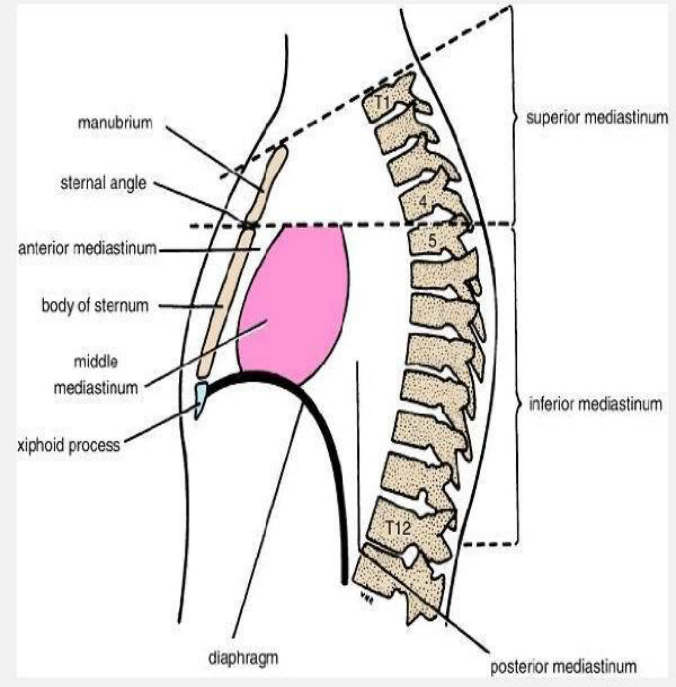
Anatomy of the heart

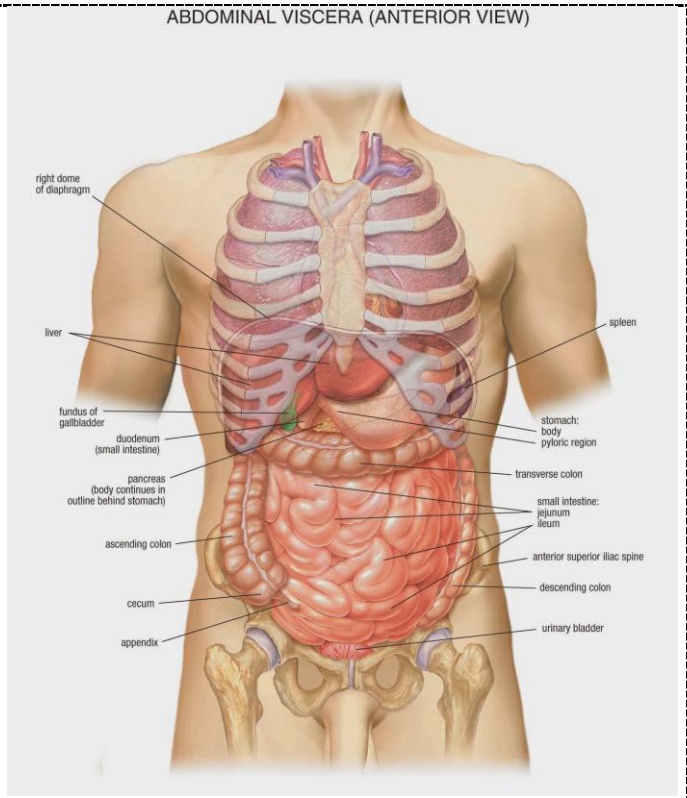
External features of the heart

Position

- It lies within the **pericardium** in the **middle mediastinum.**
- It is 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.



Middle mediastinum



Size and weight

- It is slightly larger than the size of **closed fist.**

Parts of the heart

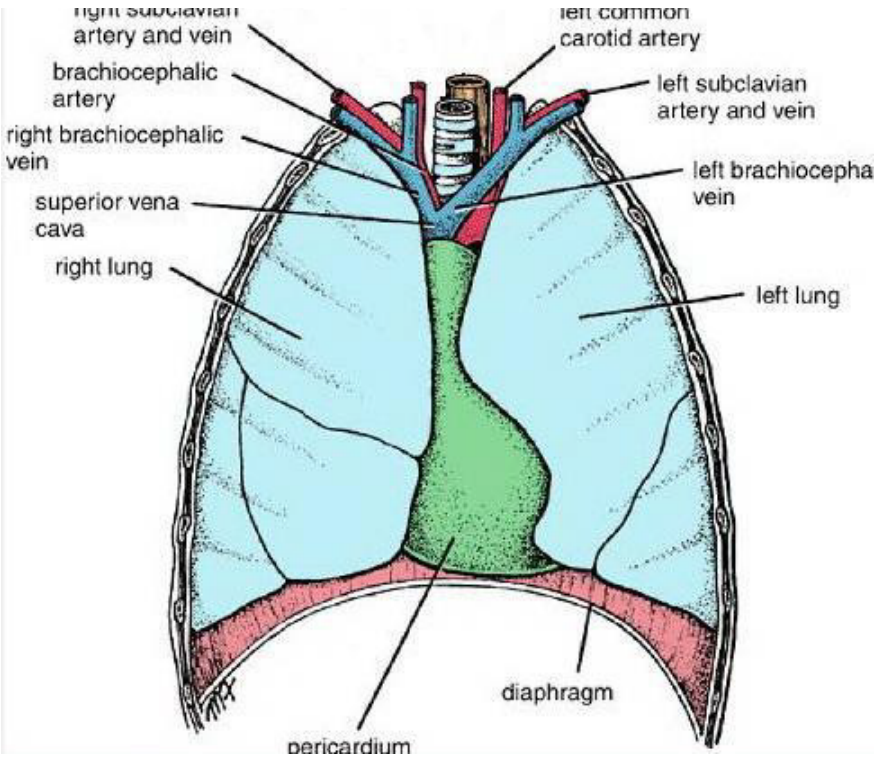
- It has 4 chambers:
  1) **2 atria** (right and left)
  2) **2 ventricles** (right and left).

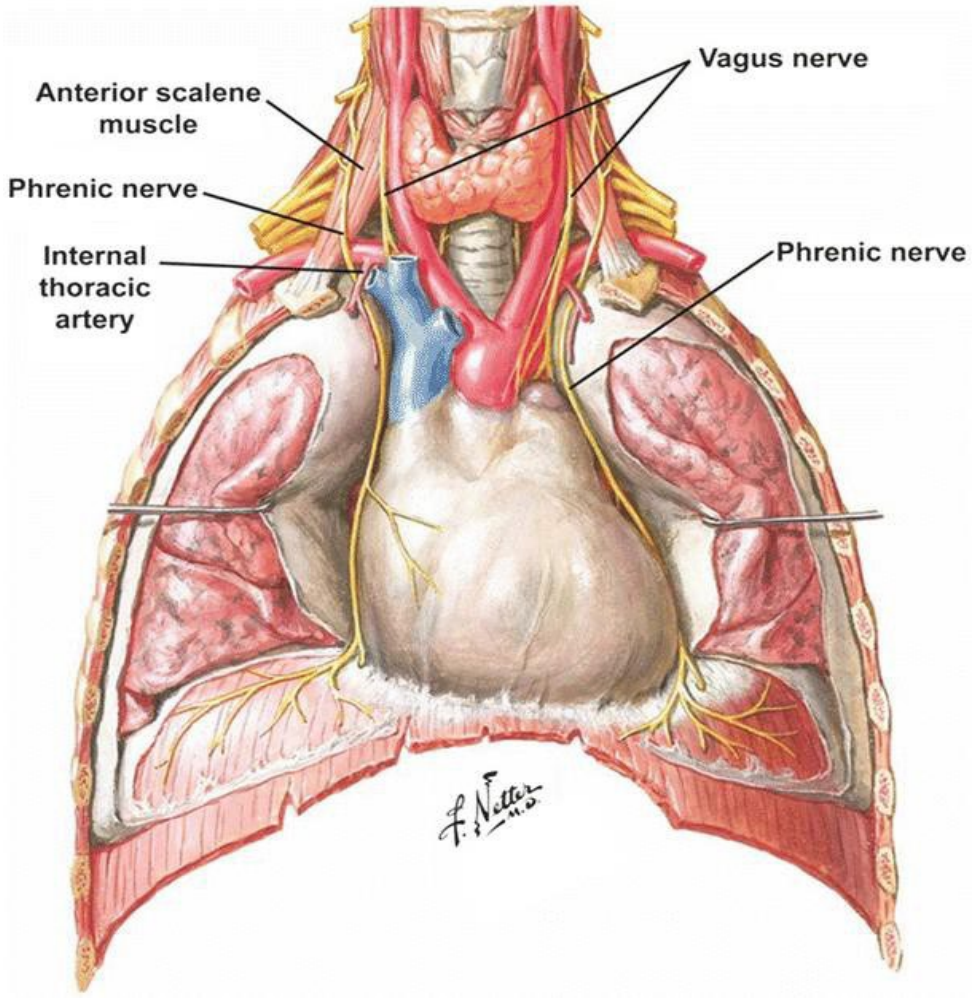
Shape

- It is conical in shape, having the followings:
  1) A **base** (or posterior surface).
  2) An **apex**.
  3) **5 surfaces**:
     - A) Sternocostal (or anterior),
     - B) Posterior surface (base),
     - C) Diaphragmatic (or inferior),
     - D) Right pulmonary borders.
     - E) Left pulmonary borders.
  4) **4 borders**: superior, inferior, right and left.

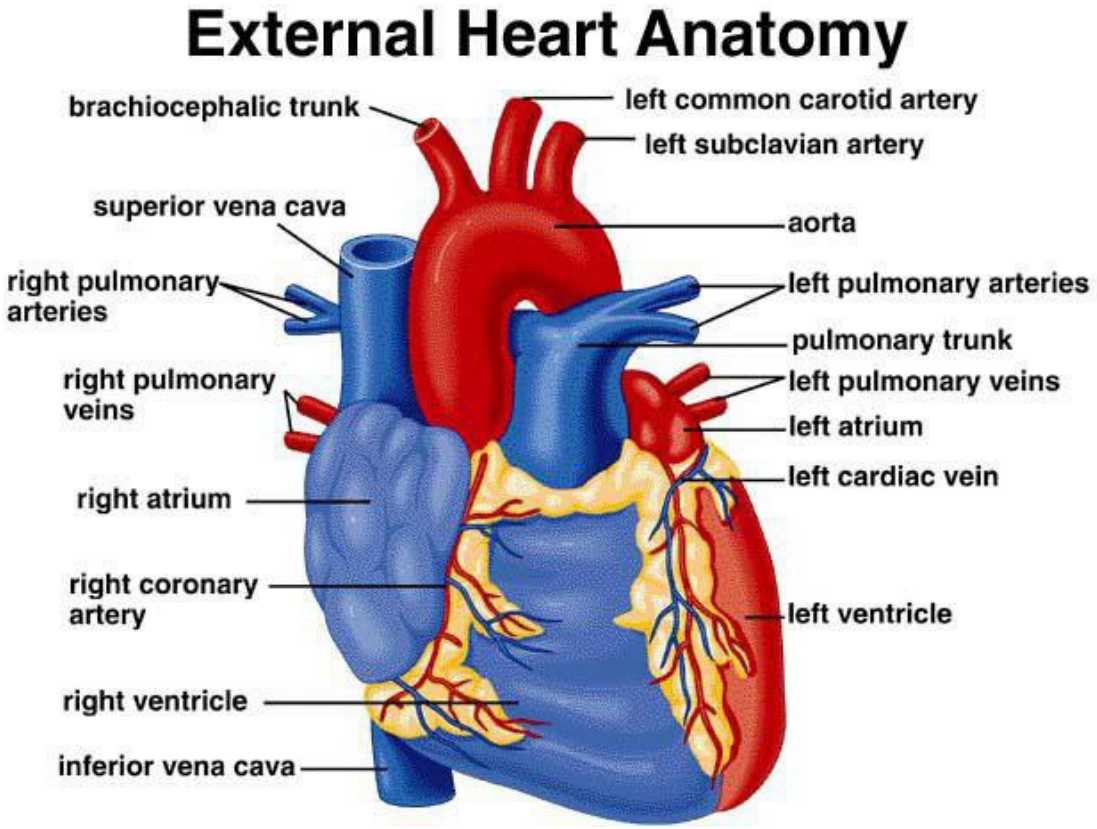
Heart Axis

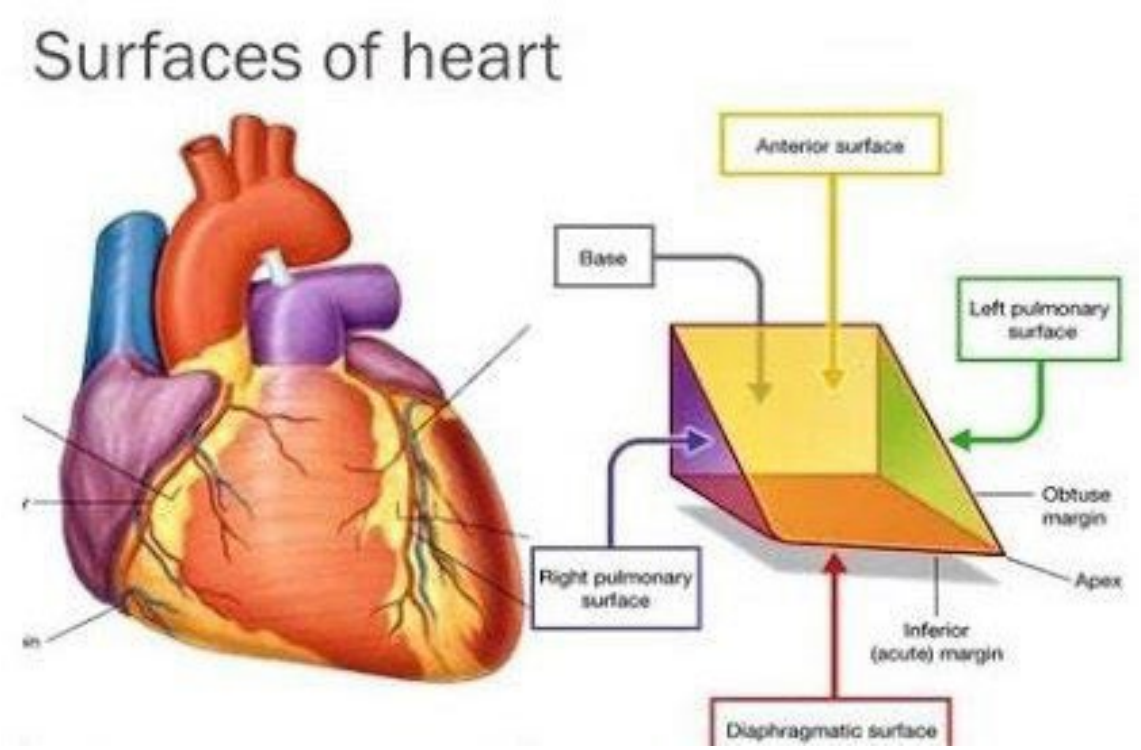
The axis of the heart extends from the base to the apex is directed downwards, forwards and to the left.





Position of heart within the pericardium in the middle mediastinum

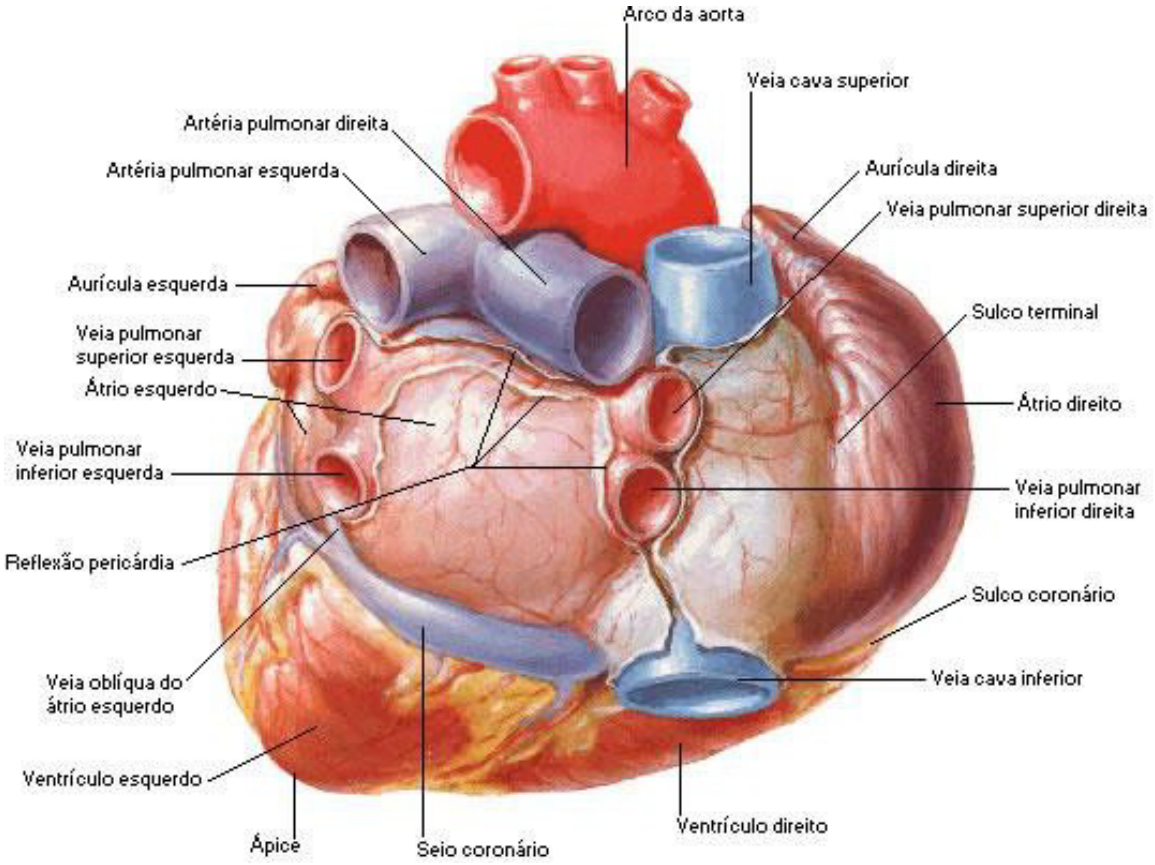


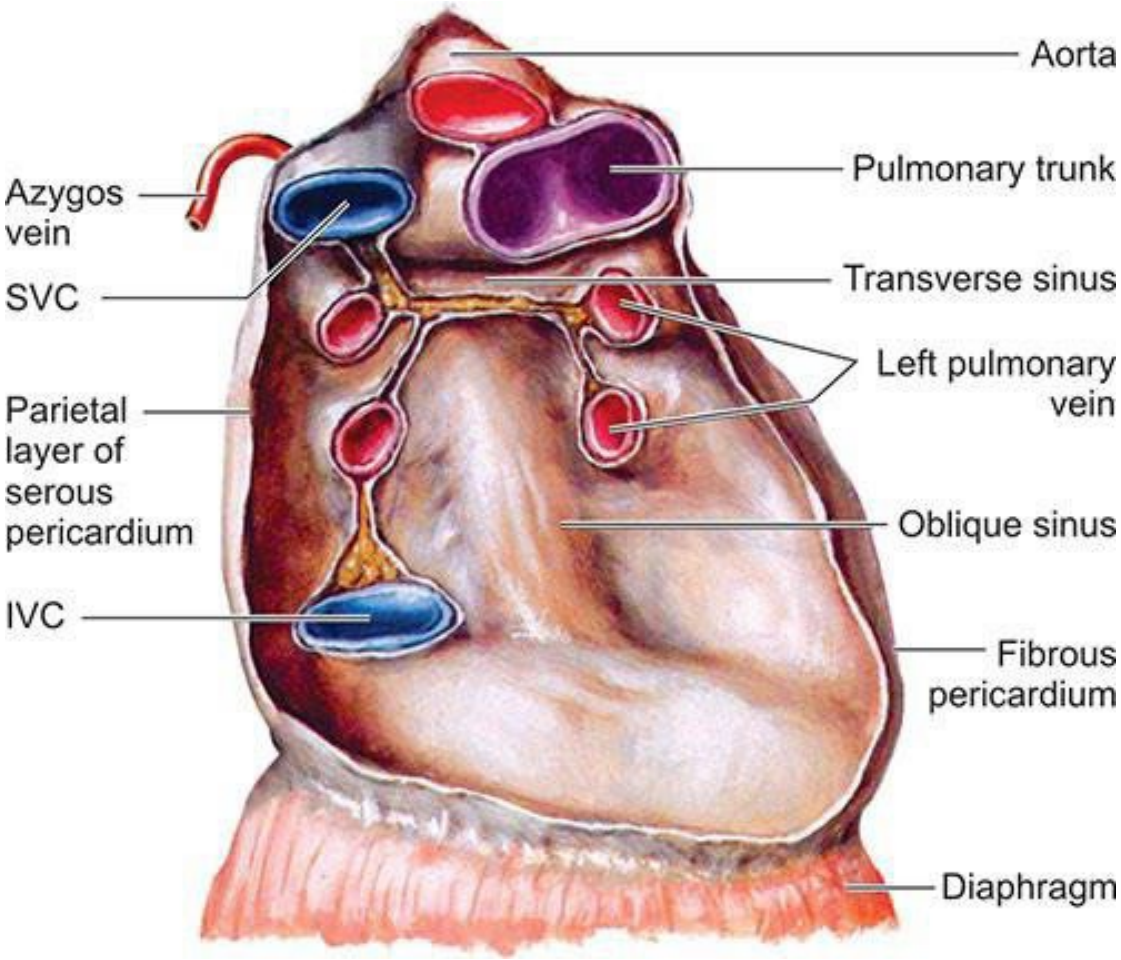


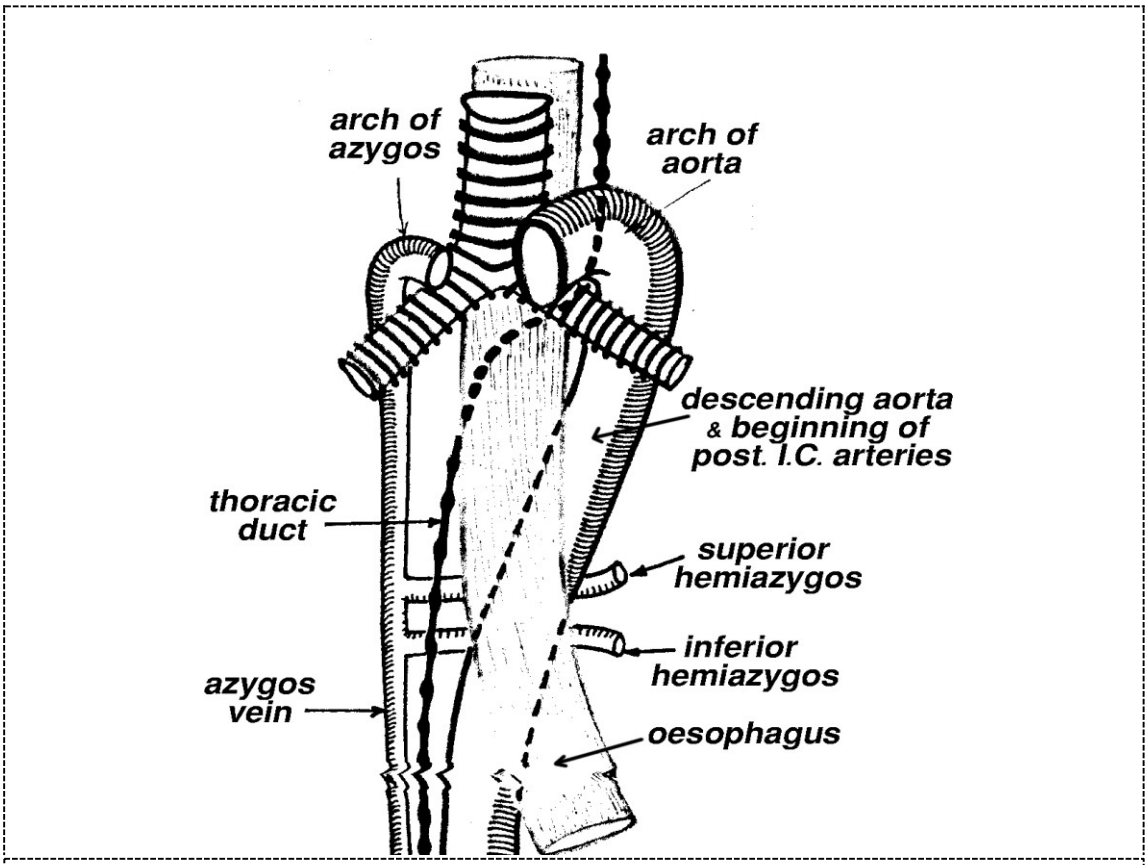
External features of the heart

I Base: (posterior surface)

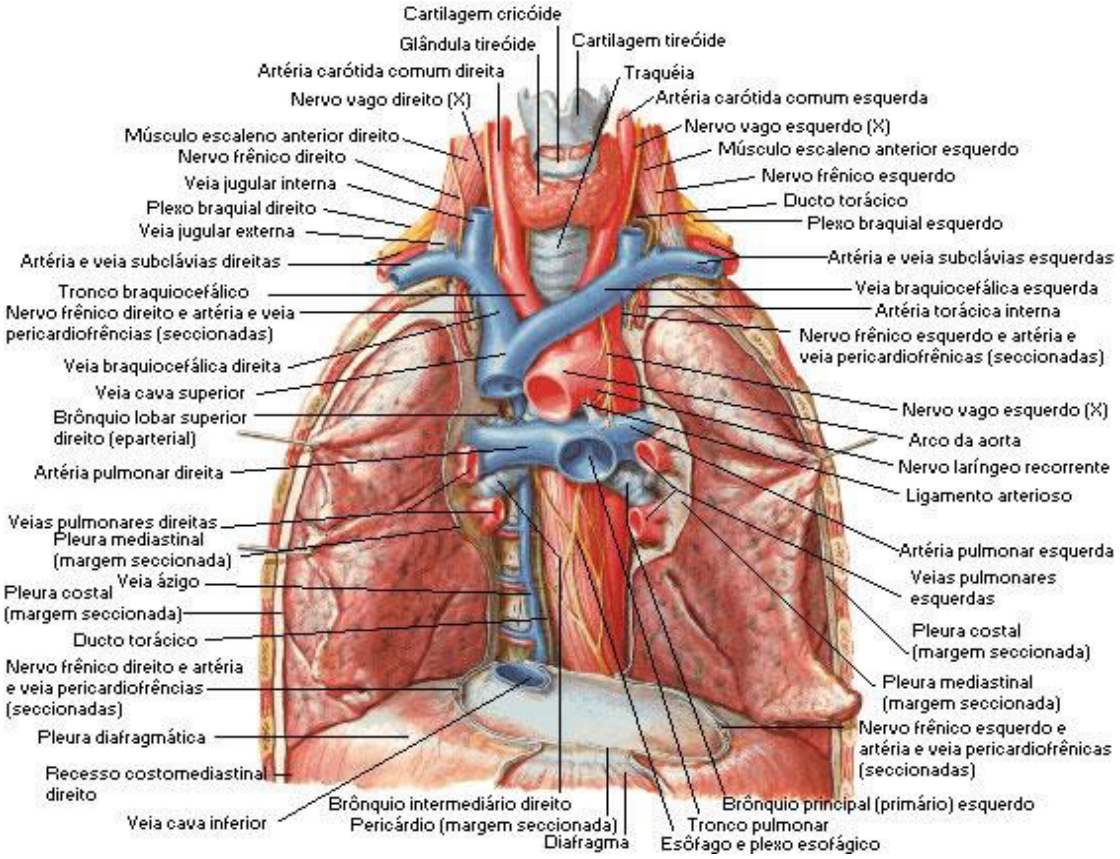
Site	➲ It is the **posterior surface** of the heart.
Direction	➲ It is **directed backwards** and to right.
Formation	➲ It is formed of **both atria** (mainly by the left atrium).
Related Vessels	➲ **Right and left pulmonary arteries run along their upper border.** ➲ **Coronary sulcus** runs along its **lower border.** ➲ The SVC & the IVC enter at the superior end & inferior end of the right atrium.
Relation	➲ Related to the **middle 4 thoracic vertebrae (5th to 8th),** separated from them by: A) **Oblique sinus** of serous pericardium and posterior wall of **fibrous pericardium.** B) The **2 left & 2 right pulmonary veins** enter at left atrium. C) Structures in the **posterior mediastinum:** descending thoracic aorta, esophagus, azygos vein and thoracic duct.


Arco da aorta
Veia cava superior
Artéria pulmonar direita
Artéria pulmonar esquerda
Aurícula direita
Veia pulmonar superior direita
Aurícula esquerda
Sulco terminal
Veia pulmonar superior esquerda
Átrio esquerdo
Átrio direito
Veia pulmonar inferior esquerda
Veia pulmonar inferior direita
Reflexão pericárdia
Sulco coronário
Veia oblíqua do átrio esquerdo
Veia cava inferior
Ventrículo esquerdo
Ápice
Seio coronário
Ventrículo direito


Aorta
Azygos vein
Pulmonary trunk
SVC
Transverse sinus
Left pulmonary vein
Parietal layer of serous pericardium
Oblique sinus
IVC
Fibrous pericardium
Diaphragm

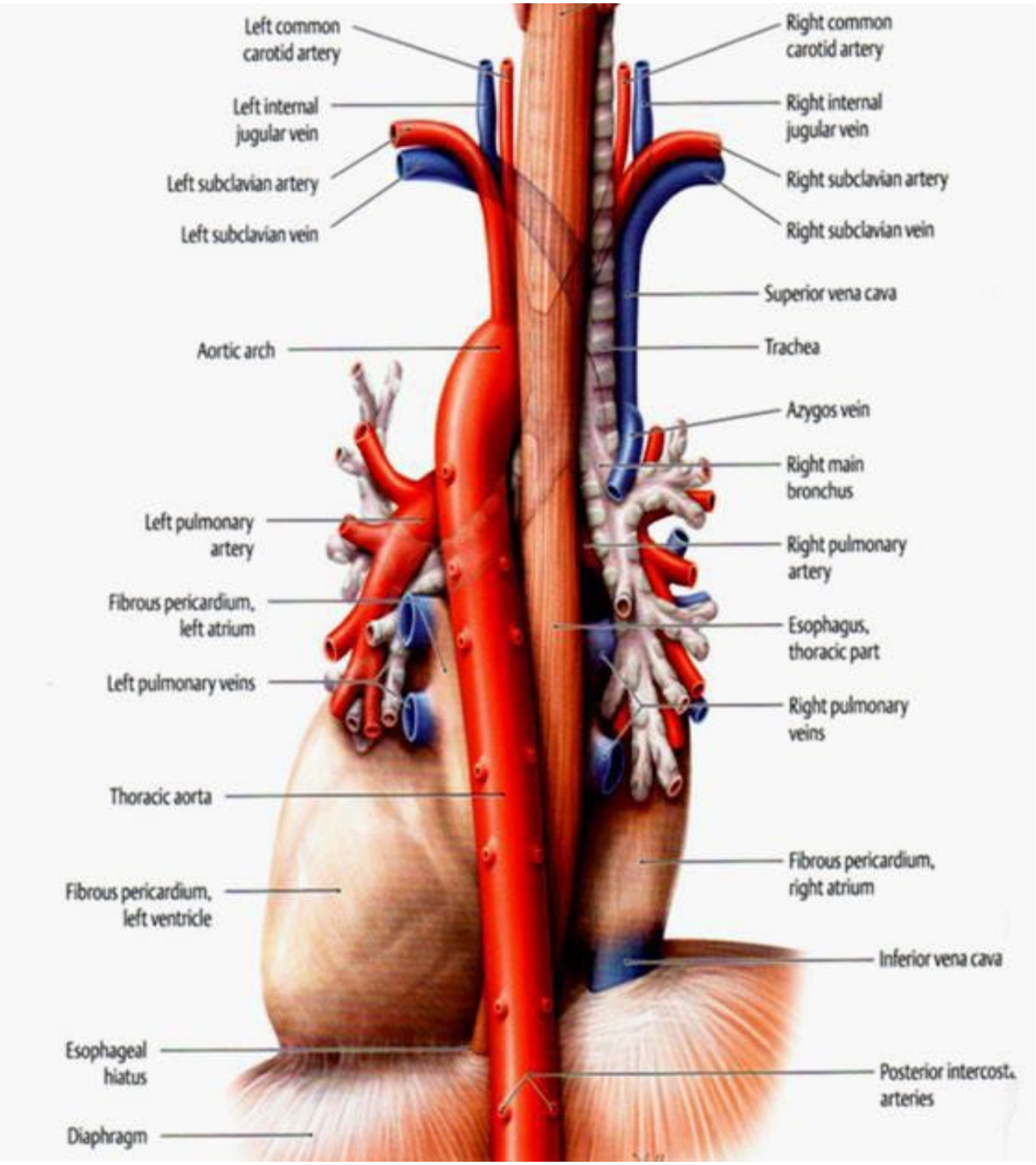


Structures in posterior mediastinum



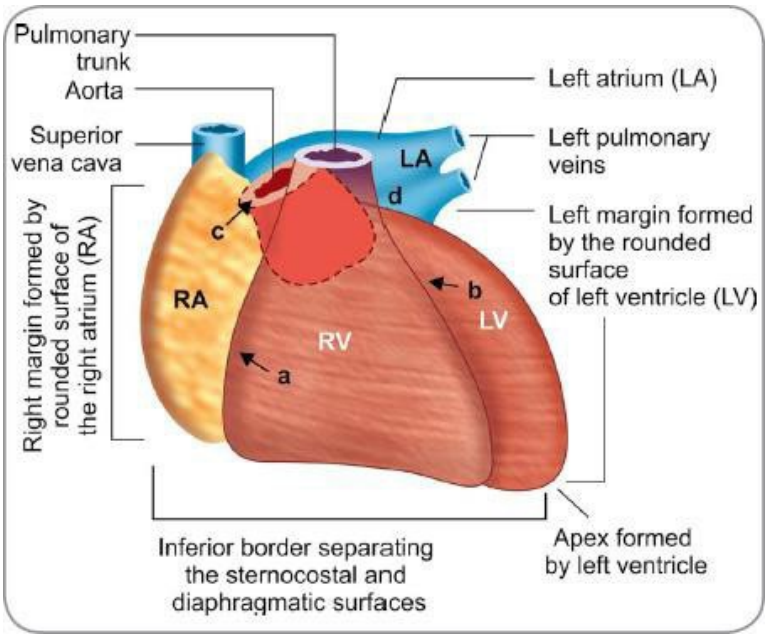
Posterior mediastinum and relation of base of the heart

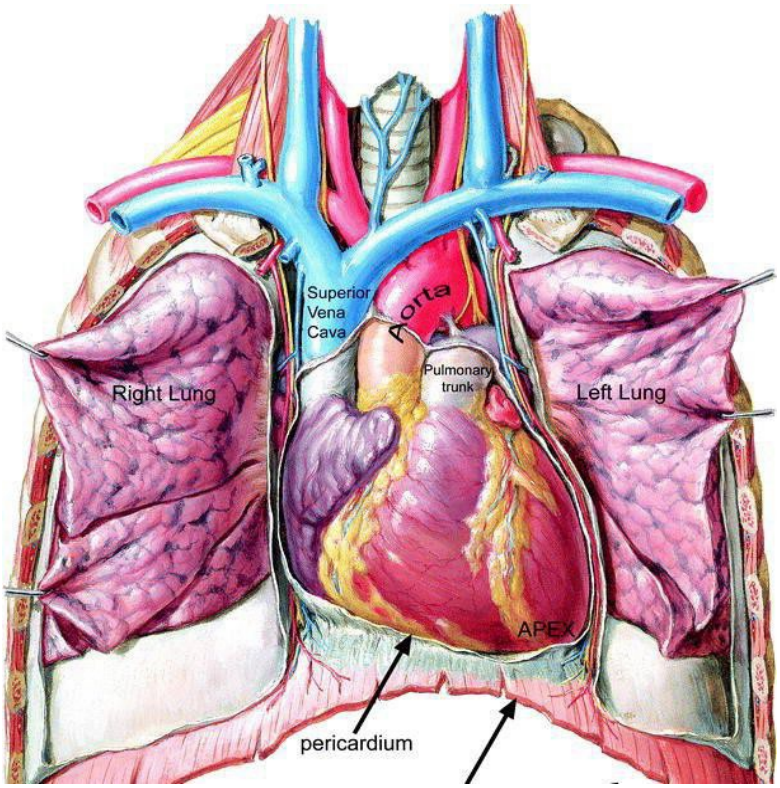
Posterior view to the base of the heart



II Apex

Site	➲ It is **the lowest and most left most point of the heart.**
Direction	➲ It is **directed downwards, forwards and to the left.**
Formation	➲ It is formed only by the **left ventricle.**
Relation	➲ 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.**





Surfaces of the Heart

1- Sternocostal (anterior) surface

Boundaries	➲ It is bounded by the 4 borders of the heart.
Formation	➲ This surface is formed mainly by right ventricle and parts of other chamber.
Division	➲ **It is divided by coronary (A-V) sulcus into an atrial part** (posterior & to the right) **and a ventricular part** (anterior & to the left). 1) **The atrial part:** formed of **the right atrium** & its auricle and left auricle (left atrium is hidden by pulmonary trunk & ascending aorta). 2) **The ventricular part**: Its right 2/3 is formed of **right ventricle** and its left 1/3 is formed of **left ventricle.**
Grooves	➲ This surface **show 2 grooves:** 1) **Atrioventricular (A-V) groove** (or coronary sulus). 2) **Anterior interventricular groove.**
Relation	➲ It has the following relations, from before backwards: 1) **Anterior thoracic wall:** sternum and 2-6 costal cartilages. 2) **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) 3) **Contents of the anterior mediastinum.** 4) **Pericardium.**

2- Posterior surface (Base)

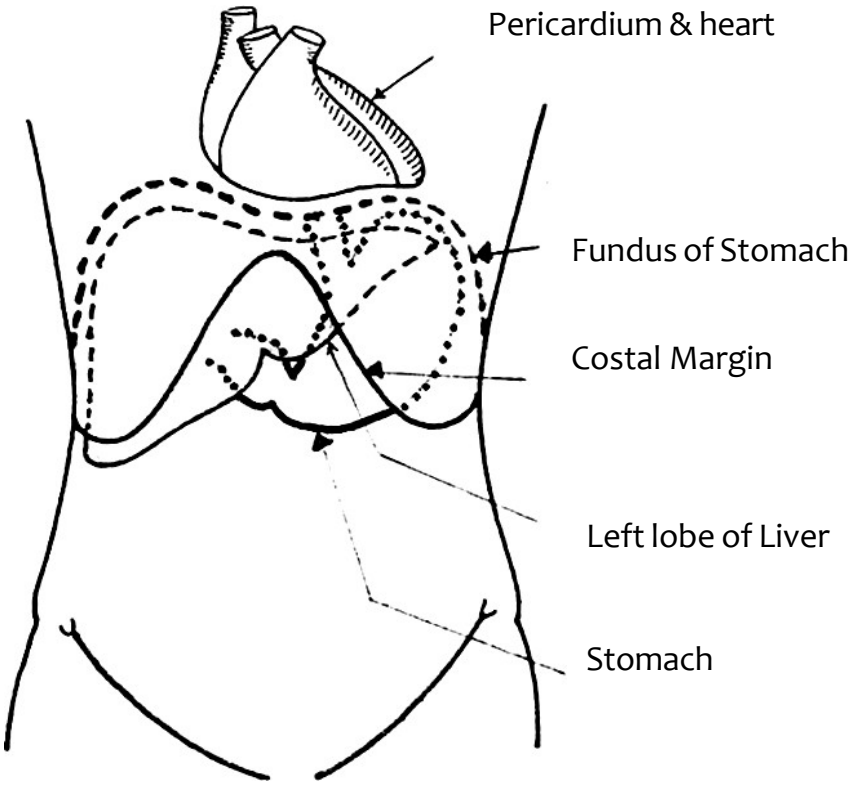
See before

3&4- Right & left pulmonary surfaces

↳ Related to **corresponding pleura and lung.**

5- Diaphragmatic (inferior) surface

Site	➲ It rests on the central tendon of the diaphragm and is limited posteriorly by the coronary sulcus.
Formation	➲ 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).
Grooves	➲ The 2 ventricles are separated by the inferior interventricular groove.
Relation	➲ This surface is related to base of pericardium, central tendon of diaphragm which separates the heart from underlying left lobe of liver and fundus of stomach.



Relations of diaphragmatic surface

IV

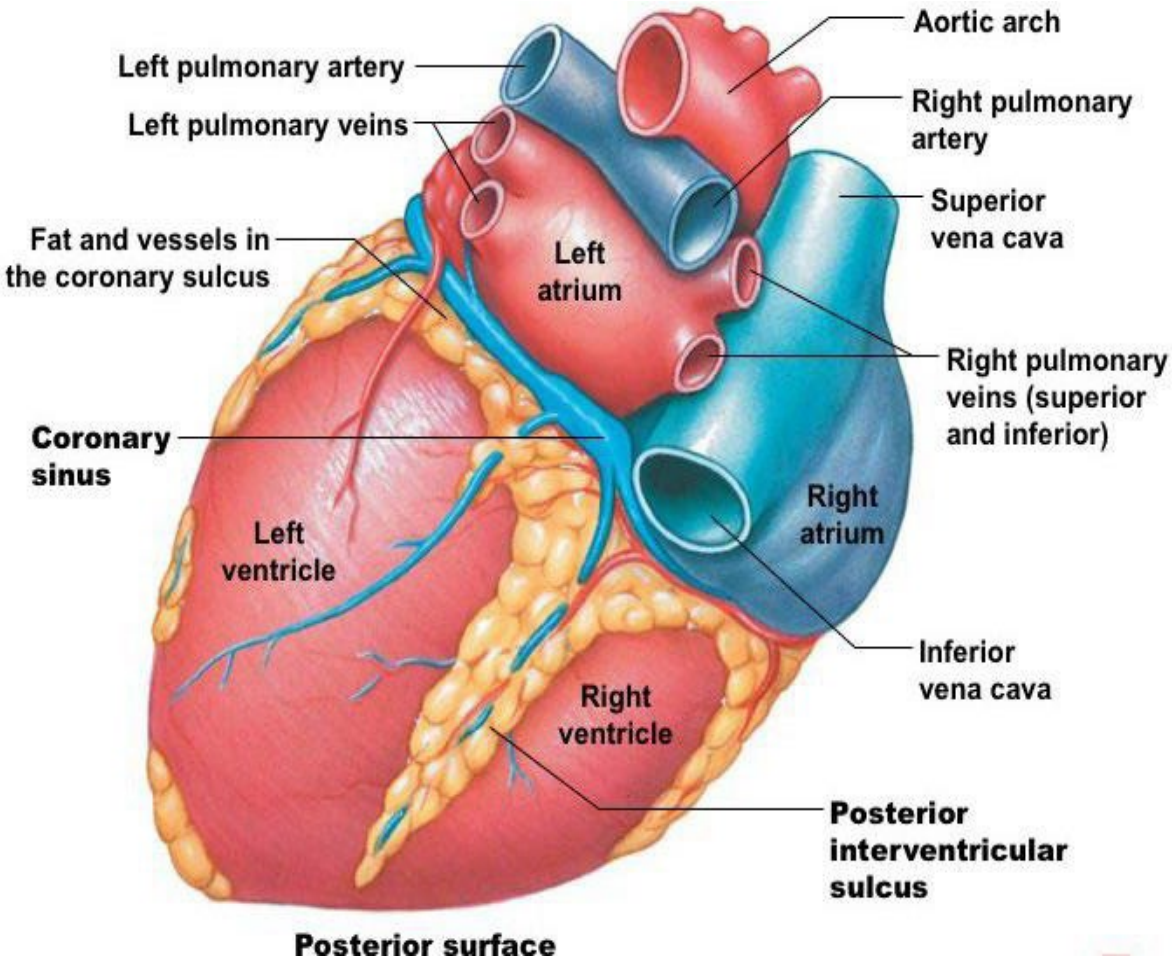
Borders of the Heart

The Upper& Lower borders

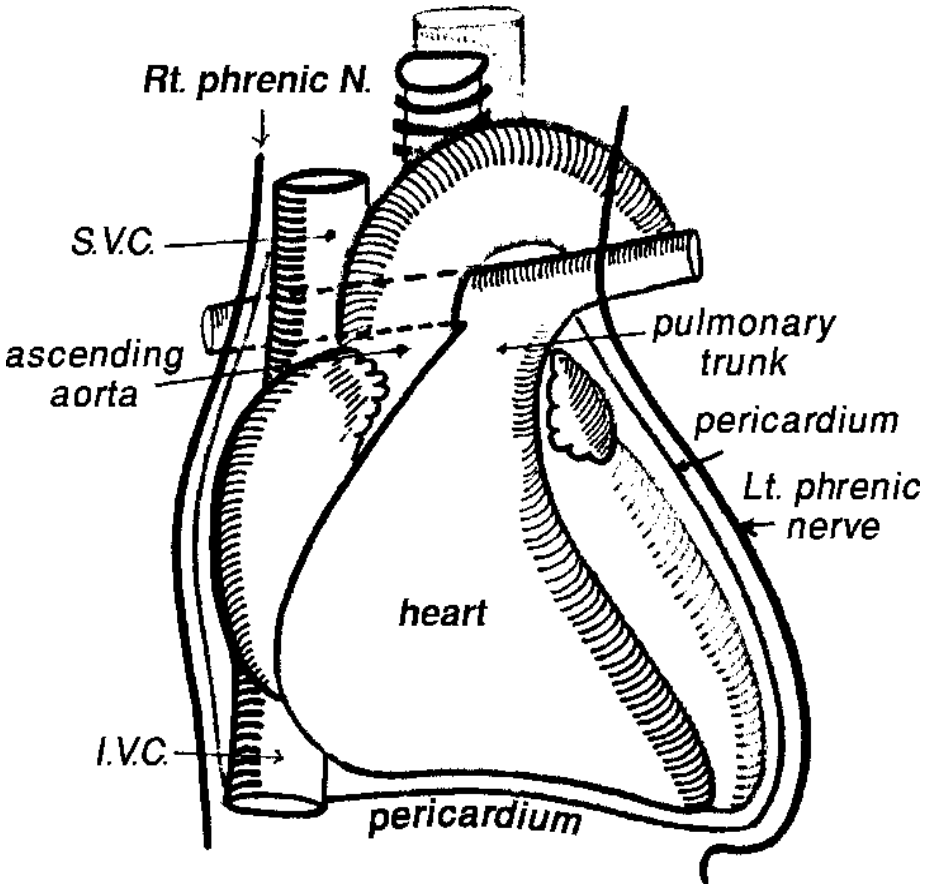
	The upper border	The lower border
Formation	↳ It is formed by **2 atria** (mainly by the left atrium i.e. like the base).	↳ It is formed by **2 ventricles**: mainly by the right ventricle and small part near the apex by the left ventricle.
Boundaries	↳ It is **hidden anteriorly** by the roots of the ascending aorta and pulmonary trunk. ↳ The right and left pulmonary arteries run along it.	↳ It extends from the opening of the I.V.C. into the right atrium to the apex of the heart.

The Left& Right borders

	Left border	Right border
Formation	↳ It is formed in its **lower main part by the left ventricle** and in its upper smaller part by the **left auricle**.	↳ It is formed by the **right atrium only**.
Boundaries		↳ It extends from the opening of the **S.V.C.** above to the opening of the **I.V.C.** below.
Relation	↳ It is related to the pericardium and left phrenic nerve which separate it from the left lung and pleura.	↳ It is related to the pericardium and right phrenic nerve which separate it from the right lung and pleura.



Posterior surface



Grooves or Sulci

The heart has the following grooves:

1) **Atrio-ventricular groove: (coronary groove):**

Formation	➲ It is formed in its lower main part by the left ventricle and in its upper smaller part by the left auricle.

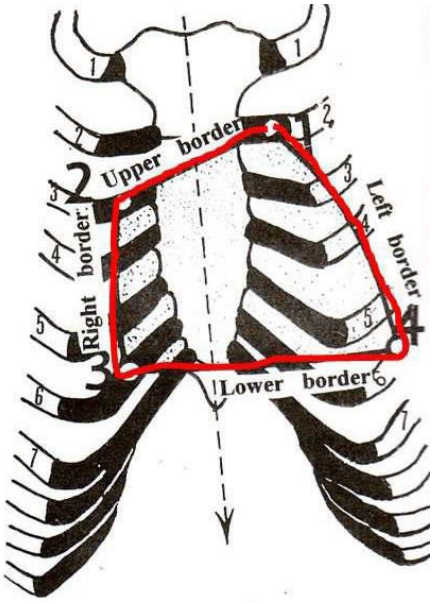
2) **The anterior and inferior interventricular grooves.**

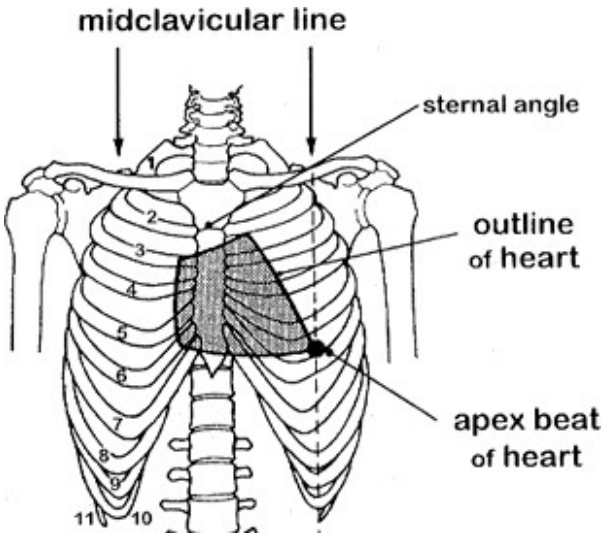
Site	➲ It separates the two ventricles from anterior and inferior surfaces respectively.

Surface Anatomy of the borders of the heart

Remember 2365

Upper border	➲ from lower border of **2nd** left costal cartilage 1.5 cm from sternal margin **(point 1)** to the upper border of **3rd** right costal cartilage 1.5 cm from sternal margin **(point 2).**
Right border	➲ From point 2 to rt **6th** costal cartilage 1.5 cm from sternal margin **(point 3).**
Lower border	➲ An oblique straight line from point 3 to **5th left intercostal space** 9 cm from median plane **(point 4).**
Left border	➲ From apex of the heart **(point 4) to point 1.**





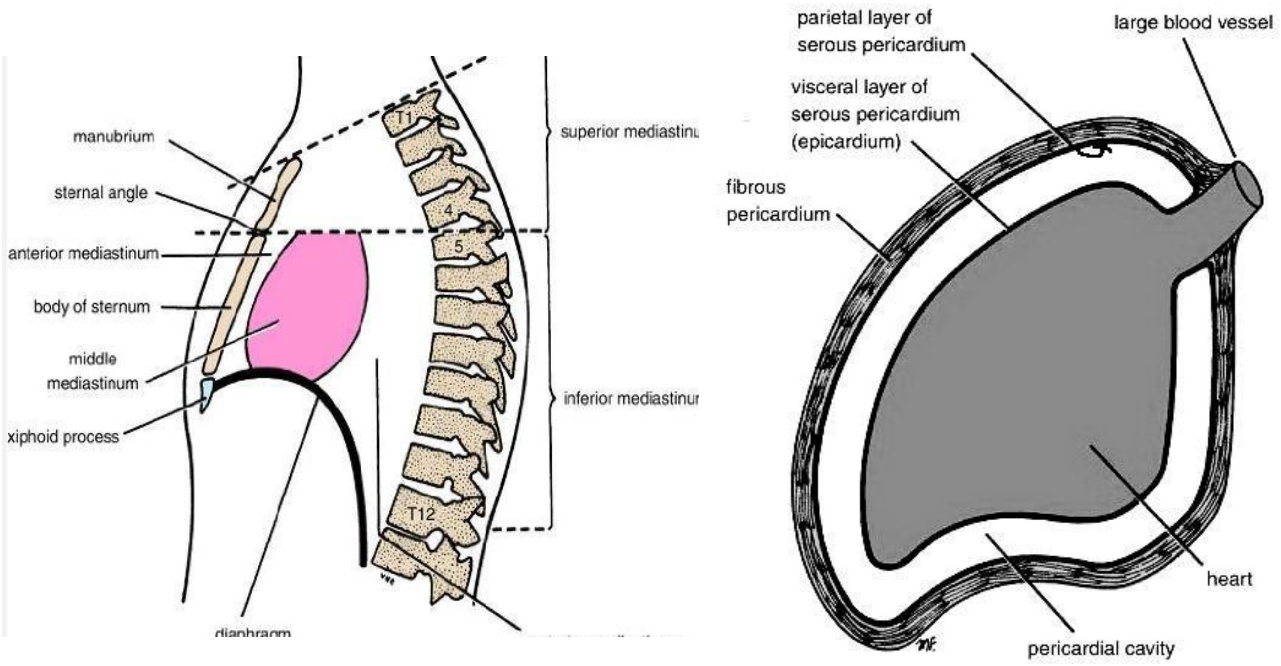
The pericardium

Definition

- The pericardium is a **fibro-serous sac** which surrounds the heart and the roots of large vessels attached to it (ascending aorta, pulmonary truck, lower ½ of SVC, terminal parts of IVC and 4 pulmonary veins).

Site

- It lies in the **middle mediastinum** extending from the plane of the sternal angle of louis above, to the diaphragm below.
- In front, it extends from the sternum and **2nd to the 6th costal cartilages**.
- Behind, it lies opposite the **5th to the 8th thoracic vertebrae**.



Position and part of pericardium

Formation

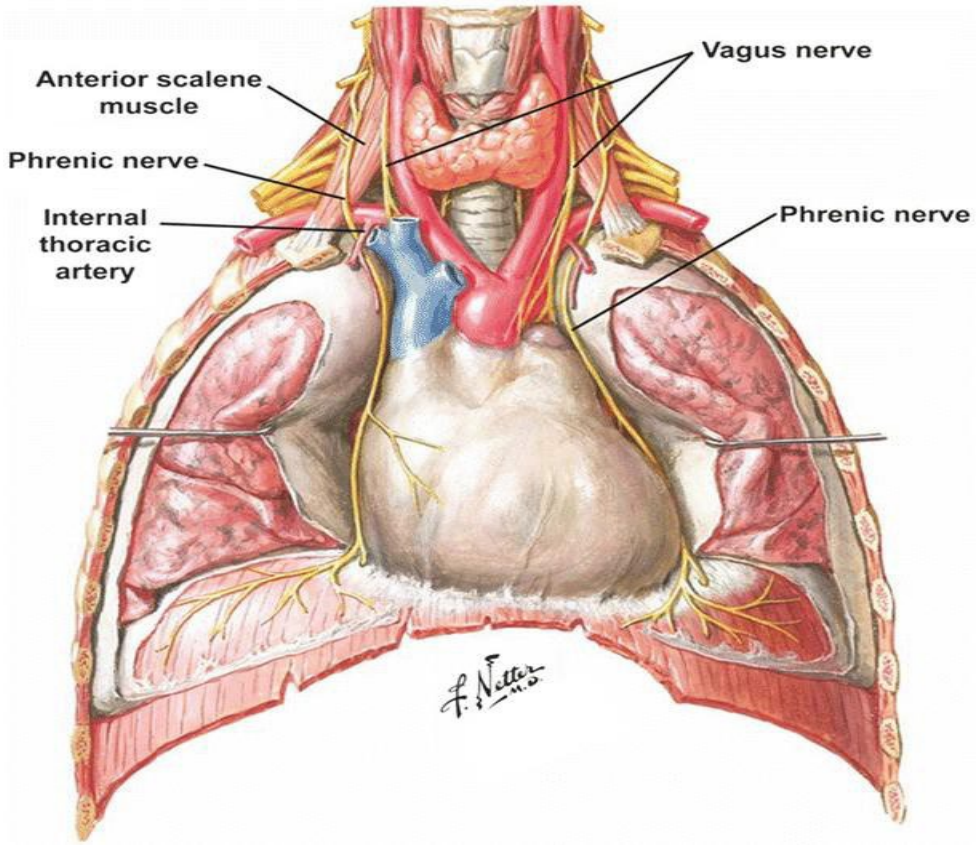
- **It is formed of two parts:**

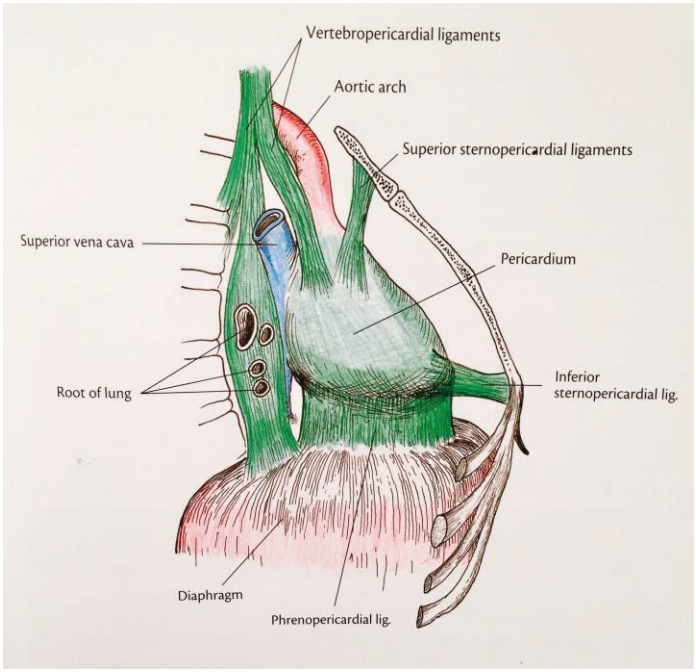
Fibrous pericardium	Serous pericardium
An outer fibrous layer.	An inner serous sac.

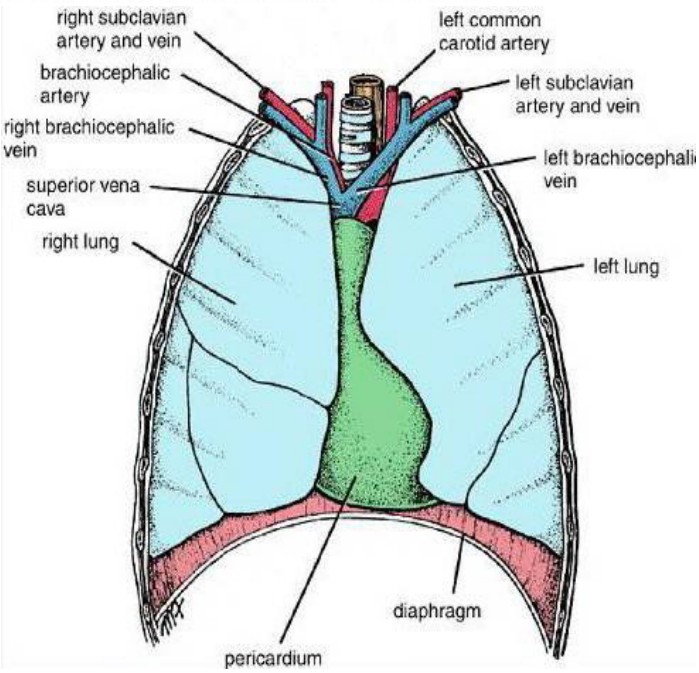
I Fibrous pericardium:

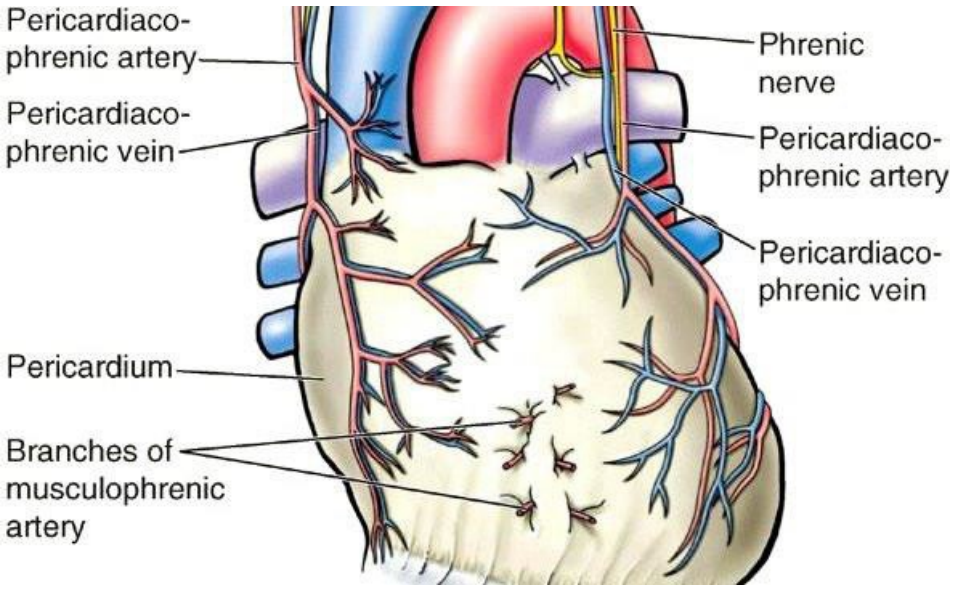
- **Structure:**
  - It is formed of **strong fibrous tissue.**
- **Formation:**
  - It forms the **boundaries of the middle mediastinum.**
- **Shape:**
  - It is conical having a base below, apex above and four surfaces:

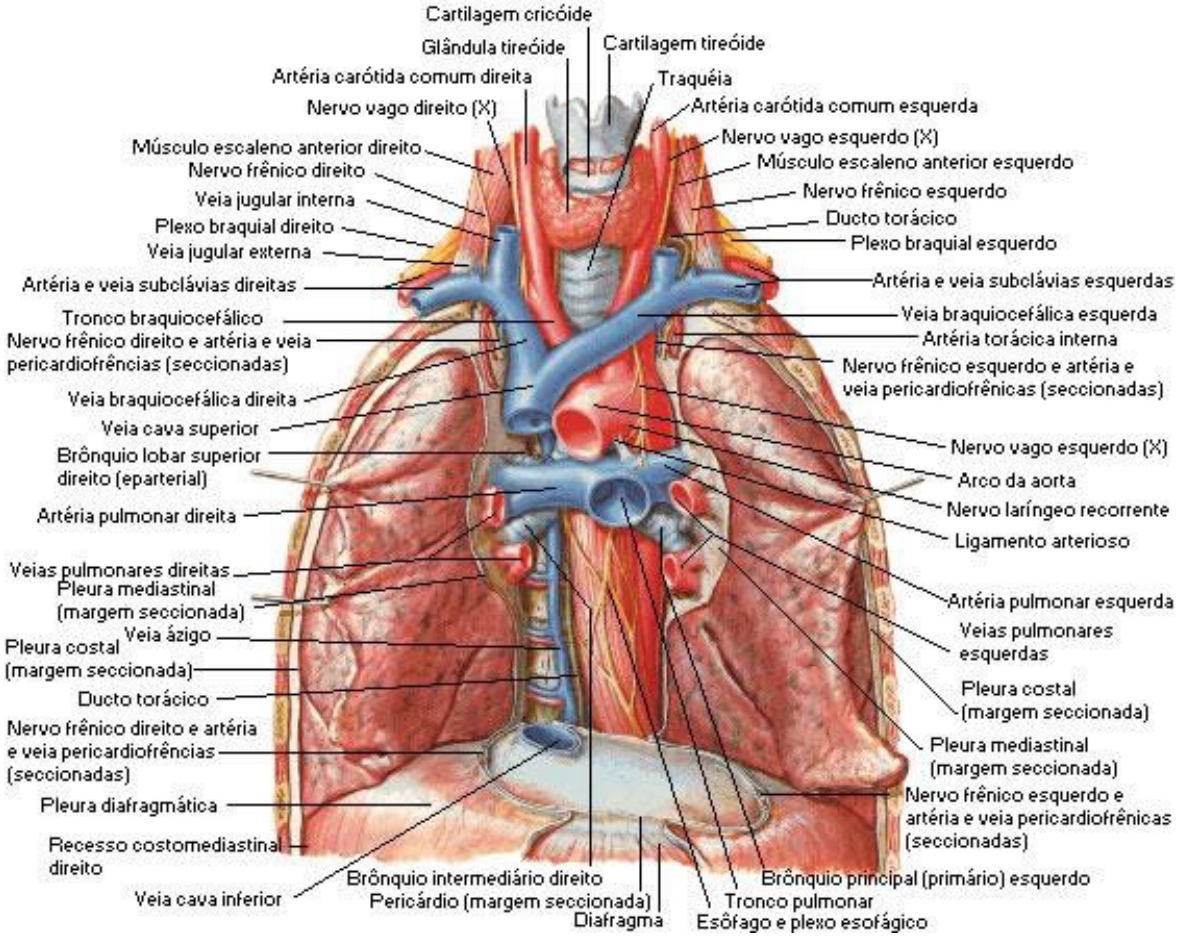
Base	➲ **Direction:** It is directed **downwards** and attached the central tendon of diaphragm.
Apex	➲ **Direction:** It is directed **upwards.** ➲ **Formation:** It **surrounds and fuses** with the outer coats of the ascending aorta, pulmonary trunk and SVC.
Anterior surface	➲ **Connection:** It is connected to the body of the sternum by superior and inferior **sterno-pericardial ligaments.** ➲ **Relation:** The anterior borders of the **two pleurae and lungs** separate it from body of sternum **except** the lower left part of body of sternum which lies in direct relation to the pericardium (**bare area of pericardium**).
Two lateral surfaces	➲ **Relation:** Each surface is related mainly to the corresponding lung, pleura, phrenic nerve and pericardiophrenic vessels.
Posterior surface	➲ **Relation:** Related to oesophagus and descending aorta.


Anterior scalene muscle
Phrenic nerve
Internal thoracic artery
Vagus nerve
Phrenic nerve


Vertebropericardial ligaments
Aortic arch
Superior sternopericardial ligaments
Superior vena cava
Pericardium
Root of lung
Inferior sternopericardial lig.
Diaphragm
Phrenopericardial lig.


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


Pericardiaco-phrenic artery
Pericardiaco-phrenic vein
Pericardium
Branches of musculophrenic artery
Phrenic nerve
Pericardiaco-phrenic artery
Pericardiaco-phrenic vein


Cartilagem cricóide
Glândula tireóide
Cartilagem tireóide
Artéria carótida comum direita
Traquéia
Nervo vago direito (X)
Artéria carótida comum esquerda
Músculo escaleno anterior direito
Nervo vago esquerdo (X)
Nervo frênico direito
Músculo escaleno anterior esquerdo
Veia jugular interna
Nervo frênico esquerdo
Plexo braquial direito
Ducto torácico
Veia jugular externa
Plexo braquial esquerdo
Artéria e veia subclávias direitas
Artéria e veia subclávias esquerdas
Tronco braquiocefálico
Veia braquiocefálica esquerda
Nervo frênico direito e artéria e veia pericardiofrências (seccionadas)
Artéria torácica interna
Nervo frênico esquerdo e artéria e veia pericardiofrênicas (seccionadas)
Veia braquiocefálica direita
Veia cava superior
Nervo vago esquerdo (X)
Brônquio lobar superior direito (eparterial)
Arco da aorta
Artéria pulmonar direita
Nervo laríngeo recorrente
Ligamento arterioso
Veias pulmonares direitas
Pleura mediastinal (margem seccionada)
Artéria pulmonar esquerda
Veia ázigo
Veias pulmonares esquerdas
Pleura costal (margem seccionada)
Ducto torácico
Pleura costal (margem seccionada)
Nervo frênico direito e artéria e veia pericardiofrências (seccionadas)
Pleura mediastinal (margem seccionada)
Pleura diafragmática
Nervo frênico esquerdo e artéria e veia pericardiofrênicas (seccionadas)
Recesso costomediastinal direito
Brônquio intermediário direito
Brônquio principal (primário) esquerdo
Veia cava inferior
Pericárdio (margem seccionada)
Tronco pulmonar
Diafragma
Esôfago e plexo esofágico

II Serous pericardium:

Structure & Development:

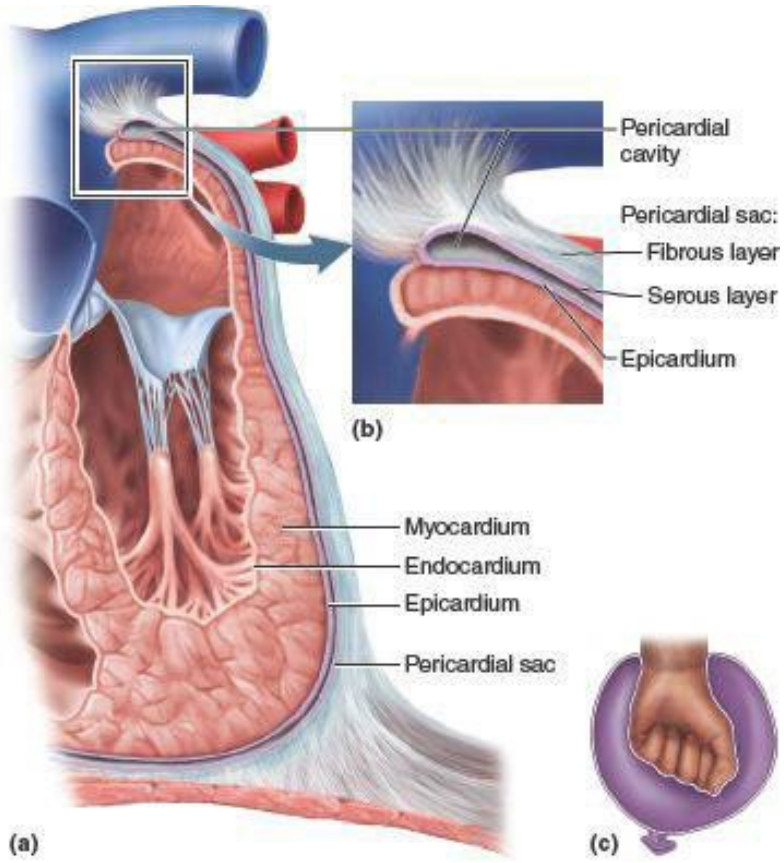
- It is a closed serous sac invaginated during fetal life from above and behind by the developing heart.

Formation:

- It is formed of 2 layers and a cavity:

Parietal layer	Visceral layer
➲ It lines the inner surface of the fibrous pericardium. ➲ It is reflected onto the heart and the roots of the great vessels.	➲ It covers and adherent to the heart forming the epicardium.

Pericardial cavity
➲ The potential space between the parietal and visceral layers is the pericardial cavity; it is empty except for a thin film of serous fluid.



Sinuses of the Pericardium

There are 2 sinuses related to the serous pericardium (inside the pericardial cavity):

1) **Transverse Sinus of Pericardium.**
2) **Oblique Sinus of Pericardium.**

I Transverse Sinus of Pericardium:

Definition:

- **A transverse passage between the arterial and the venous ends of the heart.**

Function:

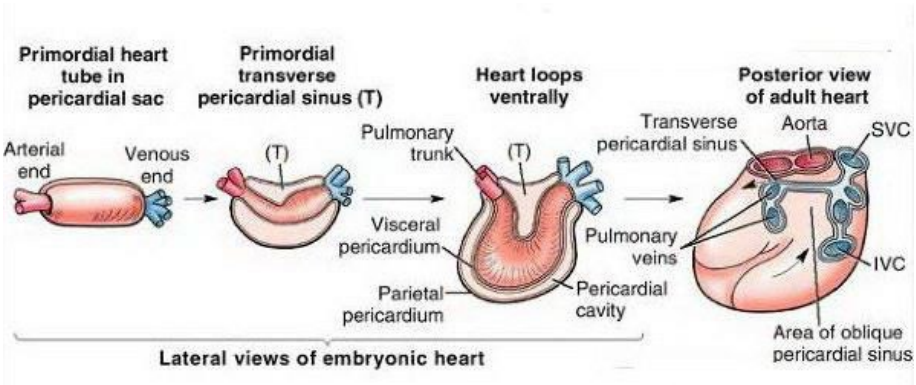
- It connects the **right and left sides of the pericardial cavity.**

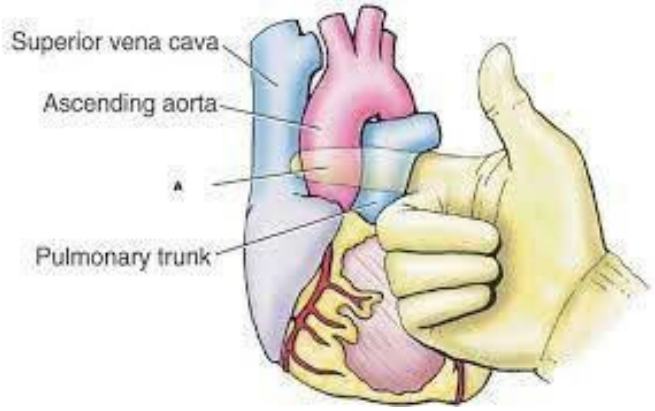
Boundaries:

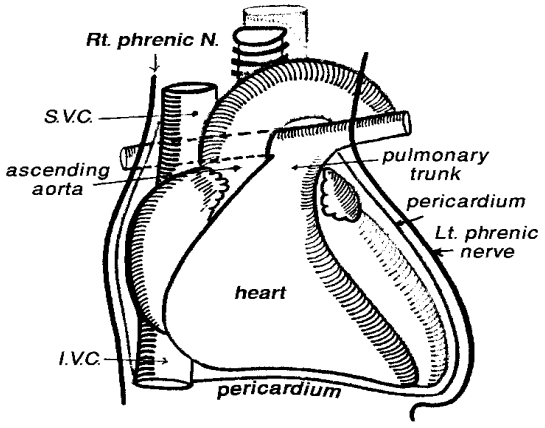
Anterior	**Ascending aorta and pulmonary trunk.**
Superior	**Right pulmonary artery.**
Posterior	**Lower part of S.V.C. and the 2 atria, mainly left.**
Inferior	**The 2 atria, mainly left.**

How to reach:

- A finger is pushed from the right side in front of the lower part of the S.V.C. and **behind the ascending aorta and pulmonary trunk.**







II Oblique Sinus of Pericardium:

Site & Formation:

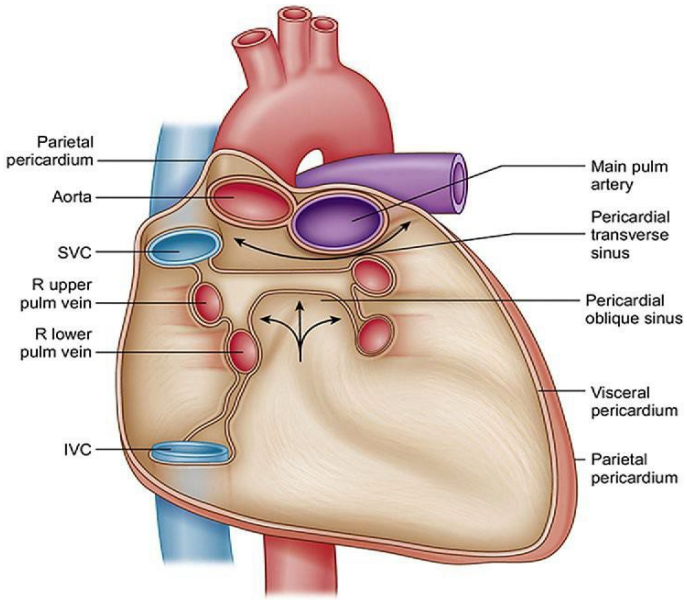
- The visceral layer of serous pericardium passes to **cover the back of the left atrium** and reflected on the fibrous pericardium to form the parietal layer of serous pericardium.
- Thus a **blind recess in the pericardial cavity is formed between the left atrium (in front) and the fibrous pericardium (behind).**

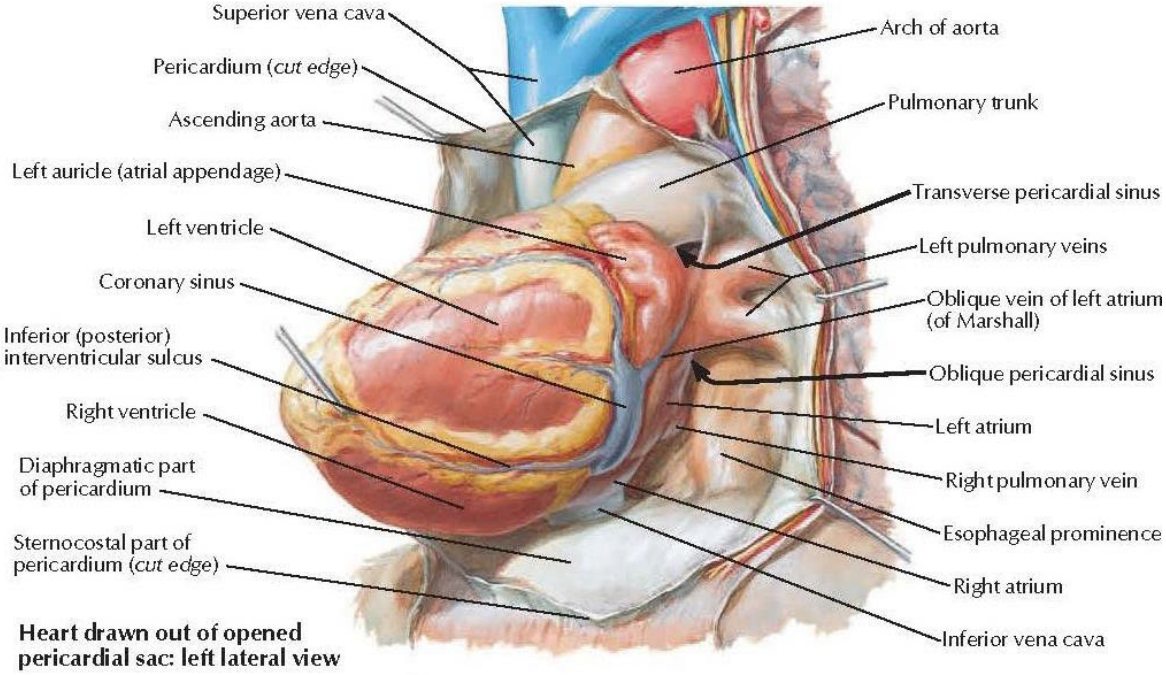
Boundaries:

Anterior	**Back of the left atrium** (i.e. base of the heart).
Posterior	Parietal layer lining posterior fibrous pericardium separating the sinus from the structures in the posterior mediastinum (descending aorta and esophagus).
Superior	The sinus is **closed** by the reflection of visceral layer of serous pericardium covering the **back of the left atrium** to the parietal layer of serous pericardium lining the **posterior part of fibrous pericardium.**
On the right side	Reflection of serous pericardium onto **the S.V.C., the 2 right pulmonary veins and the I.V.C.** (from above downwards).
On the left side	Reflection of serous pericardium onto the **2 left pulmonary veins** (the left boundary is shorter than the right).
Inferior	The sinus is open into the **main pericardial cavity.**

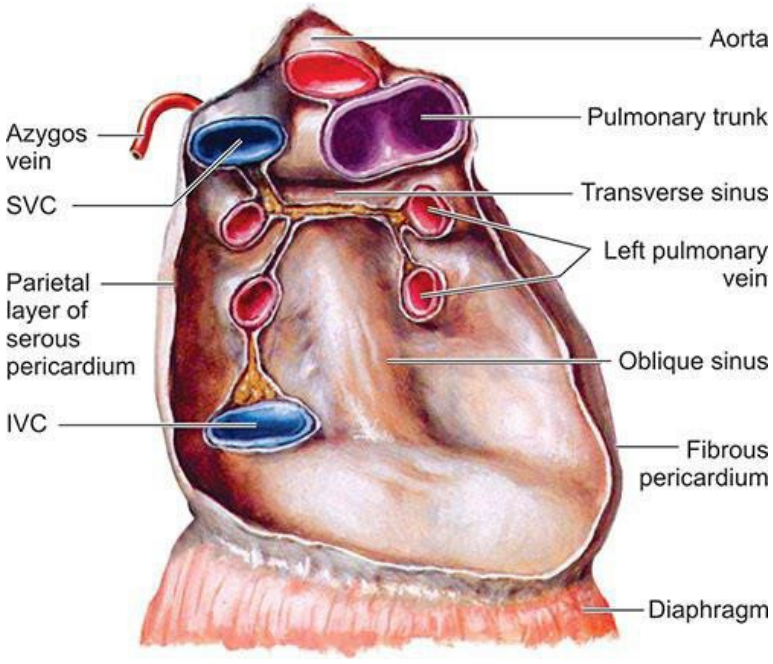
How to reach:

- The apex of the heart is lifted upwards and 3 fingers are placed behind the heart to the left of the I.V.C. then pushed upwards till they are stopped by the blind upper end of the sinus.
- The **upper border** of the left atrium separates the fingers in the oblique sinus from a finger put through the transverse sinus which lies just above and in front.





Heart drawn out of opened pericardial sac: left lateral view



Transverse sinuous

Oblique sinuous

Blood supply of the pericardium

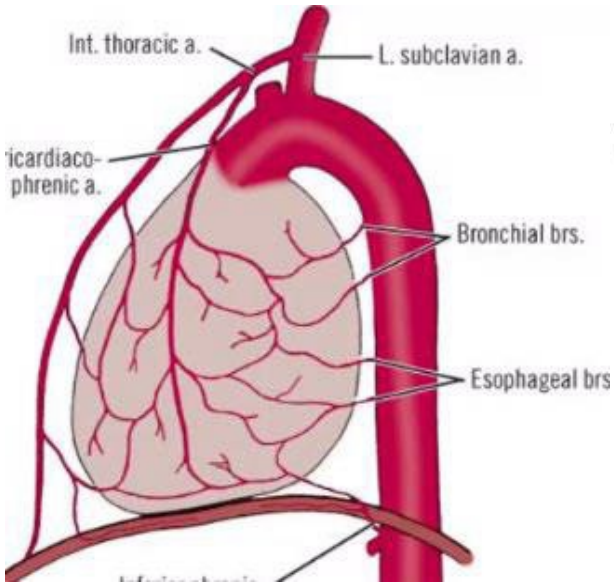
I Fibrous pericardium & parietal layer of serous pericardium:

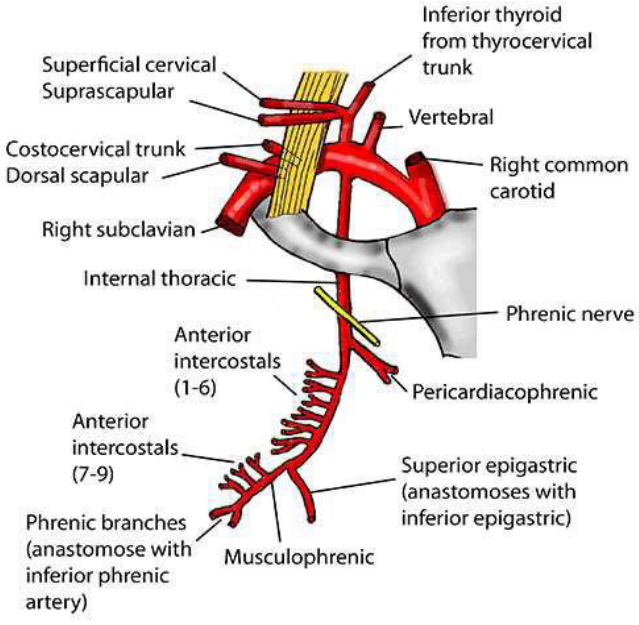
The arterial supply	➲ From the **internal thoracic arteries** and their pericardiophrenic and musculophrenic branches and from descending aorta. ➲ In addition, **arterial blood from bronchial and esophageal arteries.**
The venous drainage	➲ Through the azygos venous system.

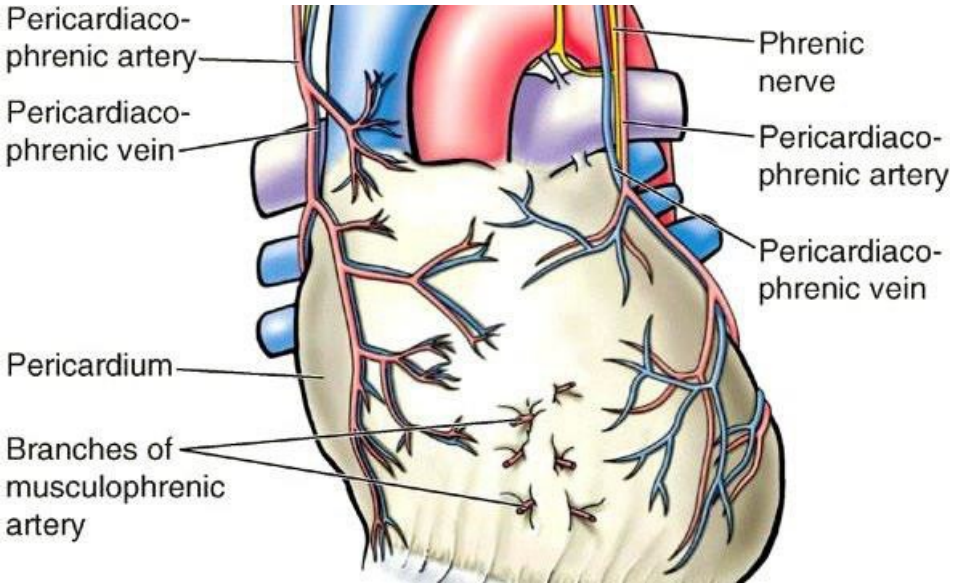
II Visceral layer of serous pericardium:

➲ **The epicardium has the same blood supply as the heart.**

➲ It receives its arterial supply from the right and **left coronary arteries** and its venous drainage is via the **coronary sinus.**







Nerve supply of the pericardium

I Fibrous pericardium & parietal layer of serous pericardium:

- It is supplied by the **phrenic nerves (C3-5)** which transmit somatic sensation; they are sensitive to pain (e.g. in pericarditis).

II Visceral layer of serous pericardium:

- **It is supplied, as the heart, by autonomic fibres** (sympathetic trunk and vagus).
- It is insensitive to pain but sensitive to ischaemia.

Functions of Pericardium

1-	**The fibrous pericardium**	1) **Protects & maintains position of the heart** and prevents its over distension. 2) **Keeps the mouth of the large vessels open.**
2-	**The serous pericardium**	1) It allows **free movements of the heart** during systole and diastole 2) **The oblique sinus acts as a potential space behind the left atrium allowing its movements.** It also allows the pulsation of the descending thoracic aorta and the expansion of the esophagus during swallowing. 3) **The transverse sinus allows the distension of the great vessels**, the ascending aorta and the pulmonary trunk, during systole.

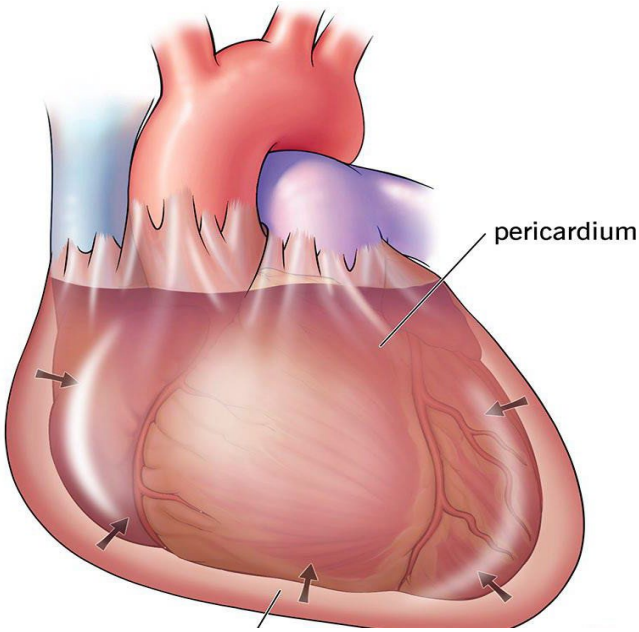
Applied anatomy

Applied anatomy

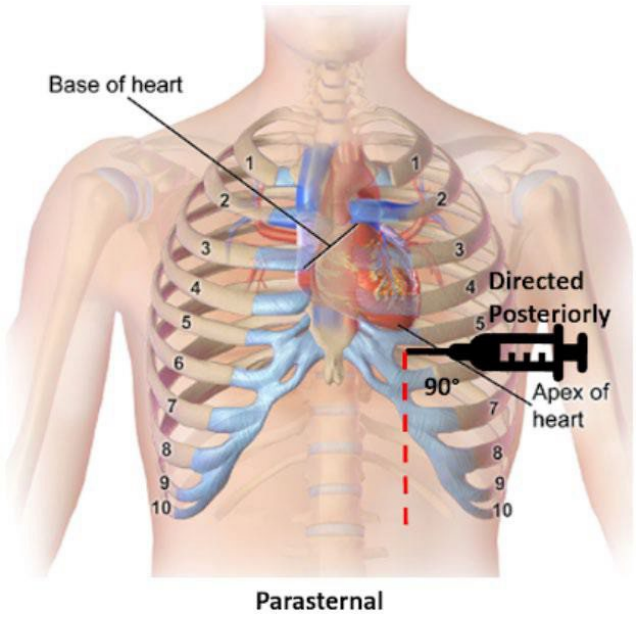
1-	**Pericarditis**	➲ **Definition:** **Inflammation in the pericardium.** ➲ **C/P:** Usually, cause **chest pain and pericardial rub on auscultation.**
2-	**Pericardial effusion**	➲ **Definition:** Accumulation of fluid in the pericardial cavity. ➲ **C/P:** dullness around the normal cardiac dullness on percussion and distal heart sounds on auscultation.
3-	**Haemo-pericardium**	➲ **Definition:** Accumulation of blood in the pericardiac cavity. ➲ **Causes:** Infarction, cardiac operation or cardiac trauma. ➲
4-	**Cardiac tamponade**	➲ **Definition:** cardiac compression by haemo-pericardium usually leathal due to impairment of cardiac filling and cardiac output.

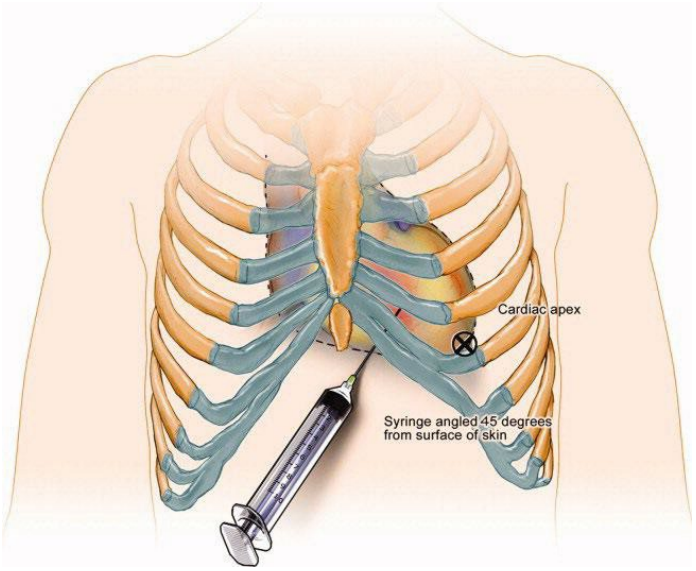
Procedures

1-	**Pericardiocentesis**	➲ **Definition:** ▪ **Drainage of fluid from the pericardial cavity by a wide bore needle inserted parasternal in the left 5th. or 6th. intercostal space** (i.e. bare area of pericardium to avoid injury of left pleura, left lung and left internal thoracic vessels). ▪ The pericardial sac can also be reached via the **left infrastenal angle** by passing the needle postero-superior towards the left shoulder.
2-	**During open heart surgery**	➲ The transverse sinus of pericardium is used to pass a rubber catheter around the ascending aorta and pulmonary trunk to fix the heart or to divert the circulation to heart lung machine..



Pericardial effusion





Sites of Pericardiocentesis