Anatomy Lab 2

Cardiovascular System

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Heart

★ The heart is a **hollow muscular** organ which **pumps** the blood to the big vessels.

★ **Position:**

- It lies within the **pericardium** in the **middle mediastinum**.
- It behind the **body of the sternum** & 2-6 **costal cartilages**.
- **1/3** of the heart is to the **right** while its **2/3** is to the **left** of the median plane.

★ **Size and weight:**

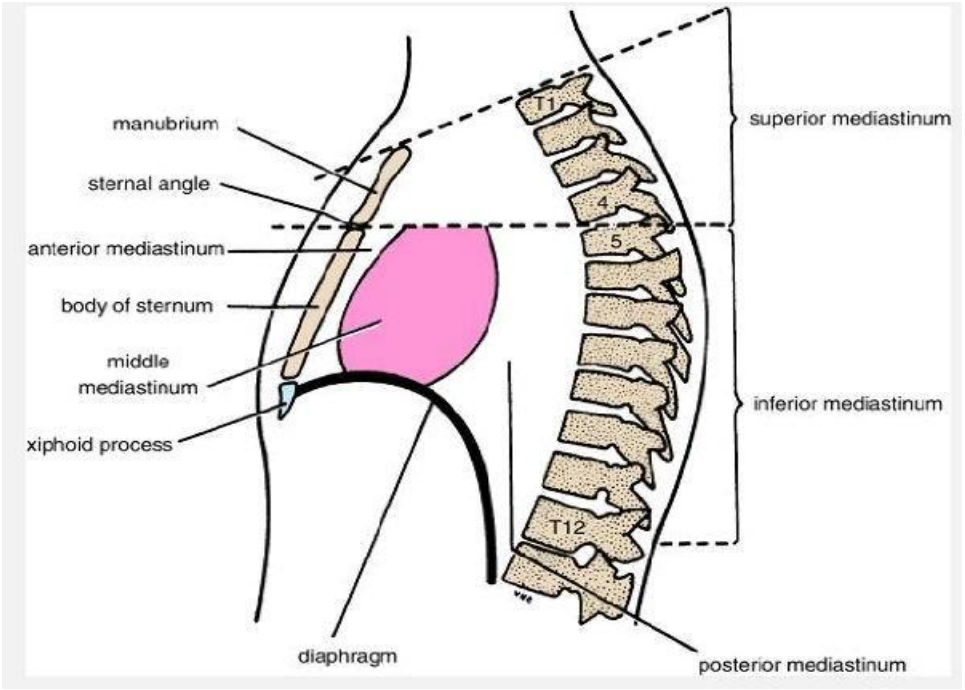
- It is slightly larger than the size of **closed fist**, with an average weight of **250-300 gm**.
- In **living** the dimensions of the heart can be detected by **percussion** and **echocardiography**.

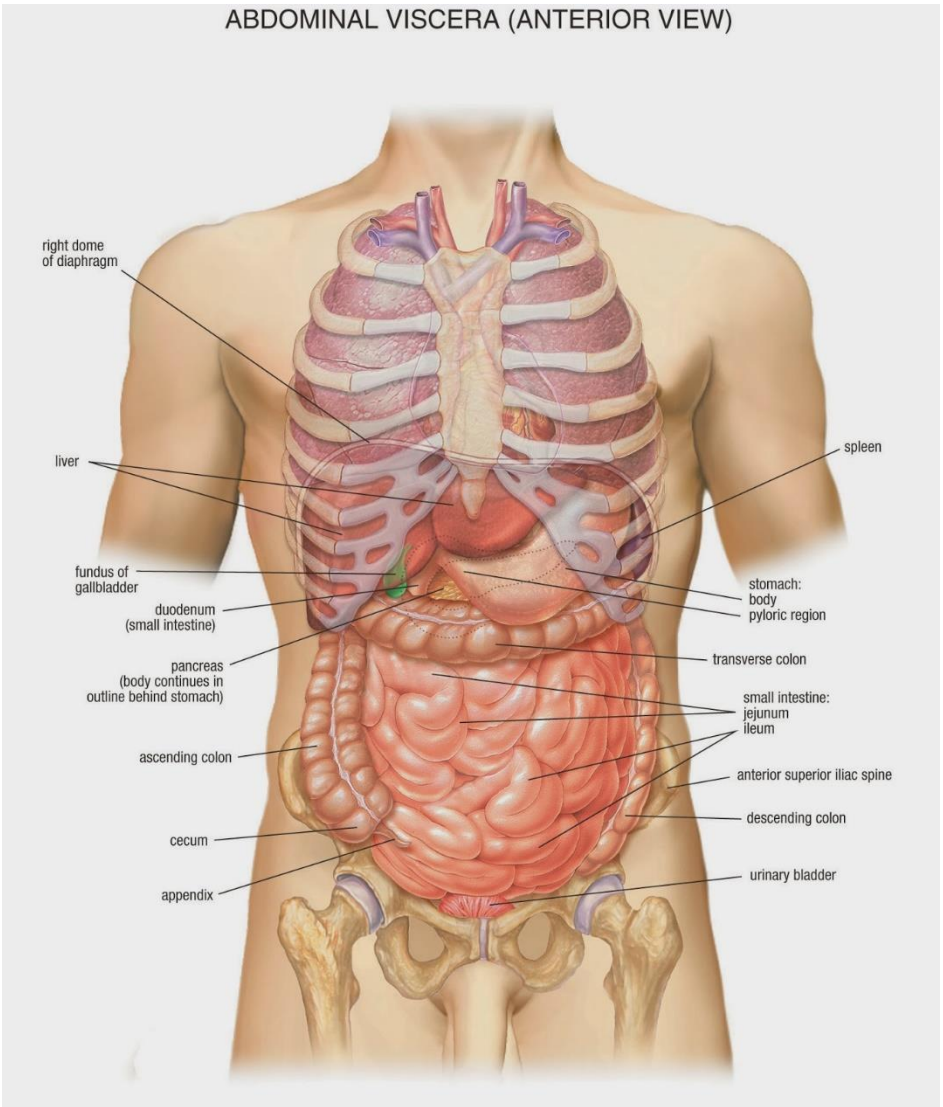
★ **Parts of the heart:** it has **4 chambers**; **2 atria** (right and left) and **2 ventricles** (right and left).

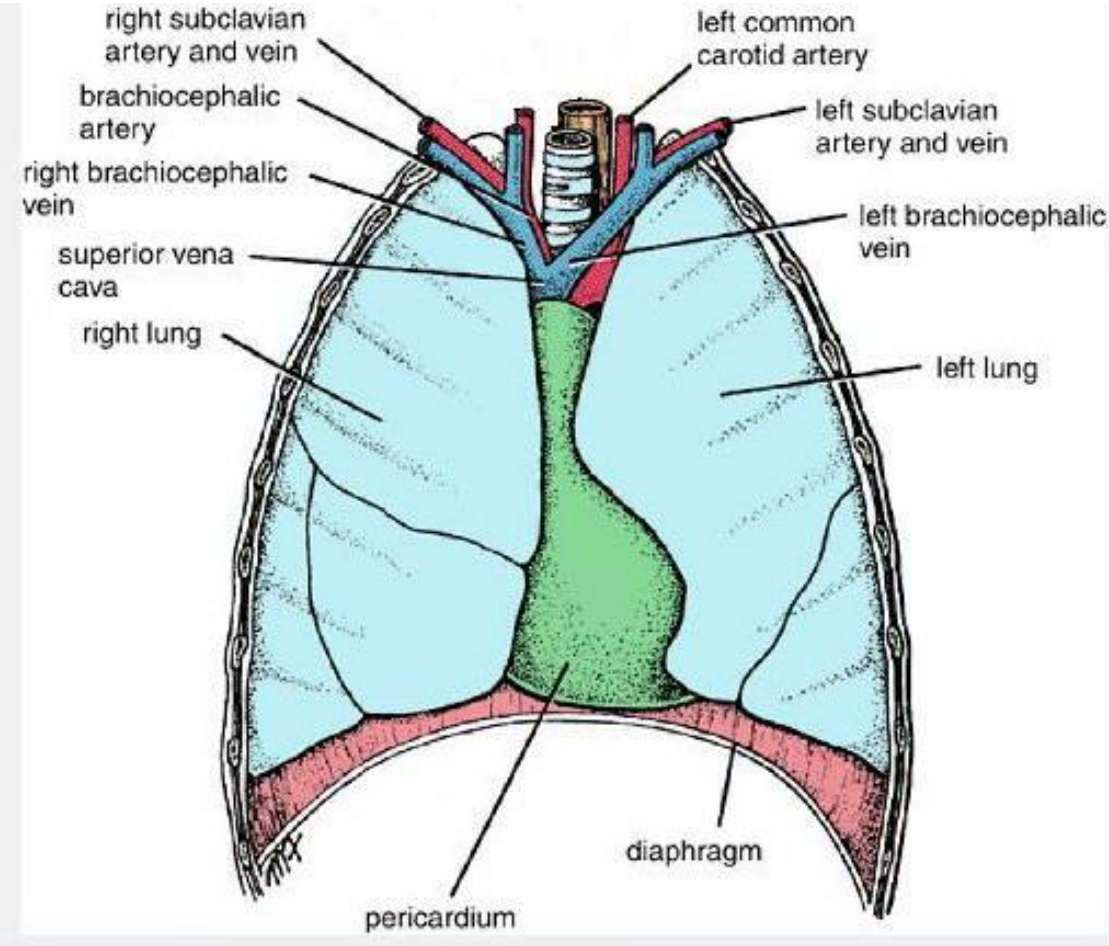
★ **Shape:** it is **conica**l in shape, having the followings:

- A **base** (or posterior surface).
- An **apex.**
- The **axis** of the heart extends from the **base to the apex** is directed downwards, forwards and to the left.
- **2 surfaces**: sternocostal (or anterior) and diaphragmatic (or inferior)
- **4 borders**: superior, inferior, right and left.

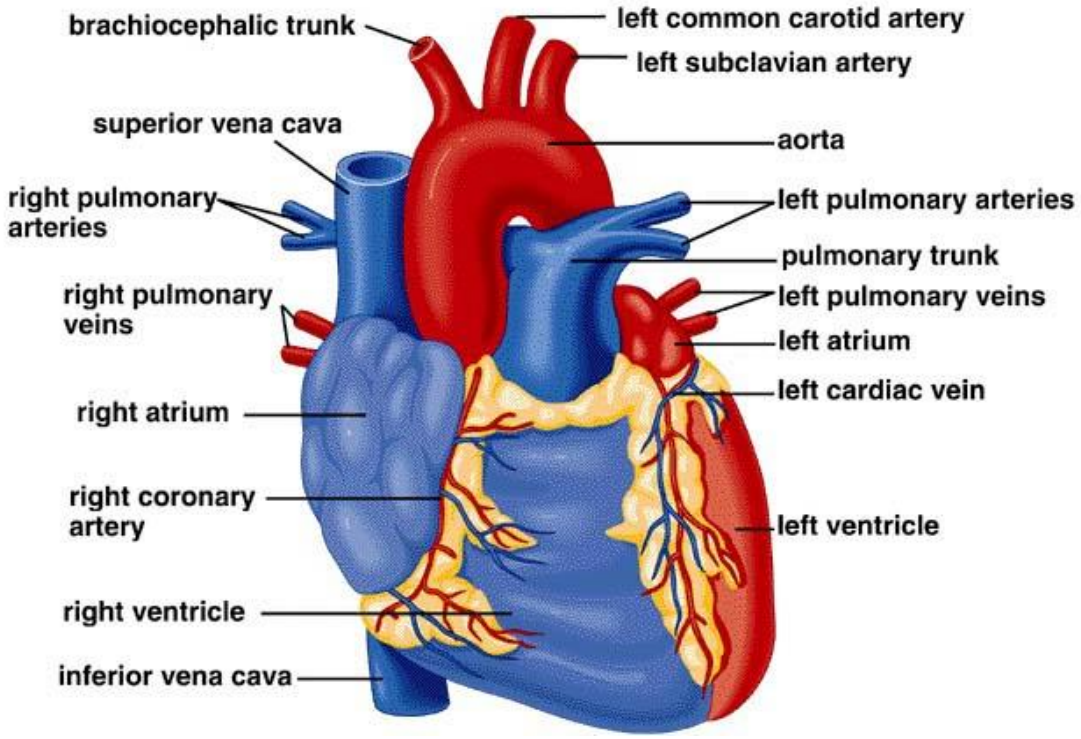
Middle mediastinum

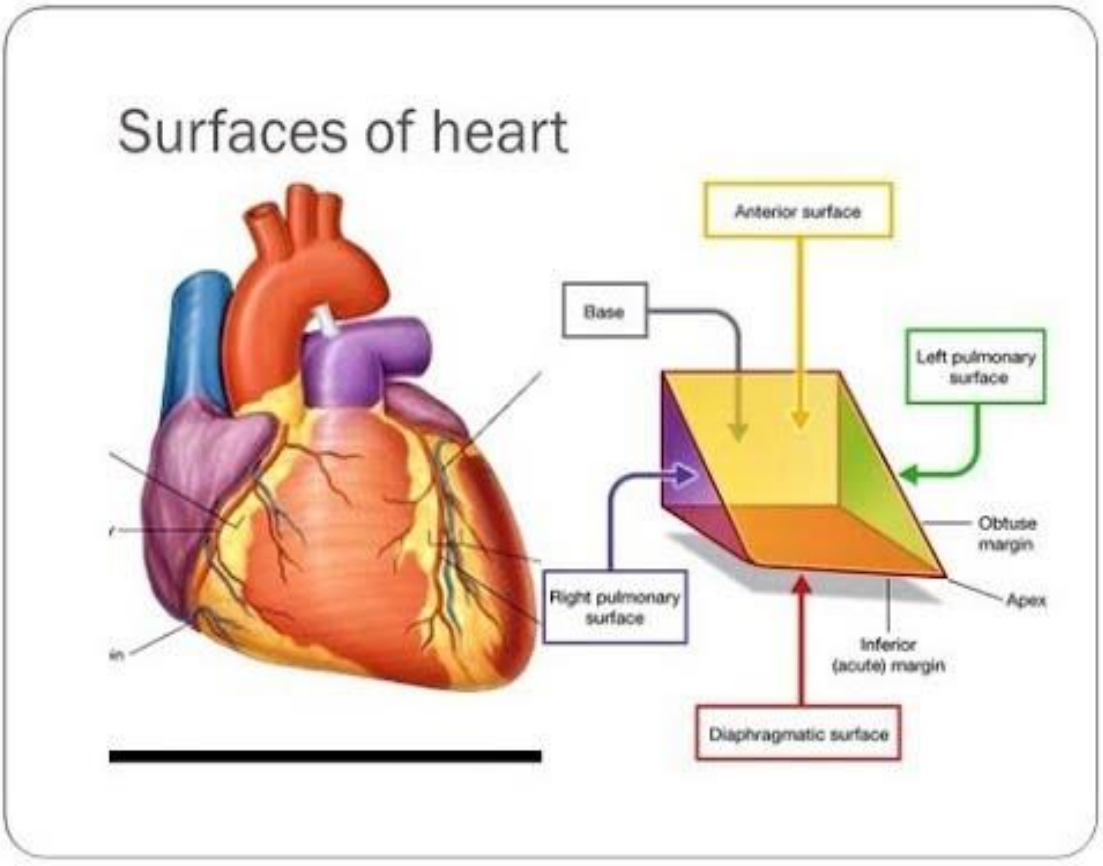





right subclavian artery and vein
brachiocephalic artery
right brachiocephalic vein
superior vena cava
right lung
left common carotid artery
left subclavian artery and vein
left brachiocephalic vein
left lung
diaphragm
pericardium

External Heart Anatomy



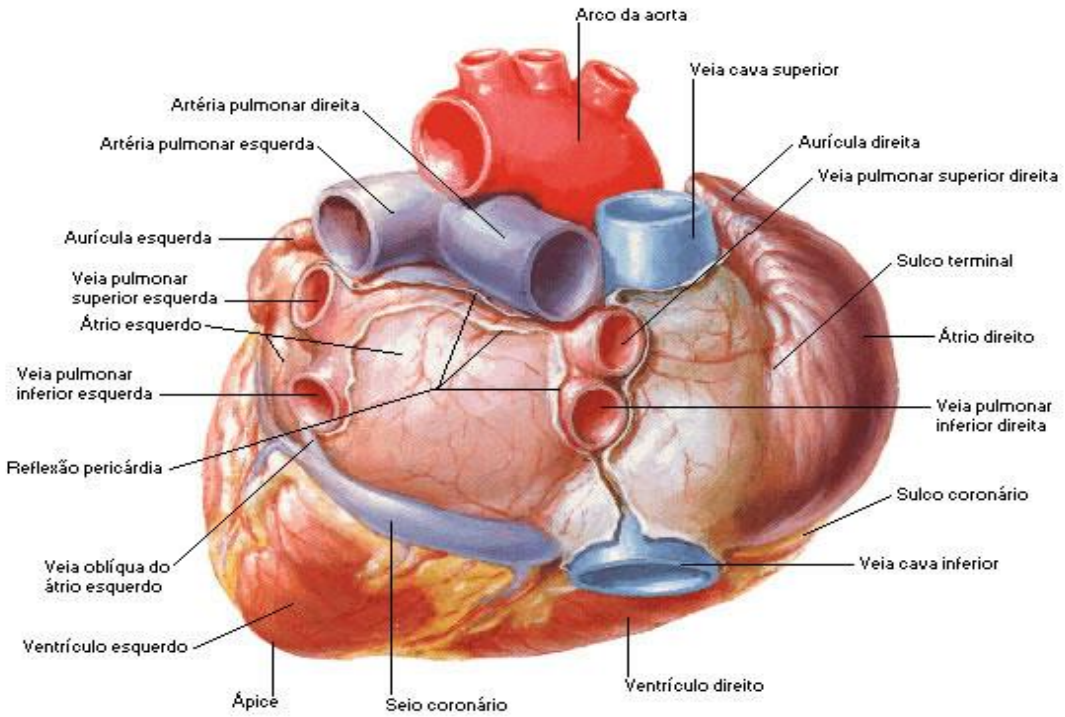


★ **External Features of the Heart :**

(A) Base and apex of the Heart:

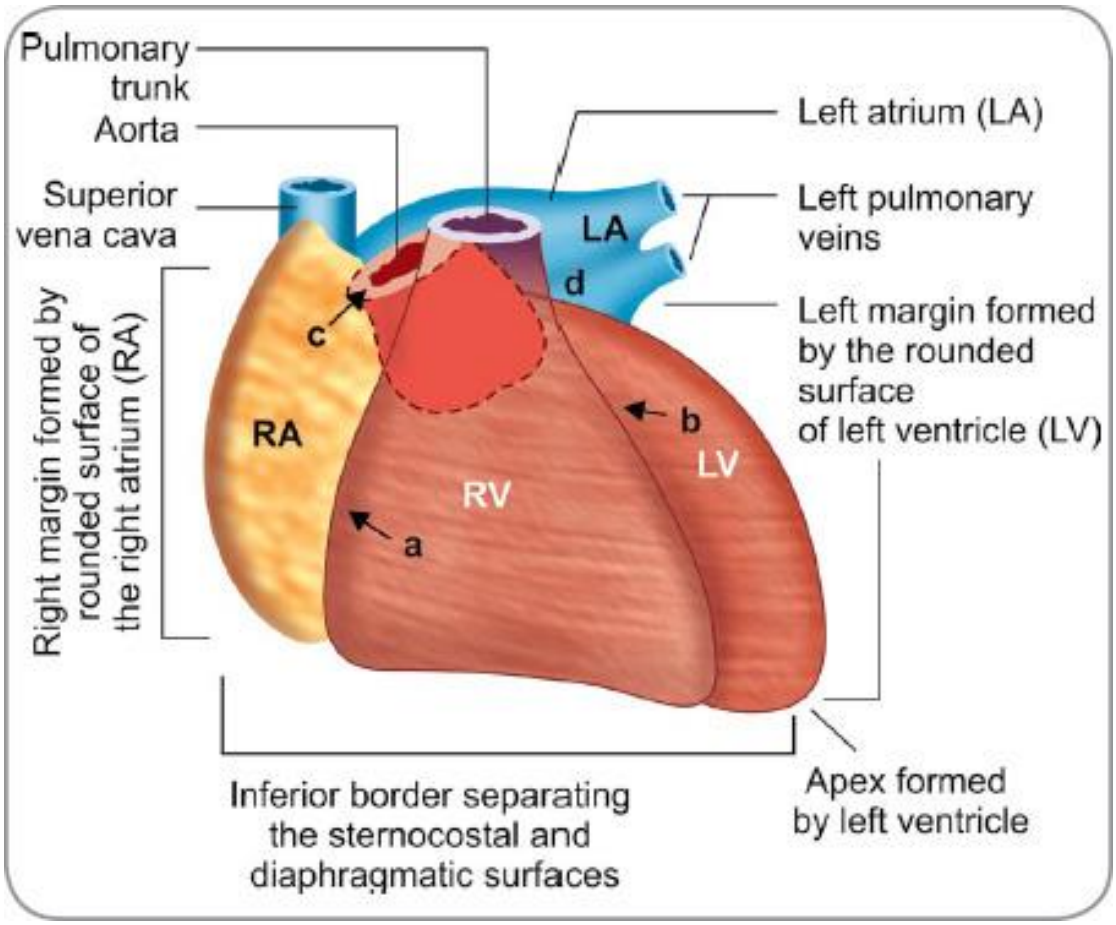
1- Base: (posterior surface**)**

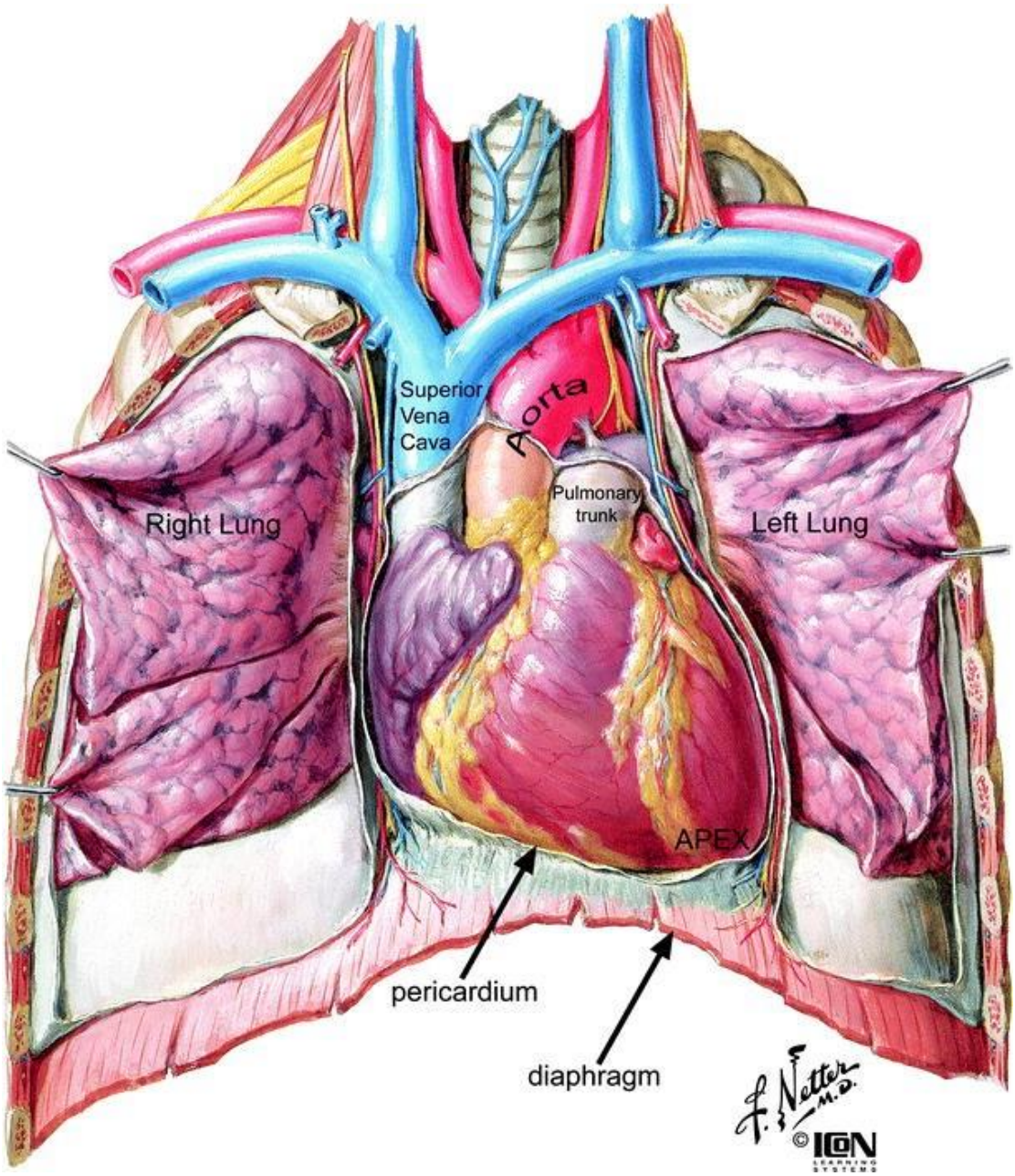
- It is the **posterior surface** of the heart.
- It is directed **backwards and to right.**
- It is **formed** of both atria (**mainly** by the **left** atrium).
- Right and left **pulmonary arteries** run along its **upper border**.
- **Coronary sulcus** which contains coronary sinus and circumflex artery run along the **lower border.**
- The **SVC & the IVC** enter at the superior end & inferior end of the right atrium.
- It is related to the **middle 4 thoracic vertebrae** (5^{th} to 8^{th}) .



2- Apex:

- It is the **lower most** and **left most point** of the heart.
- It is **directed** downwards, forwards and to the left.
- It is **formed** only by the left ventricle.
- It **lies in** the left 5th intercostal space, just medial to the midclavicular line (about 3½ inches or 9 cm from the median plane).
- It is **related to** the left lung and pleura.





(B) Surfaces of the Heart:

1- Sternocostal (anterior) surface:

- It is **convex** bounded by the **4 borders** of the heart.
- This surface is fomed **mainly by right ventricle**.

  It is divided by **coronary (A-V) sulcus** into an **atrial part** (posterior & to the right) and a **ventricular part** (anterior & to the left).

- The **atrial part** is formed of the right atrium & its auricle and left auricle (left atrium is hidden by pulmonary trunk & ascending aort).
- The **ventricular part**: Its **right 2/3** is formed of right ventricle and its **left 1/3** is formed of left ventricle.

- **This surface show 2 grooves:**

  1-**Atrioventricular** groove (**coronary** sulus)

  2- **Anterior interventricular** groove

- It has the following relations, from **before backwards**:

  a- **Anterior thoracic wall:** sternum and 2-6 costal cartilages.

  b- Anterior borders of the 2 pleurae and lungs: separate it from the anterior thoracic wall **except** at the region of cardiac notch of the left lung **(bare area of pericardium)**

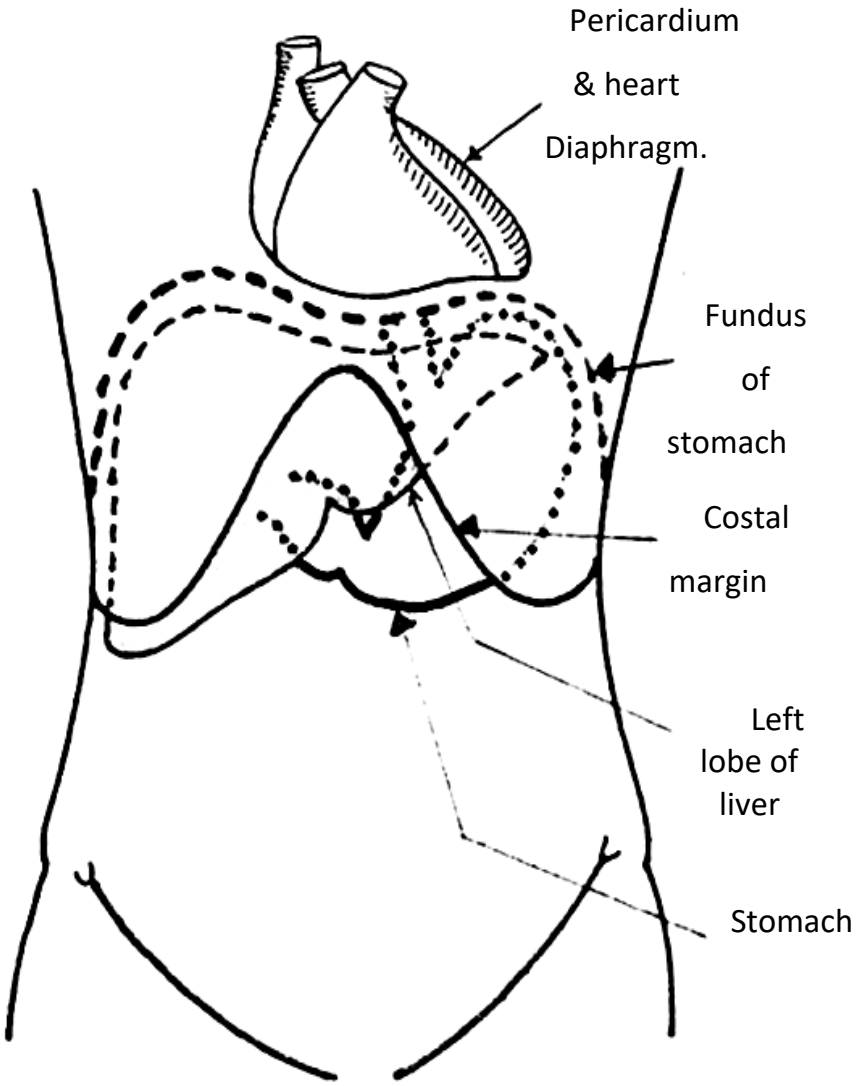
  c- Contents of the anterior mediastinum.

  d- Pericardium.

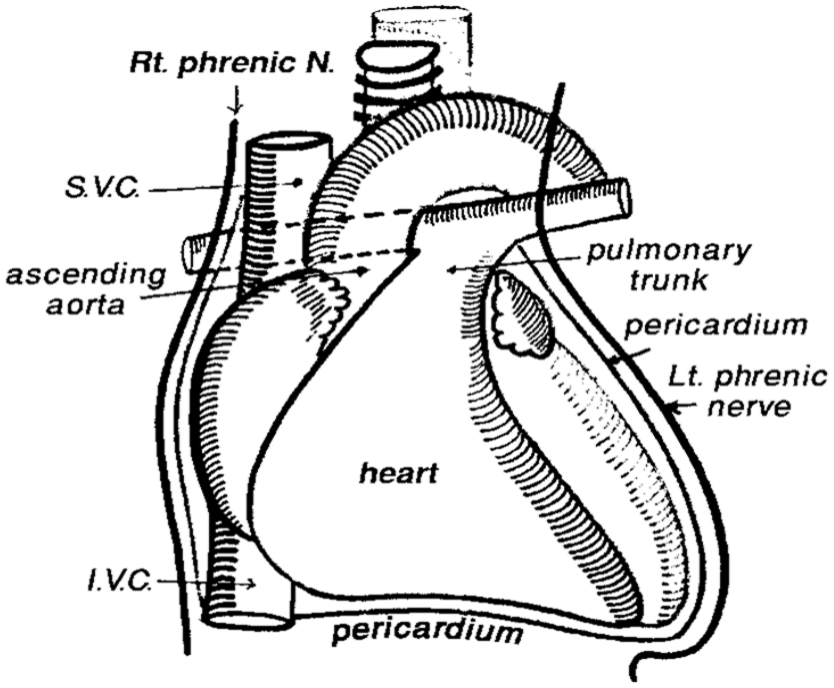
2- Diaphragmatic (inferior) surface:

- It rests on the central tendon of the **diaphragm**, and is **limited** posteriorly by the coronary sulcus.
- Its left 2/3 is **formed** of left ventricle and its right 1/3 is formed of the right ventricle (the reverse of sternocostal surface).
- The 2 ventricles are separated by the **inferior interventricular** groove.
- This surface is related to base of **pericardium, c**entral tendon of **diaphragm** which separate the heart from underluing left lobe of **liver** and fundus of **stomach.**

Relations of diaphragmatic surface



Borders of the heart



(C) Borders of the Heart:

1- The upper border:

- It is formed by 2 atria (**mainly by** the left atrium).
- It is **hidden anteriorly** by the roots of the ascending aorta and pulmonary trunk.
- The right and left **pulmonary arteries run along it**.

2- The lower border:

- It is **formed by 2 ventricles: mainly** by the **right** ventricle and small part near the apex by the left ventricle.
- It **extends** from the opening of the **I.V.C.** into the right atrium to the **apex** of the heart.

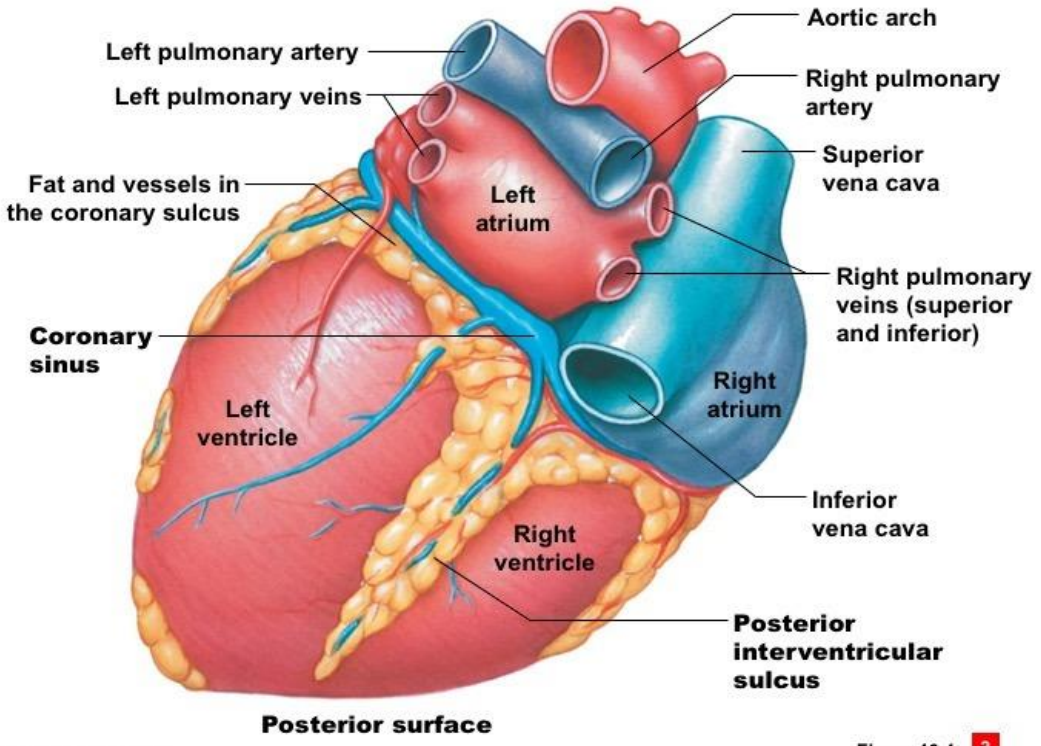
3- Left border:

- It is slightly **convex**, and is **formed** in its **lower main part** by the **left ventricle** and in its **upper smaller part** by the **left auricle.**
- It is **related to** the pericardium, left phrenic nerve and pericardiaco-phrenic vessels which separate it from the left lung and pleura.

4- Right border:

- It is slightly **convex**, and is **formed by** the **right atrium only.**
- It **extends** from the opening of the **S.V.C.** above to the opening of the **I.V.C.** below.
- It is **related** to the pericardium, right phrenic nerve and pericardiaco-phrenic vessels which separate it from the right lung and pleura.

Superficial view of the posterior surface of the heart



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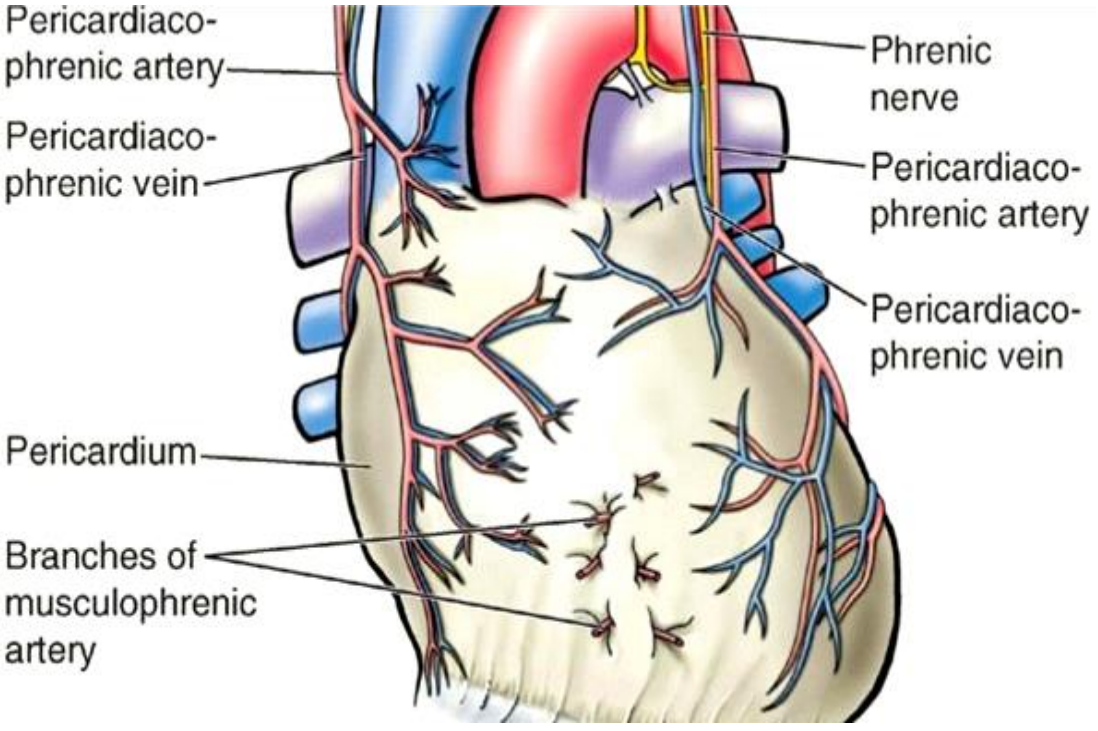


★ **Grooves or Sulci:** The heart has the following grooves:

1- Atrio-ventricular groove: (coronary groove)

- It forms a circle around the heart separating the two atria (posterior and to right) from two ventricles (anterior and to left).

2- The anterior and inferior interventricular grooves:

- It separates the two ventricles from anterior and inferior surfaces respectively.

Chambers of the heart

I) The atria

★ **Thickness** of the atrial wall is about **3 mm**.

★ The 2 atria are separated by the **interatrial septum.**

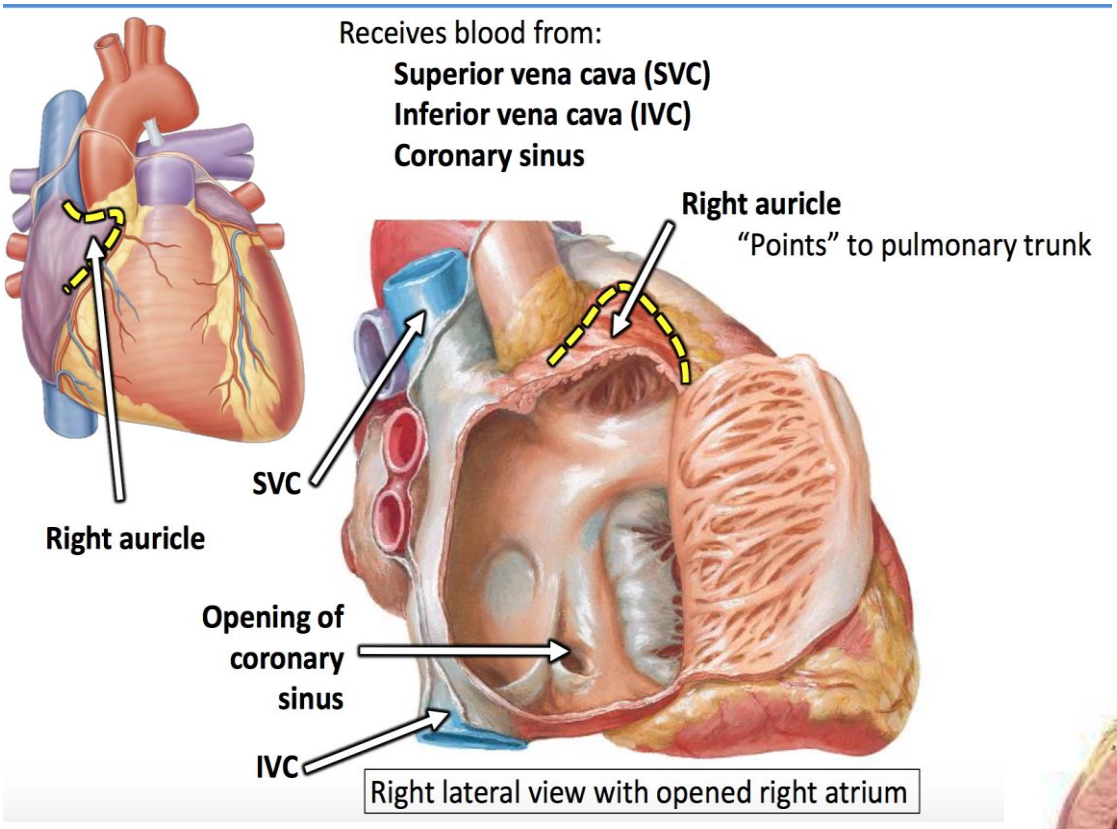
★ Each atrium has an **auricle** projecting up and forwards.

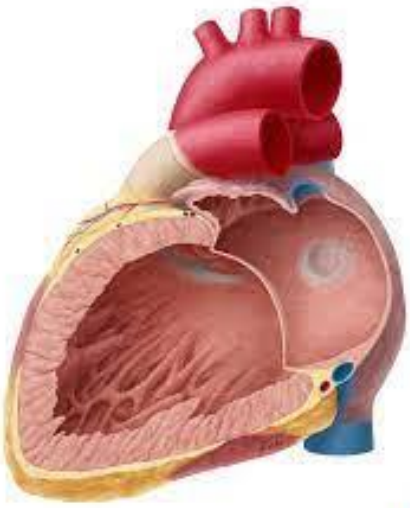
★ **Different between right and left atria :**

	1. Right atrium	2.Left atrium
Type of blood	• It receives **non-oxygenat**ed blood from all parts of the body through IVC , SVC & coronary sinus .	• It receives **oxygenated** blood from the lungs through **4 pulmonary veins**.
Exit of blood	• Through **tricuspid** valve which has **3 cusps**, admits **3 fingers** and leads to right ventricle.	• Through **mitral** valve which has **2 cusps**, admits **2 fingers** and leads to left ventricle.
Site	• It lies **anterior and to the right** to the left atrium.	• It lies **posterior and to the left** to the right atrium.
	• It forms **alone** the **right border** of the heart & **small part** of the base and anterior surface.	• Forms **main** part of **upper border** & main part of the **base**.

Auricle	• Its auricle overlaps the right aspect of ascending aorta.	• Its auricle overlaps left aspect of root of pulmonary trunk.
Cavity	**1. The crista terminalis:** • A thick muscular vertical ridge extends from the opening of SVC to the opening of IVC and marked on the outer surface by **sulcus terminalis**. • The crista terminalis divides the right atrium to **anterior and posterior** walls. **2. Anterior wall: (Atrium proper)** • It forms the right auricle, **rough** due to the presence of **musculi pectinati** (muscular ridges **extend** from **crista** terminalis into the auricle to **prevents over distention** of the right atrium during diastole). **3. Posterior wall: (sinus venerum)** • It is **smooth** with S.V.C., I.V.C. and the coronary sinus **open in this wall**. **4.The septal wall: (The interatrial septum)** presents • **The fossa ovalis:** in the lower part of the septum **above** the orifice of **IVC**. It is the remains of **foramen ovale** of the embryo.	• **Smooth**, except its auricle which contains few musculi pectiniti. • The **interatrial septum is smooth**

Orifices	1.**S.V.C. orifice:** has **no valve**, it lies in **superior** part of posterior wall. 2. **I.V.C. orifice:** opens in the **inferior** part of posterior wall, it has a small remnant embryological **valves** directs blood to foramen ovale to the left atrium. 3.**Coronary sinus orifice:** on the **left side** of the opening of I.V.C. **between** it and the tricuspid orifice. It is guarded by **valve**. 4. **Right atrioventricular opening** present in the **inferior part** of right atrium. It is guarded by the **tricuspid valve.** 5. **Orifices of venae cordis minimae and anterior cardiac veins.**	1.**Four pulmonary veins**: two from each side open into **upper** part of **posterior** surface. 2. **Left atrioventricular opening**: presents in the **inferior** part of left atrium. It is **guarded** by the the mitral valve.



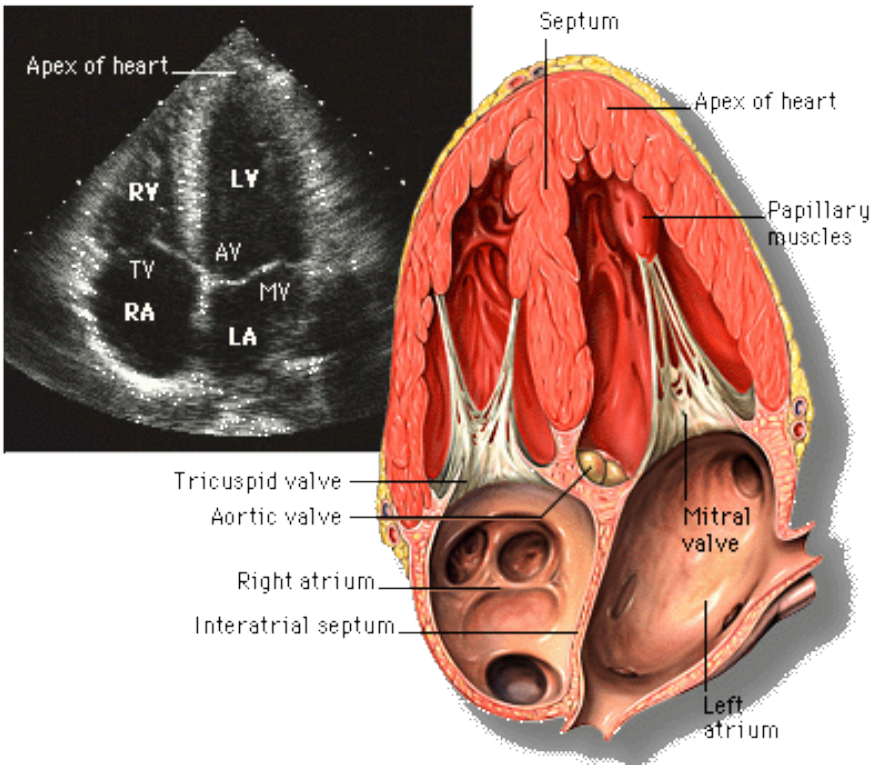


II) The ventricles

★ The two ventricles are separated from each other by the **interventricular septum** which is marked **on the surface** to the anterior and inferior **interventricular grooves**.

★ The **interventricular septum:** convex anterior and to the right and concave posterior and to the left. It's derived from 2 sources in embryo that is why it is formed of 2 parts:

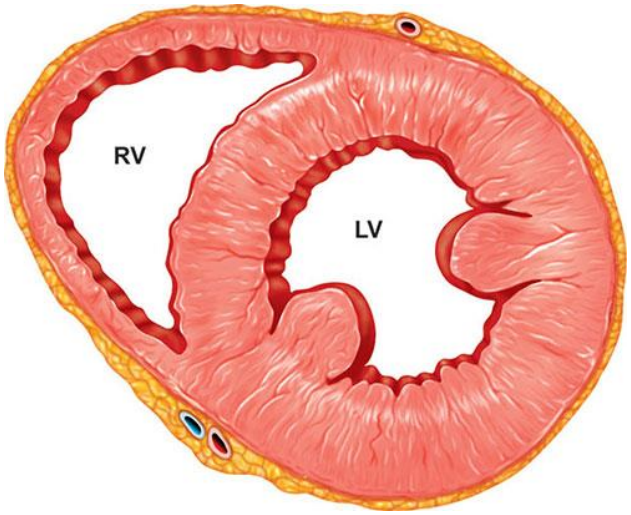
1. **Membranous part**: thin, forms the **upper posterior** part of the septum. It **separates** the left ventricle from both right ventricle and right atrium.
2. **Muscular part:** thick, larger **lower part**. It **separates** the left ventricle from the right ventricle.

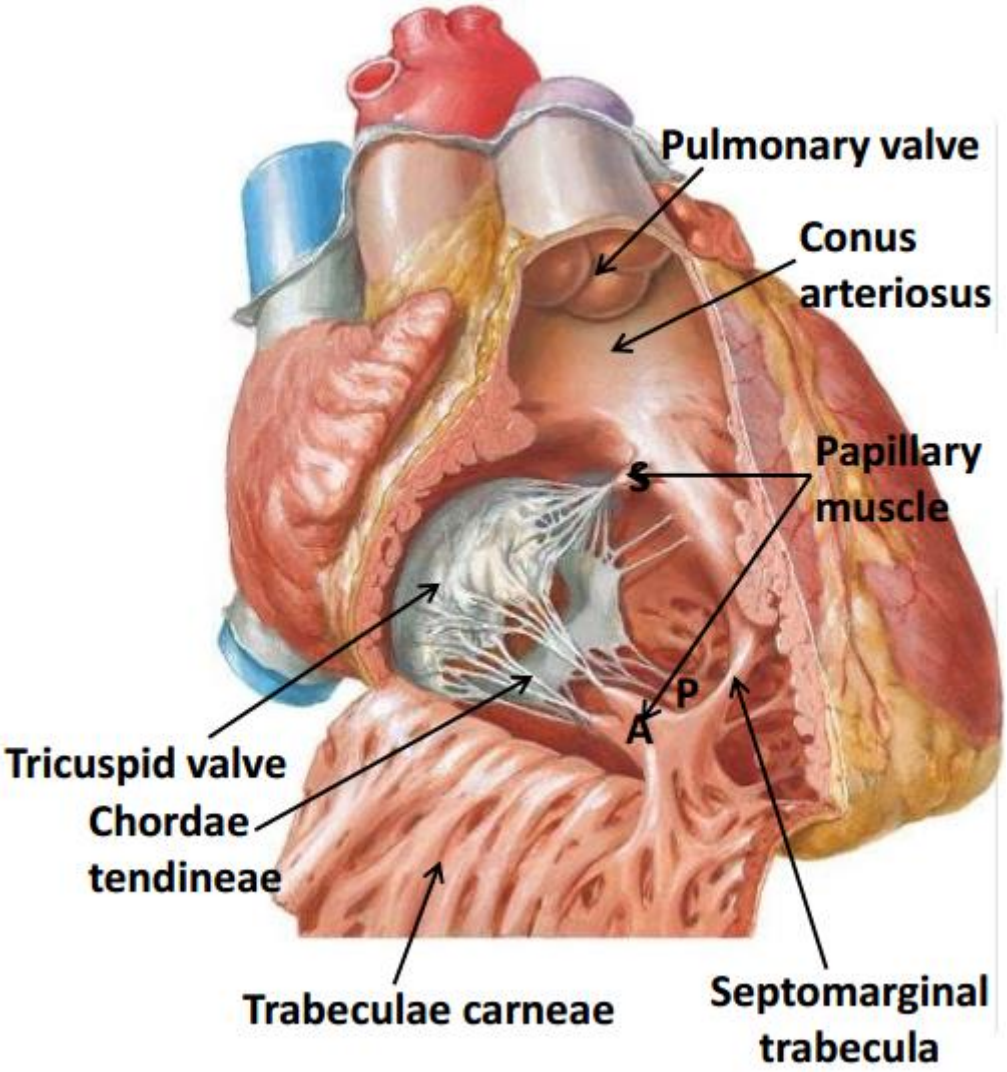


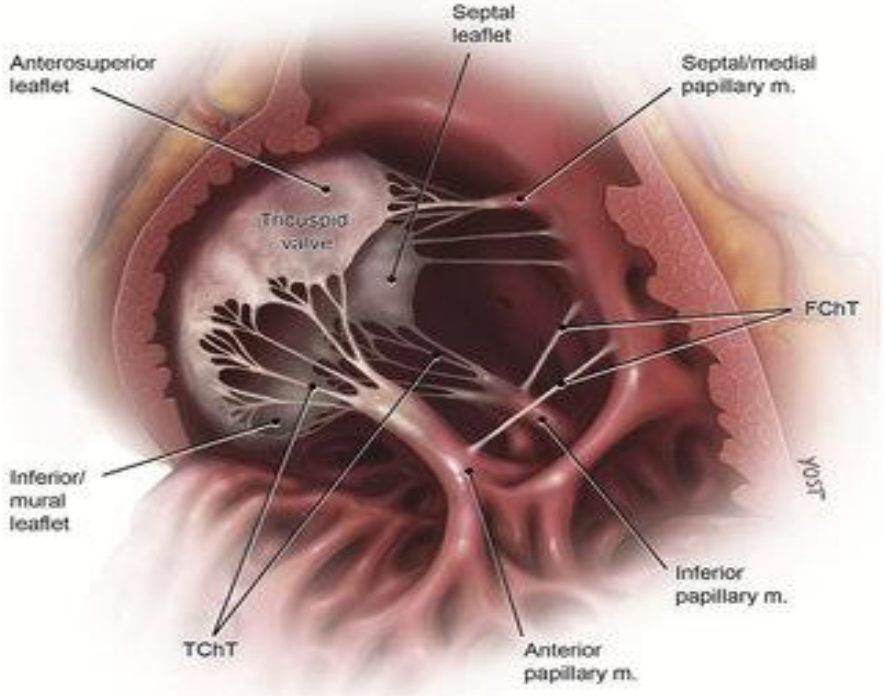
★ **Different between right and left ventricles:**

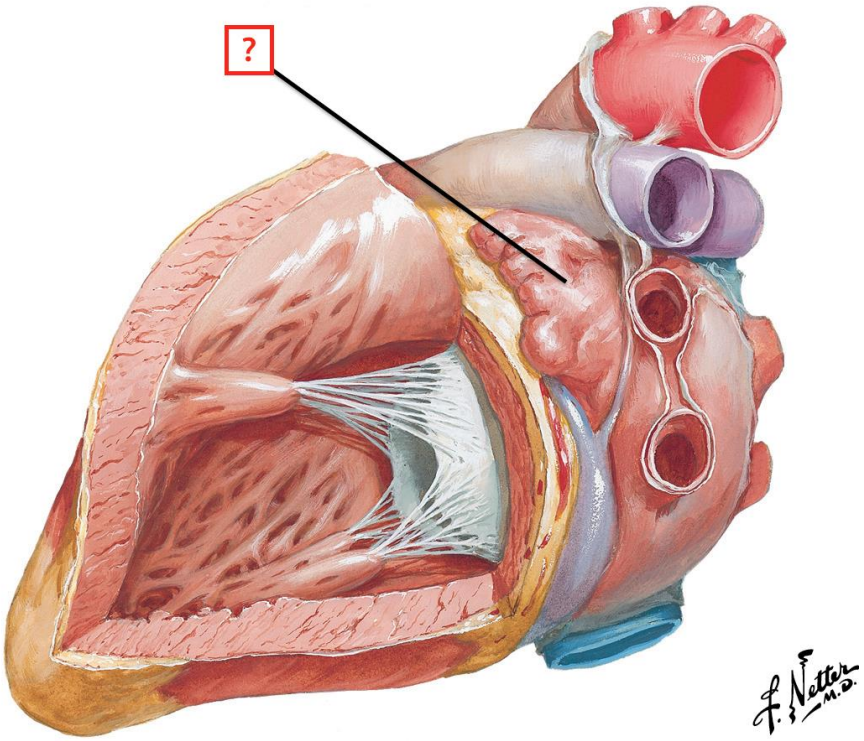
	1.Right ventricle	2.left ventricles
position	• Anterior and to the right of the left ventricle.	• Posterior and to the left of the right ventricle.
General features	• It has 3 walls: 1) **Anterior wall** forms main part of **sterno-costal** surface. 2) **Inferior wall** forms right 1/3 of **diaphragmatic** surface. 3) **Left** (**septal) wall** formed by the interventricular septum which is **convex** toward its cavity → this cavity appears **cresentic in cross section**. • It forms the main part of **lower border** of the heart except at apex.	• It has 3 walls: 1)**Anterior wall** forms small left part of **sternocostal** surface. 2)**Inferior wall** forms left 2/3 of **diaphragmatic** surface. 3) **Right (septal) wall concave** towards its cavity → this cavity appears **circular in cross section**. • It **forms** most of **left border** & part of lower border at the **apex** .
Thickness	• 9 mm	• 27 mm| i.e. 3 times thicker since it pushes blood in all parts of body.
Cavity	**I) Inflow rough lower part** shows the following features :	
	1.Trabeculae carnae (thick muscular ridges)	
	• Few and coarse.	• Multiple and fine.
	2. Moderator band (Septomarginal trabecula)	
	• Is thick muscle band between the IV septum and to the base of the anterior papillary muscle. • It prevents over distention of the right ventricle • It transmit the right branch of AV bundle .	• Absent.
	3.Papillary muscles:	

	• Are **conical** muscular projections. • The **apex** of each muscle is attached to **cordae tendenae** which connect them to the **free** border & **ventricular surfaces** of A-V cusps.	
	• **3 papillary muscles:** **a-Anterior** papillary muscle :(largest) attached to **anterior** wall. **b- Posterior** papillary muscle: (smallest) attached to **inferior** wall. **c- Septal** papillary muscles: **numerous** small projections which arise from the interventricular septum. • **Small** in size	• 2 papillary muscles : **Anterior & posterior** attached to the anterior and inferior walls respectively & their chordae tendinae are attached to **both cusps** of mitral valve • **Larger** in size.
	II)Outflow smooth upper part	
	• It lies just below pulmonary orifice and called **Infundibulum** (funnel shape) or conus arteiosus.	• It lies just below aortic orifice and called **aortic vestibule.**
Orifices	• Right atrio-ventricular (**tricuspid**) **orifices** is inlet orifice. It is guarded by the **tricuspid valve.** • **Pulmonary orifices** is the outlet orifice. It is guarded by the **pulmonary valve.**	• Left atrio-ventricular (**mitral**) orifices is the inlet orifices. It is guarded by the **mitral valve.** • **Aortic** orifice is the outlet orifice. It is guarded by the **aortic valve.**




Pulmonary valve
Conus arteriosus
Papillary muscle
S
P
A
Tricuspid valve
Chordae tendineae
Trabeculae carneae
Septomarginal trabecula


Septal leaflet
Anterosuperior leaflet
Septal/medial papillary m.
Tricuspid valve
FChT
Inferior/ mural leaflet
Inferior papillary m.
TChT
Anterior papillary m.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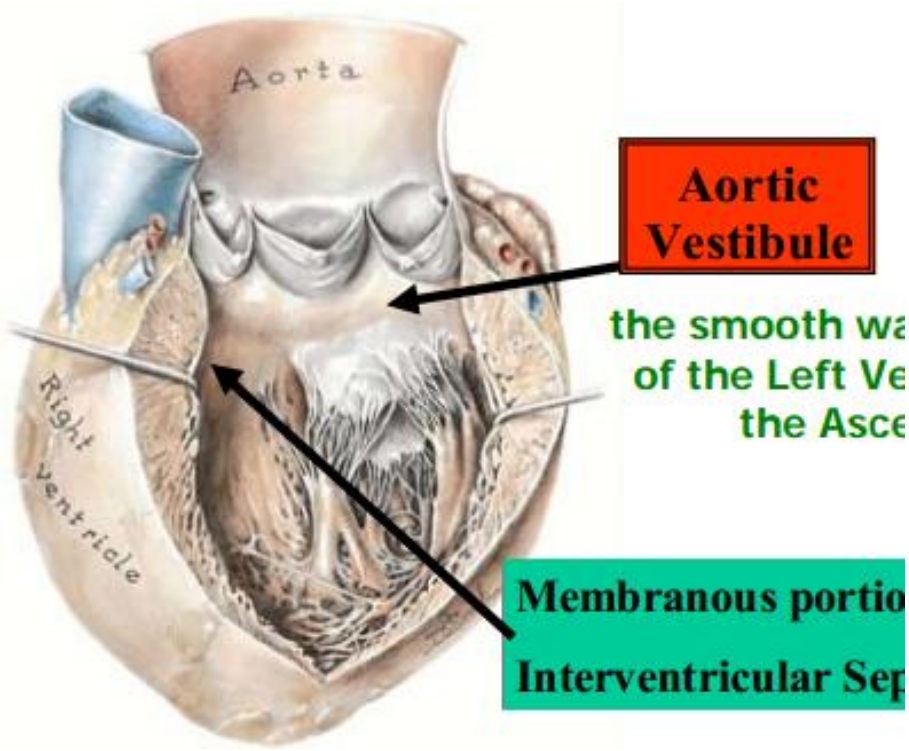
Aorta
Right ventricle
Aortic Vestibule
the smooth wa
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the Asce
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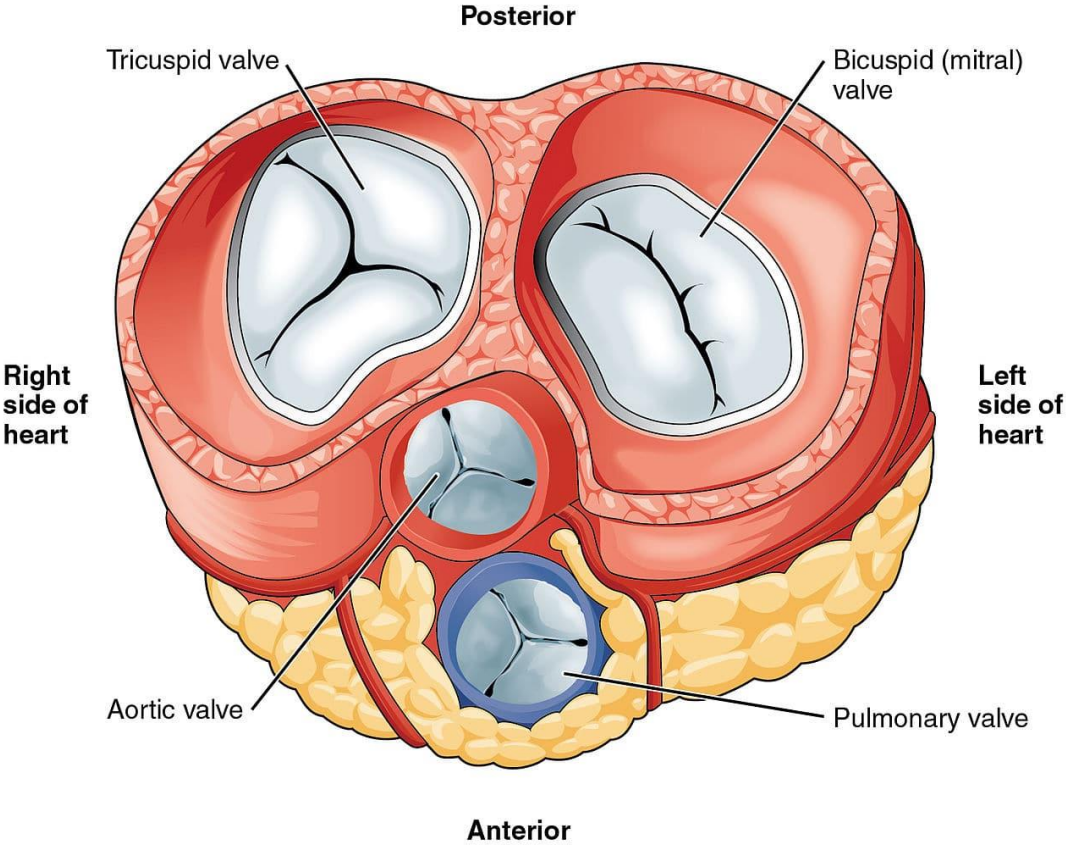
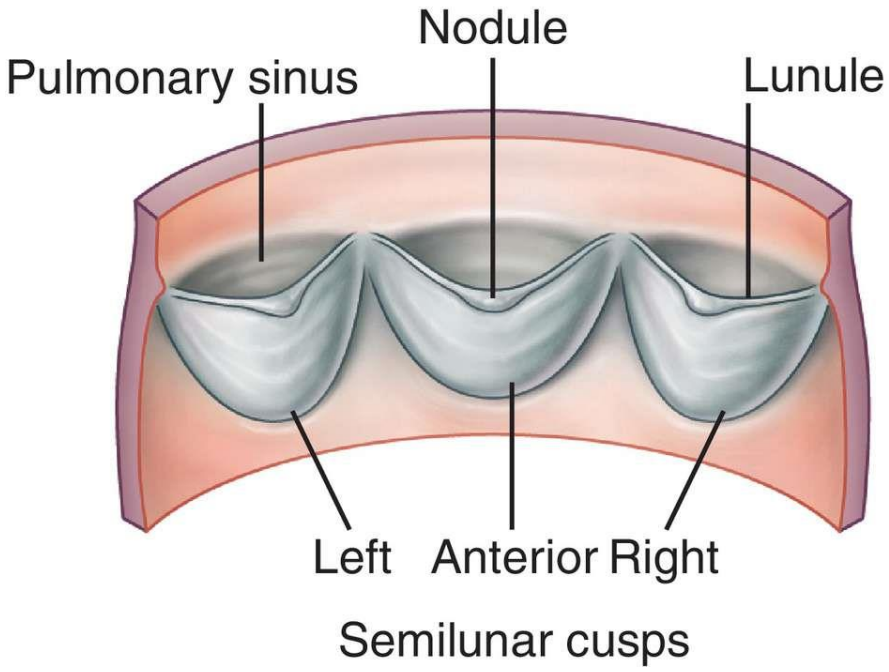
★ Orifices and Valves of the heart:

I) Orifices and Valves of the atria: (see before)





II) Orifices and valves of the ventricles:

Orifices & Valves of right ventricle	Orifices & Valves of left ventricle
A-Right atrioventricular (A-V) orifice:	**A- Left atrioventricular (A-V) orifice:**
• It is an **oval** orifice.	• It is a **circular** orifice.
• **Between** the right atrium and right ventricle.	• **Between** the left atrium and left ventricle.
• Its plane is **vertical.**	
• Directed forwards and to the left (**towards the apex** of the heart).	
• It admits the tips of **3 fingers**.	• It admits the tips of **2 fingers.**
B- Tricuspid valve:	**B- Mitral (bicuspid) valve:**
• It consists of **3 cusps**: **1) Anterior** cusp attached to the **anterior wall** of the ventricle. **2) Posterior** cusp attached to the **inferior wall** of the ventricle. **3) septal** cusp attached to the interventricular **septum**.	• It consists of **2 cusps**: 1) **Anterior cusp** is larger and attached to the **anterior wall** of the ventricle. **2) Posterior cusp** attached to the **inferior wall** of the ventricle.
▪ The **atrial surface** of each cusp is **smooth** while its **ventricular surface** is **rough** as it gives attachment to the **chordae tendinae**.	• **Both surfaces** of the **anterior cusp** are **smooth** (as it gives no attachement to chordae tendinae) . • While **only the atrial** surface of the posterior cusp is **smooth** as its ventricular surface gives attachment to chordae tendinae.
C- Pulmonary orifice:	**C- Aortic orifice:**
• It is a **circular** orifice.	
• It is situated horizontally at the upper end of the **infundibulum**	• It is situated horizontally at the upper end of the aortic vestibule

• It is **surrounded** by a fibrous ring that gives **attachment** to the 3 **cusps** of the corresponding valve.	
D- Pulmonary valve:	**D- Aortic valve:**
• It consists of **3 semilunar cusps:** 2 anterior and one posterior.	• It consists of **3 semilunar cusps**; 2 posterior and one anterior.

Surface Anatomy of the Heart

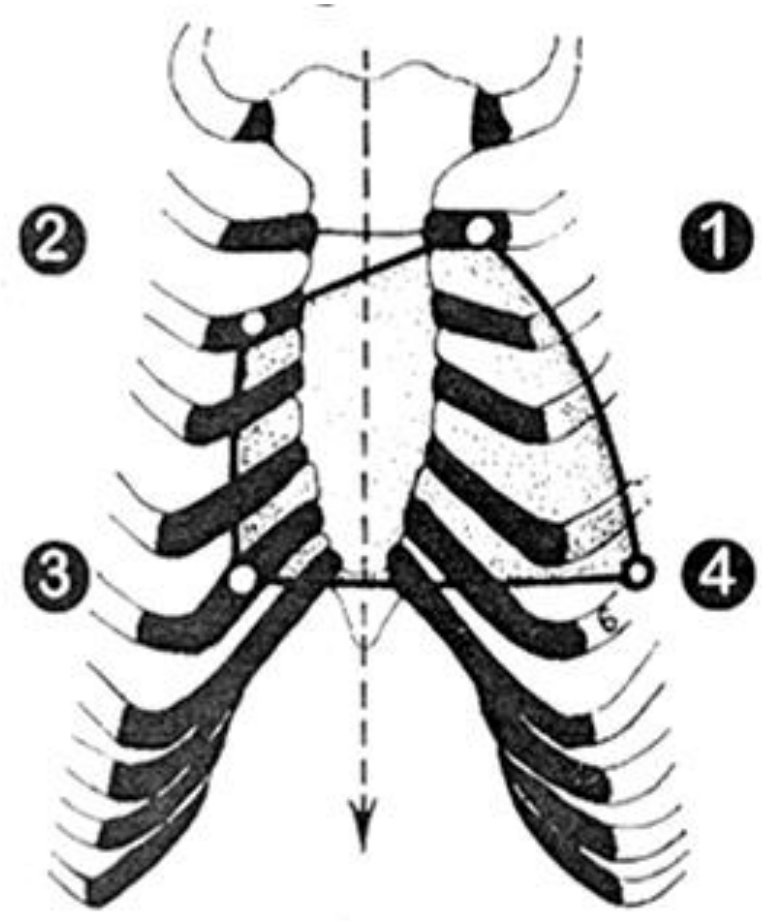
[A] Borders of the heart:

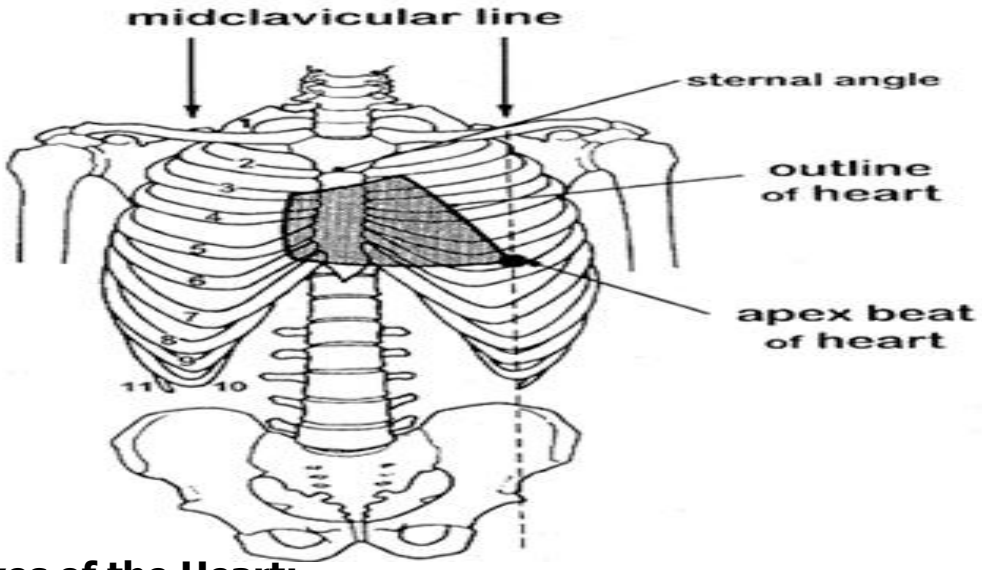
1- Upper border: an oblique straight line from lower border of 2nd left costal cartilage 1.5 cm from sternal margin (**point 1**)the upper border of 3rd right costal cartilage 1.5 cm from sternal margin (**point 2**)

2- Right border: a vertical line, slightly convex to the right, from **point 2** to 6th right costal cartilage 1.5 cm from sternal margin (**point 3)**

3- Lower border: an oblique straight line from **point 3** to 5th left intercostal space 9 cm from median plane (**point 4**)

4- Left border: a vertical line, slightly convex to the left, from apex of the heart **(*point 4*) to *point 1*.**





[B] Valves of the Heart:

1- **Pulmonary valve:** lies behind the **3rd left sternocostal junctions**.

2- **Aortic valve:** behind the left margin of the sternum opposite the **3rd left intercostal space**.

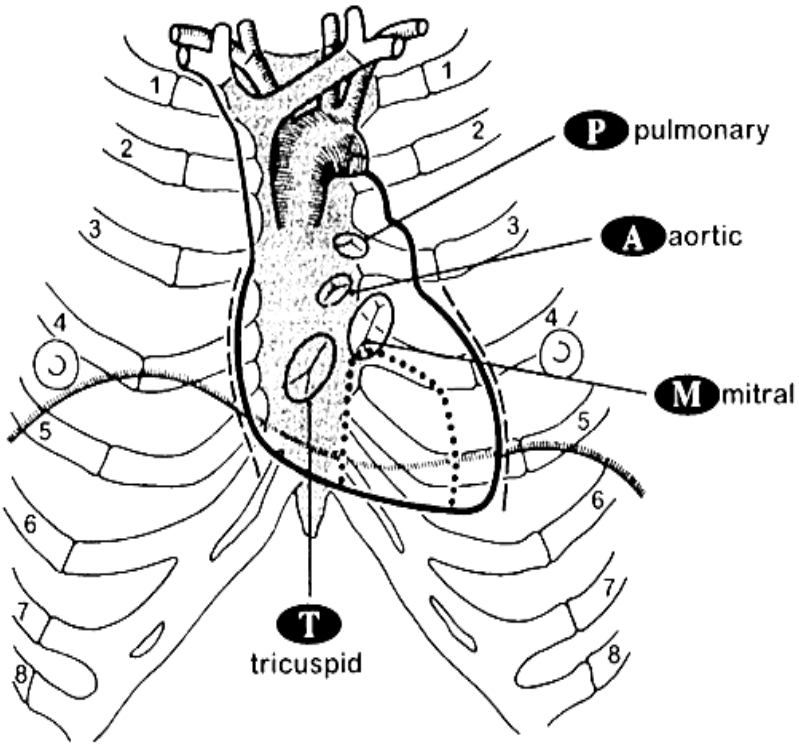
3- **Mitral valve:** behind the left half of the body of the sternum, opposite the **4th left sternocostal junction**.

4- **Tricuspid valve:** behind the center of the sternum opposite **4th intercostal space.**

[C] Auscultatory areas:

- The closure and opening of the cardiac valves produce the heart sounds. Because of the mechanics of propagation of

sound, the sounds of the valves are **not** heard best over their anatomical position, but at the auscultatory areas.



Surface anatomy of the heart and its valves

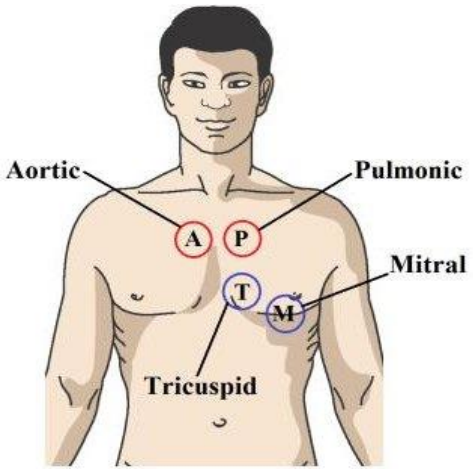
- **Clinically** the sounds of valves are best heard at the following sites:

  ***1.*Pulmonary valve:** at 2nd left sternocostal junction.

  ***2.*Aortic valve:** at 2nd right sternocostal junction.

  ***3.*Mitral valve:** at the apex of the heart.

  4.*Tricuspid valve*: at xiphisternal junction.

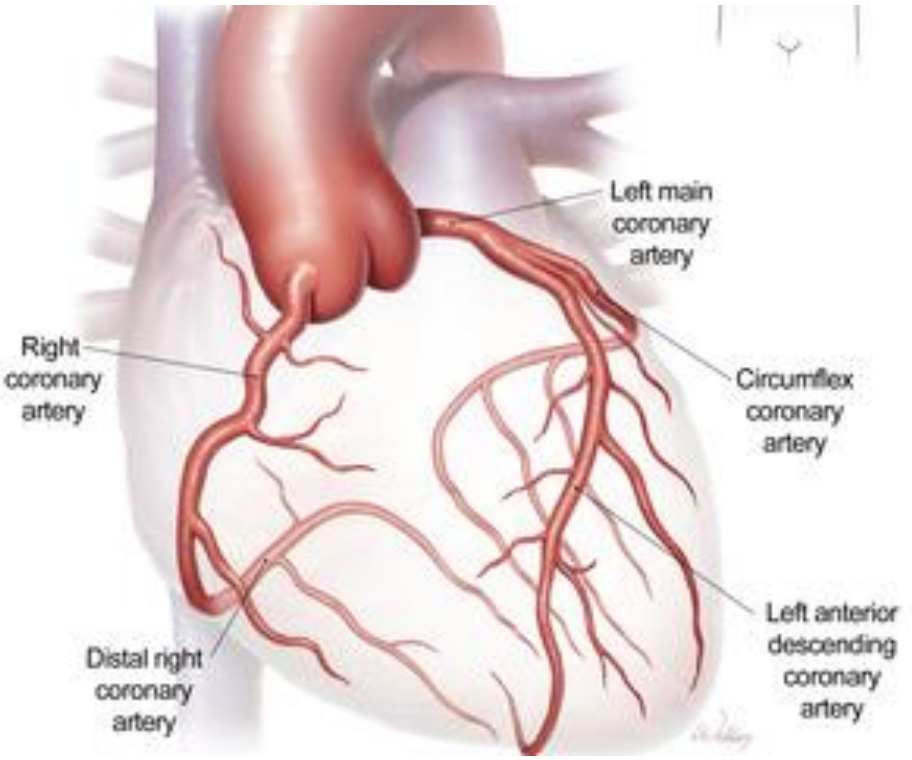


Blood supply of the heart

A.Arterial supply

(Coronary arteries)

☐The heart is supplied by **two coronary arteries** (right and left) which run in the sulci of the heart **encircling** it like a ***crown*** and hence the name coronary.



1. Right coronary artery:

- It **arises** from **anterior aortic sinus** of ascending aorta.
- It **passes between** the root of pulmonary trunk and right auricle.
- It **runs** downwards and to the right in the **coronary sulcus** directed till it reaches the point of **junction** of the right and inferior borders of the heart, here it **gives** the **right marginal** artery.
- Then it **turns** backwards to the left and **runs** in the posterior part of coronary sulcus where it **ends** by anastomosing with the circumflex branch of left coronary artery.
- **Branches of right coronary artery:**

a. **Right marginal artery:**

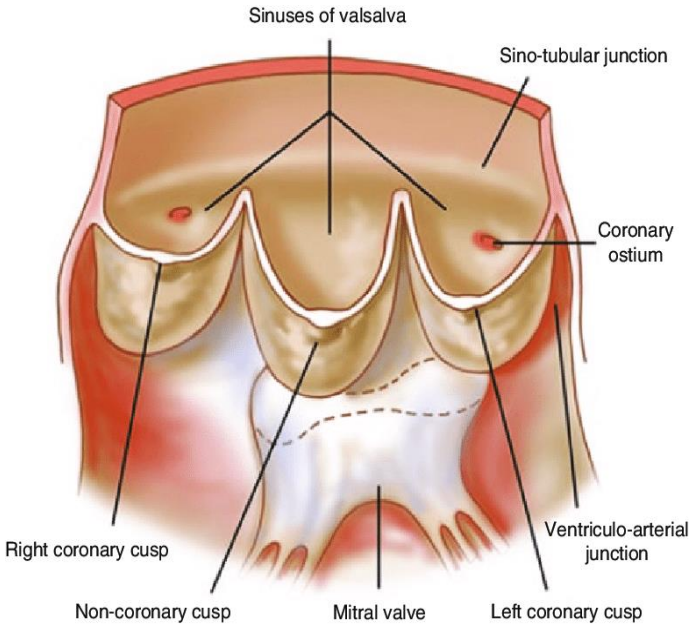
- It runs **along** inferior border to the apex of the heart.
- It **supplies** the right ventricle.

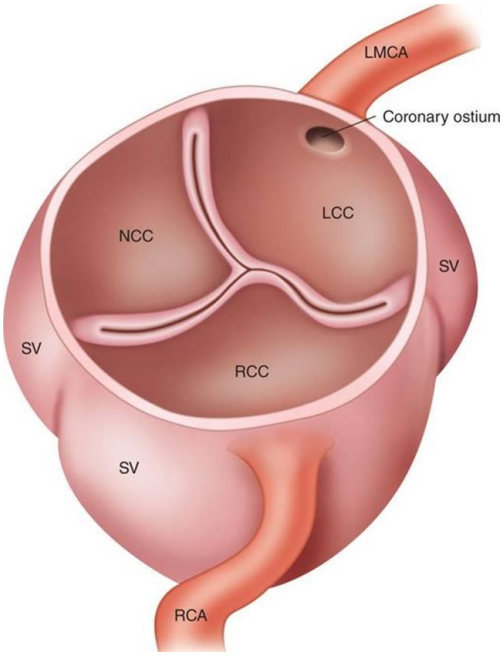
b. **Inferior interventricular artery**:

- It **arises** near the termination of the right coronary artery.
- It **passes** in the inferior interventricular groove
- It **ends** near the apex by anastomosing with the anterior interventricular branch of left artery.
- It **supplies** both ventricles and posterior 1/3 of interventricular septum.

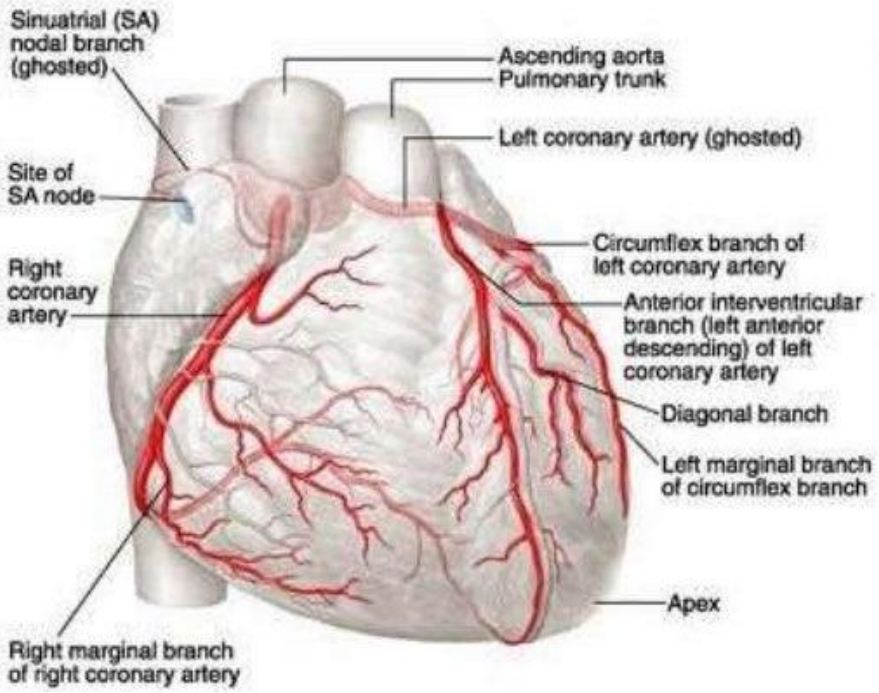
c. **Small branches**:

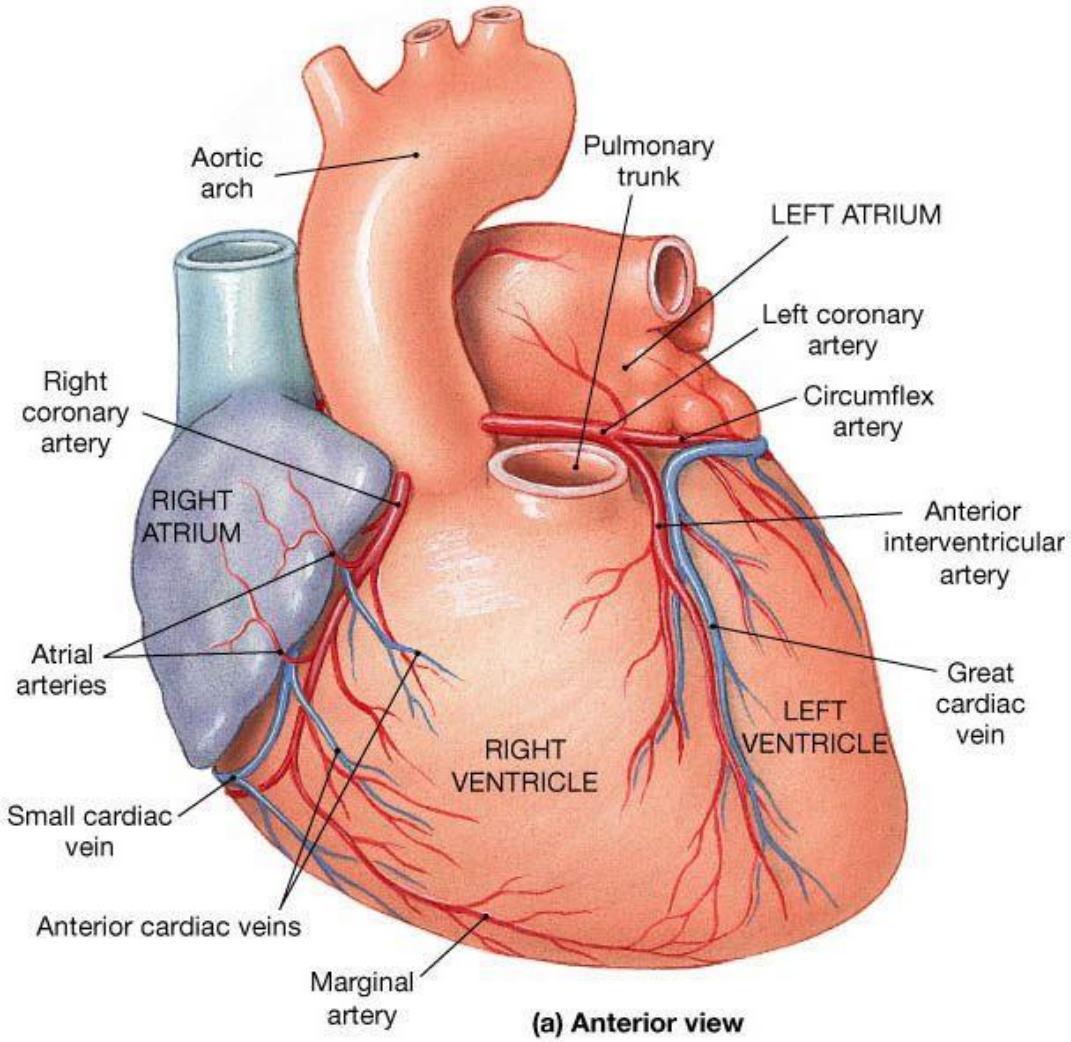
- Right atrium
- Right ventricle.
- SA node (sino-atrial)
- AV node (atrio-ventricular nodes).



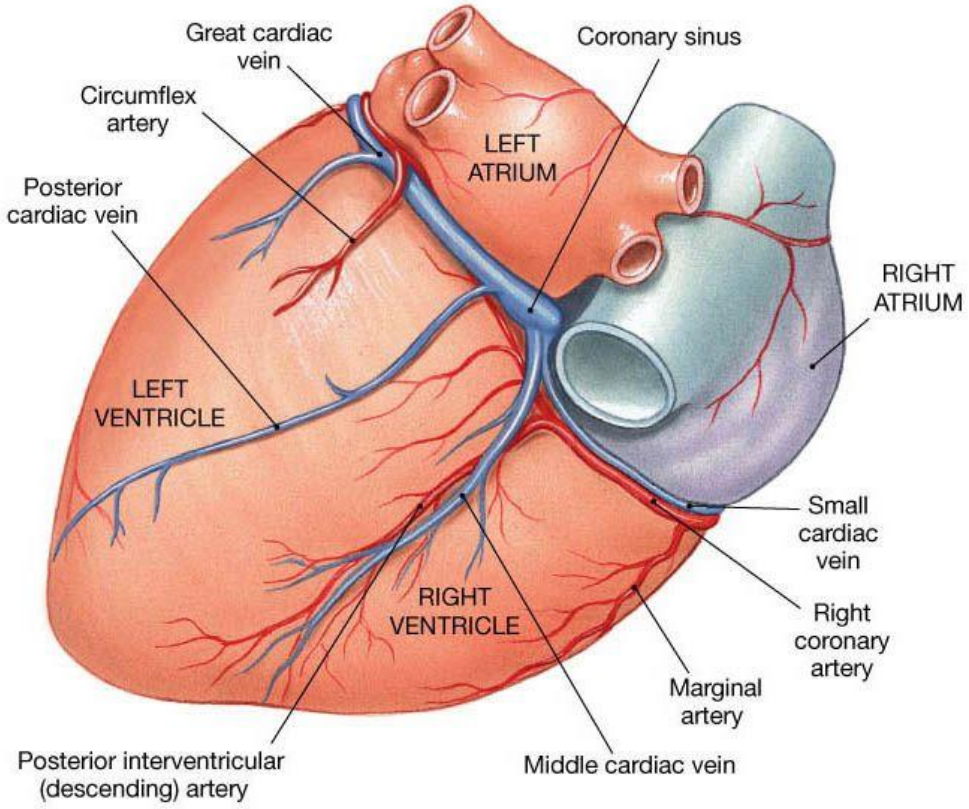


A. Normal arterial pattern, anterior view

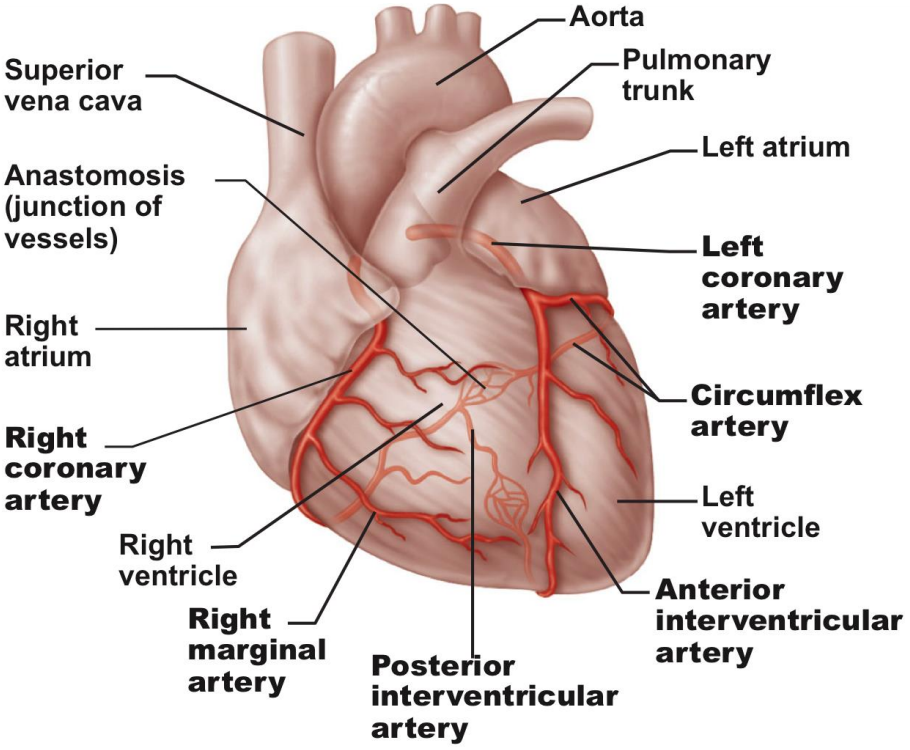




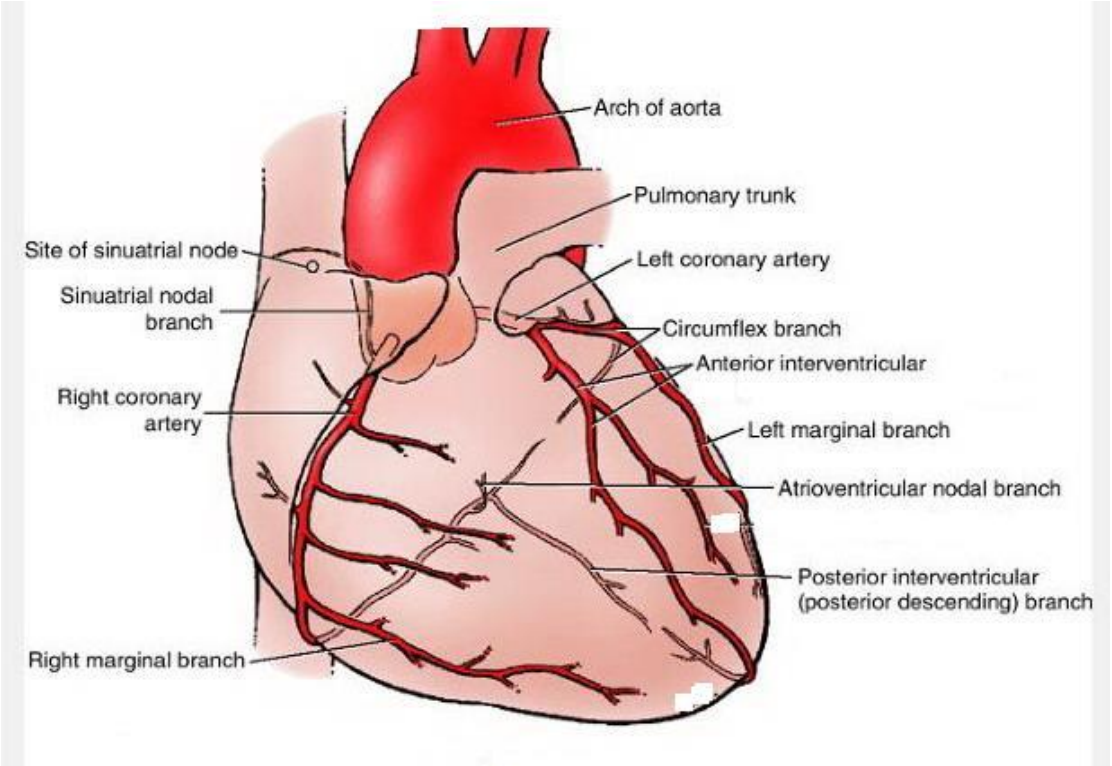
(a) Anterior view



(b) Posterior view



(a) The major coronary arteries



Anterior view

Distribution of the coronary arteries

2. Left coronary artery:

- It **arises** from **left posterior aortic sinus** of the ascending aorta.
- It is a very short artery **runs** forwards between the root of pulmonary trunk and left auricle to **reach** the upper end of anterior interventricular groove where it **ends** by dividing into two arteries: circumflex artery and artery anterior interventricular artery.

- **Branches:**

a. **Circumflex artery:**

- It **passes** to the left in the coronary sulcus where it gives **left marginal** branch, then **turns** backwards around the left border of the heart and **continue** in the coronary sulcus with the coronary sinus to **end** by anastomosing with the right coronary artery.
- It **supplies** the left atrium and left ventricle.

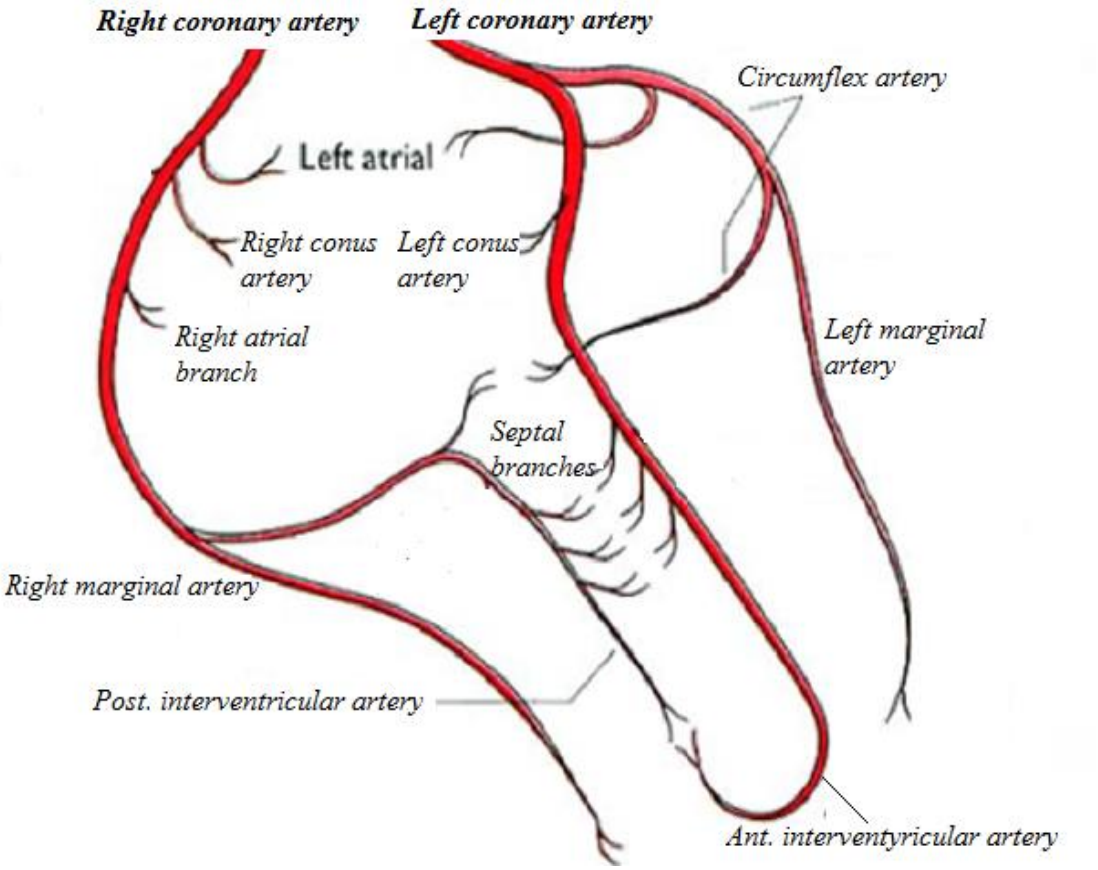
b. **Anterior interventricular artery:**

- It **descends** in the anterior interventricular groove to **reach** the inferior border of the heart near the apex, then **turns** to reach the inferior interventricular groove.
- It **ends** by anastomosing with inferior interventricular artery.
- It **supplies** the anterior surface of both ventricles and anterior 2/3 of interventricular septum.

c. **Small unnamed branches:**

- Most of left atrium and left ventricle
- Anterior 2/3 of the interventricular septum
- Branch to SA node and AV bundle & its branches.

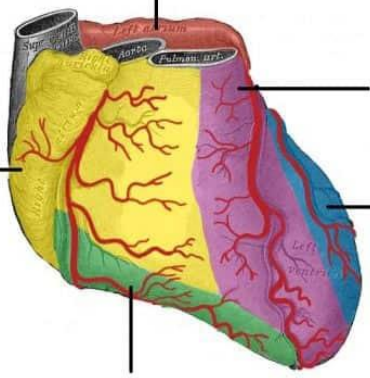
Anastomosis between the branches of the coronary arteries



Summary of arterial supply to the heart:

	Right coronary artery	**Left coronary artery**
Right ventricle	All of the right ventricle except small area .	small area related to the anterior
Left ventricle	Small area of inferior surface close to inferior interventricular sulcus.	All of the left ventricle except small area supplied by right coronary .
Atria	Right atrium and small area of left atrium.	Most of the left atrium.
Interventricular septum.	Posterior 1/3 of interventricular septum.	Anterior 2/3 of interventricular
Conductive system	S.A node and A.V node	S.A node and AV bundule & its branches

Left Circumflex Artery
Supplies the left atrium and left ventricle



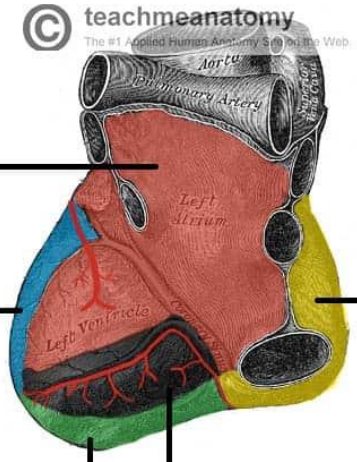
Left Anterior Descending Artery
Supplies the right ventricle, left ventricle and interventricular septum

Right Coronary Artery
Supplies the right atrium and the right ventricle

Left Marginal Artery
Supplies the left ventricle

Right Marginal Artery
Supplies the right ventricle and the apex

Left Circumflex Artery
Supplies the left atrium and ventricle



Left Marginal Artery
Supplies the left venticle

Right Coronary Artery
Supplies the right atrium and right ventricle

Right Marginal Artery
Supplies the right ventricle and apex

Posterior Interventricular Artery
Supplies the right and left ventricles, and the interventricular septum

★**Applied anatomy:**

- **Anastomoses** between the branches of the right and left coronary arteries exist, but they are usually **poor except in athelets**.
- **Sudden occlusion** of one of the branches of coronary arteries usually leads to **myocardial infarction**, except in athelets.
- **Sudden occlusion** of one of the large branches of coronary arteries is a common cause of sudden death.
- **Visualization** of **left side** of heart or **coronary** arteries by **diagnostic cardiac catheter** (introduced from radial artery) and **angiography .**
- **Visualization of right side** of the heart **and pulmonary trunk** by diagnostic cardiac catheter (introduced from femoral vein) and angiography.
- Coronary occlusion is **treated by** stenting or coronary bypass operation.
- **Cardiomegaly** is enlargement of the heart


THANK YOU
FROM THE APEX OF MY HEART