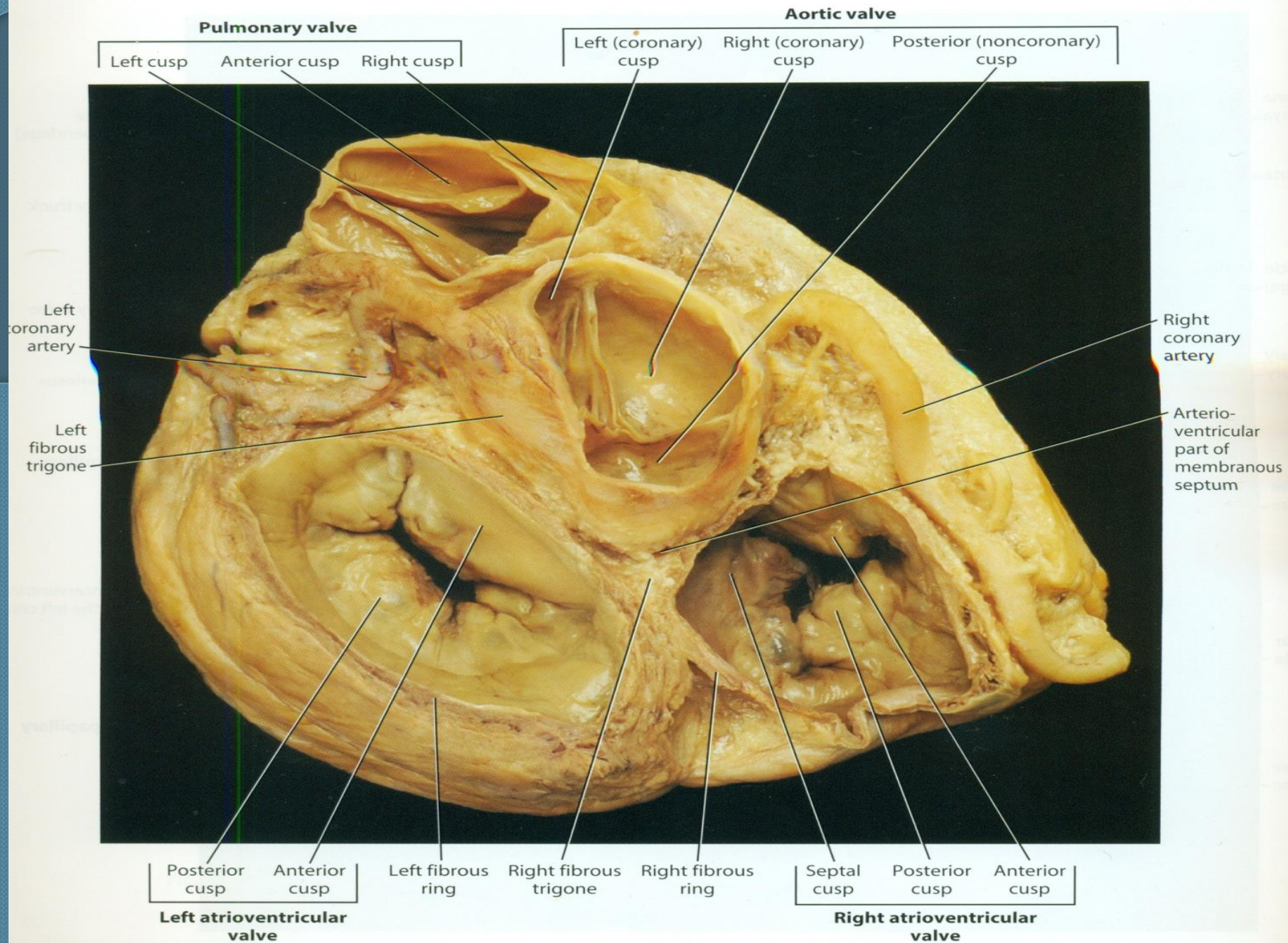
**FIGURE 30.10** Heart—right atrium. Opened right atrium from a right lateral view showing the internal features.





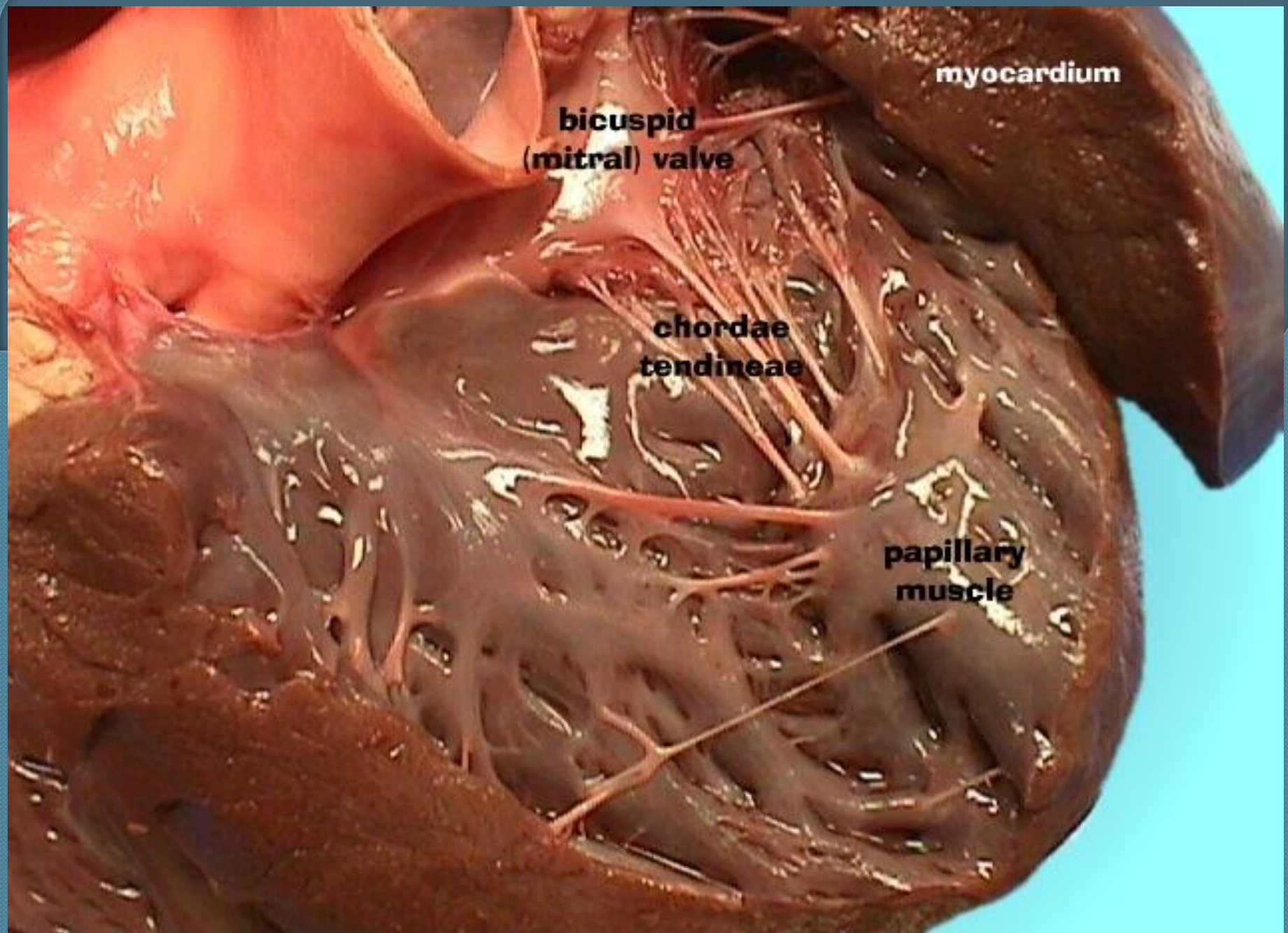
**FIGURE 30.11** Heart—right ventricle. Opened right ventricle from an anterior view showing the three papillary muscles.



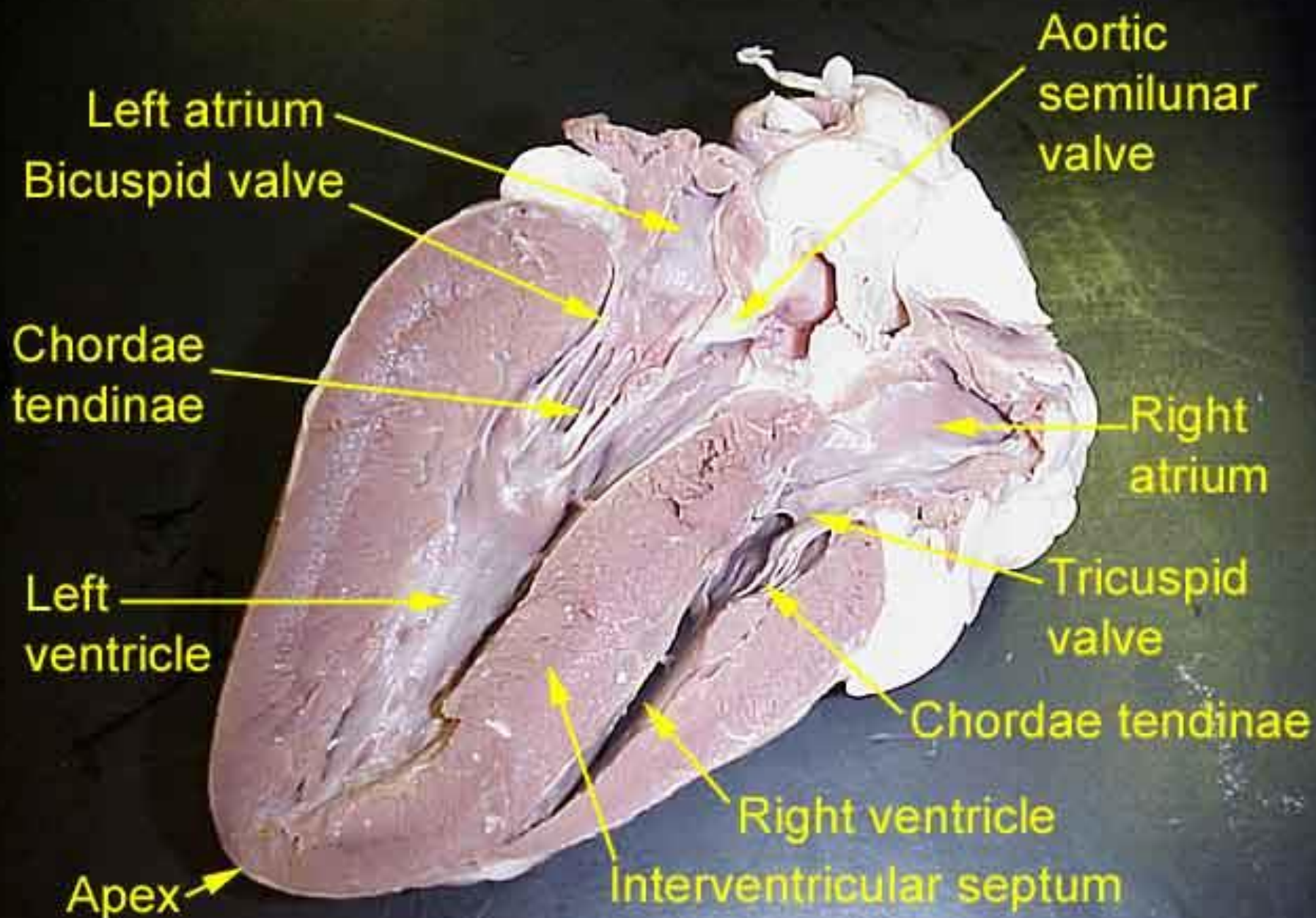


**FIGURE 30.12** Heart—valves. Superior view of the heart with the atria removed showing the 11 cusps of the four sets of valves and the fibro

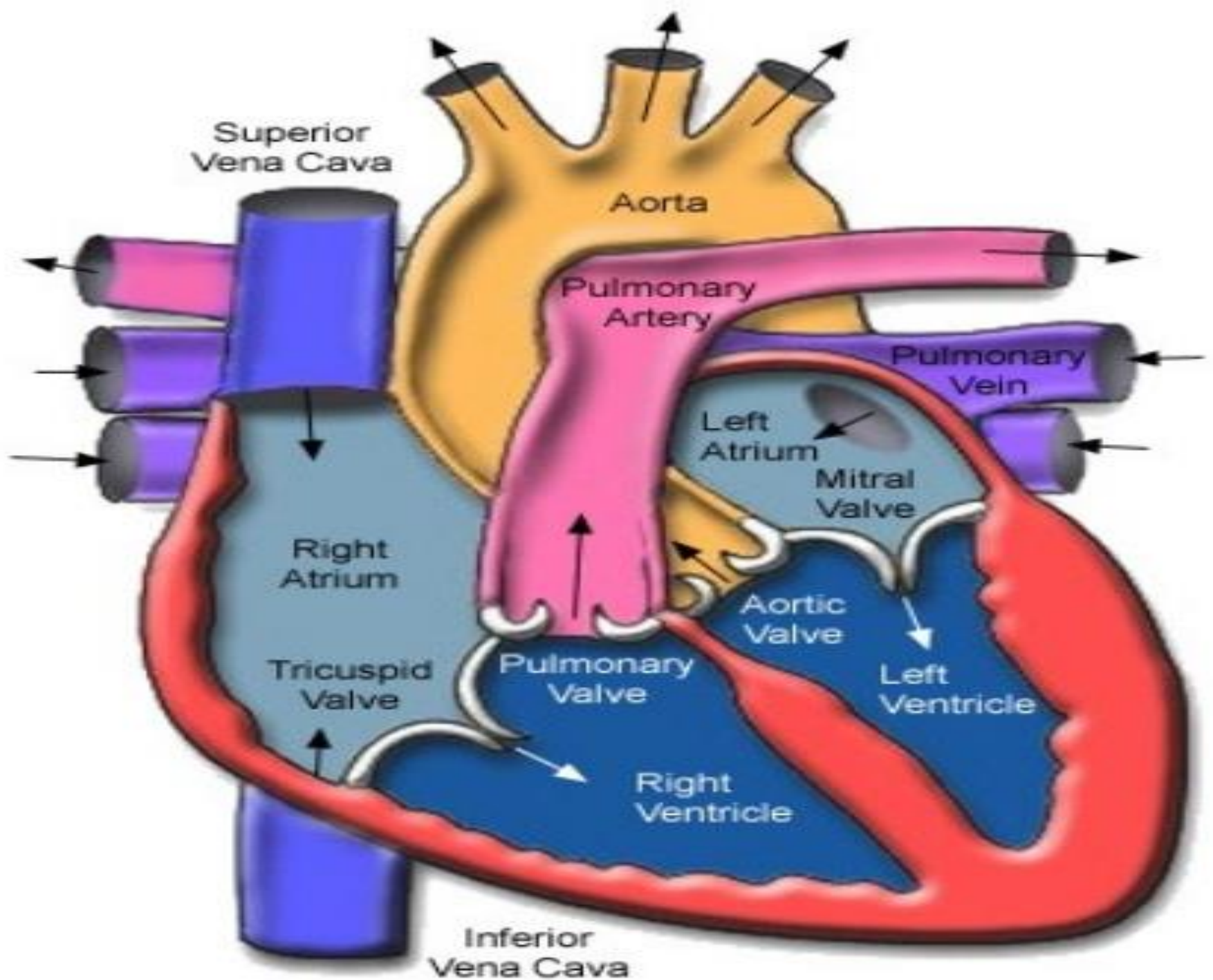




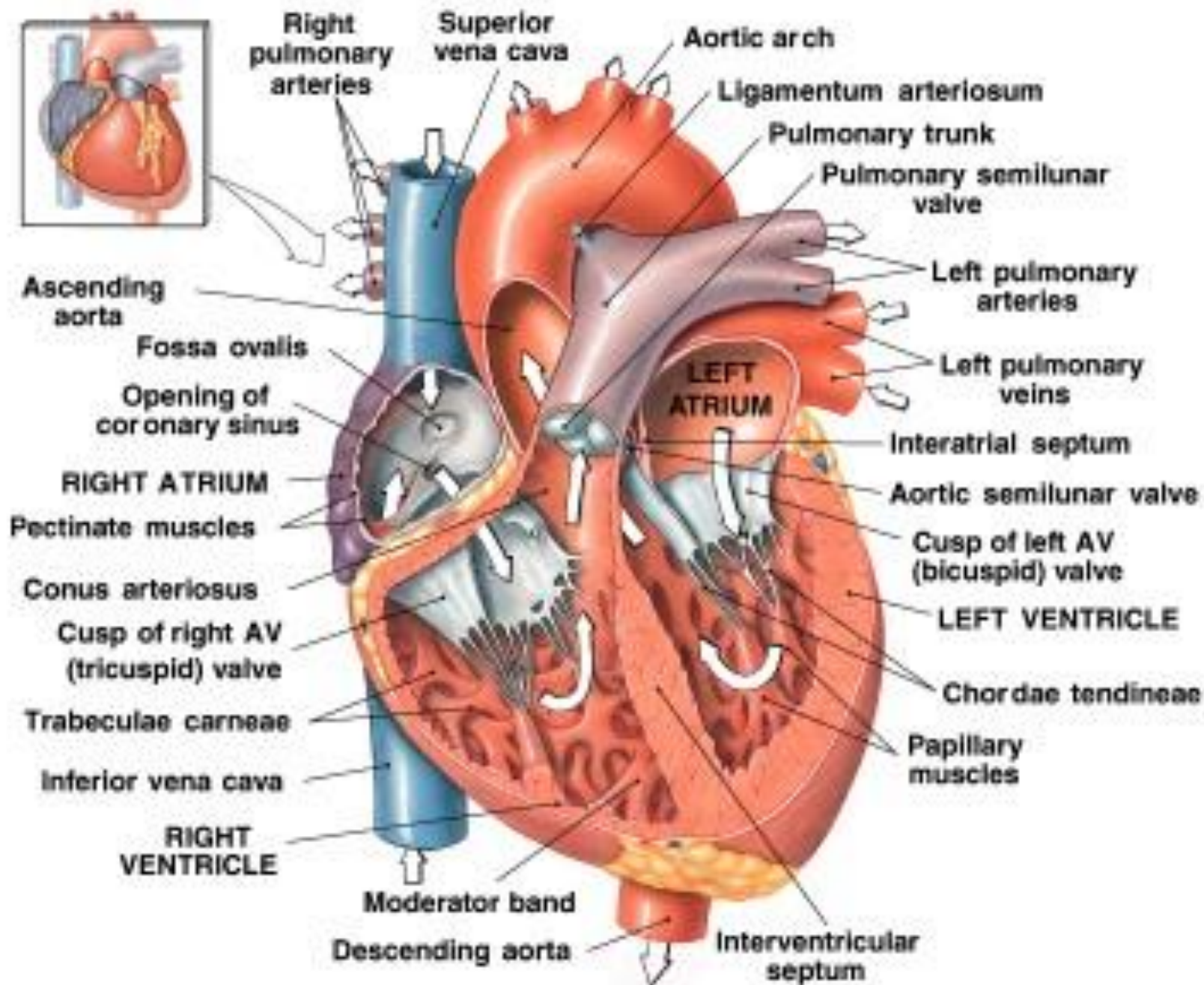












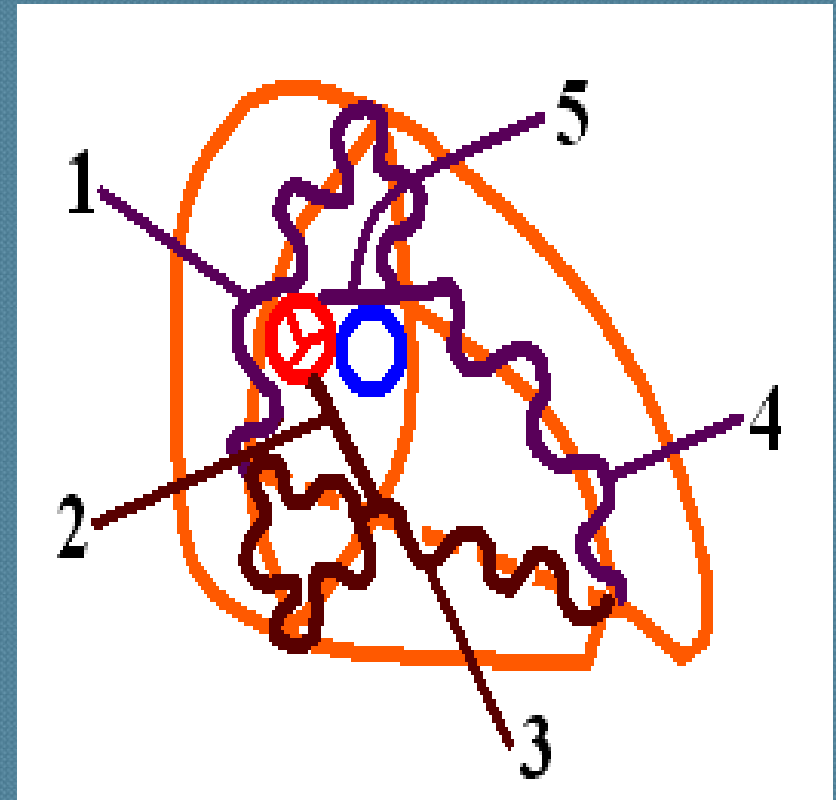


# Heart -blood and nerve supply

## *The Arteries*

The heart is supplied by the two coronary arteries, left and right, surrounding the heart like two crowns, thus given their name.

The left one supplies 75% of the whole blood flow of the miocardium.



1. Circumflex artery or atrio-ventricular (25%).
2. Right coronary artery (25%).
3. Posterior interventricular artery.
4. Anterior interventricular artery (50%).
5. Left coronary artery (75%).



**The left coronary artery** rises from the arch of the aorta, passing through an orifice situated above the left semilunar valve.

From its origin it has an oblique direction, inferiorly and to the left, passing posterior to the pulmonary artery trunk.

After a short trajectory it reaches the anterior coronary sinus, where it bifurcates, giving birth to **the anterior interventricular artery**, which is also known as the “sudden death artery” **and the circumflex artery or atrio-ventricular.**



**The right coronary artery** starts from the arch of the aorta through an orrifice situated right above the right semilunar valve.

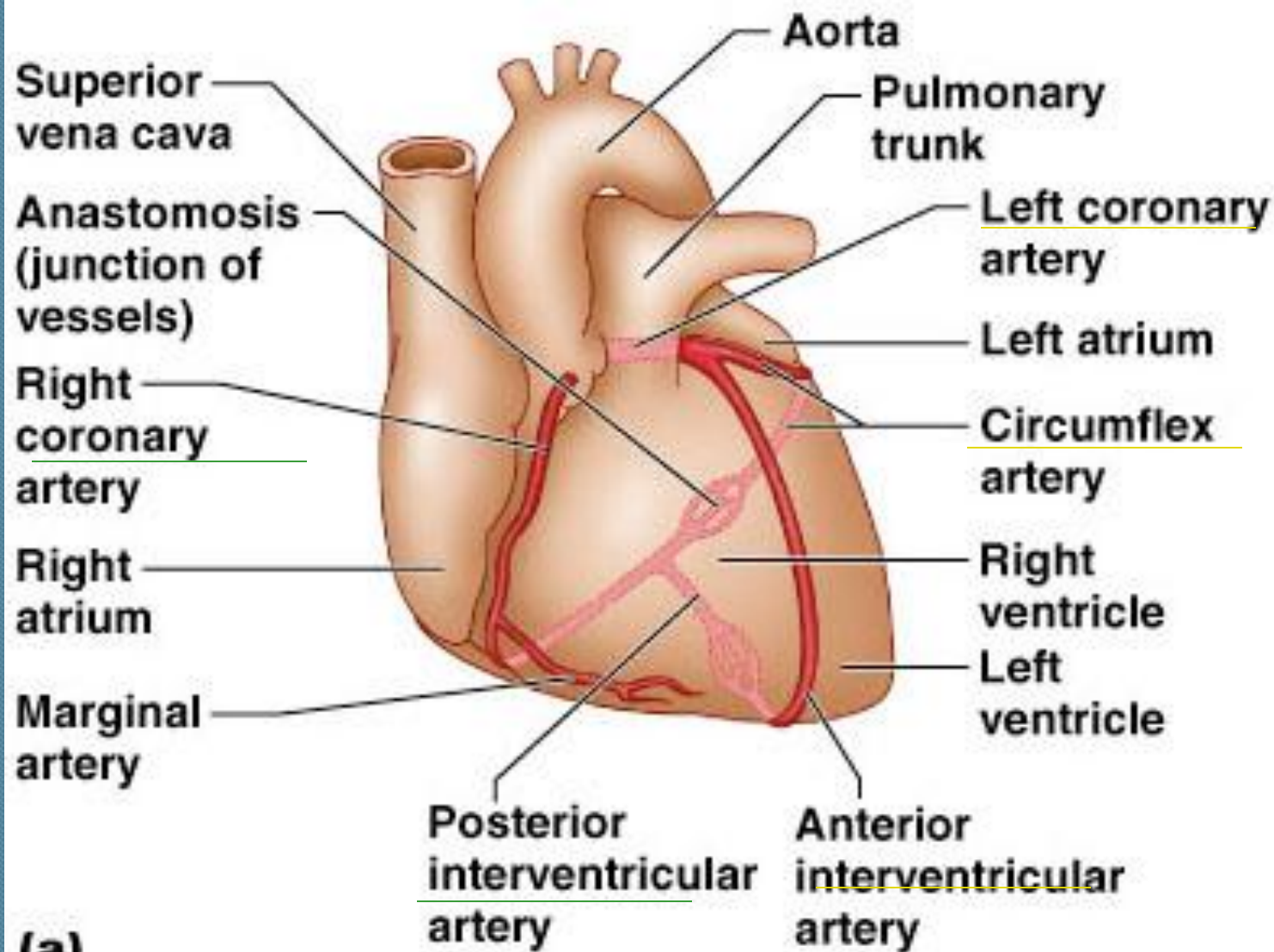
From its origin it descends between the right auricle and the beginning of the pulmonary trunk.

It reaches the anterior coronary groove where it turns right, passing through the right portion of this groove, then it surrounds the right margin of the heart, passes into the posterior coronary groove, reaching the posterior interventricular groove and then it descends toward the apex on the heart.

Its last portion is known as **the posterior interventricular artery**.

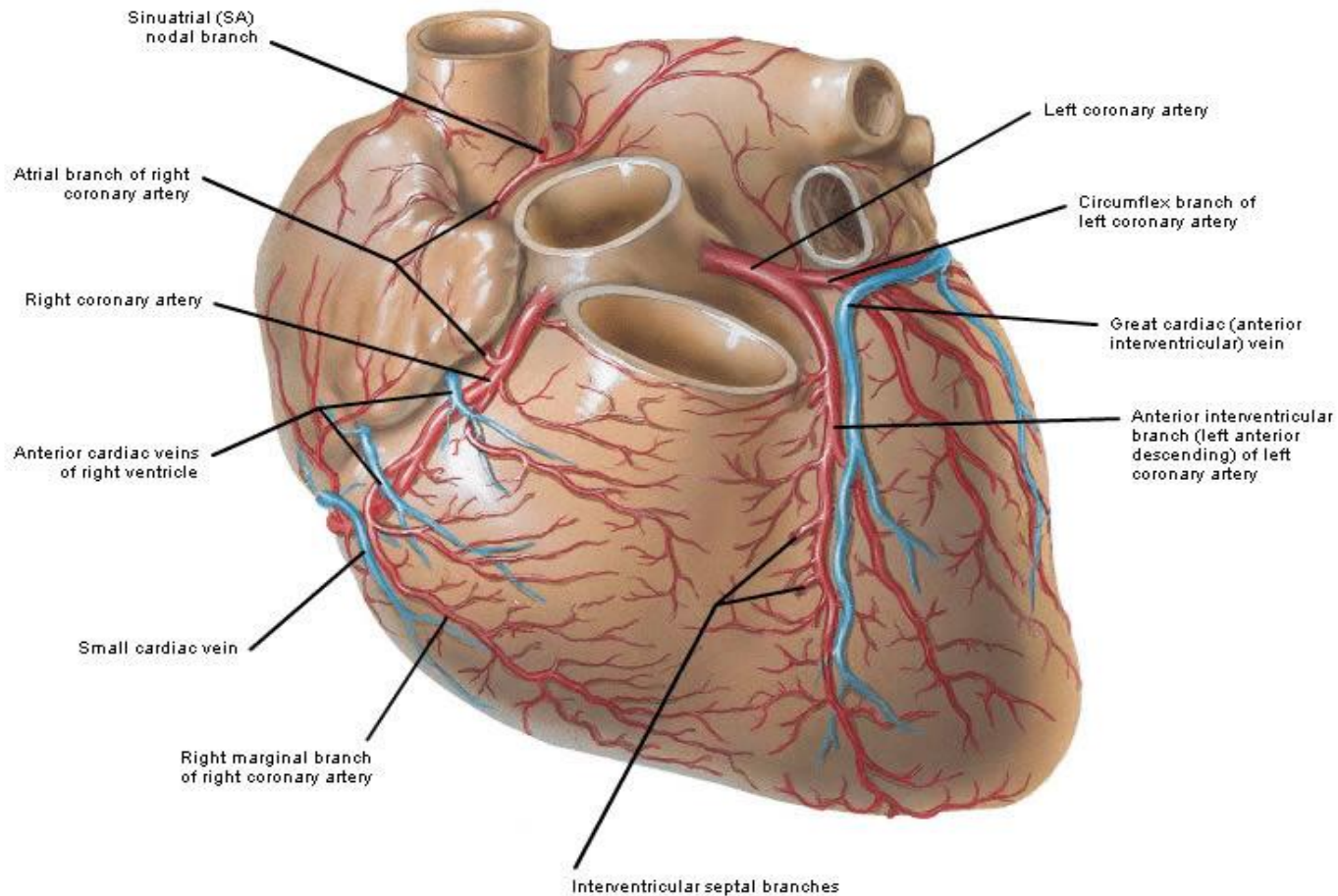
It supplies 25% of the heart blood.







## Coronary Arteries and Cardiac Veins Sternocostal Surface



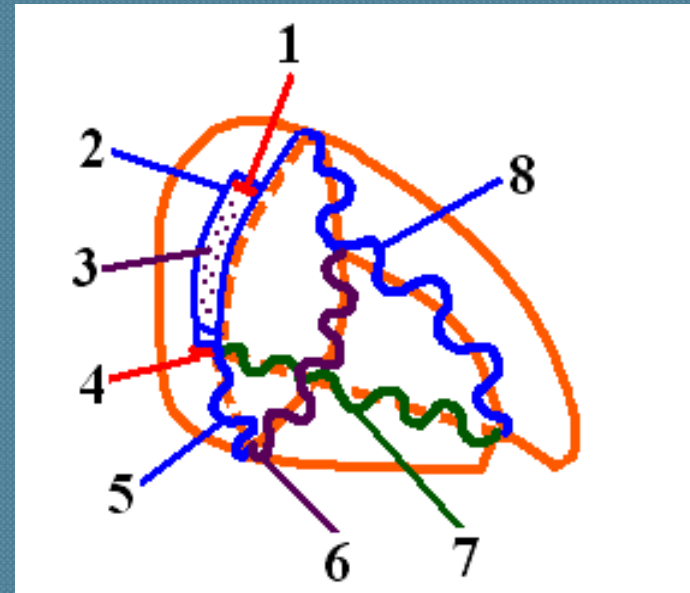


## *The Veins*

**The great cardiac vein** collects the vast majority of the venous blood of the heart.

It has its origin at the apex of the heart, travels through the anterior interventricular groove, turns laterally toward the left side, passes through the left portion of the anterior coronary groove, until it reaches the posterior coronary groove and continues with a dilated portion – the coronary sinus.

In its proximal part it presents the Vieussens valve and in its distal part it presents the Thebesius valve, opening into the right atrium.



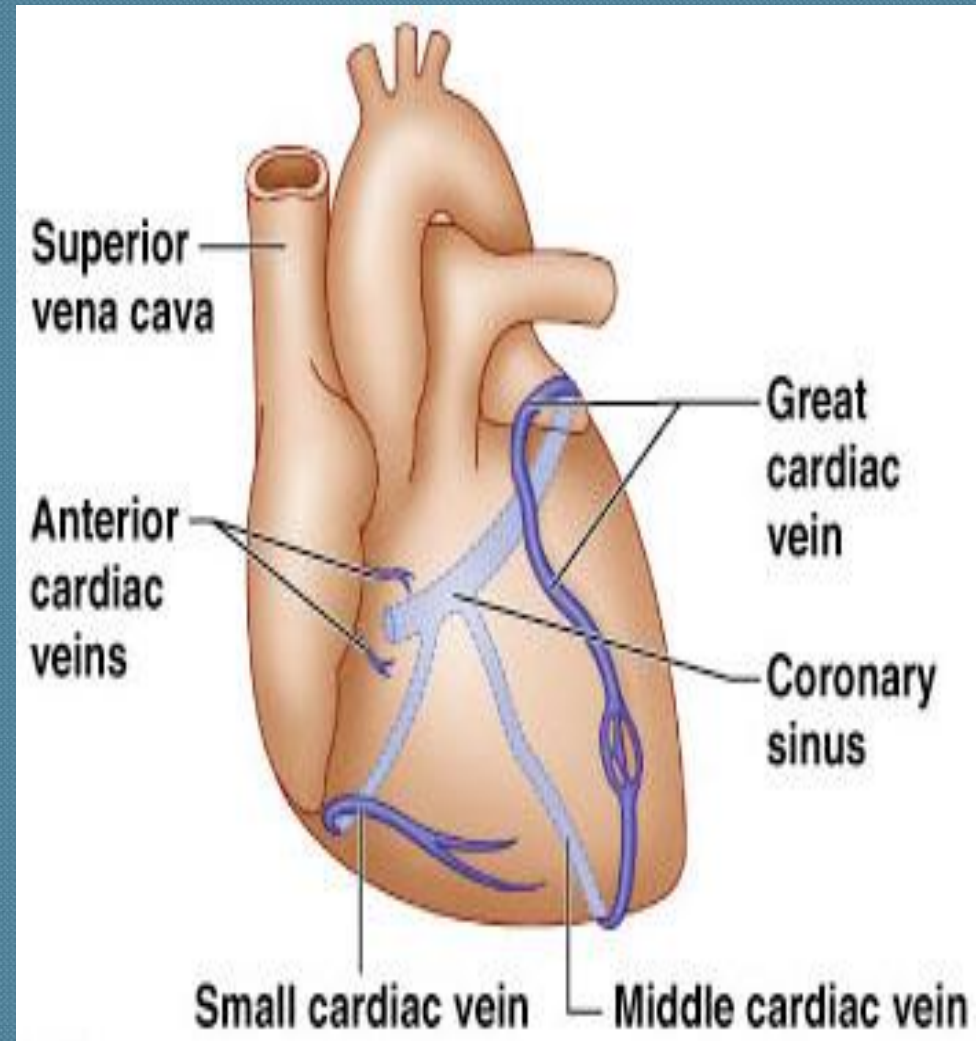
1. Vieussens valve.
2. Coronary sinus
3. Laux and Marshall valves.
4. Thebesius valve.
5. Small coronary vein.
6. Right anterior atrio-ventricular vein.
7. Posterior interventricular vein.
8. Great coronary vein.



**The small cardiac vein** begins at the right border of the heart, travels through the right portion of the posterior coronary groove and drains into the coronary sinus.

**The posterior interventricular vein** begins at the apex of the heart, travels through the posterior interventricular groove and drains into the coronary sinus.

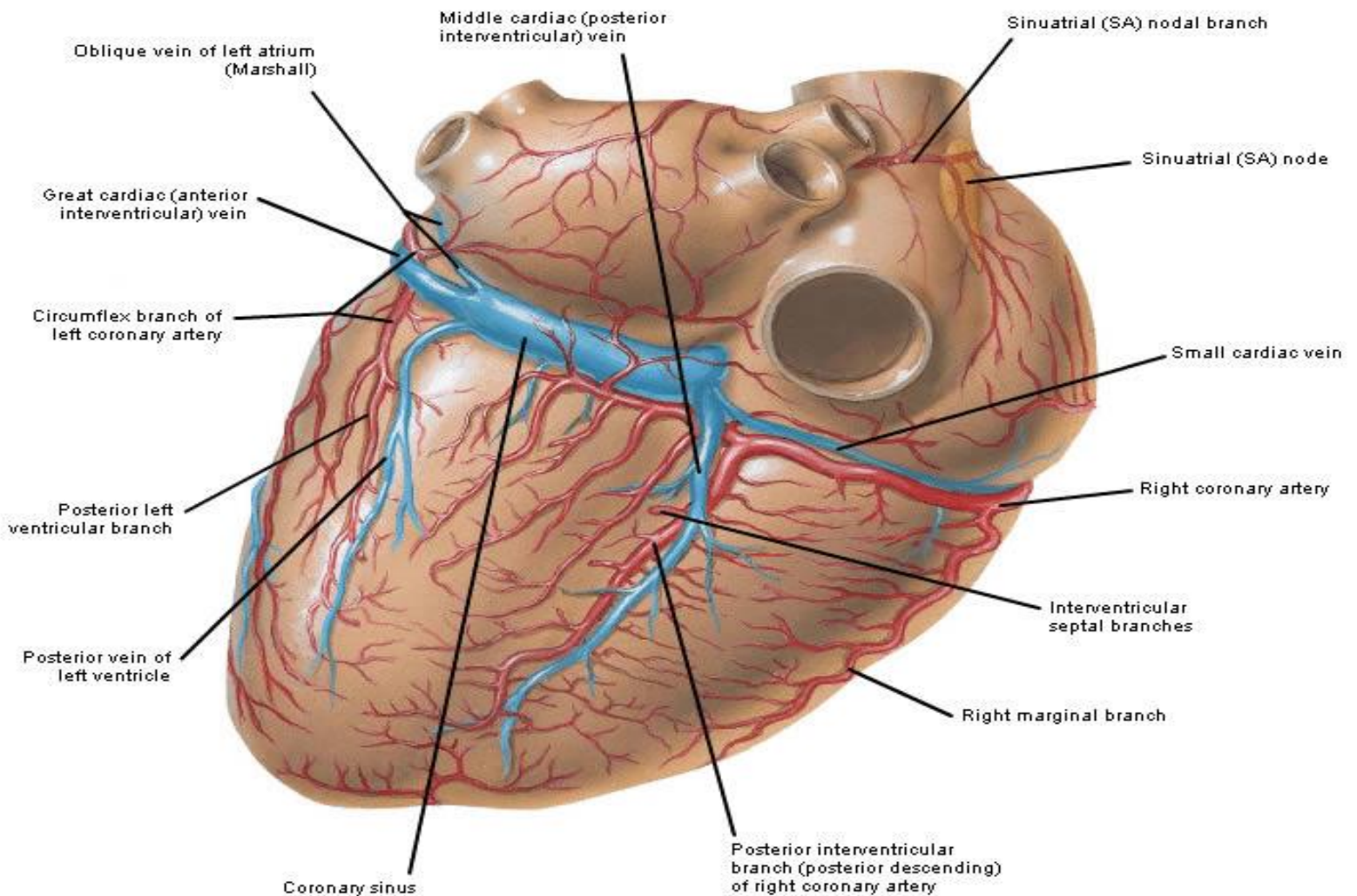
**The right anterior atrio-ventricular vein**  
Has its origin at the right border of the heart, travels through the right portion of the anterior coronary groove and drains into the great coronary vein.





# Coronary Arteries and Cardiac Veins

## Diaphragmatic Surface





# The Lymphatics

The heart presents three lymphatic networks:

- Subendocardic network;
- Miocardic network;
- Subpericardic network;

Through the three lymphatic networks the lymph drains toward two lymphatic ducts – the right and the left one, presenting 1-3 lymphatic nodes .

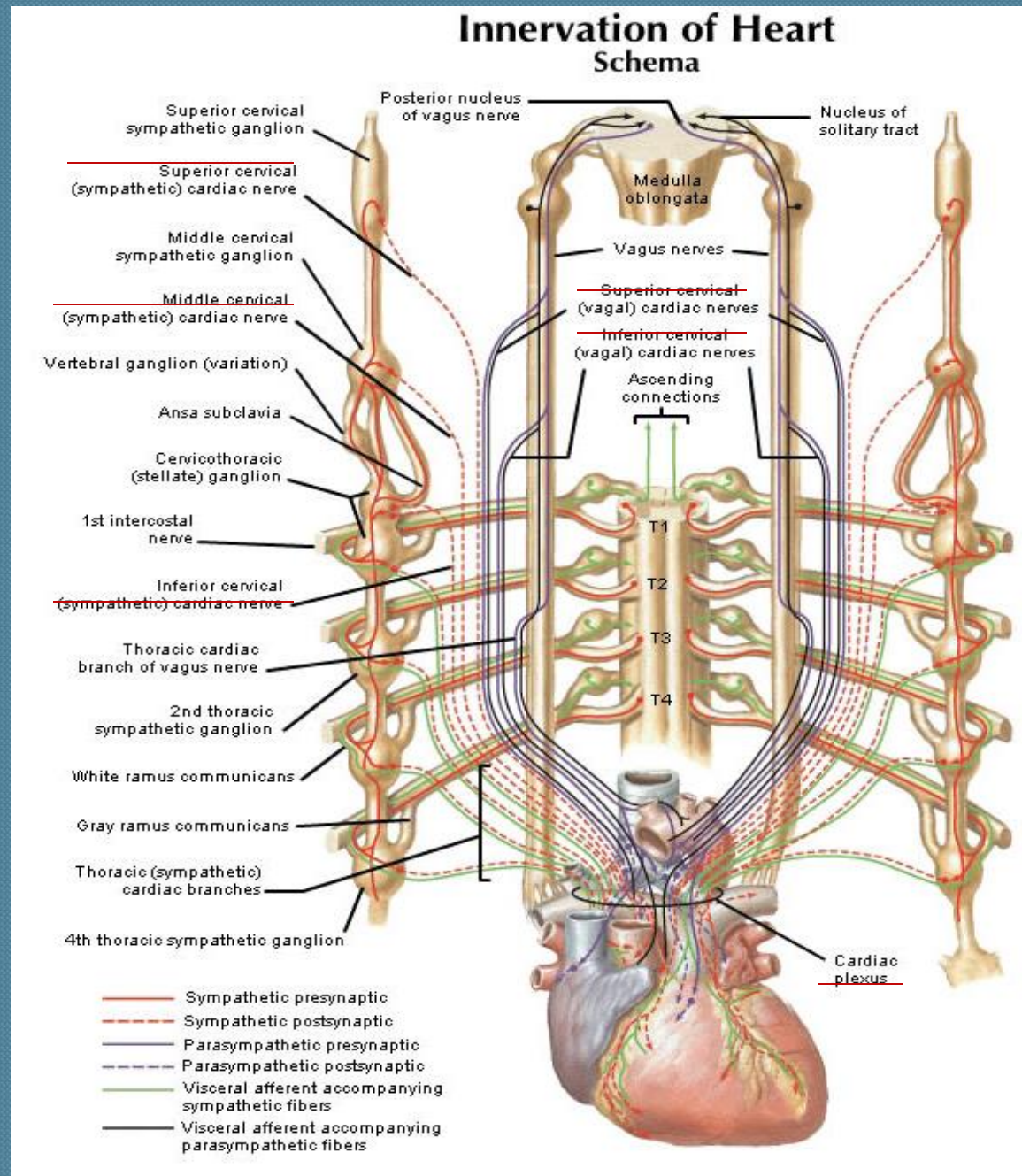
The right lymphatic duct drains into the anterior mediastinal lymph nodes and the left duct drains into the tracheo-bronchic lymph nodes.



# Innervation

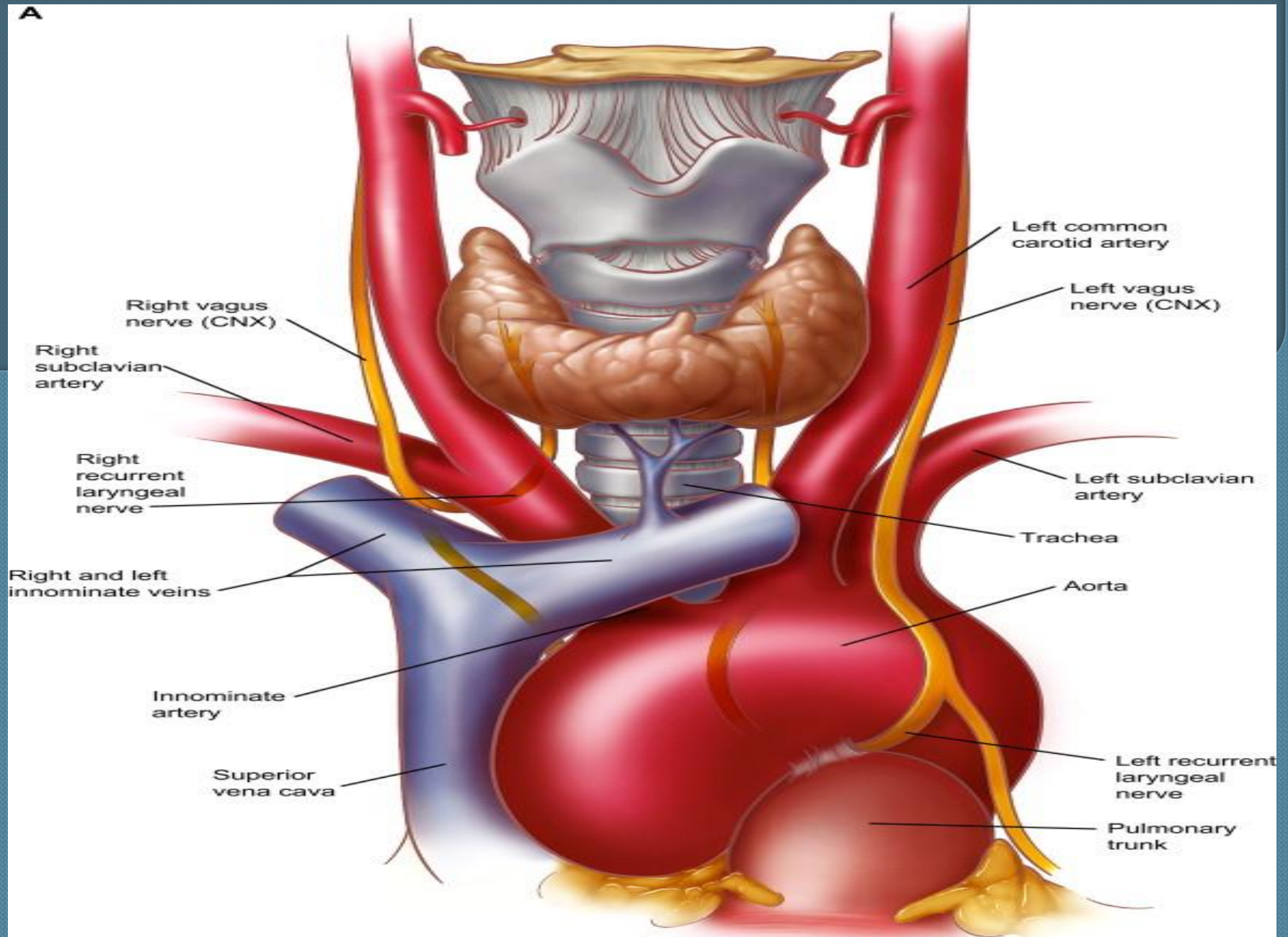
The heart presents a double innervation, intrinsic and extrinsic.

- **The intrinsic innervation** is ensured by the excito-conducting system, ensuring the heart automatism;
- **The extrinsic innervation** is given by the sympathetic and parasympathetic nervous vegetative fibers from the cardiac plexus, parasympathetic fibers from the vagus nerve and sympathetic fibers from the cervical plexus.

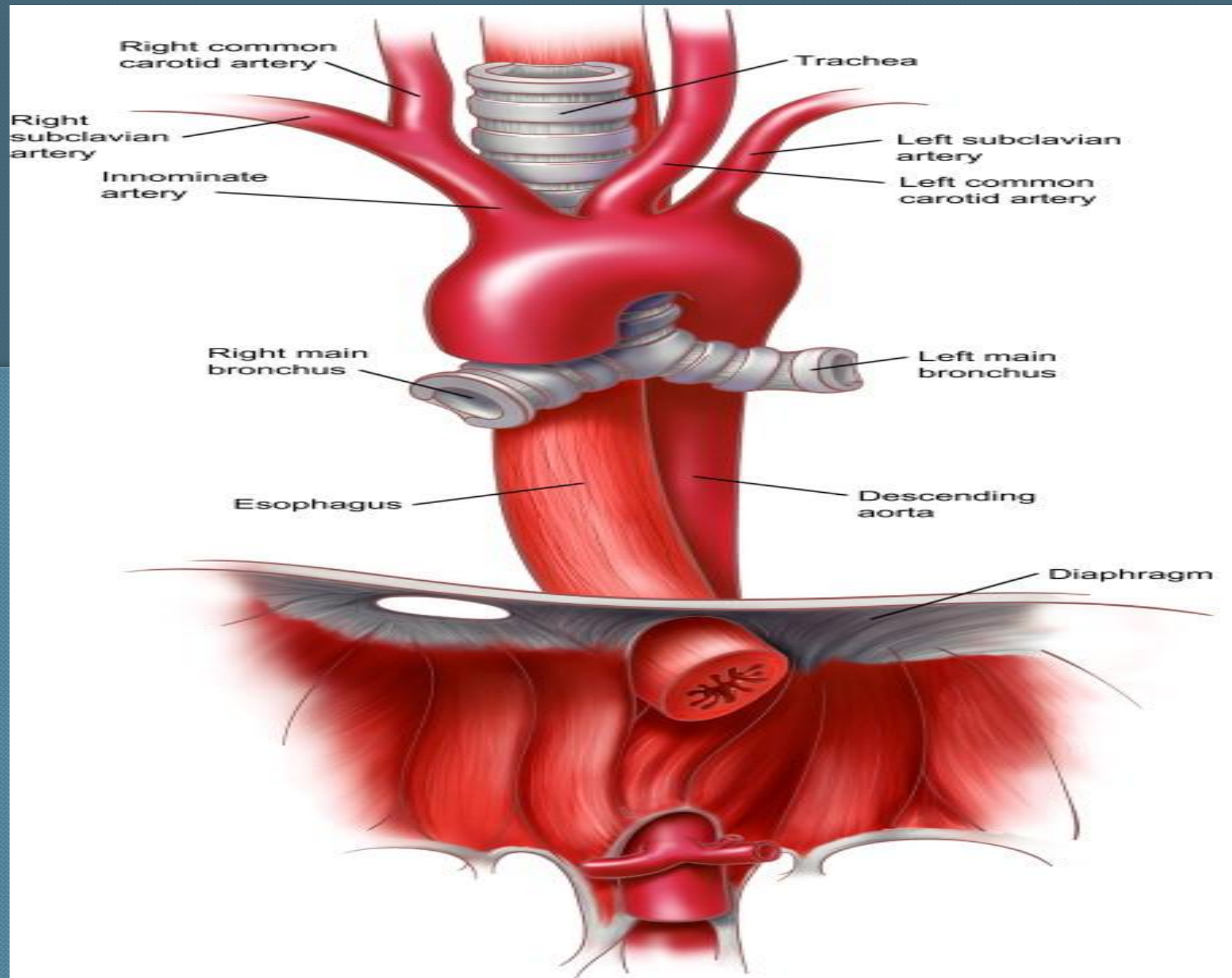




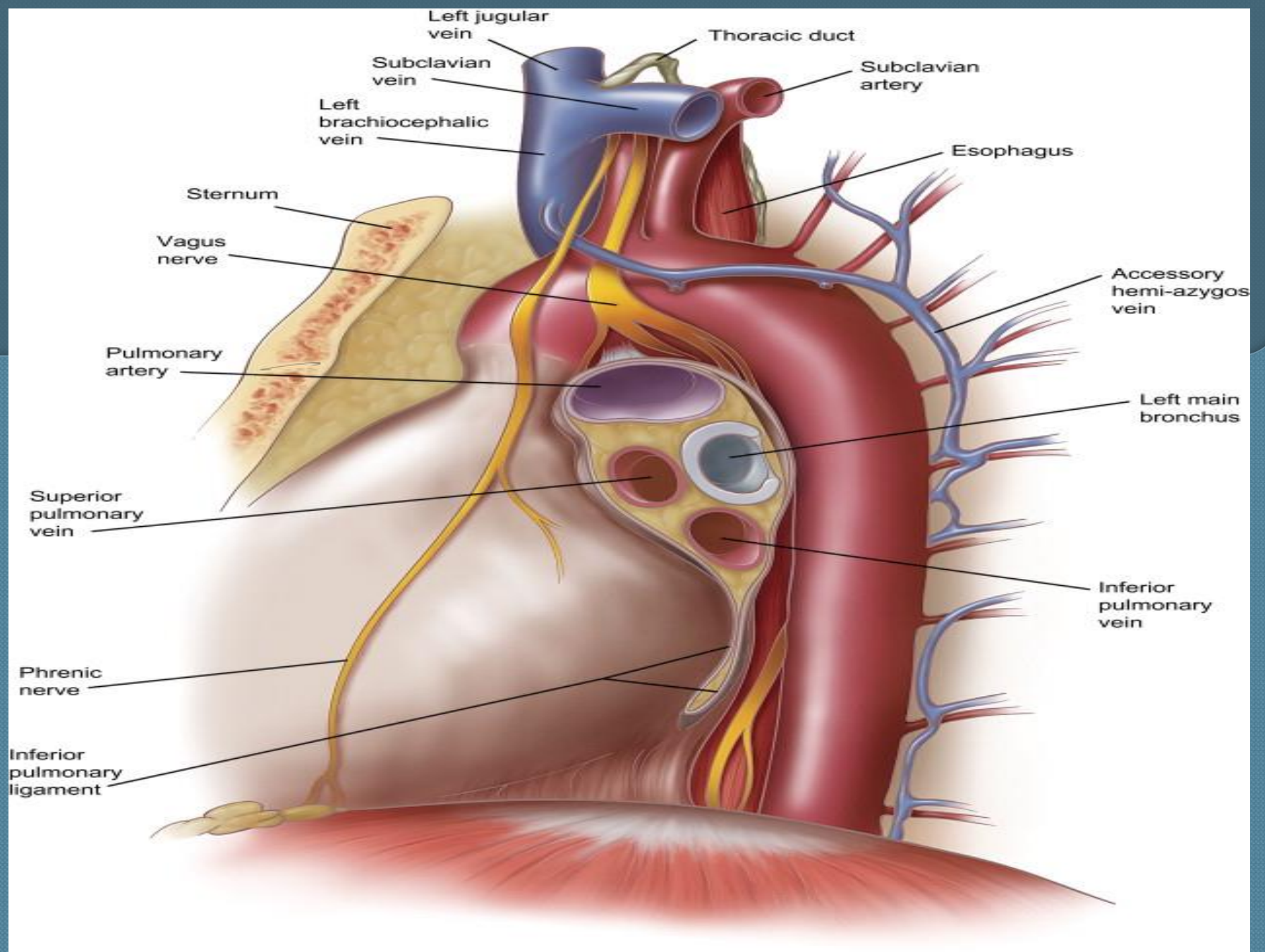
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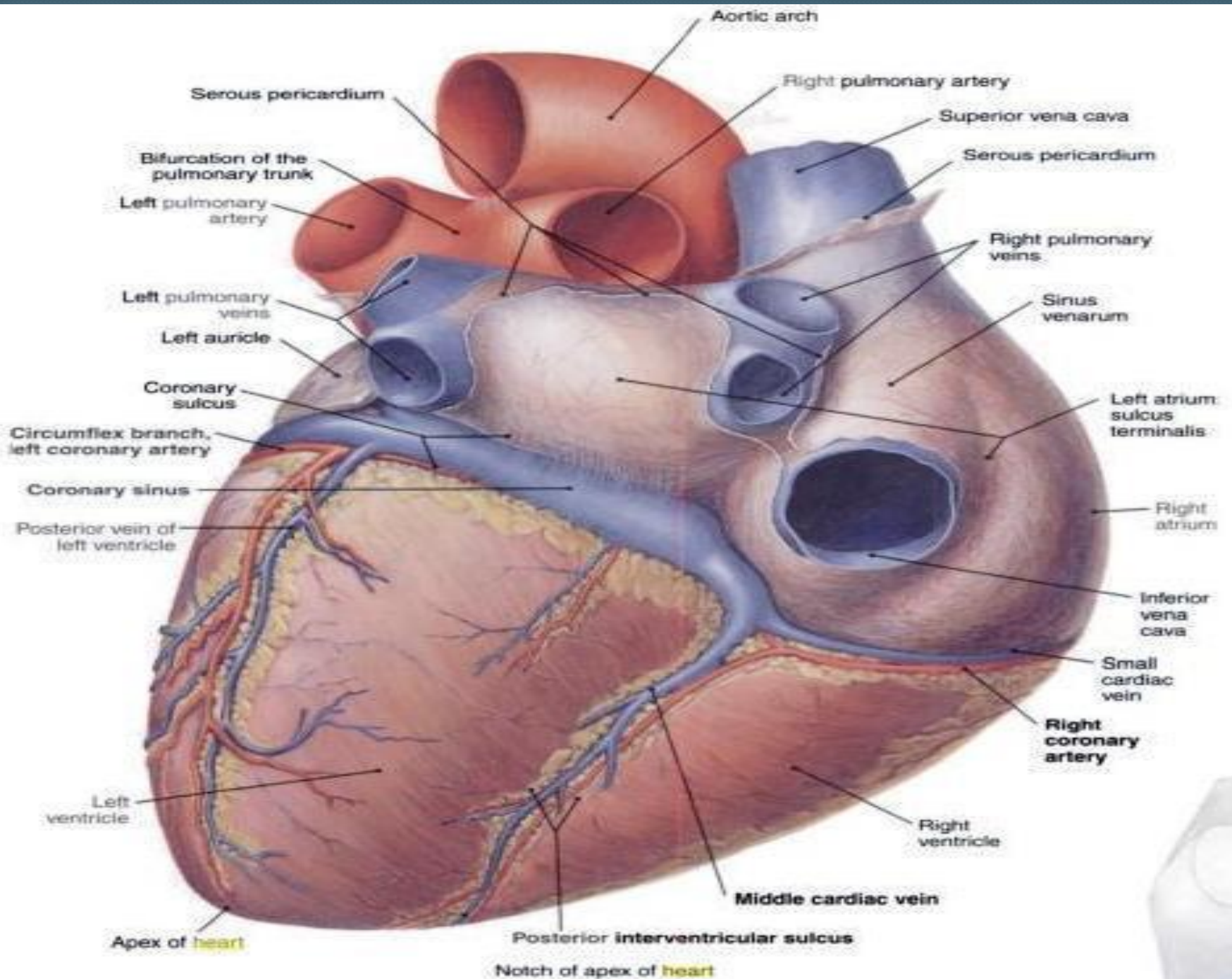






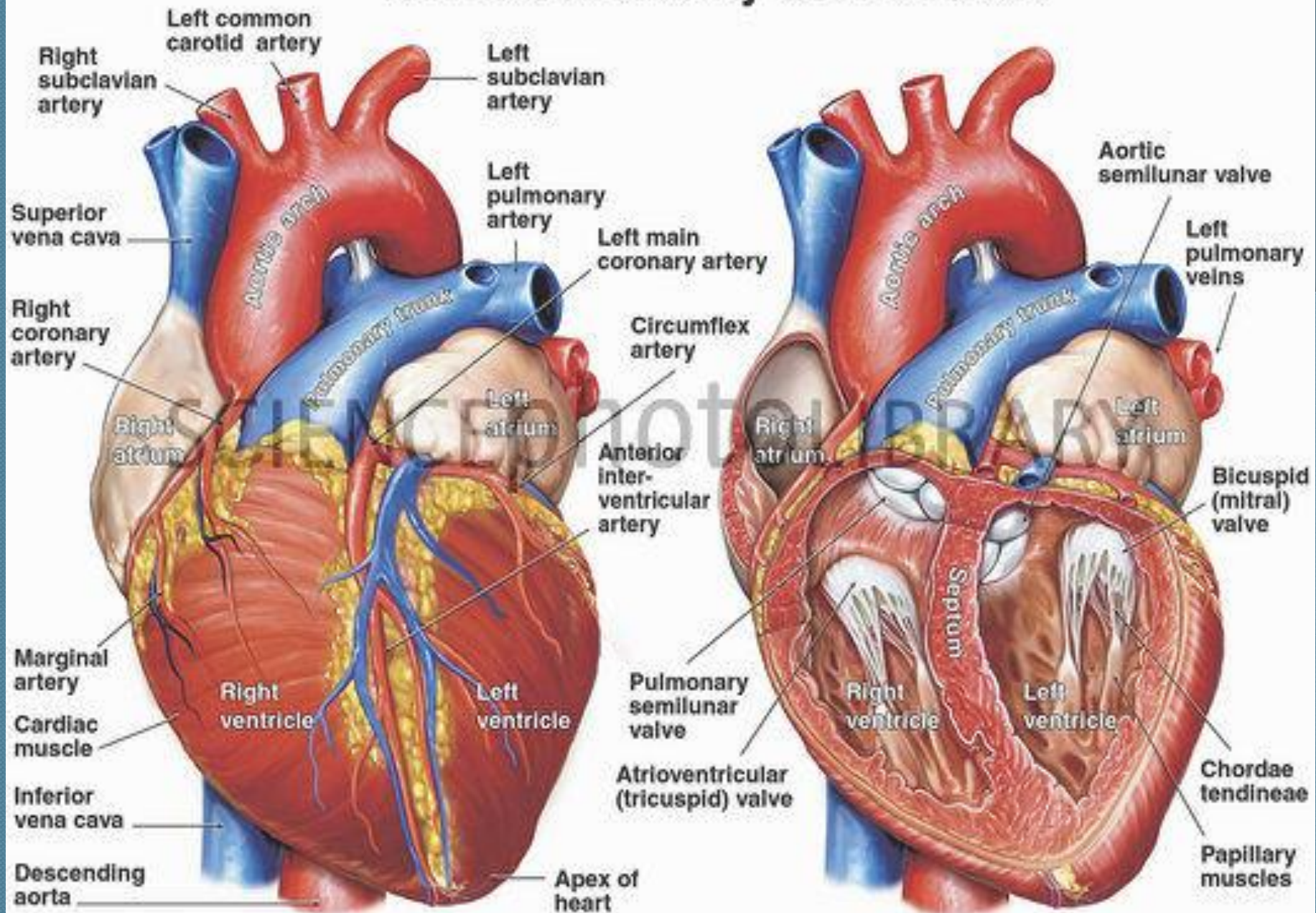




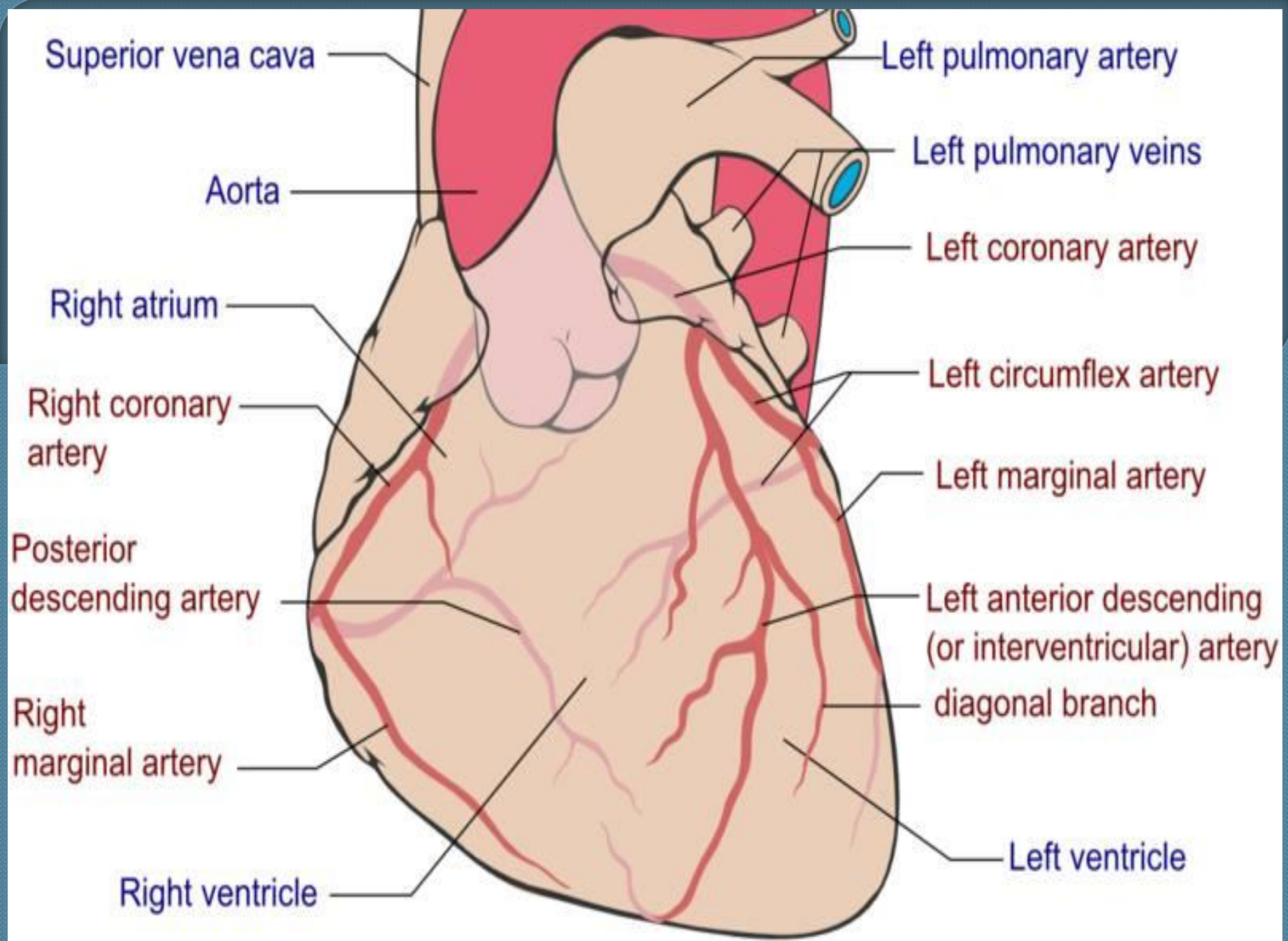




# Normal Anatomy of the Heart

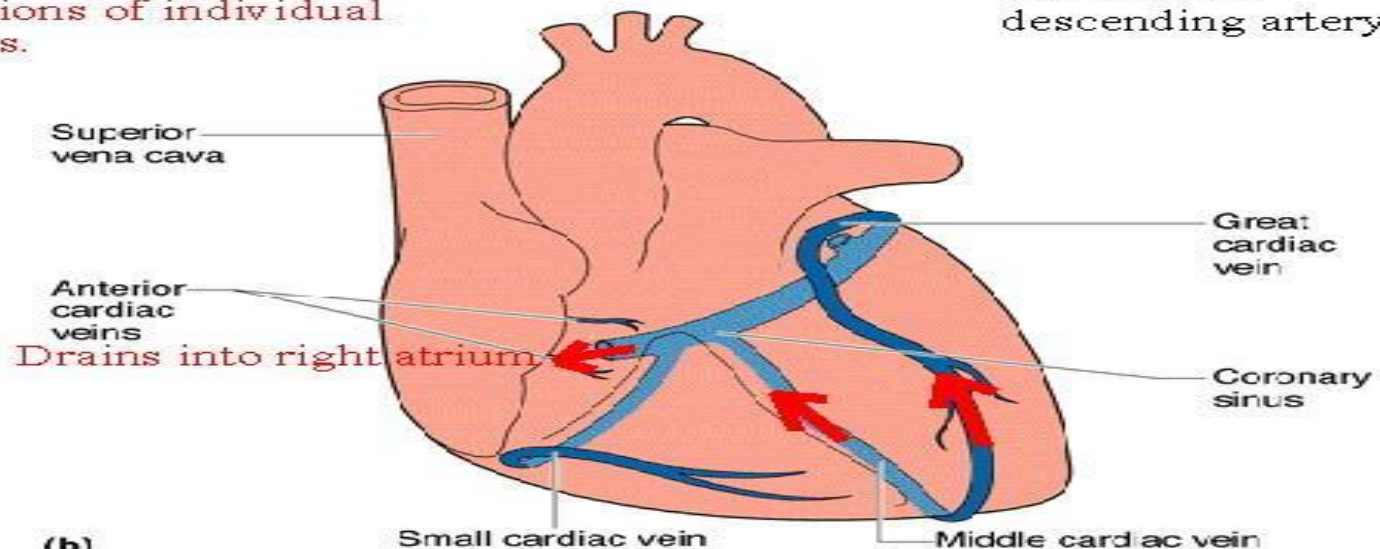
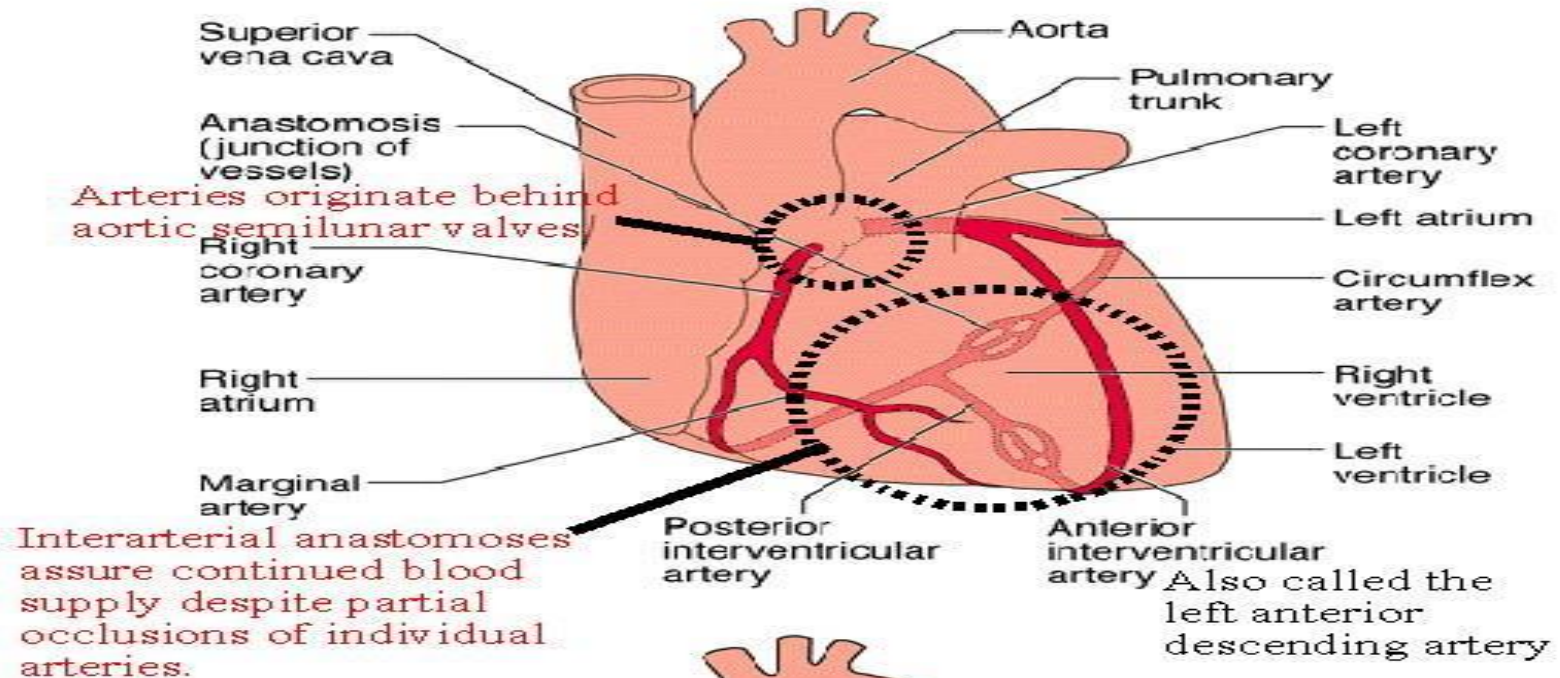








# The Coronary Circulation



(b)

© BENJAMIN/CLIMMINGS



SUPERIOR VENA CAVAL  
BRANCH (NODAL ARTERY)

ANTERIOR R. ATRIAL  
BRANCH OF  
R. CORONARY  
ARTERY

RIGHT  
CORONARY  
ARTERY

ANTERIOR  
CARDIAC  
VEINS

SMALL  
CARDIAC VEIN

STERNOCOSTAL  
ASPECT

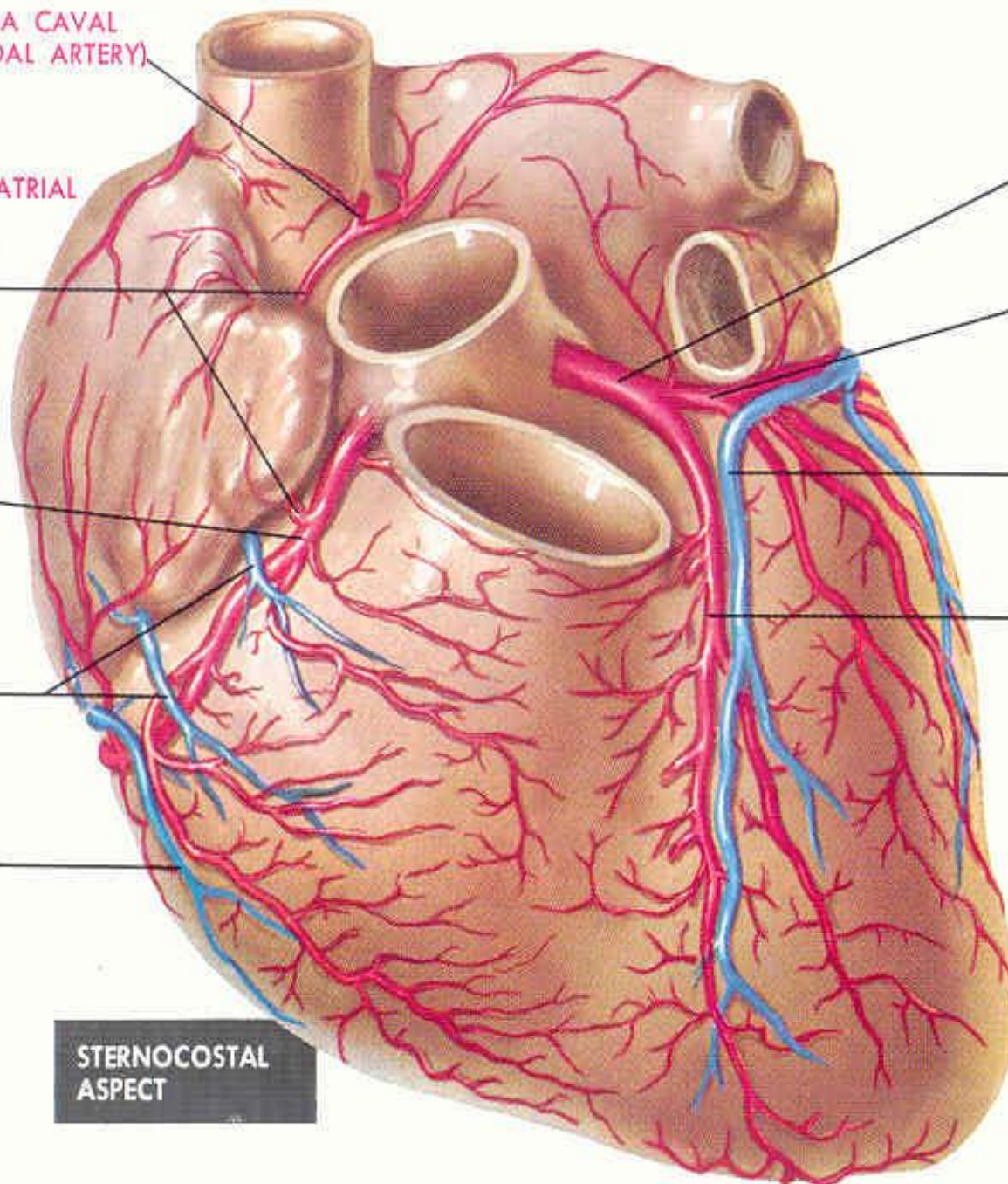
L. CORONARY ARTERY

CIRCUMFLEX BRANCH OF  
L. CORONARY ARTERY

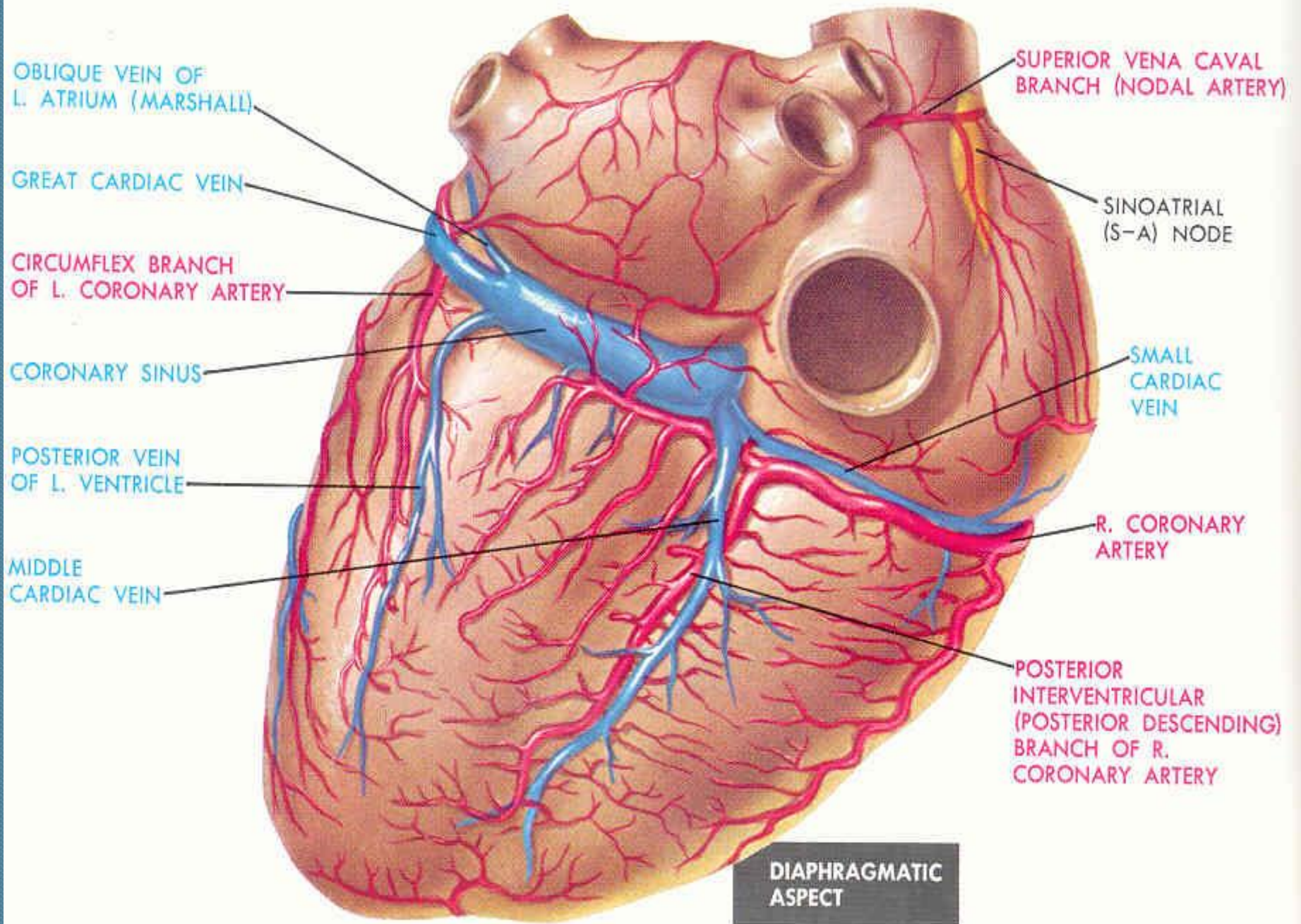
GREAT CARDIAC VEIN

ANTERIOR  
INTERVENTRICULAR  
(ANTERIOR DESCENDING)  
BRANCH OF L.  
CORONARY ARTERY

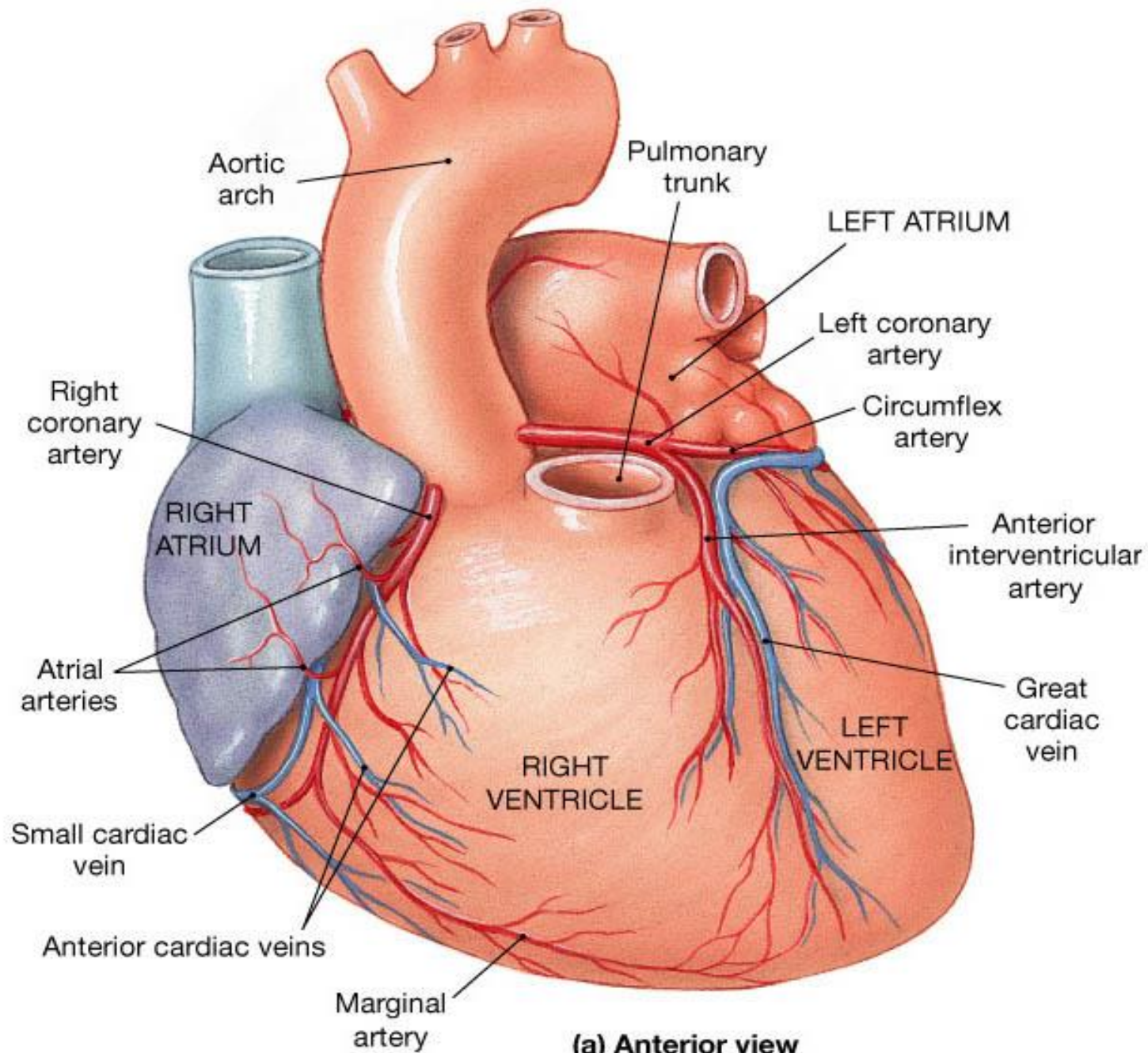
*J. Netter*  
M.D.  
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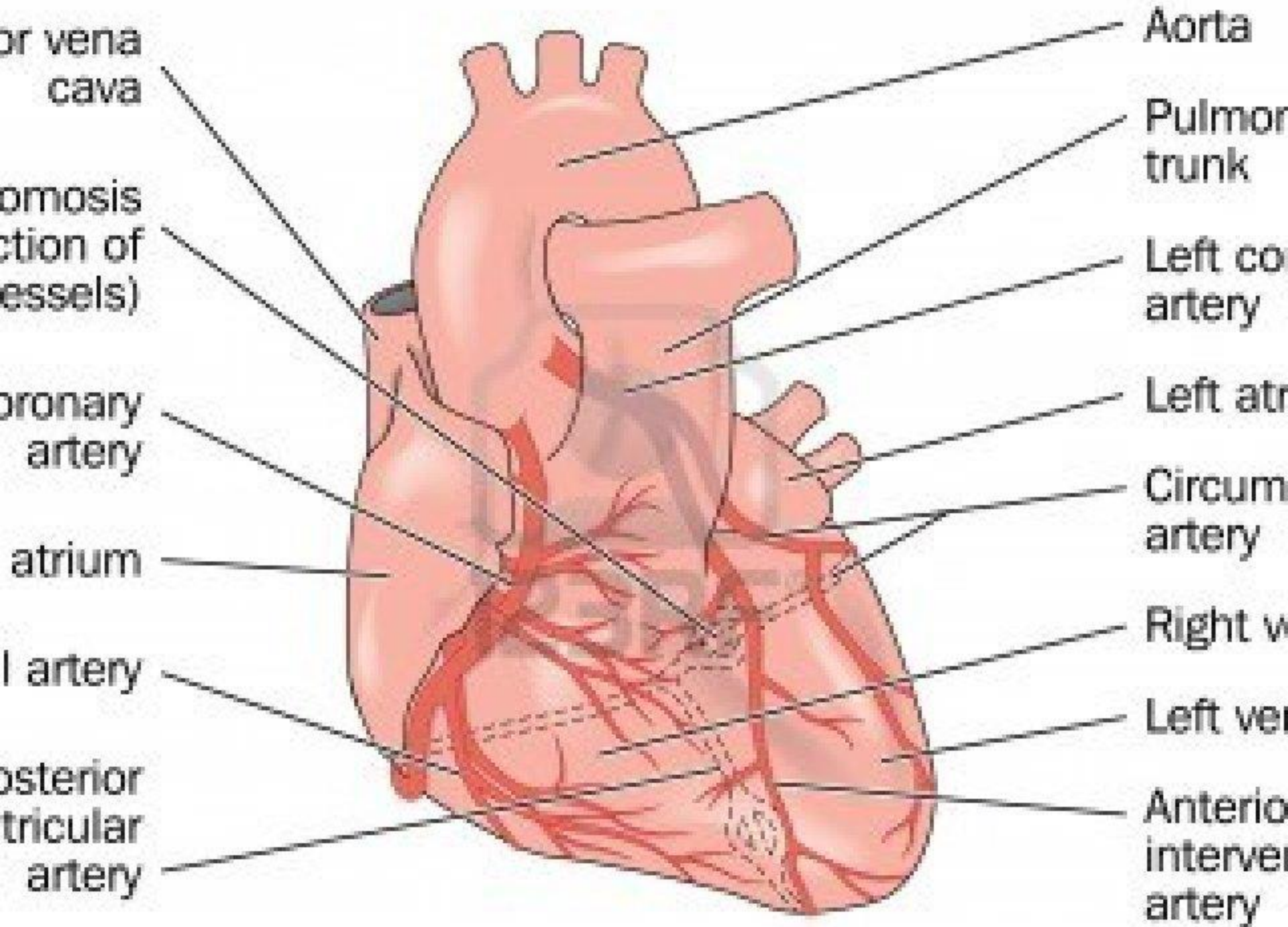




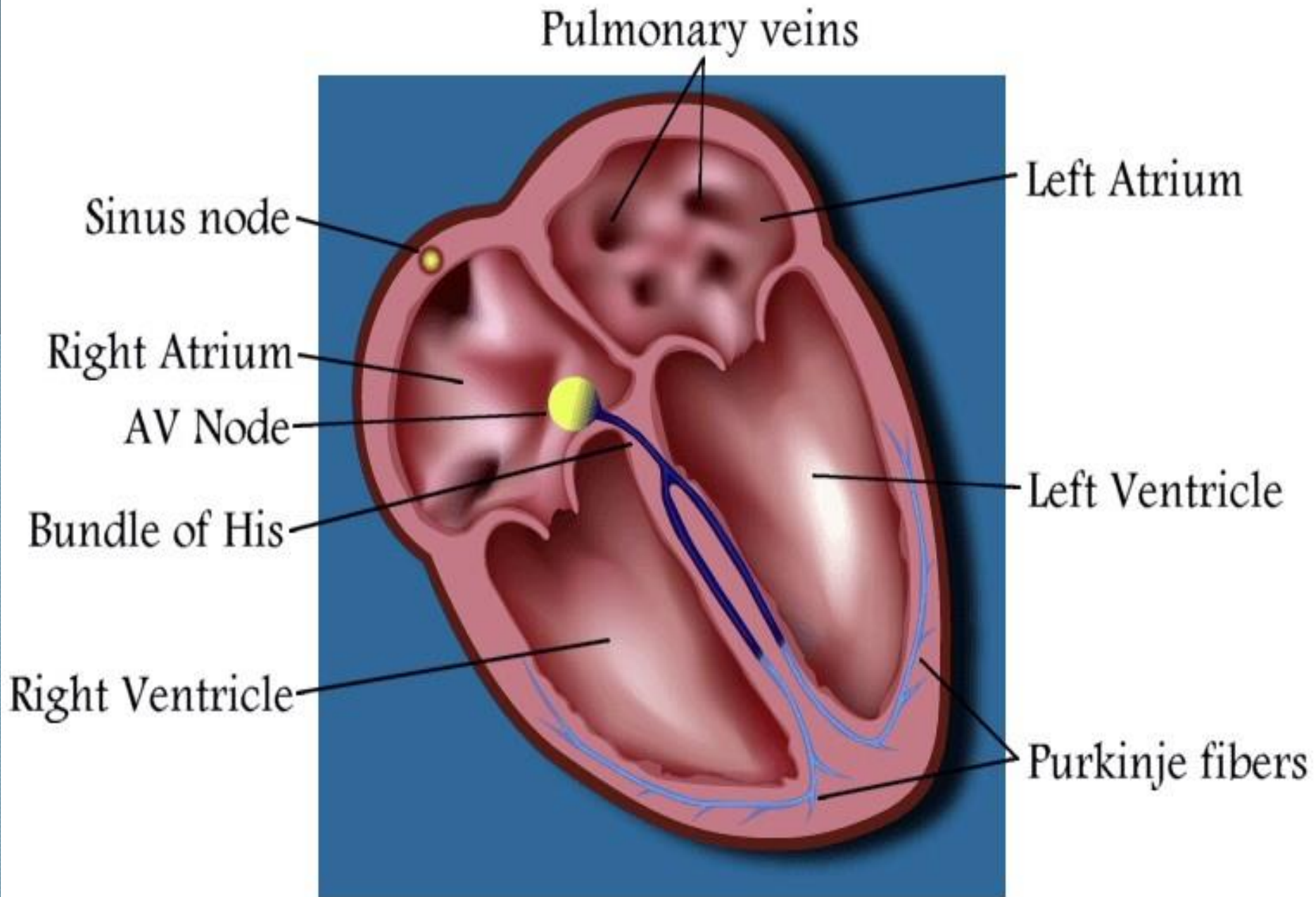






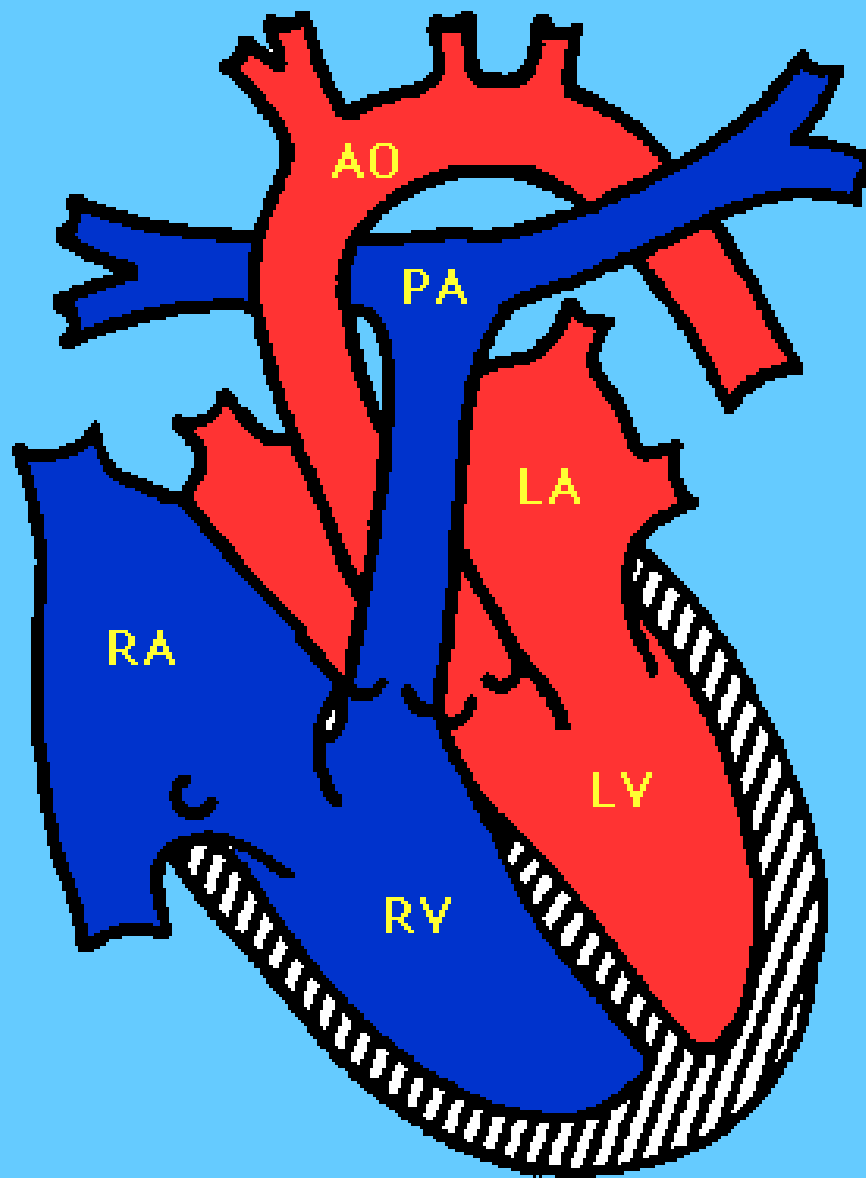




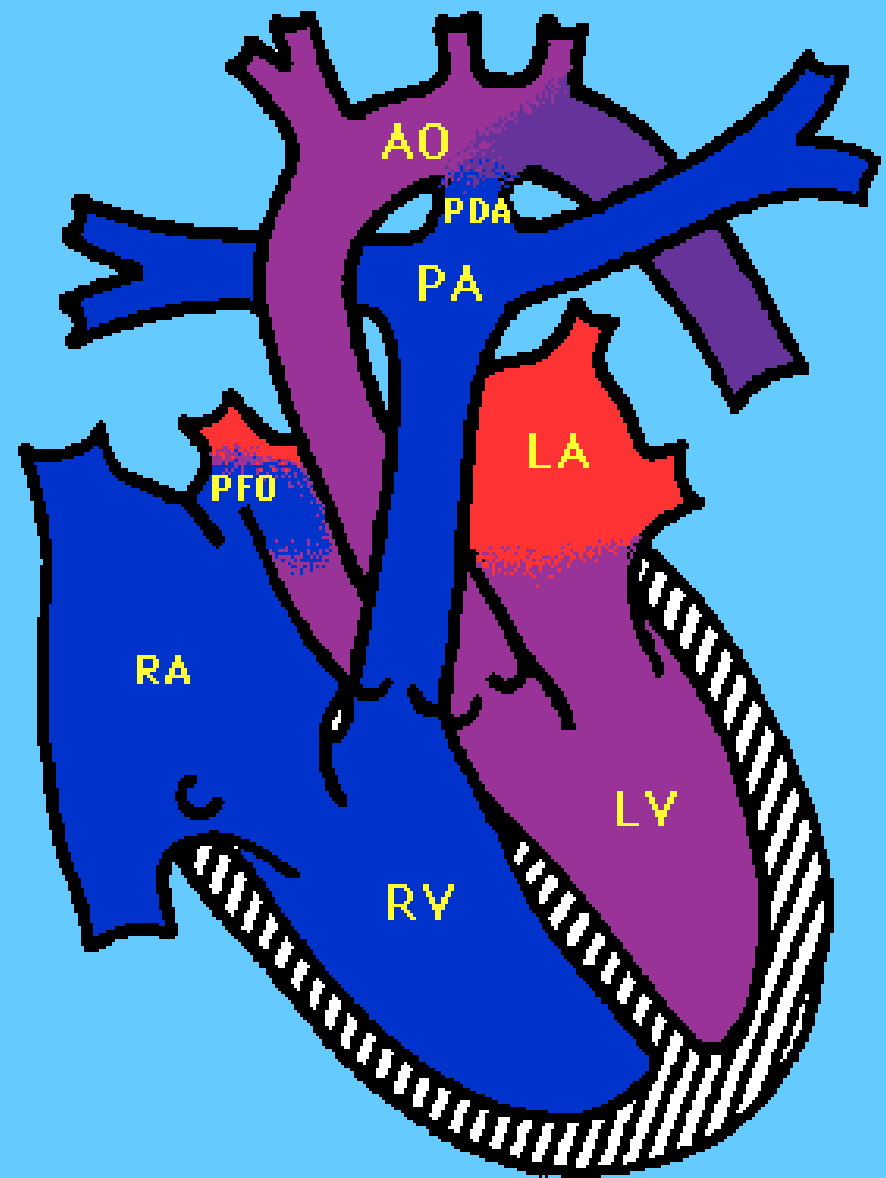




## Persistence of the Fetal Circulation



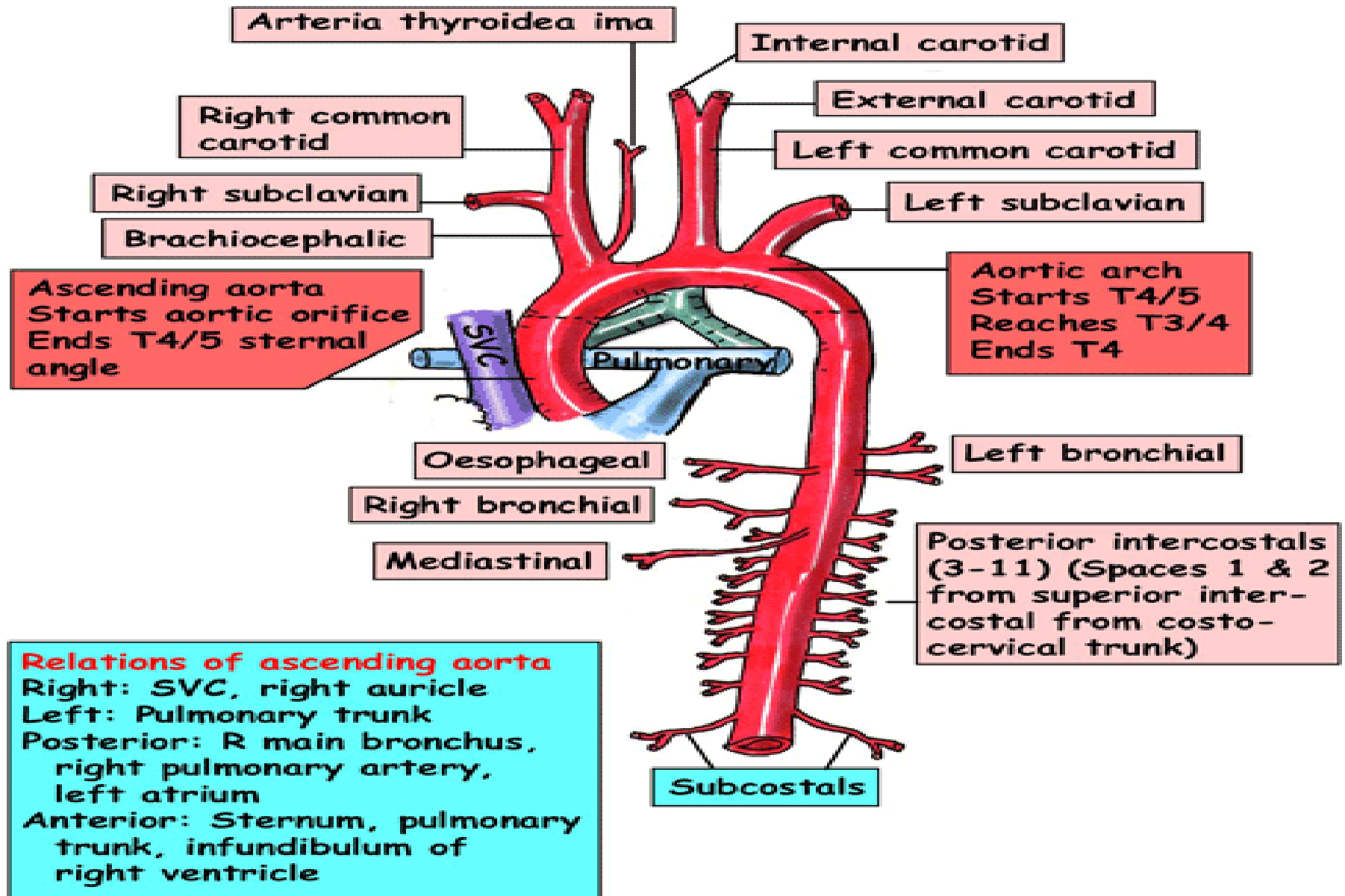
Normal



Persistence of the Fetal Circulation



# THORACIC AORTA





# Coronary Arteries and Cardiac Veins

- The heart muscle is supplied by the coronary arteries which are direct branches of the ascending aorta, so the heart muscle gets the freshest blood possible.
- The heart muscle is drained by the cardiac veins.
- Most of the venous drainage is by way of the coronary sinus into the right atrium.
- A small amount of blood drains directly into the right atrium by way of the anterior cardiac veins.



- The heart is supplied by two major coronary arteries, the right and left.
- The left coronary divides into the anterior interventricular and circumflex branches almost immediately after it arises from the left side of the ascending aorta.
- The anterior interventricular lies in the anterior interventricular sulcus and is also known as the left anterior descending artery.
- The circumflex branch lies in the coronary sulcus and forms an anastomosis with the right coronary in the posterior part of this sulcus.



- The anterior interventricular artery is the one most often involved in coronary occlusions and is often the one that is bypassed in bypass cardiac surgery.

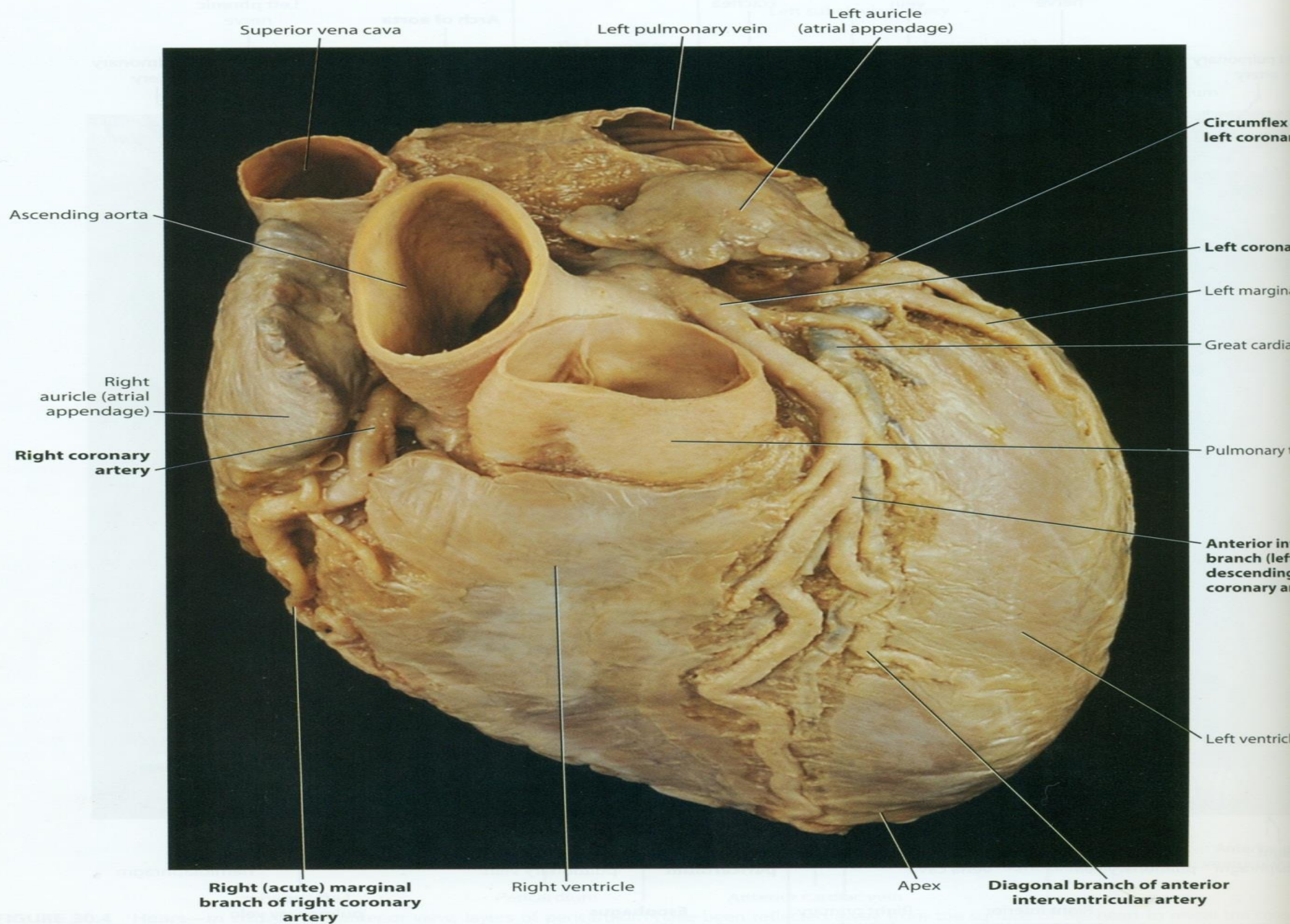


- The right coronary lies in the coronary sulcus and gives rise to an important branch immediately after leaving the ascending aorta.



- This artery supplies the sinoatrial node (SA node) or pacemaker of the heart.
- When this vessels loses its ability to supply the node, a person usually needs to have a pace maker placed in their thoracic wall to take the place of the original pace maker.
- The right coronary continues in the coronary sulcus, giving a branch along the right inferior border of the heart called **the marginal artery**.
- Finally the right coronary gives rise to the **posterior interventricular (or descending) branch**, and then anastomoses with the circumflex artery from the left coronary.





**FIGURE 30.6** Heart—anterior surface. Anterior view of the sternocostal surface of the heart showing the coronary arteries.



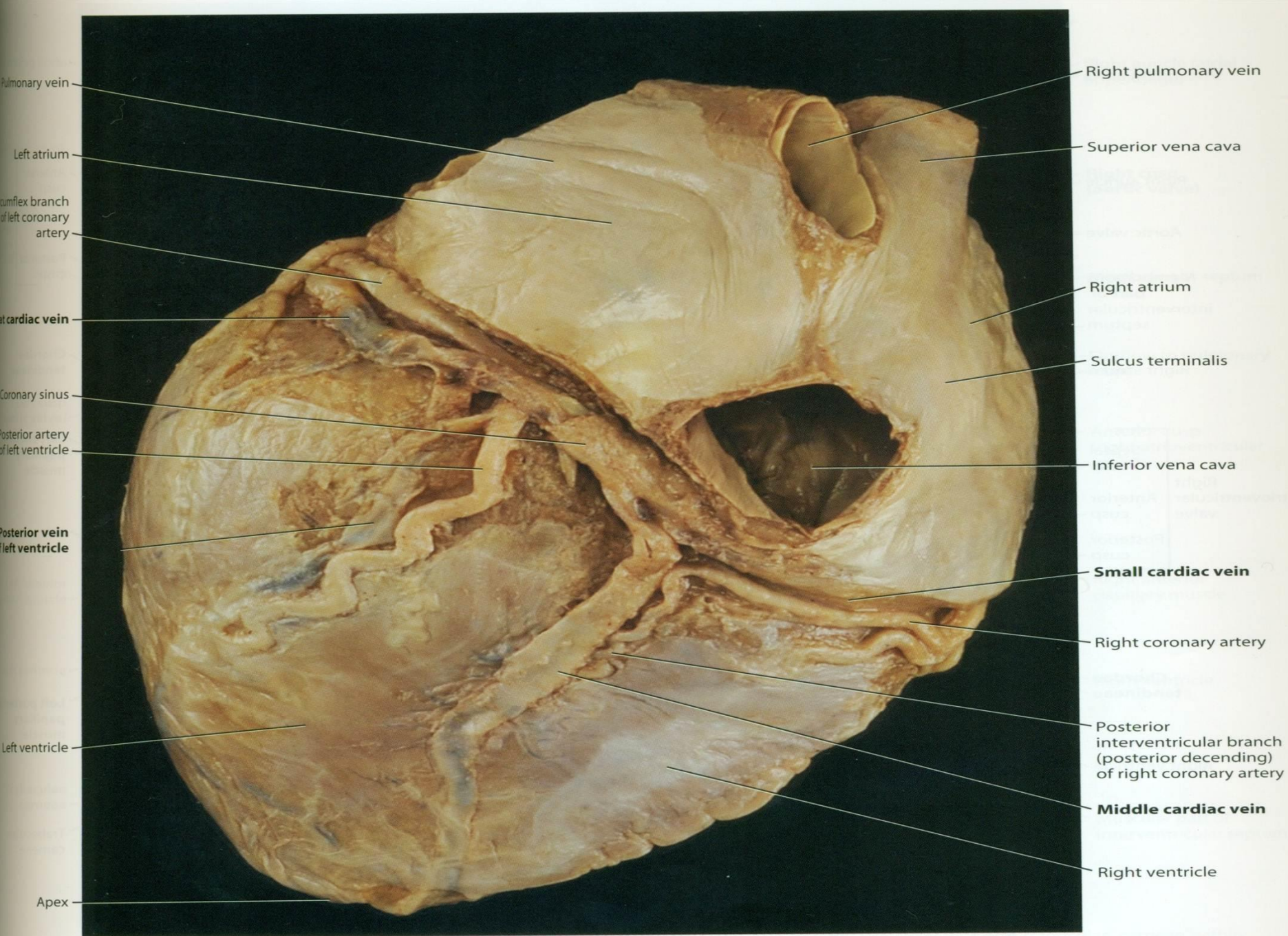
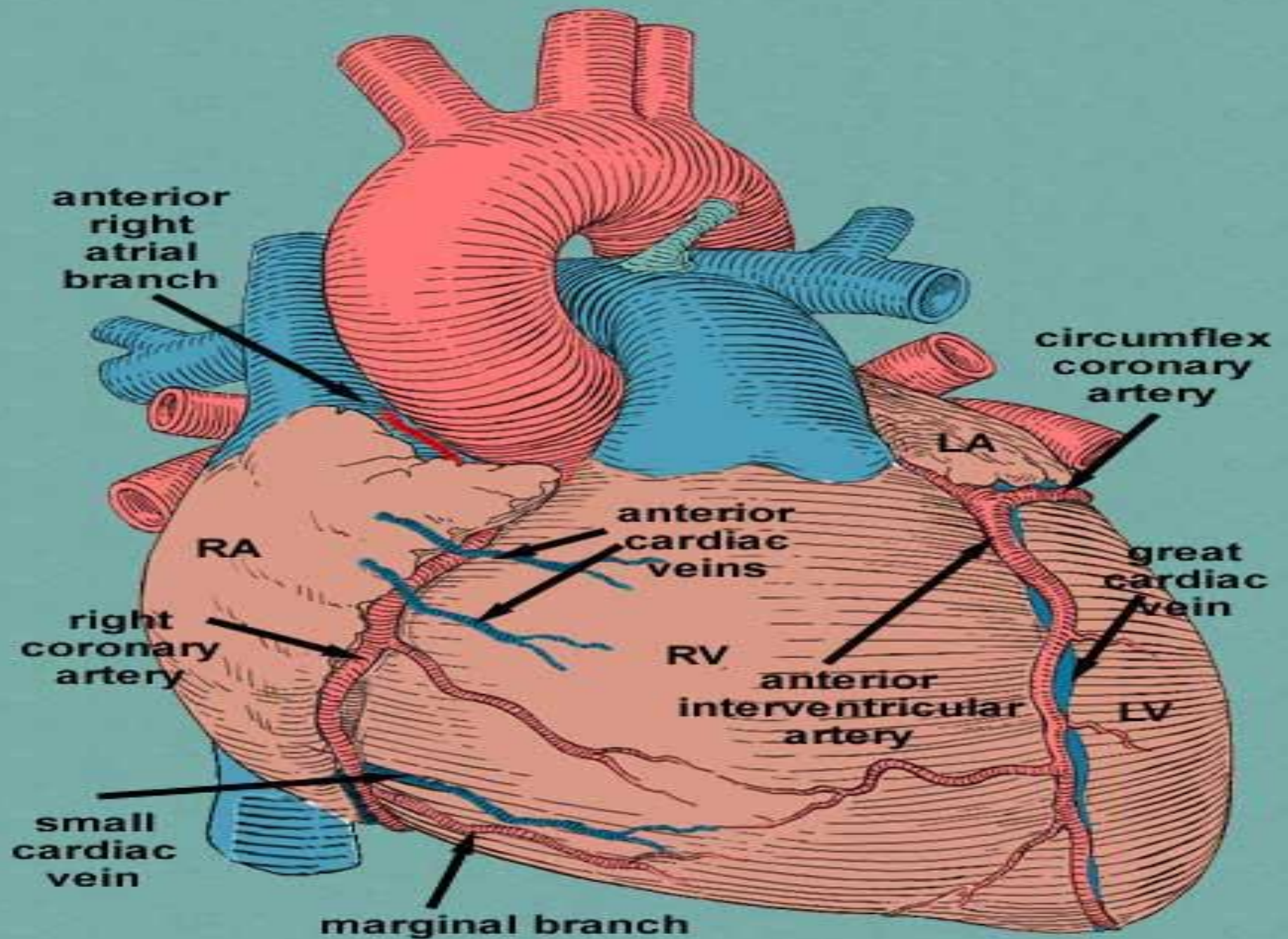


FIGURE 30.7 Heart—posterior surface. Posterior view of the diaphragmatic surface of the heart showing the venous tributaries to the coronary sinus.



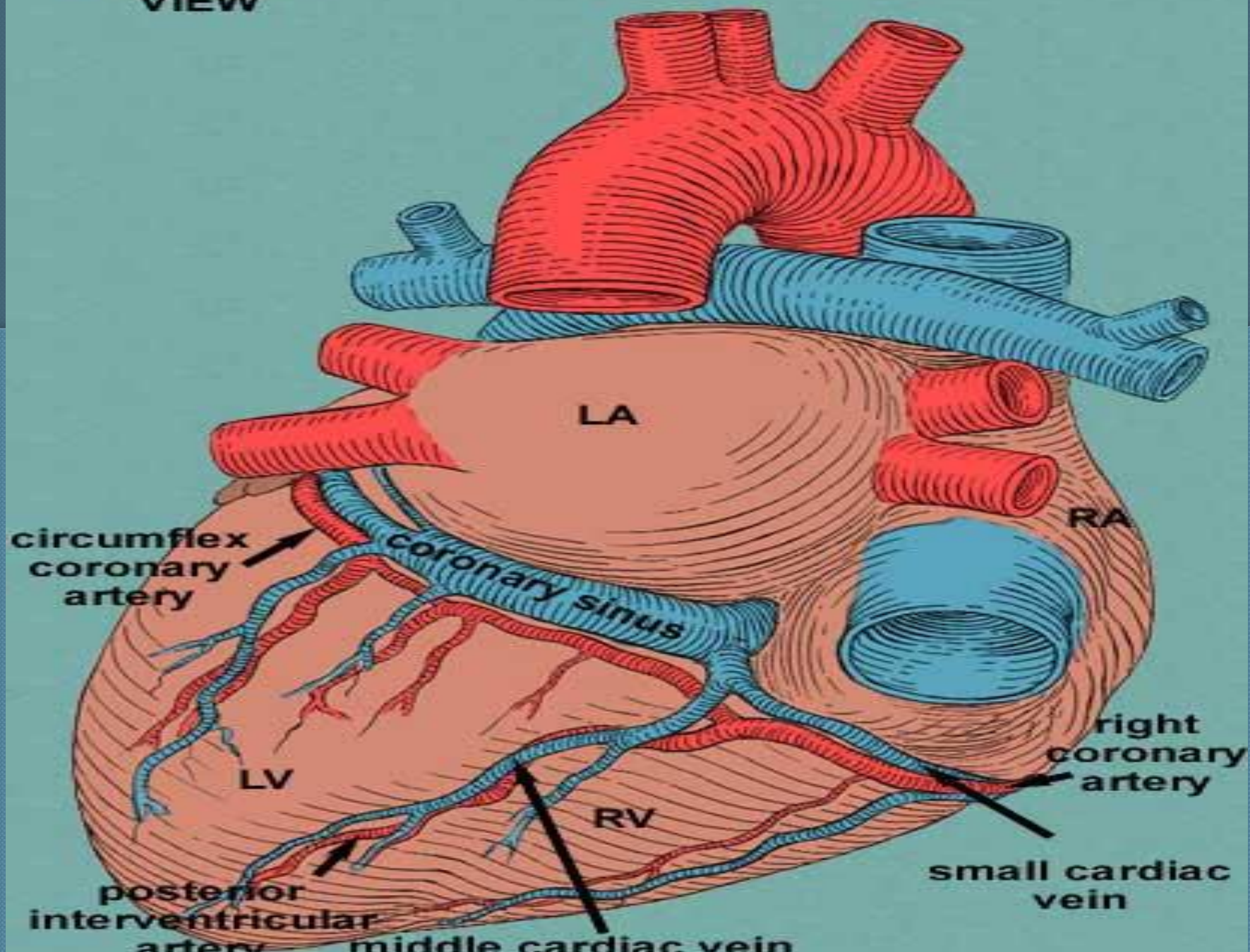




- ◉ When the heart is viewed from the back, the most obvious structure lying in the coronary sulcus is **the coronary sinus**.
- ◉ This sinus receives most of the venous blood from the heart and empties into the right atrium.
- ◉ **Its tributaries are the small cardiac vein, the middle cardiac vein and the greater cardiac vein.**
- ◉ There is a small vein that arises along the left side of the left atrium just beneath the lower left pulmonary artery called the oblique vein.
- ◉ This vein is a remnant of the embryonic left superior vena cava.
- ◉ The arteries seen in the back of the heart are the circumflex coronary artery, the terminal part of the right coronary artery and its posterior interventricular branch.

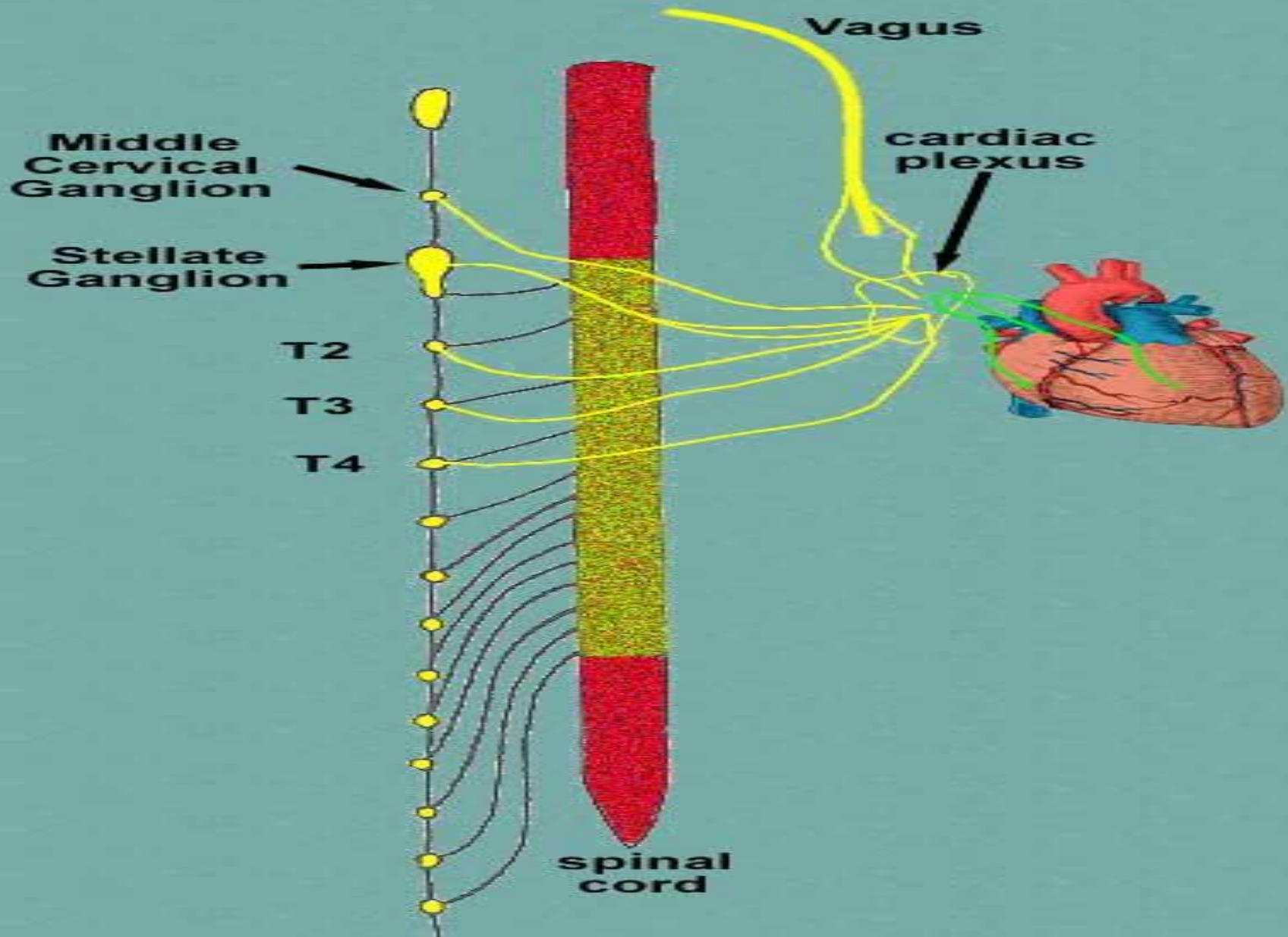


# POSTERIOR VIEW





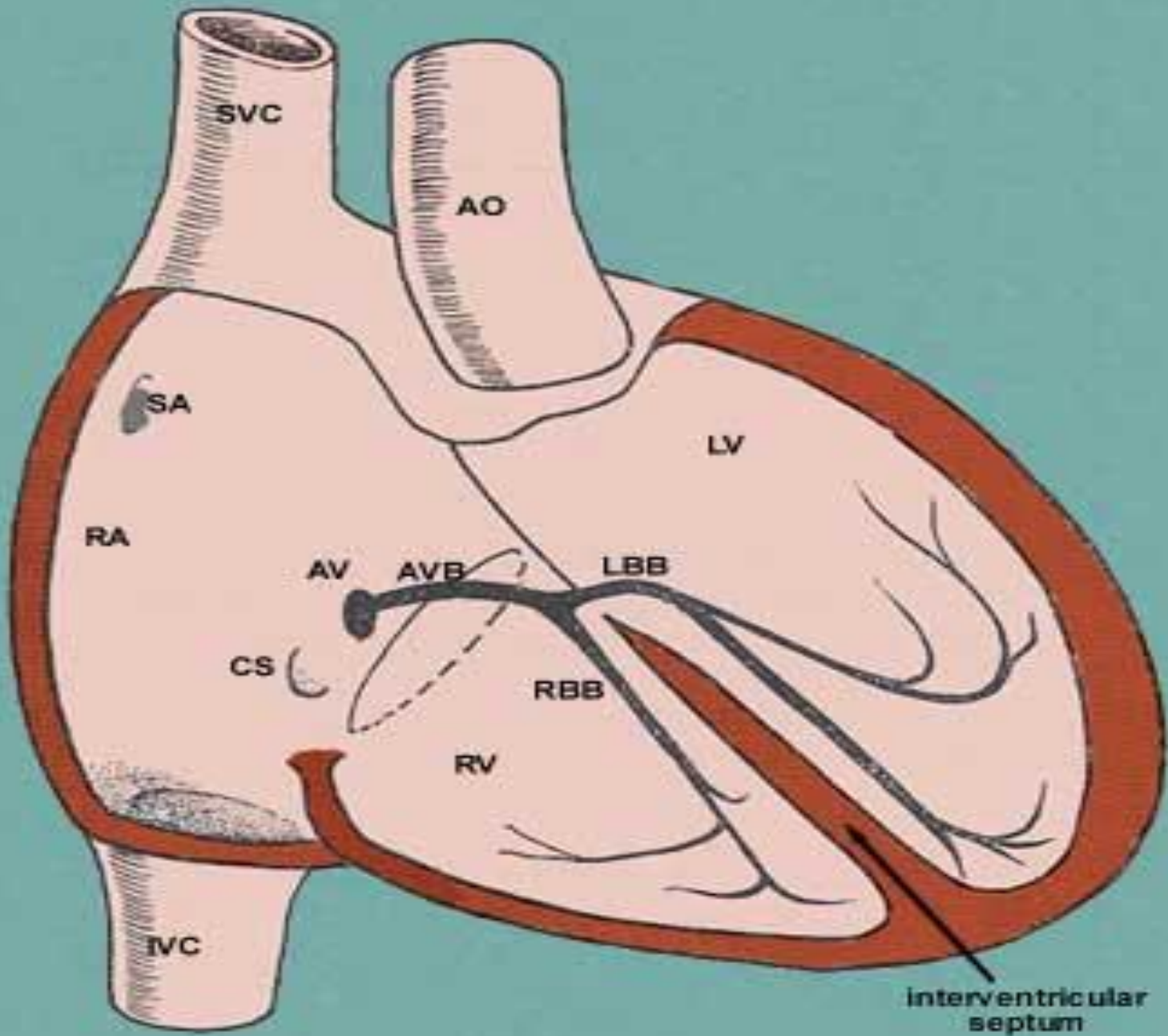
# Innervation of the Heart



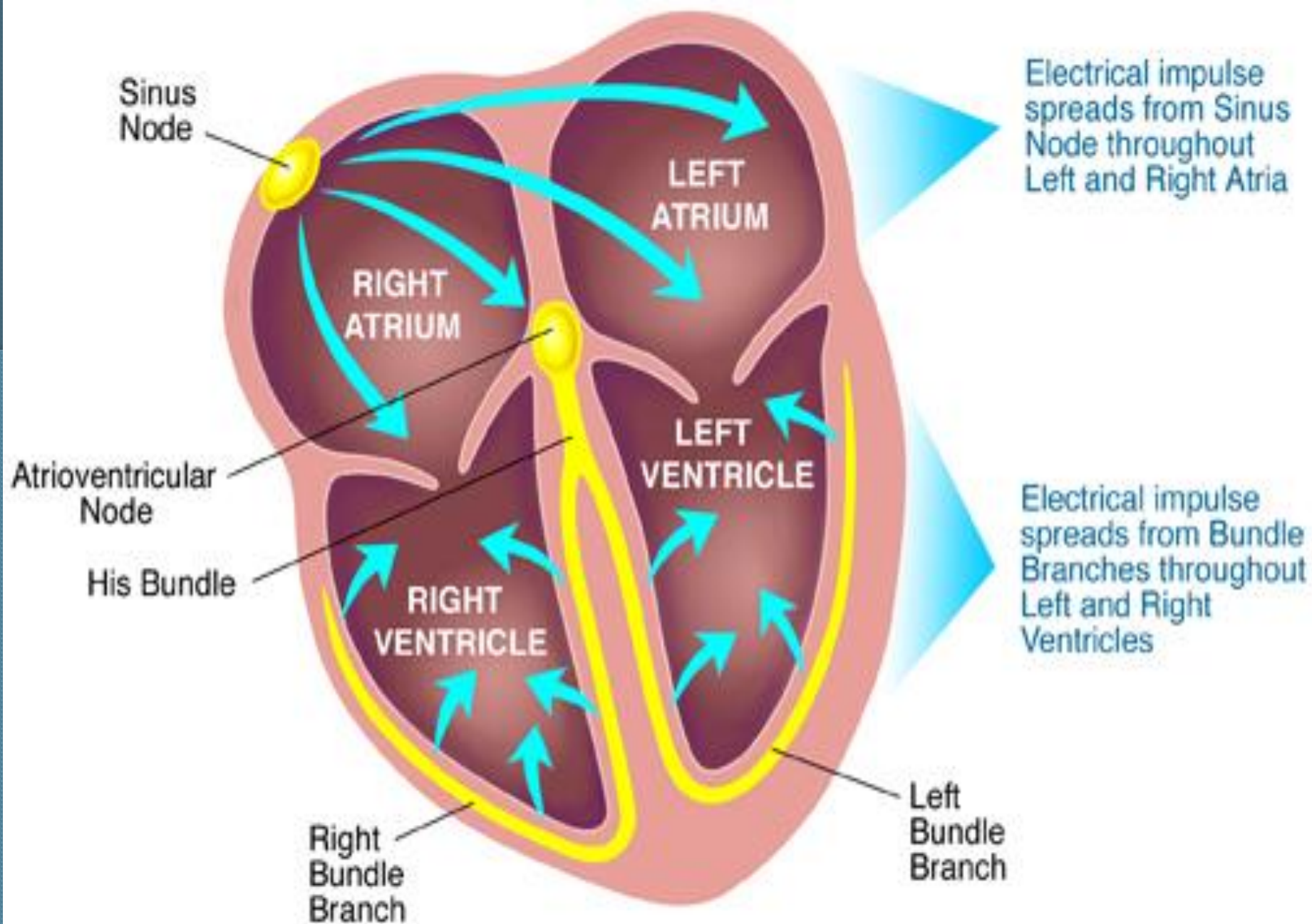


- The strength and frequency of the heart beat is controlled by the autonomic nervous system.
- Both parasympathetic and sympathetic parts of the autonomic nervous system are involved in the control of the heart.
- The sympathetic fibers arise from segments T2-T4 of the spinal cord and are distributed through the middle cervical and cervico-thoracic (or stellate) ganglia and the first four ganglia of the thoracic sympathetic chain.
- The sympathetic fibers pass into the cardiac plexus and from there to the SA node and the cardiac muscle.
- The effect of the sympathetic nerves at the SA node is an increase in heart rate.
- The effect on the muscle is an increase in rise of pressure within the ventricle, thus increasing stroke volume.
- The vagus provides the parasympathetic control to the heart.
- The effect of the vagus at the SA node is the opposite of the sympathetic nerves, it decreases the heart rate.
- It also decreases the excitability of the junctional tissue around the AV node and this results in slower transmission
- Strong vagal stimulation here may produce AV block.

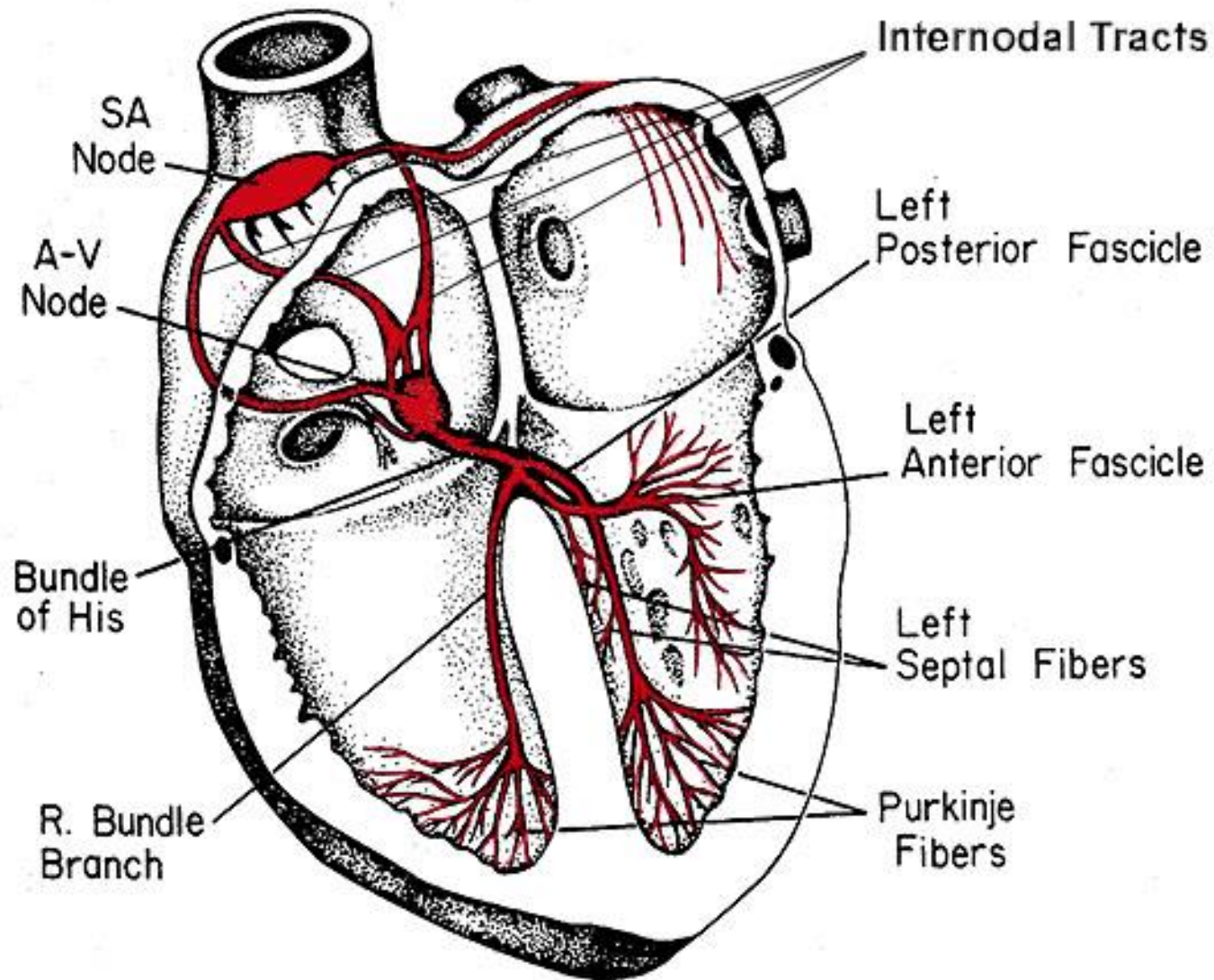








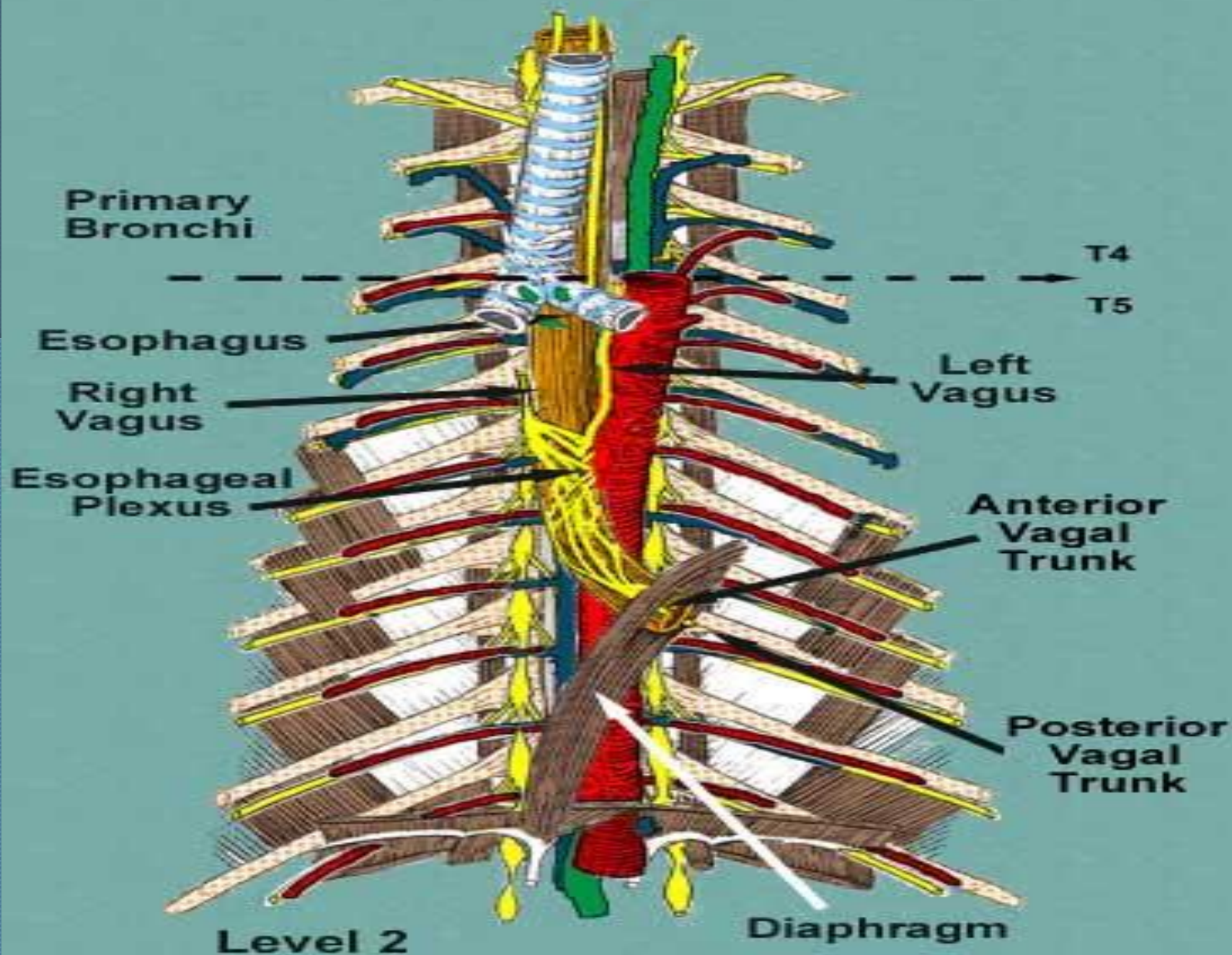






- The heart also has an internal nervous system made up of the SA (sinuatrial node) and the AV (atrioventricular) node.
- The AV bundle (His) leaves the AV node near the lower part of the interatrial septum and splits over the upper part of the interventricular septum into a left bundle branch (LBB) and a right bundle branch (RBB).
- The cardiac muscle is then supplied by branches of the two bundles.
- SVC - superior vena cava
- IVC - inferior vena cava
- AO - aorta
- RA - right atrium
- RV - right ventricle
- LV - left ventricle
- CS - opening of the coronary sinus







- The thoracic aorta starts at the T4-T5 junction and extends the full length of the posterior mediastinum passing through the aortic hiatus of the diaphragm into the abdomen.
- The thoracic aorta gives rise to **the posterior intercostal arteries** which pass posterior and lateral to join the posterior intercostal veins and intercostal nerves to form the neurovascular bundle that travels along the inferior border of a rib or the upper aspect of an intercostal space.
- It also gives rise to **bronchial branches** that enter the root of the lung to supply the bronchi and lung tissue.



## • The azygos and hemiazygos veins

- Each of these veins begin in the abdomen as the ascending lumbar veins.
- The ascending lumbar veins drain parts of the posterior abdominal wall.
- **The azygous vein** begins at the junction of **the ascending lumbar vein** and **the subcostal vein** and passes deep to the right crus of the diaphragm to enter the posterior mediastinum.
- It continues upward along the right side of the bodies of the thoracic vertebrae and to the right of the descending aorta receiving posterior intercostal veins along the way.
- At about T8, it forms an arch that passes over the root of the right lung and then enters the posterior aspect of the superior vena cava.
- The arch receives **the left superior intercostal vein** that drains the upper 2 or 3 posterior intercostal spaces.



- **The hemiazygous veins** are quite variable in their make-up but the classic description is that the upper intercostal spaces are drained by the **superior hemiazygos vein** and the lower the **inferior hemiazygos vein**.
- These two veins may join as one hemiazygos vein that passes behind the thoracic duct to empty into the azygos vein.
- The two veins may just as frequently pass into the azygos separately, forming two hemiazygos veins.
- Or, there may be multiple veins crossing into the azygos vein, whereby a true hemiazygos vein doesn't exist at all.

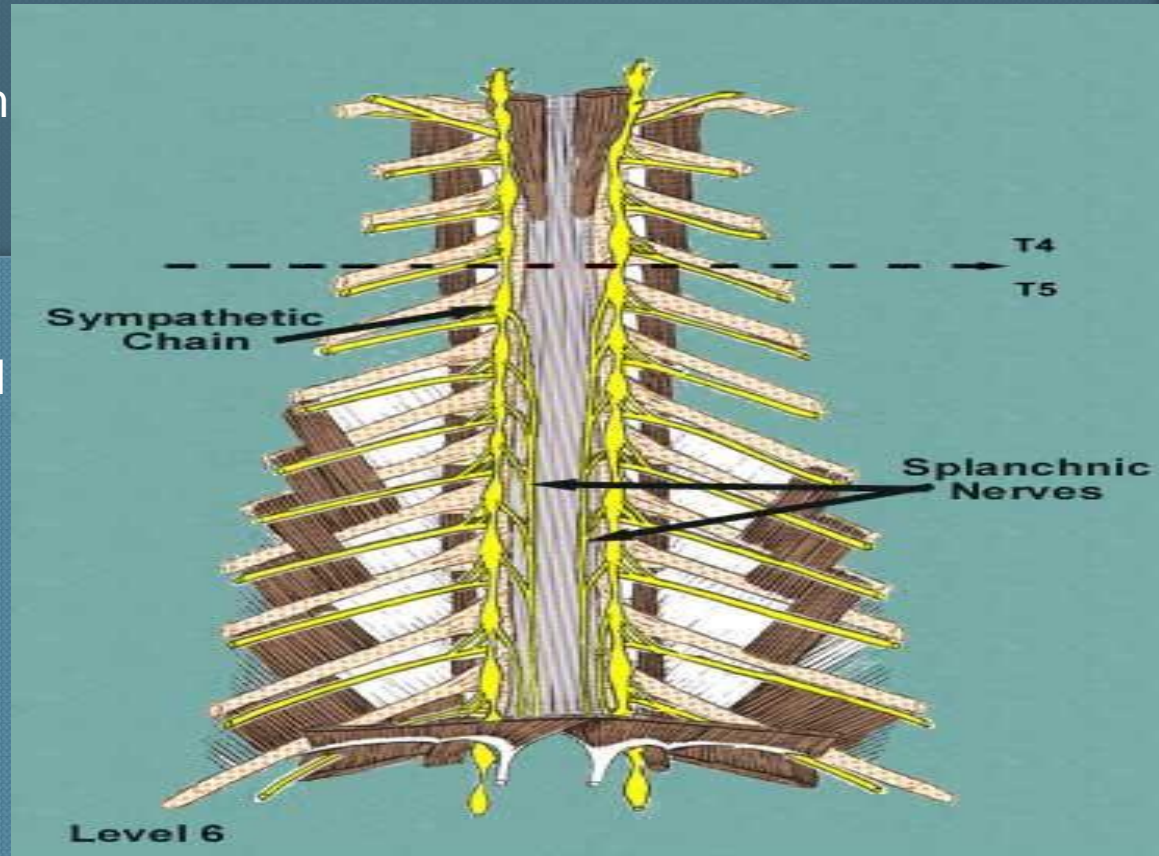


- The next structures in the posterior mediastinum would be the splanchnic nerves, specifically **the greater splanchnic nerves**.

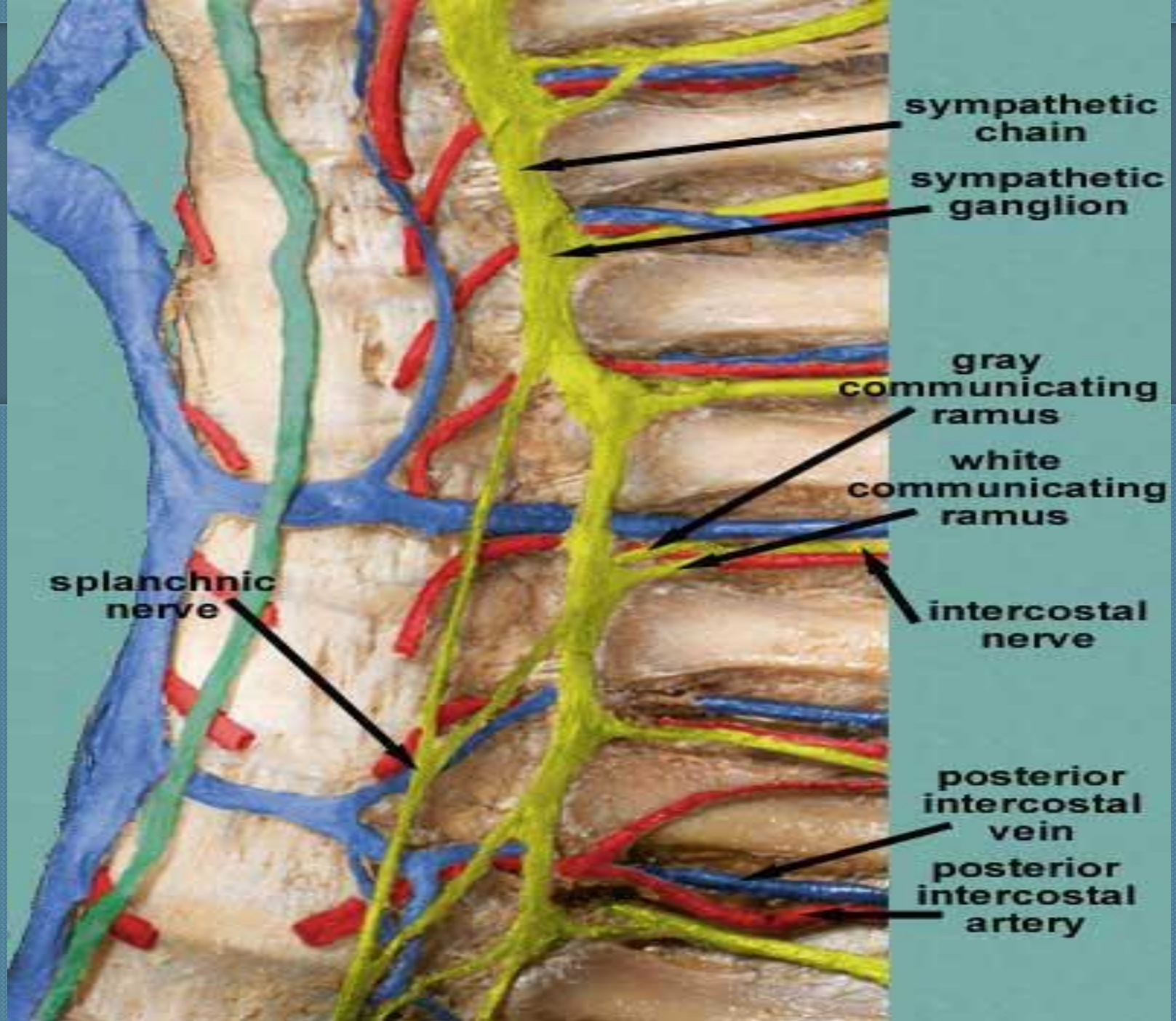
- These nerves are derived from the sympathetic chains, thoracic ganglia T5 to T10.

- There is also **lesser splanchnic nerves** that are derived from ganglion T10 and T11.

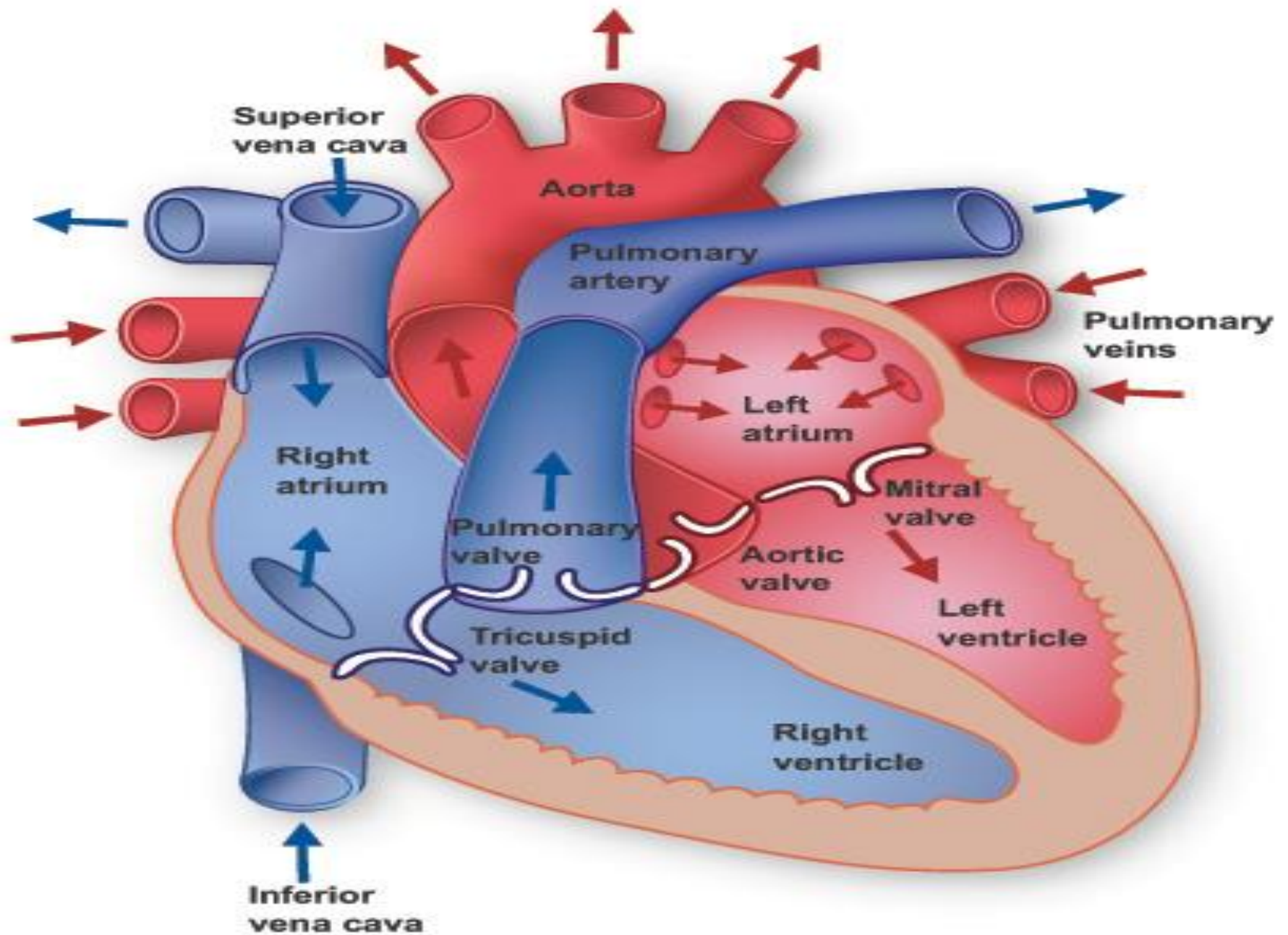
- Could be described a **splanchnic imus nerve** that is derived from ganglion T12.













hey doctor

it's my heart.. not an MP3 player



**Dr. Tynycat says your heart rate is normal**





*Don't break someone's heart,  
they have only one*



Break their bones,  
they have  
206 of them