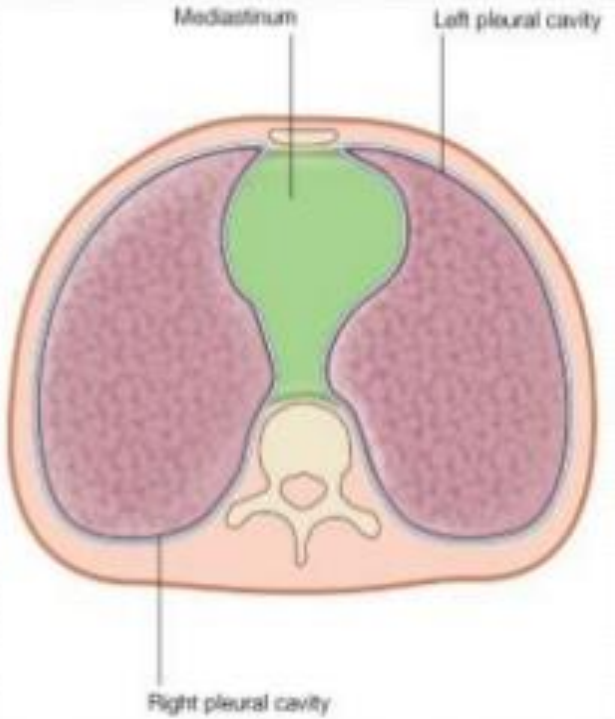
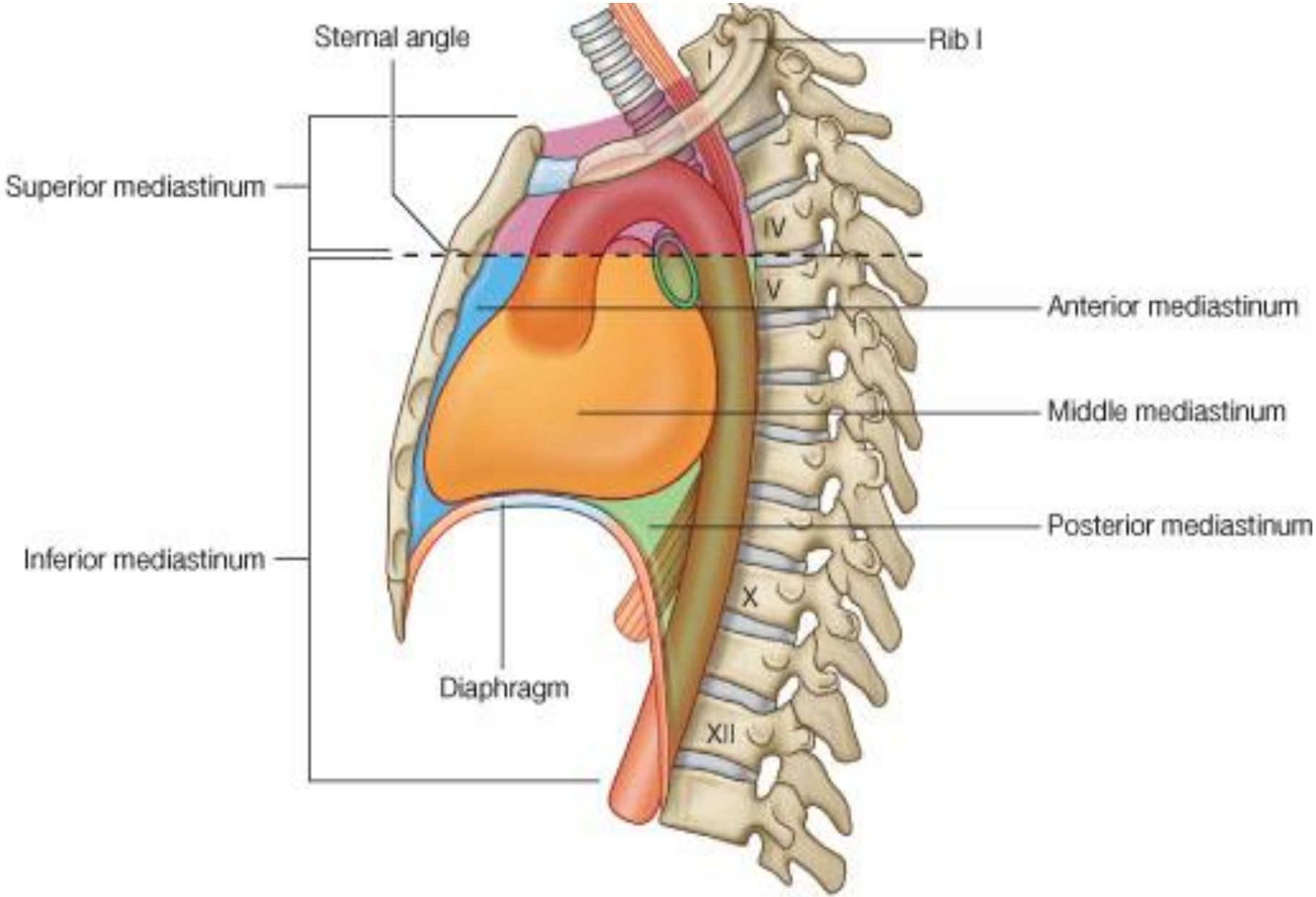
Structure of heart

- The heart is a muscular organ, which pumps blood through the blood vessels of the circulatory system.
- The heart is located between the lungs, in the middle compartment of the chest
- Four chambers: upper left and right atria; and lower left and right ventricles.
- The right atrium and ventricle are referred together as the right heart and their left counterparts as the left heart.
- The pericardium, which also contains a small amount of fluid.
- The wall of the heart is made up of three layers: epicardium, myocardium, and endocardium.

Mediastinum

- The mediastinum is a broad central partition that separates the two laterally placed pleural cavities.
- It extends:
  - from the sternum to the bodies of the vertebrae; and
  - from the superior thoracic aperture to the diaphragm
- It contains the thymus gland, the pericardial sac, the heart, the trachea, and the major arteries and veins.
- It also serves as a passageway for structures such as the esophagus, thoracic duct, and various components of the nervous system as they traverse the thorax on their way to the abdomen.



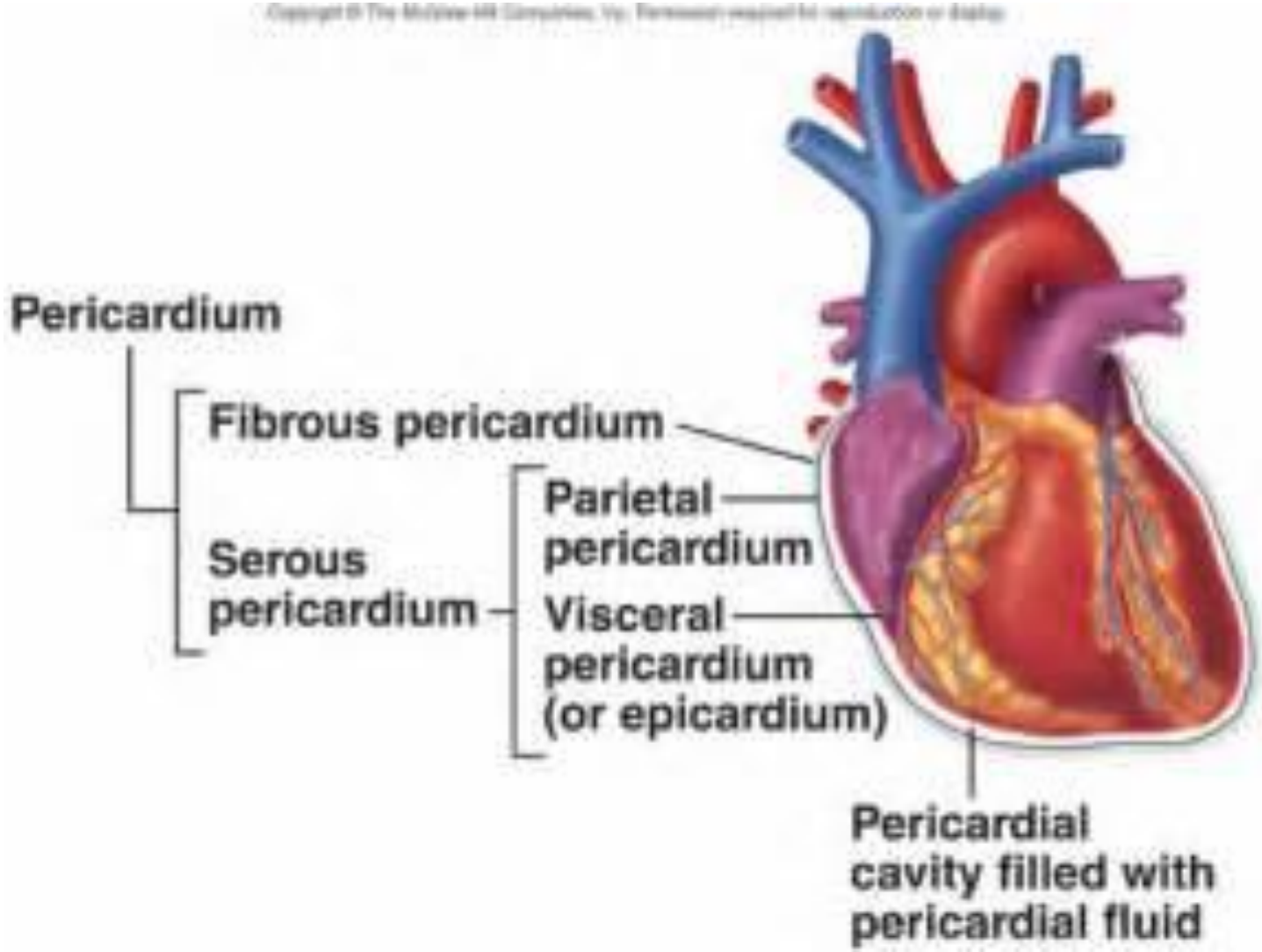

Sternal angle
Rib I
Superior mediastinum
Anterior mediastinum
Middle mediastinum
Posterior mediastinum
Inferior mediastinum
Diaphragm
I
IV
V
X
XII

- The middle mediastinum, at the level of thoracic vertebrae T5-T8.
- A double-membrane-the pericardium surrounds the heart and attaches to the mediastinum.
- The back surface of the heart lies near the vertebral column, and the front surface sits behind the sternum and rib cartilages.
- The upper part of the heart is the attachment point for several large blood vessels – the venae cavae, aorta and pulmonary trunk.

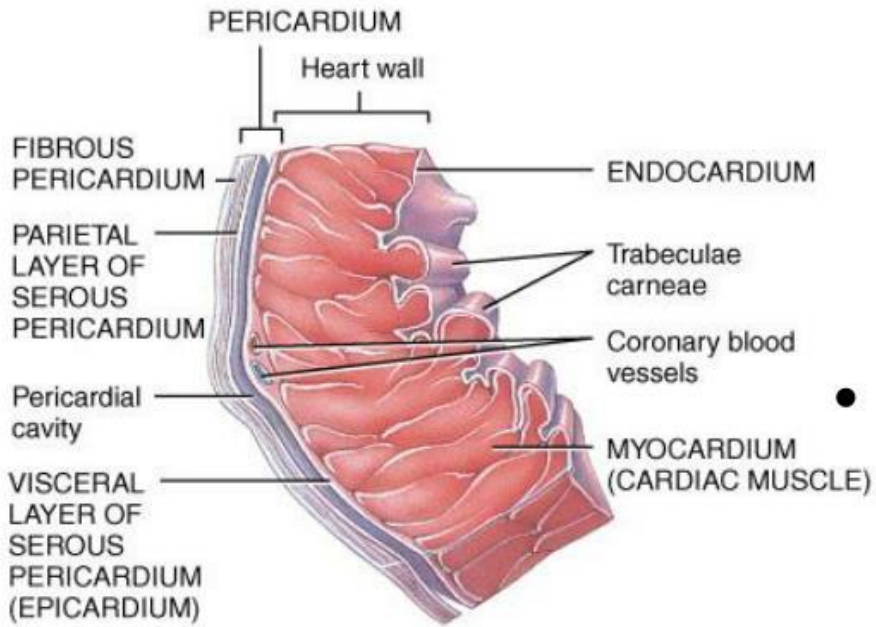
Middle mediastinum

- The **middle mediastinum** is centrally located in the thoracic cavity.
- It contains the pericardium, heart, origins of the great vessels, various nerves, and smaller vessels.

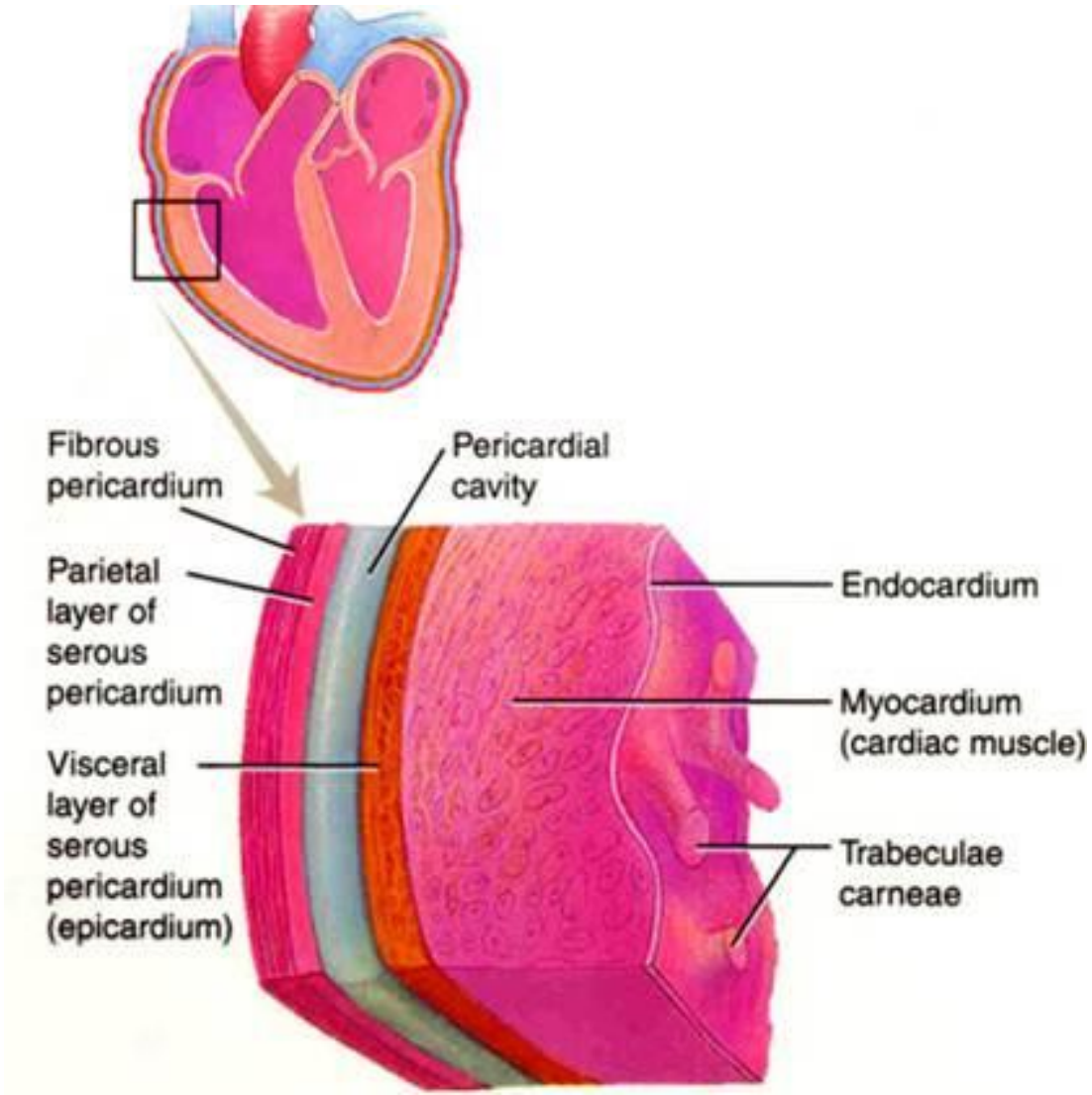
- The upper part of the heart is located at the level of the third costal cartilage.
- The lower tip of the heart, the apex, lies to the left of the sternum (8 to 9 cm from the midsternal line) between the junction of the fourth and fifth ribs near their articulation with the costal cartilages.
- The heart is cone-shaped, with its base positioned upwards and tapering down to the apex.
- An adult heart has a mass of 250–350 grams .
- The heart is typically the size of a fist: 12 cm in length, 8 cm wide, and 6 cm in thickness.

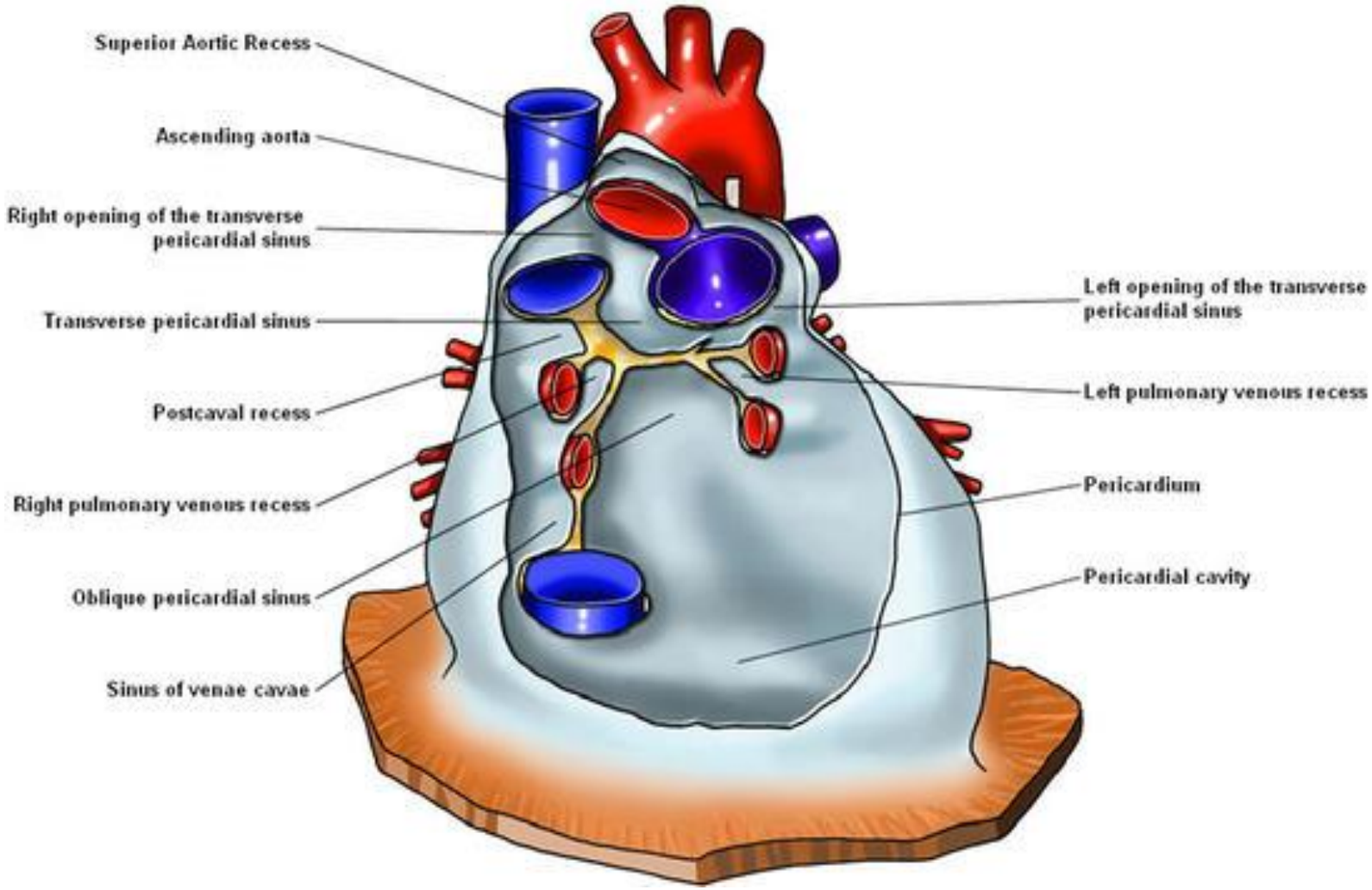


Pericardium



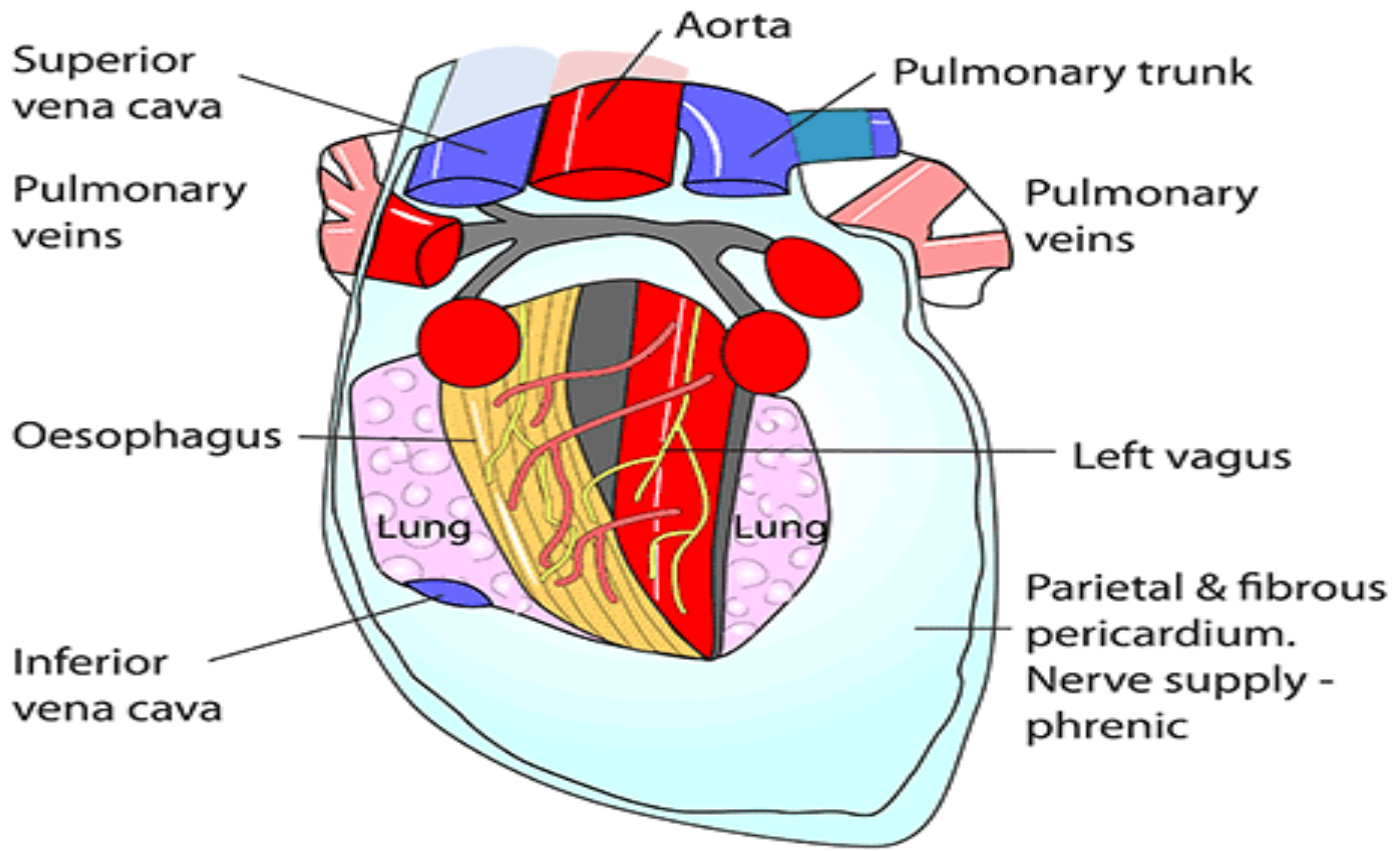
- Fibrous pericardium
  - dense irregular CT
  - protects and anchors the heart, prevents overstretching
- Serous pericardium
  - thin delicate membrane
  - contains
    - parietal layer-outer layer
    - pericardial cavity with pericardial fluid
    - visceral layer (epicardium)

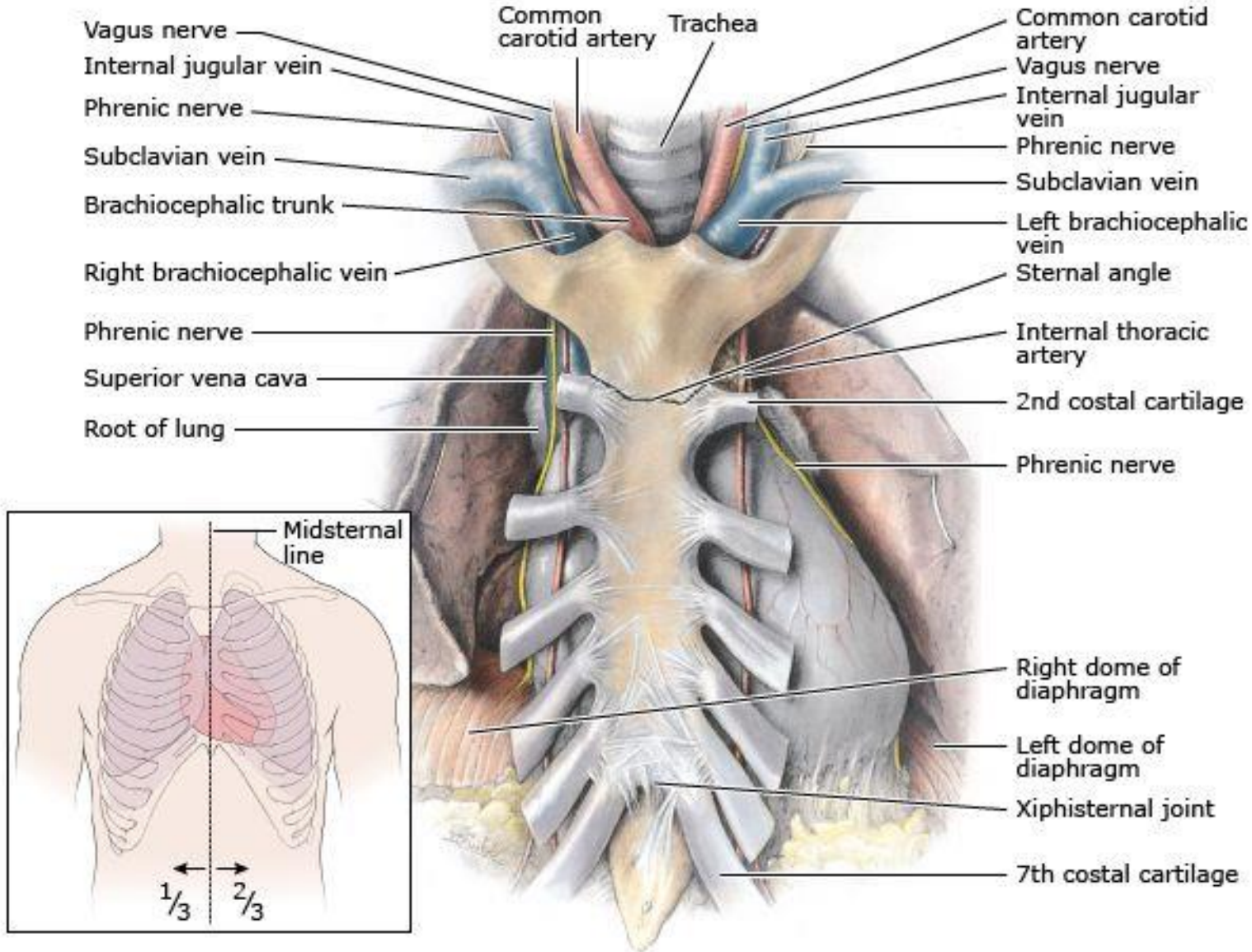

Fibrous pericardium
Pericardial cavity
Parietal layer of serous pericardium
Visceral layer of serous pericardium (epicardium)
Endocardium
Myocardium (cardiac muscle)
Trabeculae carneae


Superior Aortic Recess
Ascending aorta
Right opening of the transverse pericardial sinus
Transverse pericardial sinus
Postcaval recess
Right pulmonary venous recess
Oblique pericardial sinus
Sinus of venae cavae
Left opening of the transverse pericardial sinus
Left pulmonary venous recess
Pericardium
Pericardial cavity

PERICARDIUM - HEART REMOVED WITH VISCERAL LAYER

If the pericardial lining which makes up the oblique sinus of the pericardium is removed the structures posterior to it are exposed





Anterior views

Functions of the pericardium:

- Keeps the heart contained in the thoracic cavity(cardiac seat belt).
- Prevents over-expanding of heart when blood volume increases.
- Limits the heart's movements.
- Acts as a shock absorber with the help of the fluid filled sac.

- The cardiac skeleton is made of dense connective tissue and this gives structure to the heart.
- It forms the atrioventricular septum which separates the atria from the ventricles, and the fibrous rings which serve as bases for the four heart valves.
- The cardiac skeleton also provides an important boundary in the heart's electrical conduction system since collagen cannot conduct electricity.
- The interatrial septum separates the atria and the interventricular septum separates the ventricles.The interventricular septum is much thicker than the interatrial septum

Fibrous Skeleton of the Heart

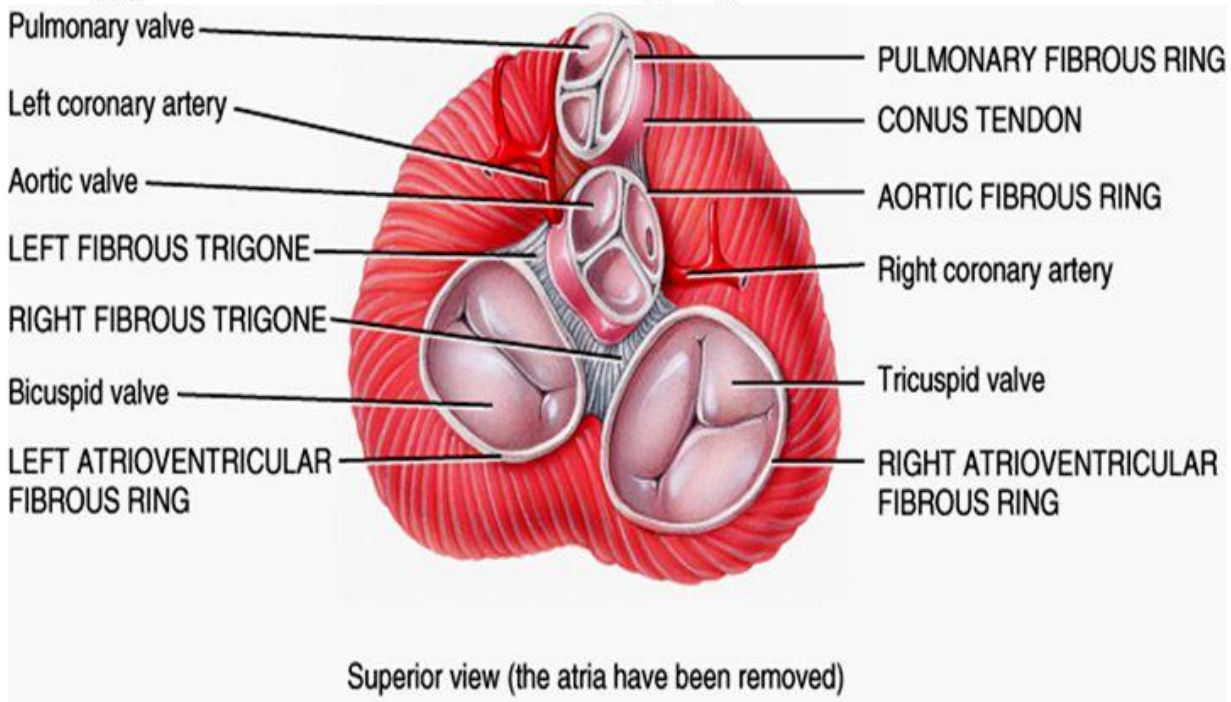
Dense collagenous fibrous tissue framework lies
at the junction of the atria with the ventricles.

Includes:

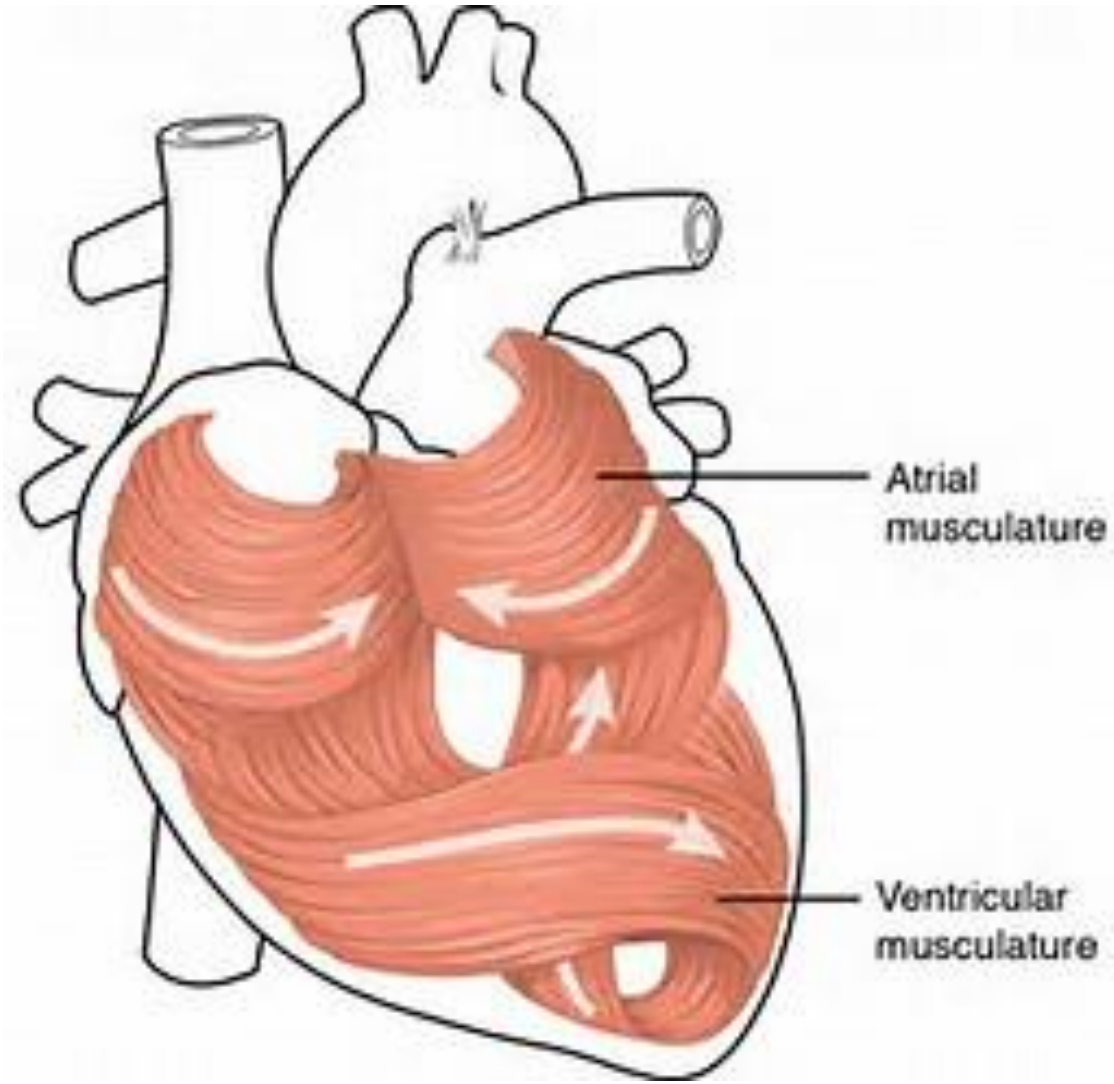
1-Tricuspid fibrous annulus: **2**-Mitral fibrous annulus
3-Pulmonary fibrous annulus: **4**-Aortic fibrous annulus

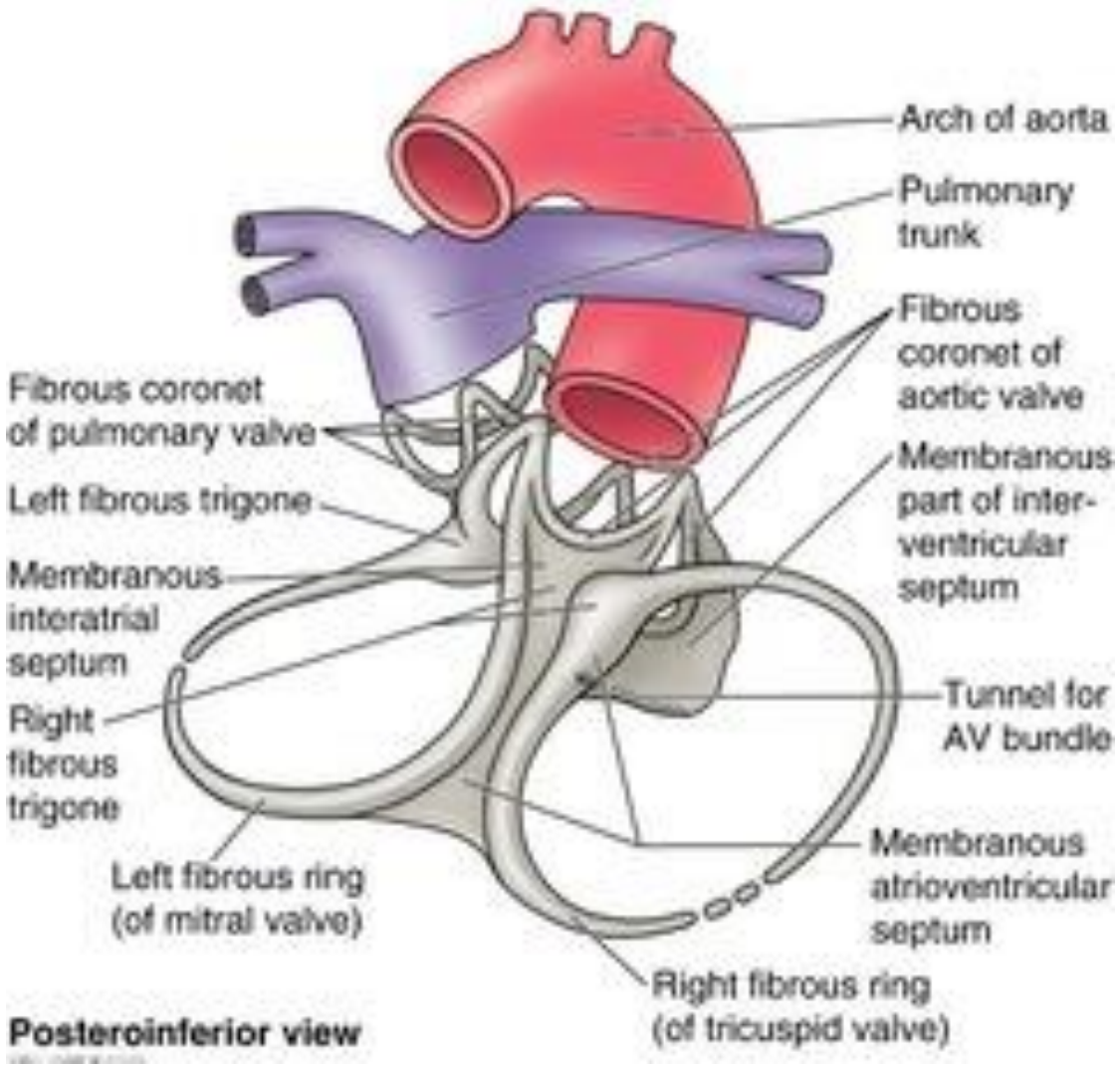
Functions:

1-Supports the valves. **2**-Electrically separetes atria from ventricles.



Superior view (the atria have been removed)


Atrial
musculature
Ventricular
musculature

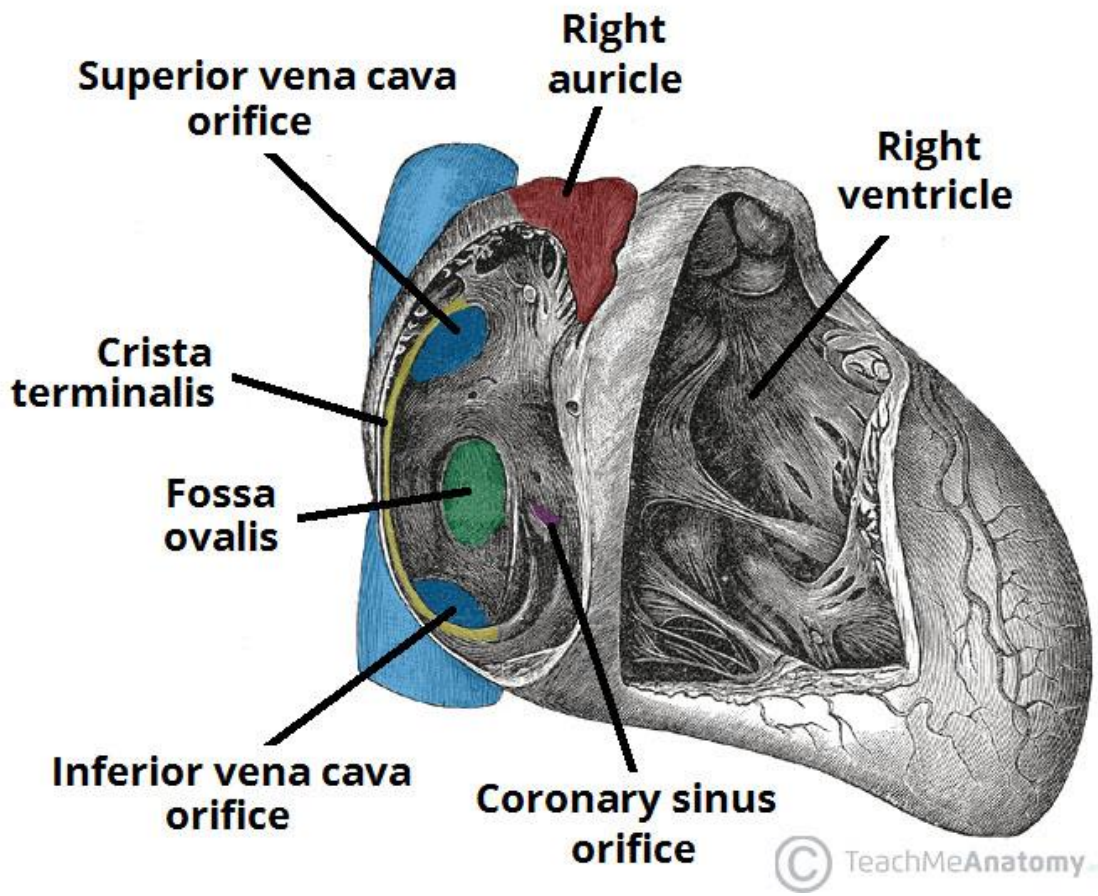


Posteroinferior view

- The heart has four valves
- The valves between the atria and ventricles are called the atrioventricular valves.
- Between the right atrium and the right ventricle is the tricuspid valve. The tricuspid valve has three cusps,which connect to chordae tendinae and three papillary muscles named the anterior, posterior, and septal muscles.
- The mitral valve lies between the left atrium and left ventricle. It is also known as the bicuspid valve due to its having two cusps, an anterior and a posterior cusp. These cusps are also attached via chordae tendinae to two papillary muscles projecting from the ventricular wall.

- The papillary muscles extend from the walls of the heart to valves by cartilaginous connections called chordae tendinae. These muscles prevent the valves from falling too far back when they close.
- Two additional semilunar valves sit at the exit of each of the ventricles.
- The pulmonary valve is located at the base of the pulmonary artery. This has three cusps which are not attached to any papillary muscles.
- The semilunar aortic valve is at the base of the aorta and also is not attached to papillary muscles. This too has three cusps.

- The right heart consists of two chambers, the right atrium and the right ventricle, separated by a valve, the tricuspid valve.
- The right atrium receives blood almost continuously from the body's two major veins, the superior and inferior venae cavae. A small amount of blood from the coronary circulation also drains into the right atrium via the coronary sinus
- In the wall of the right atrium is an oval-shaped depression known as the fossa ovalis, which is a remnant of an opening in the fetal heart known as the foramen ovale.


Right auricle
Superior vena cava orifice
Right ventricle
Crista terminalis
Fossa ovalis
Inferior vena cava orifice
Coronary sinus orifice
© TeachMeAnatomy

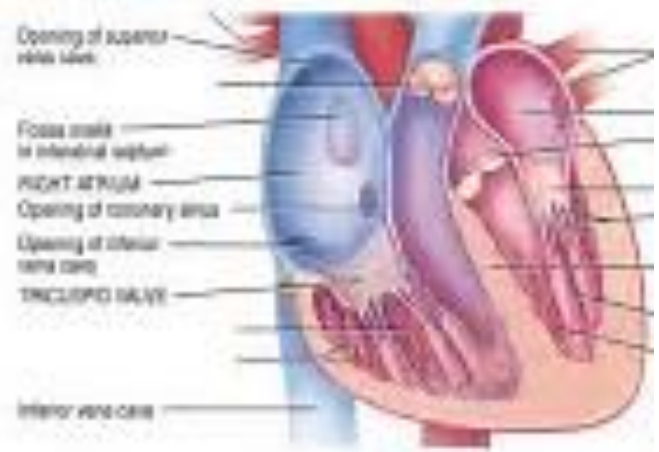
Right Atrium

Posterior wall of the right atrium:

- Opening of the superior vena cava
- Opening and valve of the inferior vena cava
- Opening and valve of the coronary sinus
- Fossa ovalis and the limbus fossa ovalis

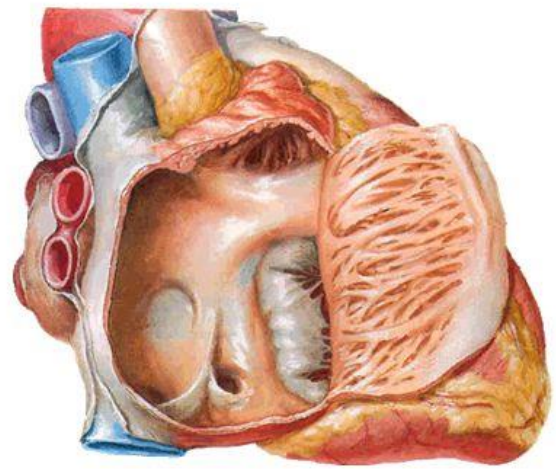
Anterior wall of the right atrium:

- Pectinate muscles
- Crista terminalis

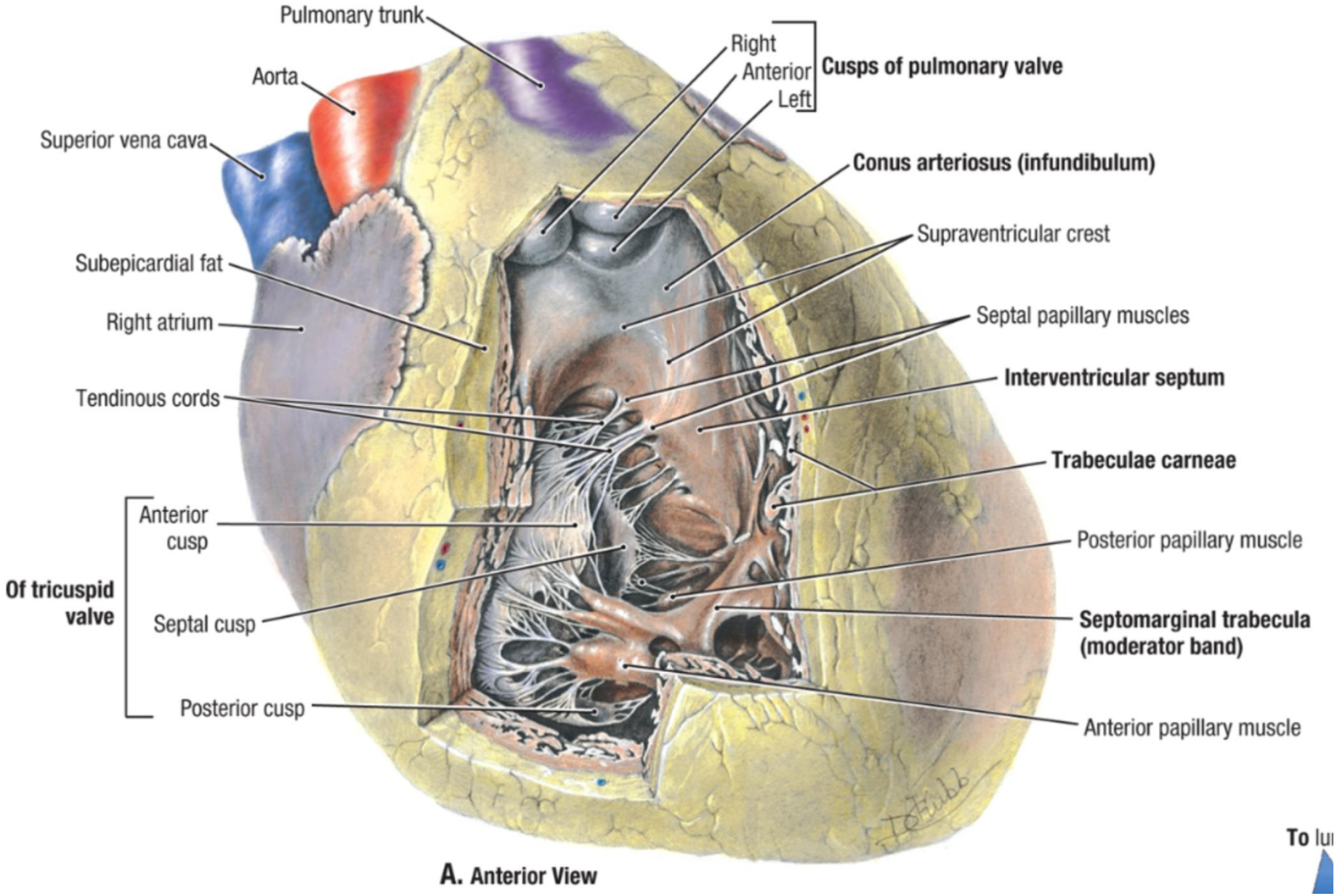


Right atrium (RA)

- **Crista terminalis** - vertical ridge that from superior vena cave to inferior vena cave
- **Sulcus terminalis** - groove on exterior of heart that corresponds to crista terminalis
- **Two parts** - separated externally by sulcus terminalis and internally by the crista terminalis
  - **Atrium proper**
  - **Sinus venarum cavarum**



- The right atrium is connected to the right ventricle by the tricuspid valve.
- The walls of the right ventricle are lined with trabeculae carneae, ridges of cardiac muscle covered by endocardium.
- In addition to these muscular ridges, a band of cardiac muscle, also covered by endocardium, known as the moderator band reinforces the thin walls of the right ventricle and plays a crucial role in cardiac conduction.
- It arises from the lower part of the interventricular septum and crosses the interior space of the right ventricle to connect with the inferior papillary muscle.
- The right ventricle tapers into the pulmonary trunk

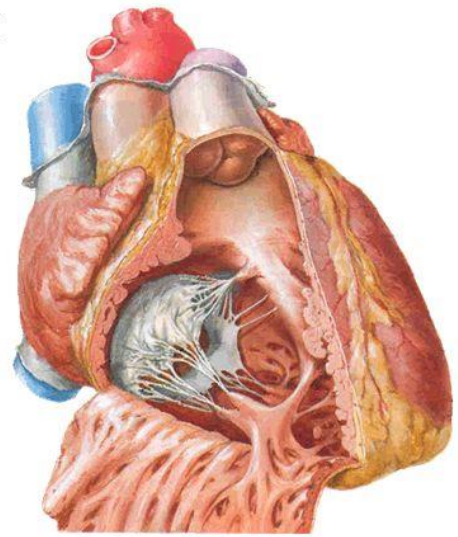


A. Anterior View

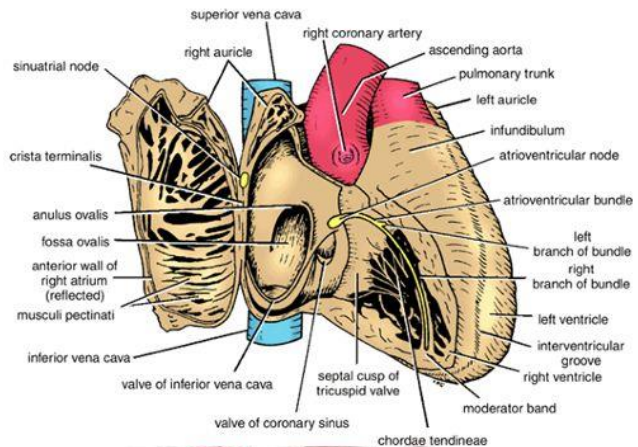
To lu

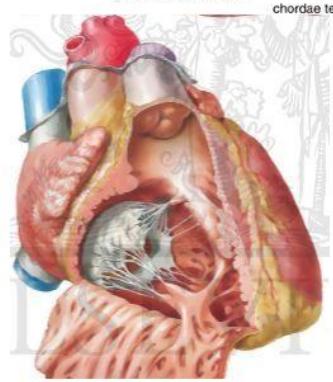
Right ventricle (RV)

- **Supraventricular crest** (a muscular ridge between right atrioventricular orifice and orifice of pulmonary trunk)
- **Two parts**
  - Inflow tract
  - Outflow tract



Cavity of right ventricle





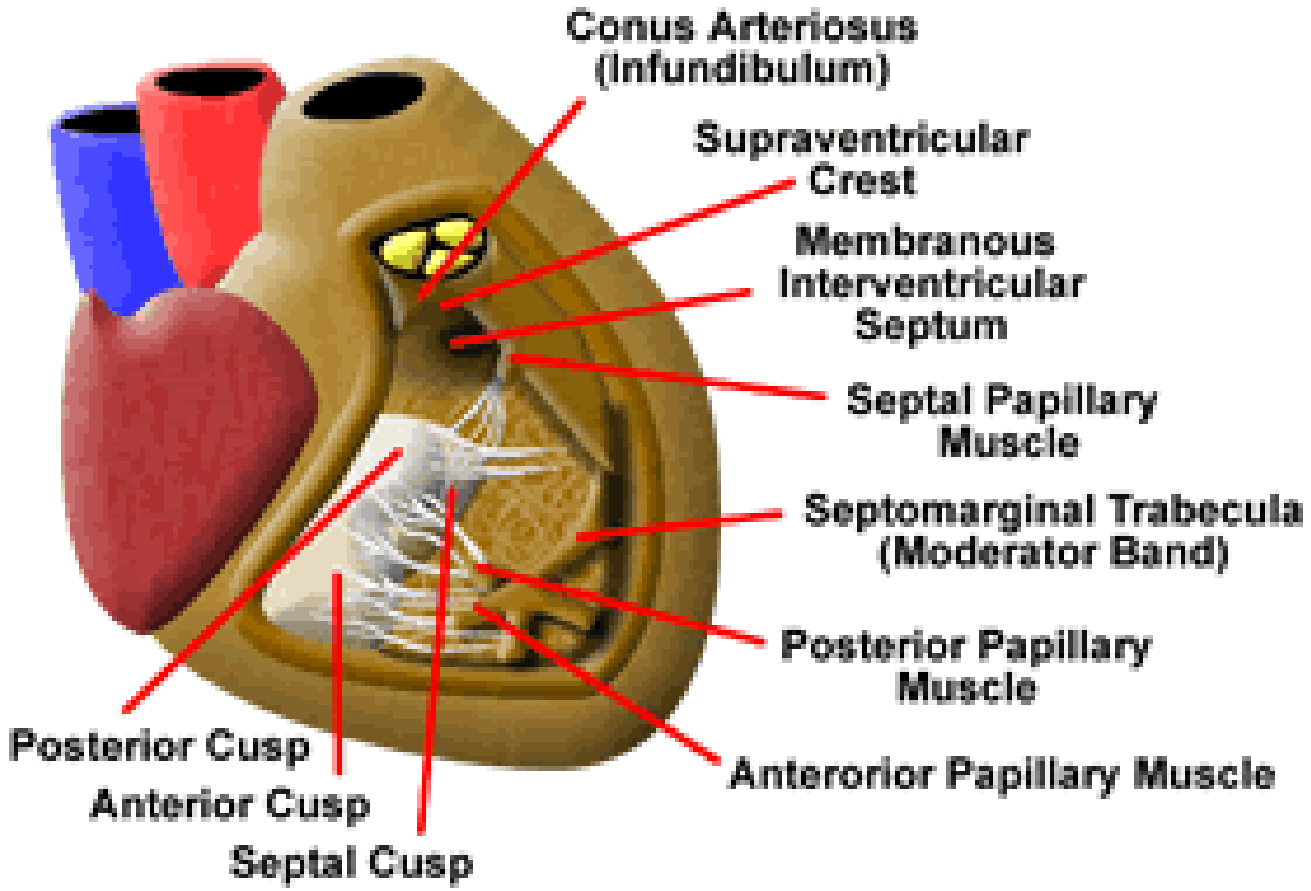
Its wall is thinner than that of left ventricle

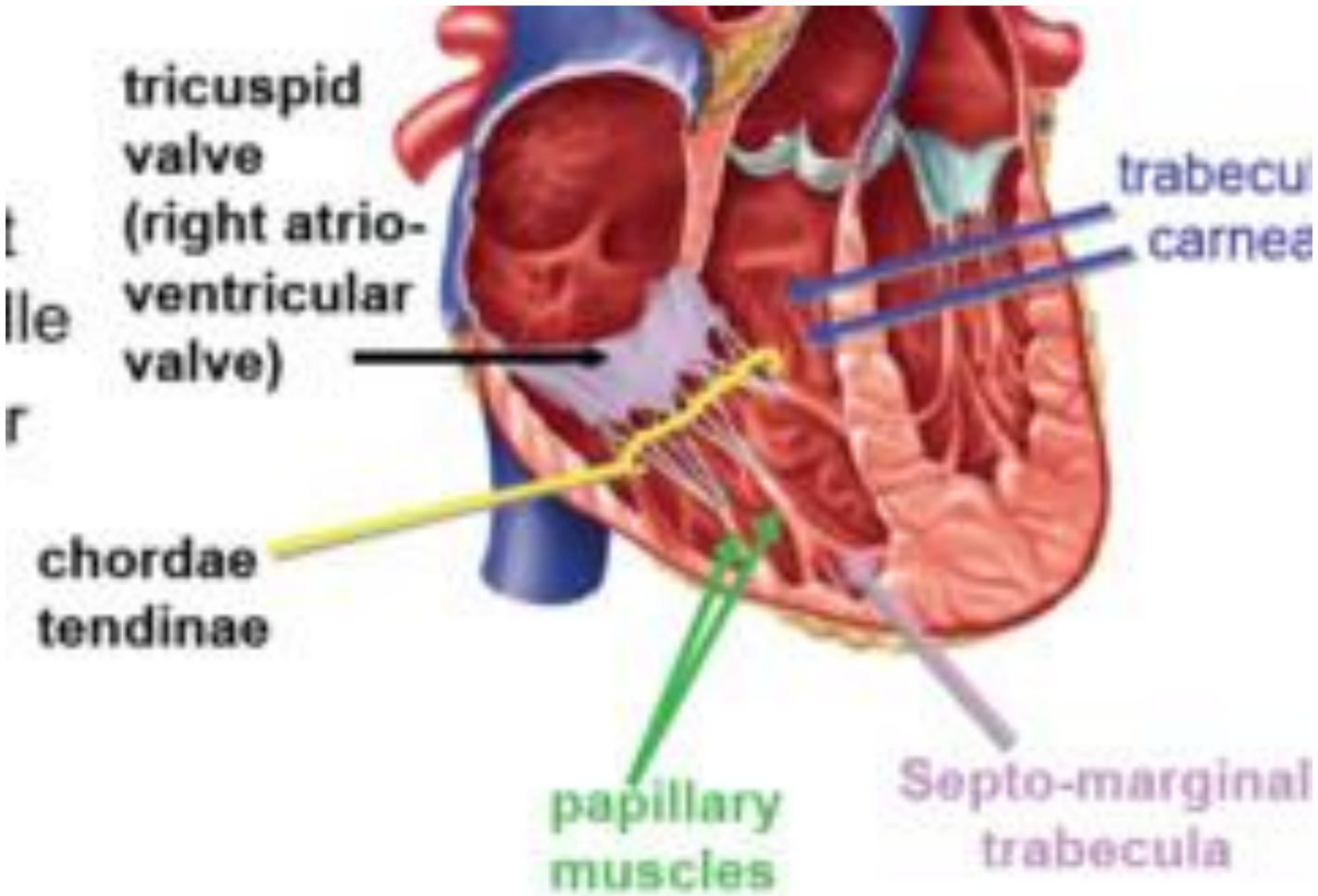
Its wall contains projections called *trabeculae carnae.*

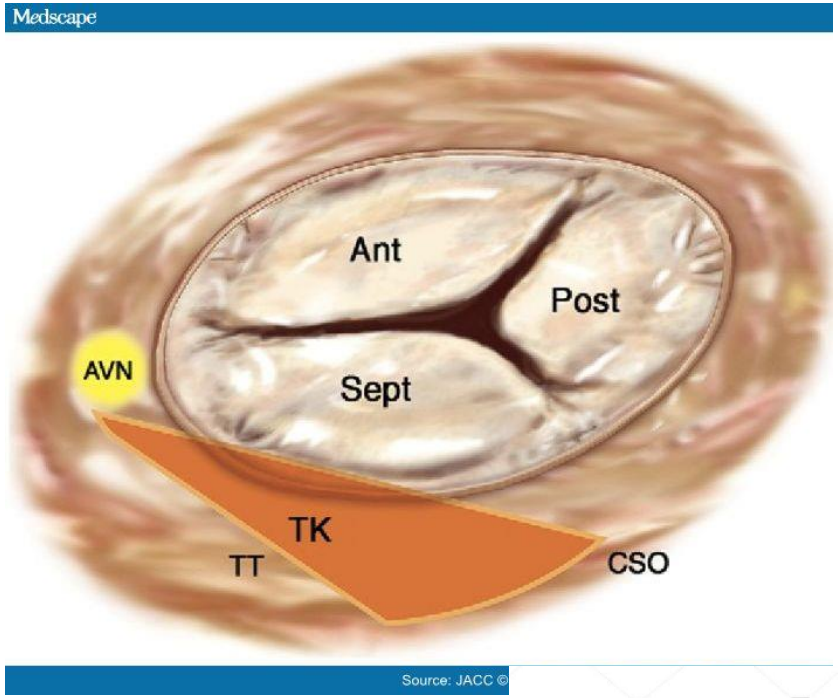
The right ventricle communicates with right atrium through right atrioventricular orifice & with pulmonary trunk through pulmonary orifice

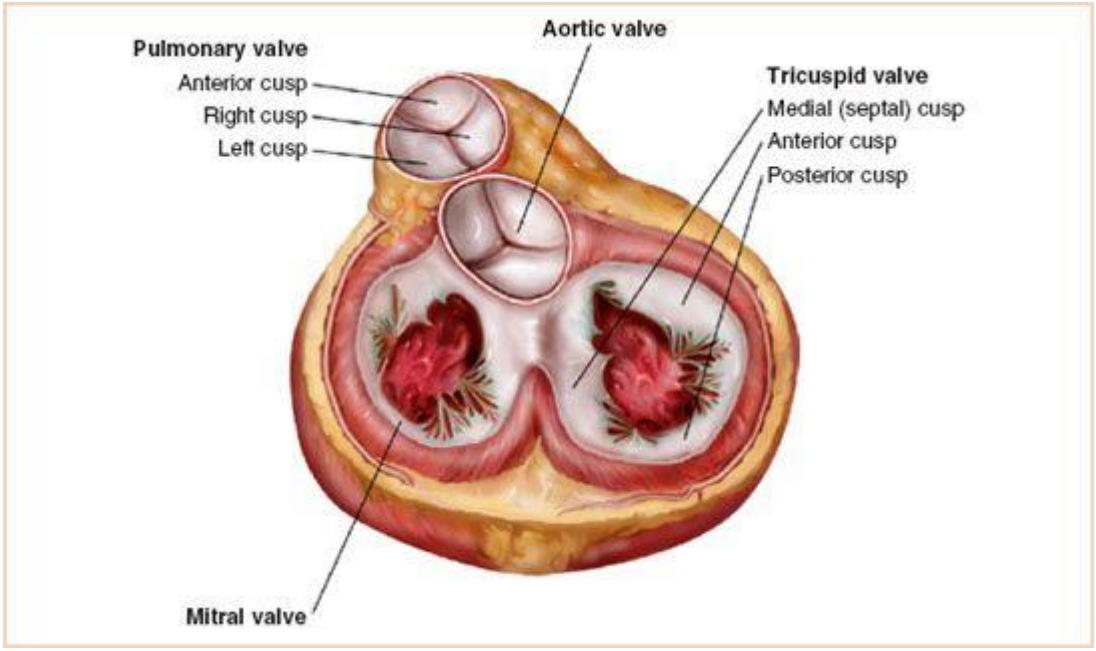
Large projections arise from the walls called ***papillary muscles***

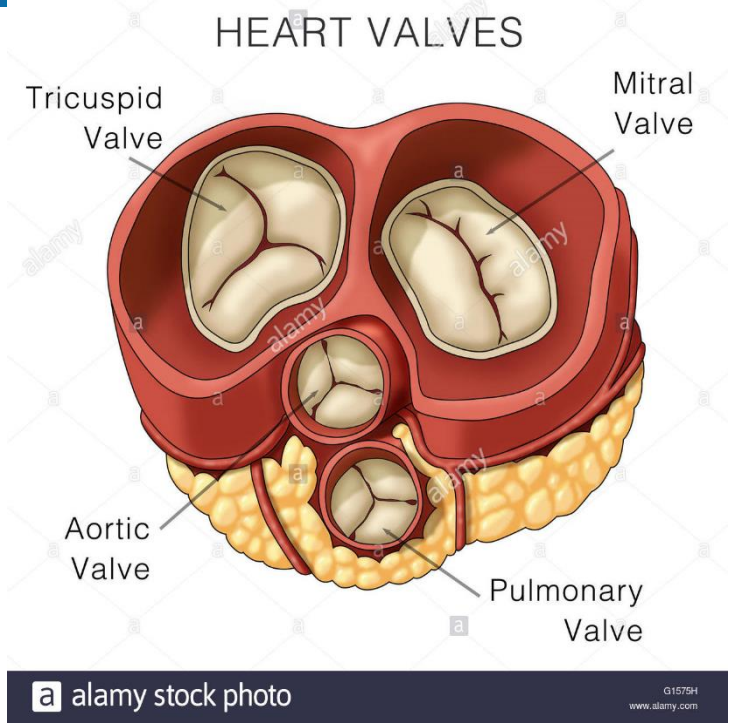
- ***Anterior papillary muscle***
- ***Posterior papillary muscle***
- ***Septal papillary muscle***


Conus Arteriosus
(Infundibulum)
Supraventricular
Crest
Membranous
Interventricular
Septum
Septal Papillary
Muscle
Septomarginal Trabecula
(Moderator Band)
Posterior Papillary
Muscle
Anterorior Papillary Muscle
Posterior Cusp
Anterior Cusp
Septal Cusp


tricuspid valve (right atrio-ventricular valve)
chordae tendinae
papillary muscles
Septo-marginal trabecula


Medscape
Ant
Post
Sept
AVN
TK
TT
CSO
Source: JACC ©


Pulmonary valve
Anterior cusp
Right cusp
Left cusp
Aortic valve
Tricuspid valve
Medial (septal) cusp
Anterior cusp
Posterior cusp
Mitral valve


HEART VALVES
Tricuspid Valve
Mitral Valve
Aortic Valve
Pulmonary Valve
alamy stock photo
G1575H
www.alamy.com

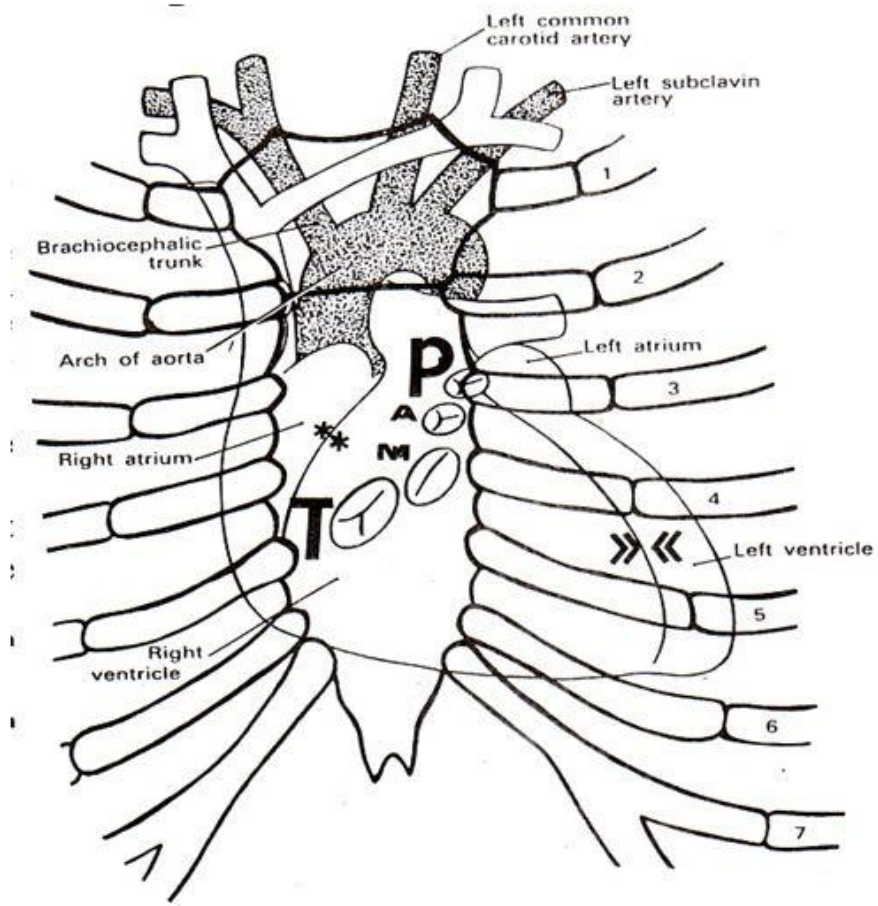
Surface anatomy of the valves

Pulmonary: Left **3rd** sternocostal junction

Aortic: Left **3rd** Intercostal space just left to sternum

Mitral: Left **4th** sternocostal junction

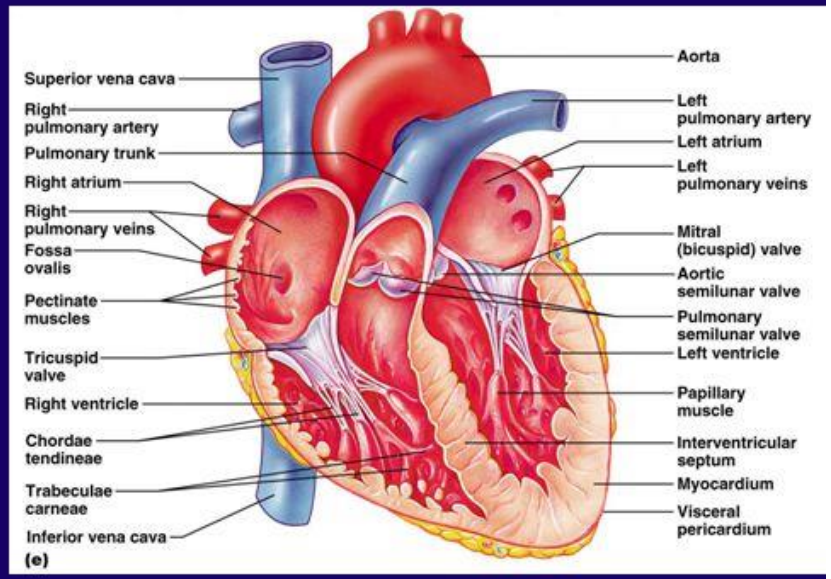
Tricuspid: **4th** Intercostal space near the middle line.



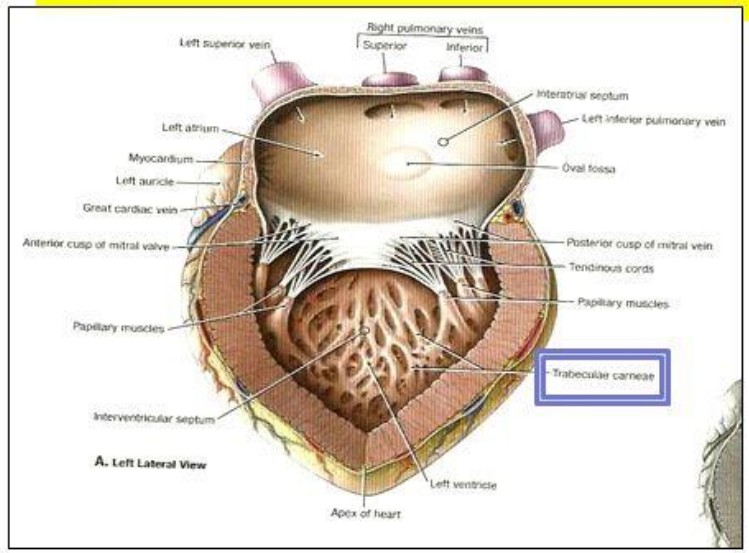
- The left heart has two chambers: the left atrium, and the left ventricle, separated by the mitral valve.
- The left atrium receives oxygenated blood back from the lungs via one of the four pulmonary veins. The left atrium has an outpouching called the left atrial appendage. Like the right atrium, the left atrium is lined by pectinate muscles.
- The left ventricle is much thicker as compared with the right, due to the greater force needed to pump blood to the entire body. Like the right ventricle, the left also has trabeculae carneae, but there is no moderator band.
- The left main coronary artery and the right coronary artery.

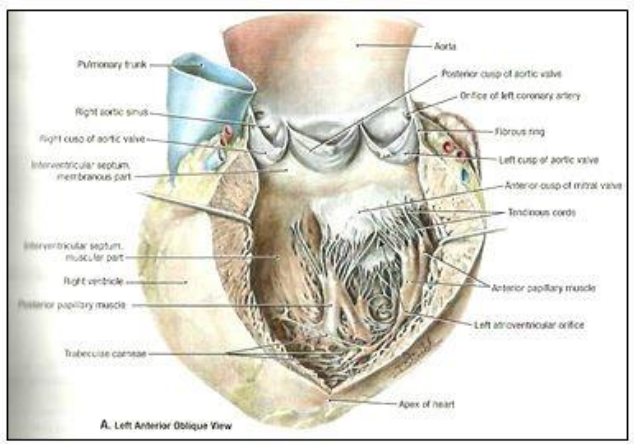
Chambers

- Left atrium
  - Makes up heart's posterior surface
  - Receives oxygen-rich blood from lungs
  - Opens into the left ventricle through the Mitral valve (left atrioventricular valve)
- Left Ventricle
  - Forms apex of the heart
  - Internal walls of left ventricle
    - Trabeculae carneae
    - Papillary muscles
    - Chordae tendineae
  - Pumps blood through systemic circuit via the Aortic semilunar valve (aortic valve)



Left ventricle of the heart





- Its wall is thicker than that of right ventricle.
- It receives blood from left atrium through left atrio-ventricular orifice which is guarded by mitral valve.
- Its wall contains trabeculae carnae.
- Its wall contains 2 large papillary muscles (anterior & posterior). They are attached by chordae tendinae to cusps of mitral valve.

Left ventricle

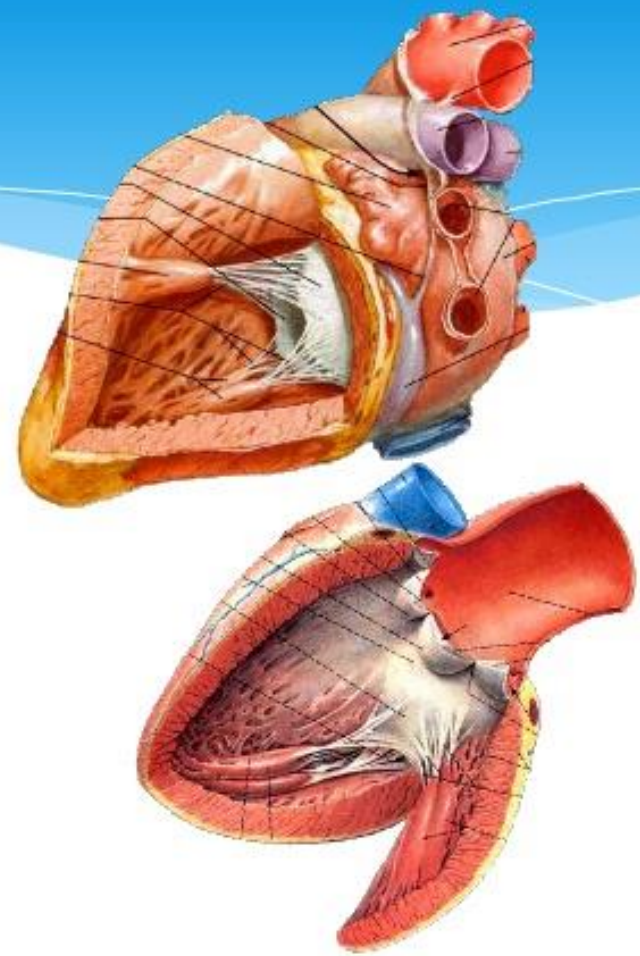
It's wall is three times thicker than that of right ventricle

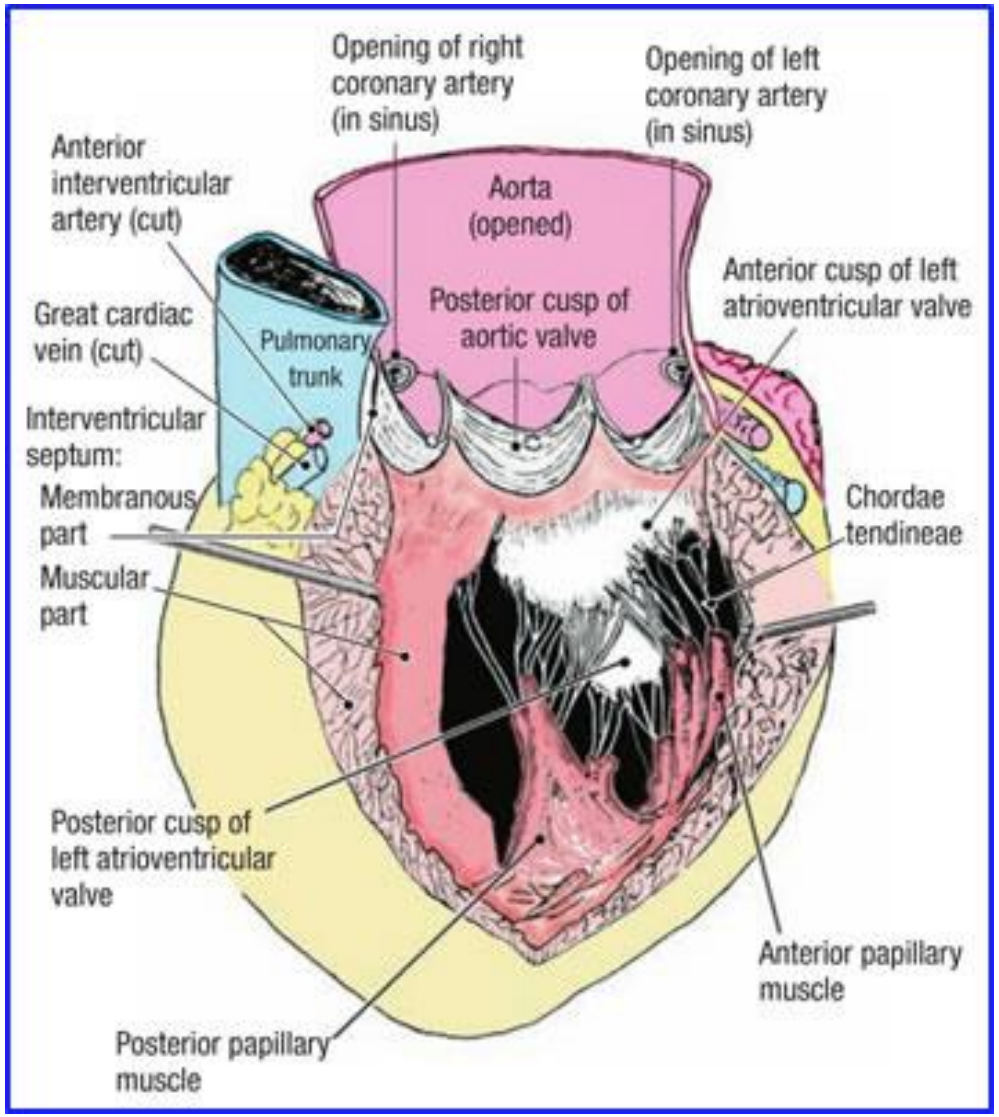
One inlet – **left atrioventricular orifice**

One outlet – **aortic orifice**

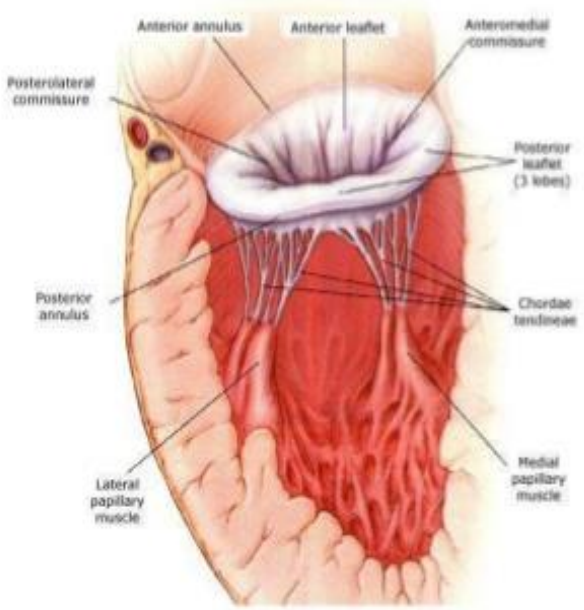
Two parts – divided by anterior cusps of mitral valve

- Inflow tract – rough walls
- Outflow tract – **aortic vestibule** smooth area leading to aortic orifice




Opening of right coronary artery (in sinus)
Opening of left coronary artery (in sinus)
Anterior interventricular artery (cut)
Aorta (opened)
Great cardiac vein (cut)
Pulmonary trunk
Posterior cusp of aortic valve
Anterior cusp of left atrioventricular valve
Interventricular septum:
Membranous part
Muscular part
Chordae tendineae
Posterior cusp of left atrioventricular valve
Anterior papillary muscle
Posterior papillary muscle

Anatomy: Mitral valve

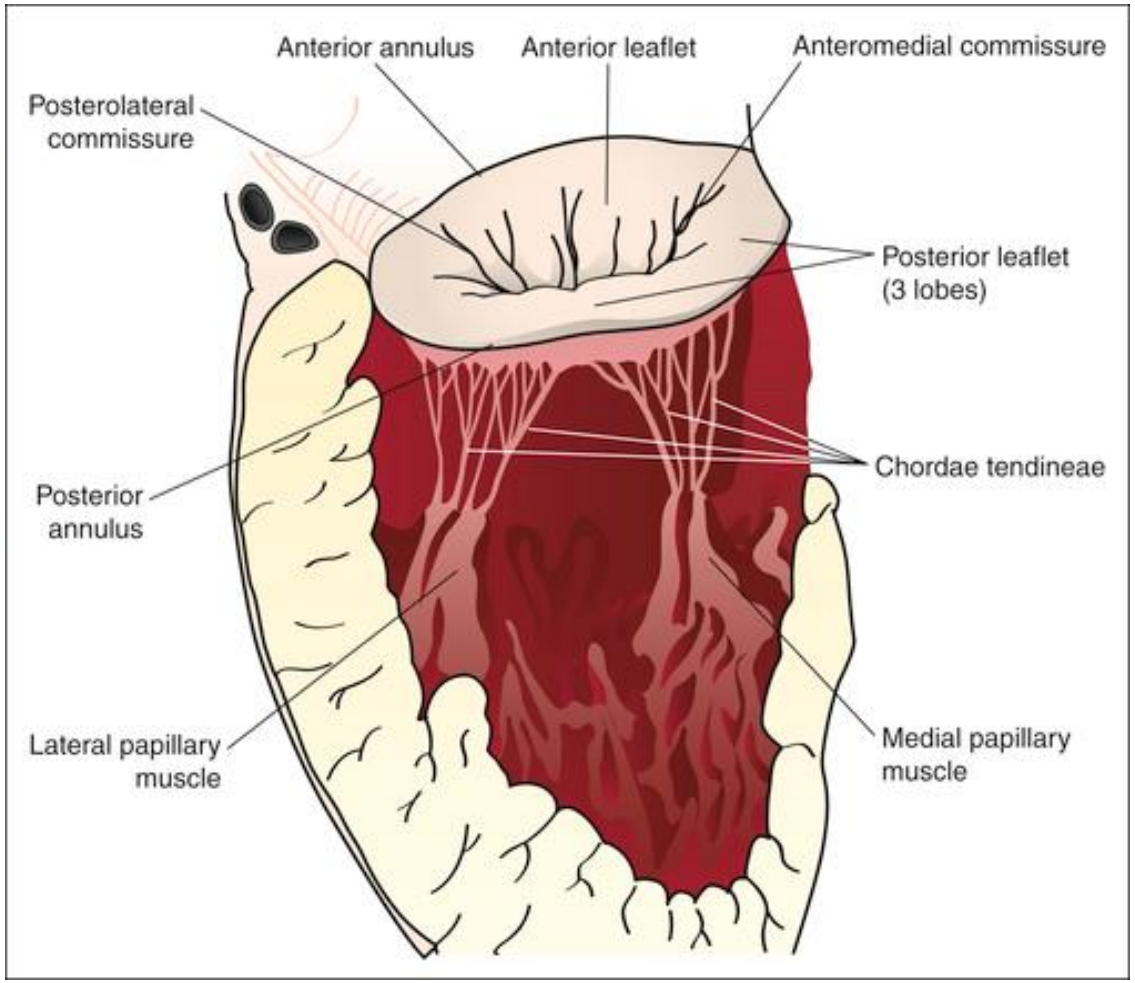


Pic source: www.heart-valve-surgery.com

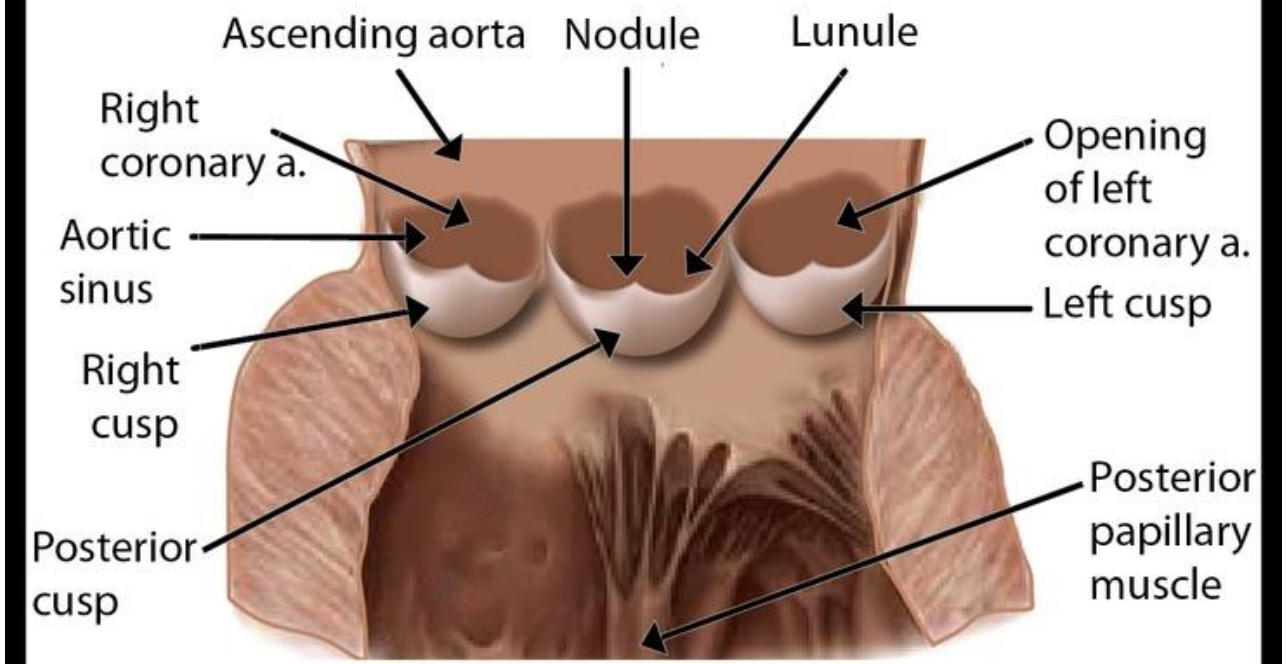
- The mitral valve connects the left atrium (LA) and the left ventricle (LV).
- The mitral valve opens during diastole to allow the blood flow from the LA to the LV.
- During ventricular systole, the mitral valve closes and prevents backflow to the LA.

The mitral apparatus is composed of

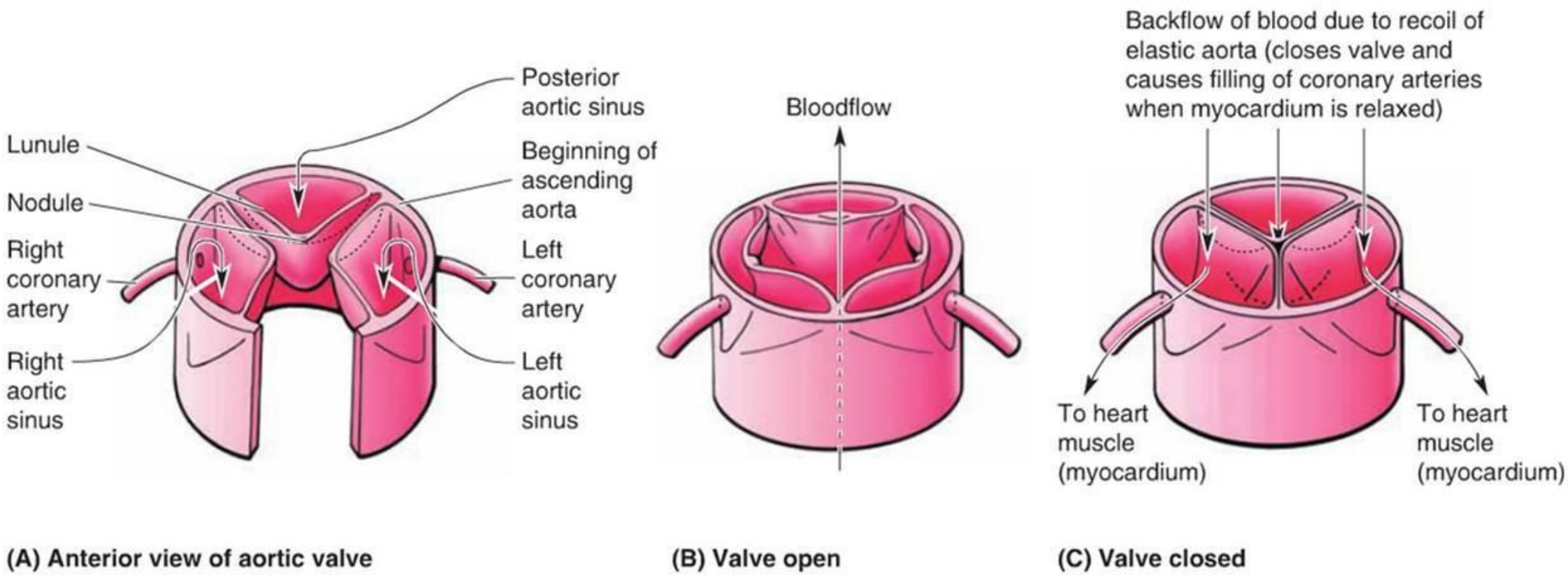
1. the left atrial wall
2. the annulus
3. the leaflets
4. the chordae tendineae
5. the papillary muscles
6. the left ventricular wall



Aortic valve



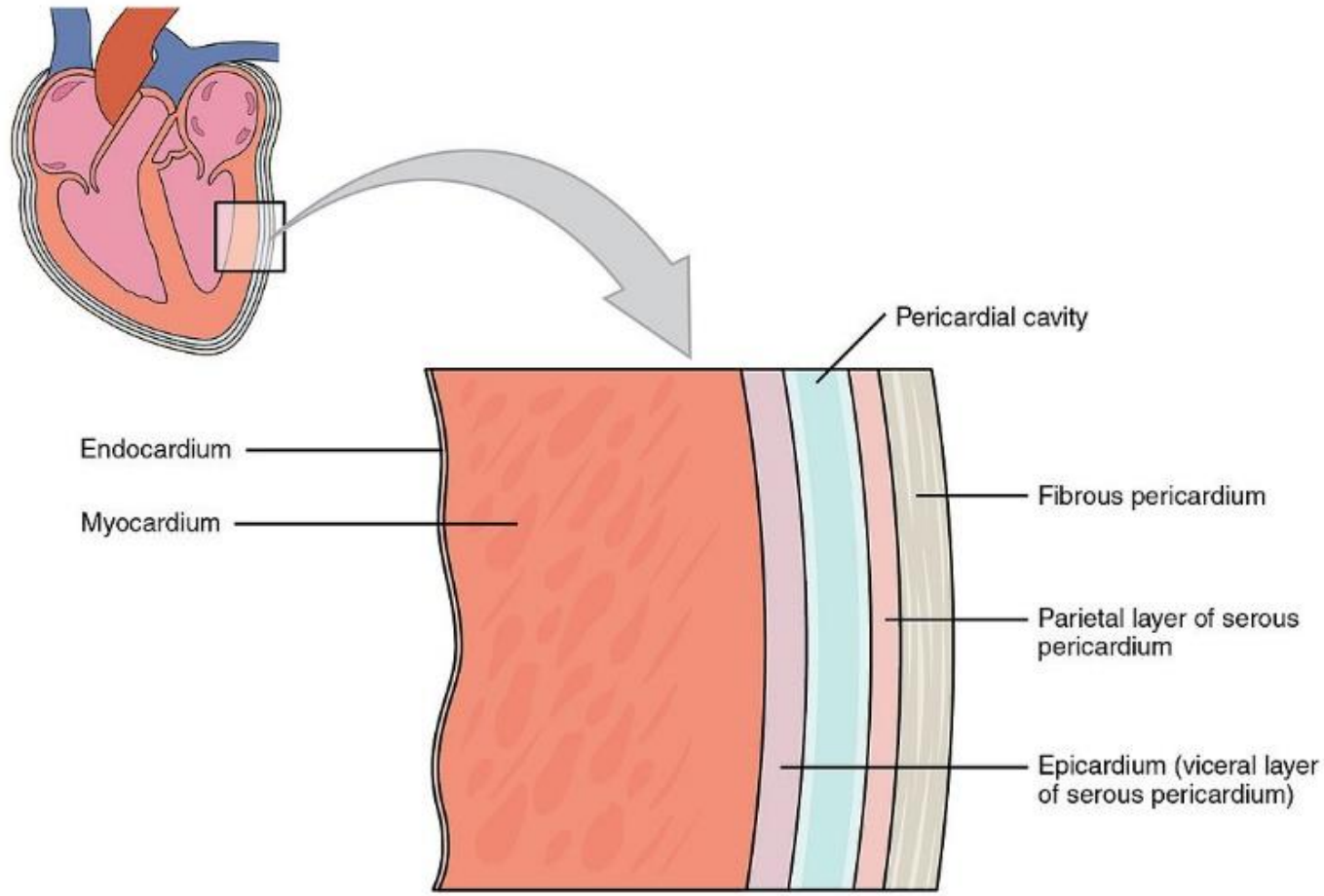
Health Education Library for People

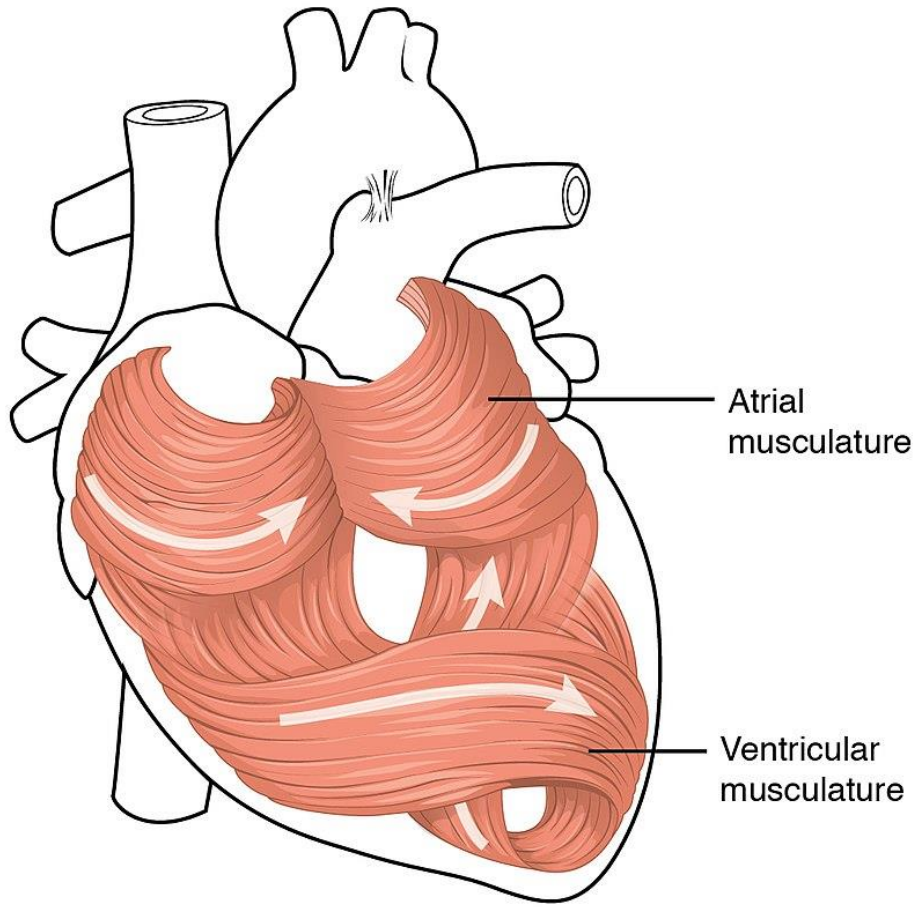


(A) Anterior view of aortic valve **(B) Valve open** **(C) Valve closed**

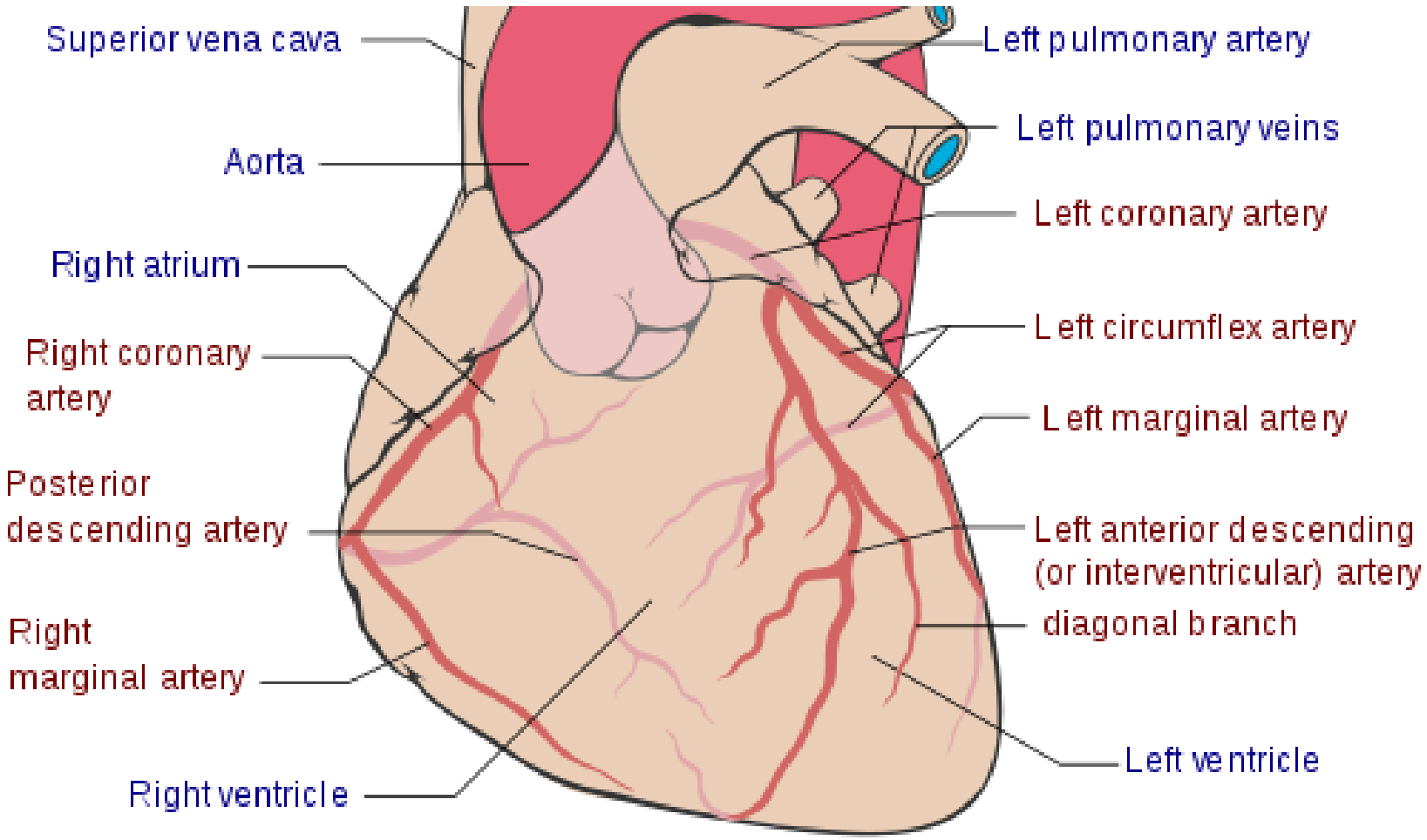
Fig 1.58, Moore's Clinically Oriented Anatomy, 6th Ed. LW&W, 2012

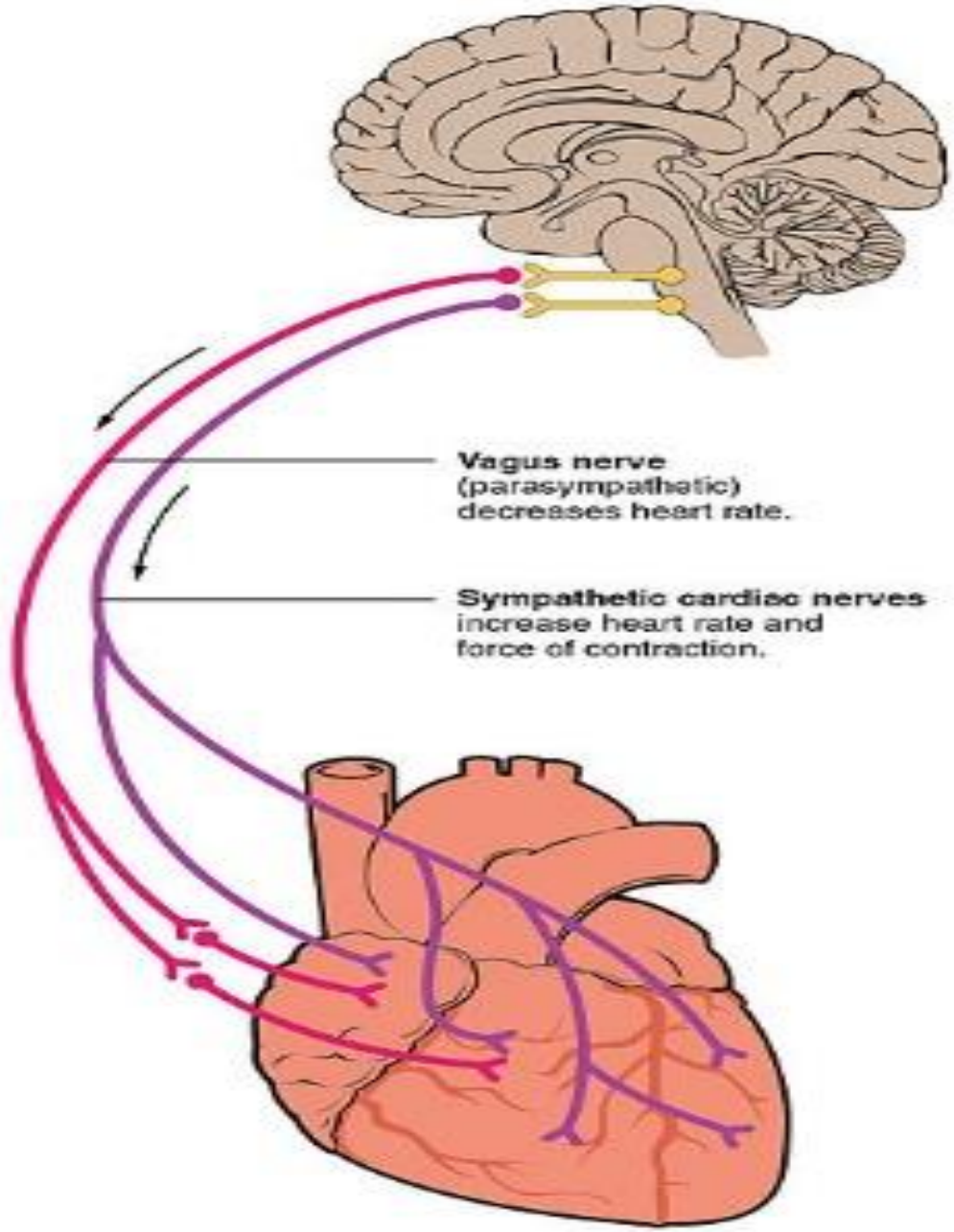
- Inner endocardium, middle myocardium and outer epicardium. These are surrounded by a double-membraned sac called the pericardium.
- The innermost layer of the heart is called the endocardium. It is made up of a lining of simple squamous epithelium.
- The swirling pattern of myocardium helps the heart pump effectively
- The middle layer of the heart wall is the myocardium, which is the cardiac muscle – a layer of involuntary striated muscle tissue surrounded by a framework of collagen.
- figure 8 pattern around the atria and around the bases of the great vessels, and inner muscles formining a figure 8 around the two ventricles and proceed toward the apex.

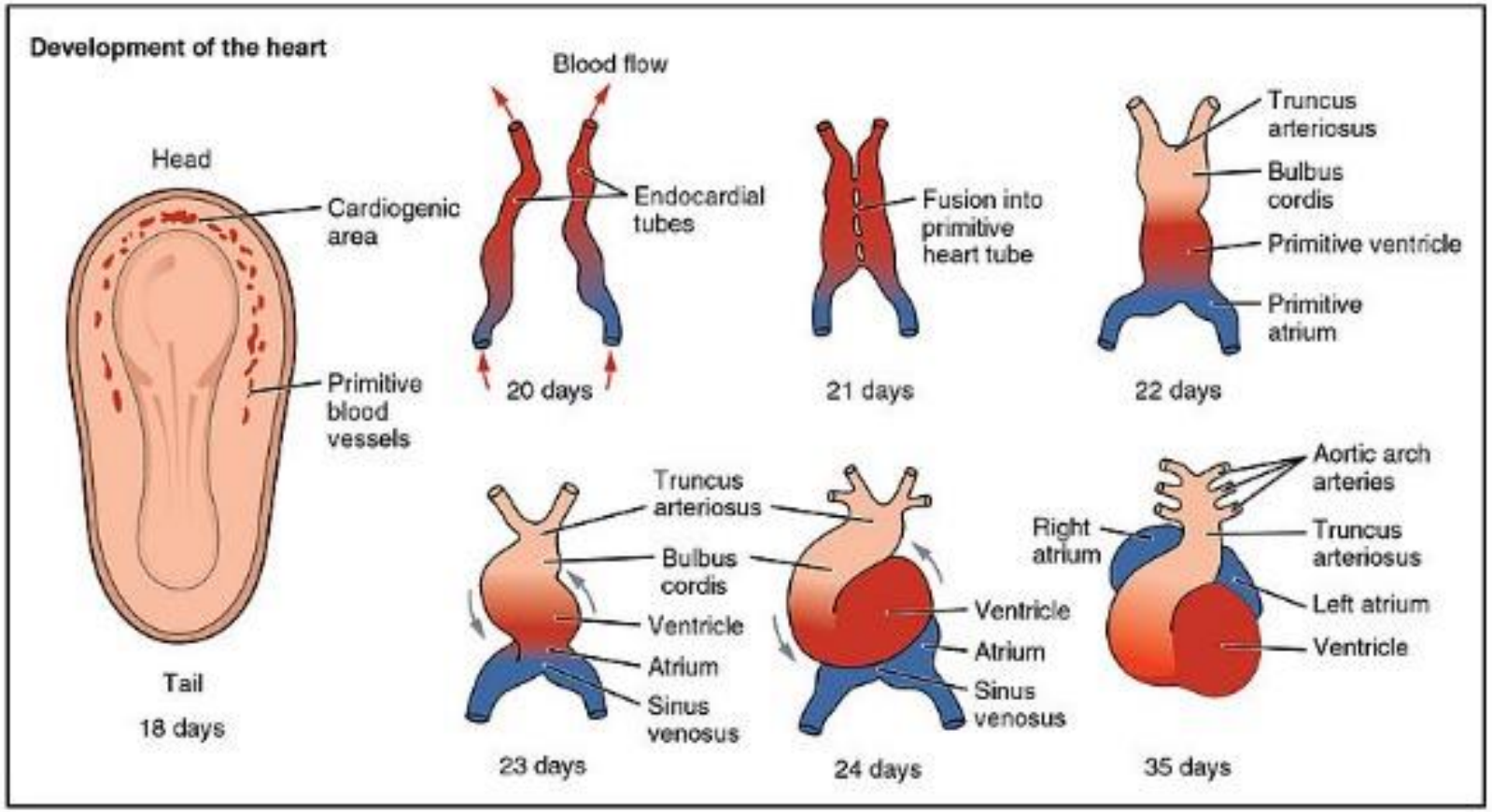

Pericardial cavity
Endocardium
Myocardium
Fibrous pericardium
Parietal layer of serous pericardium
Epicardium (viceral layer of serous pericardium)

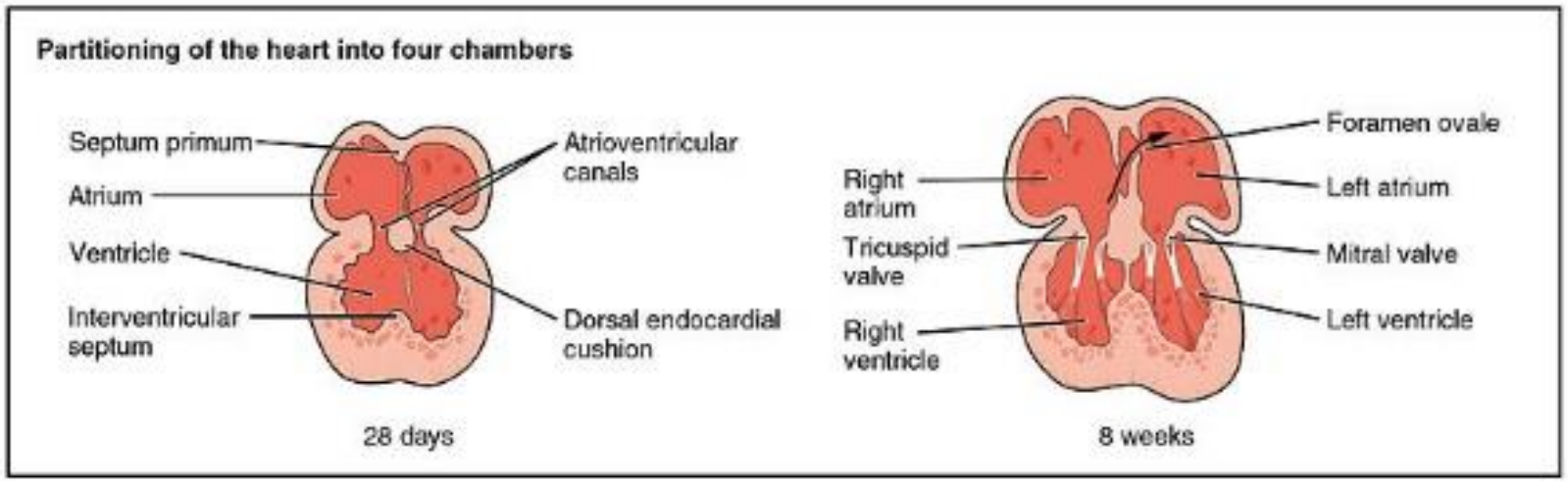

Atrial
musculature
Ventricular
musculature

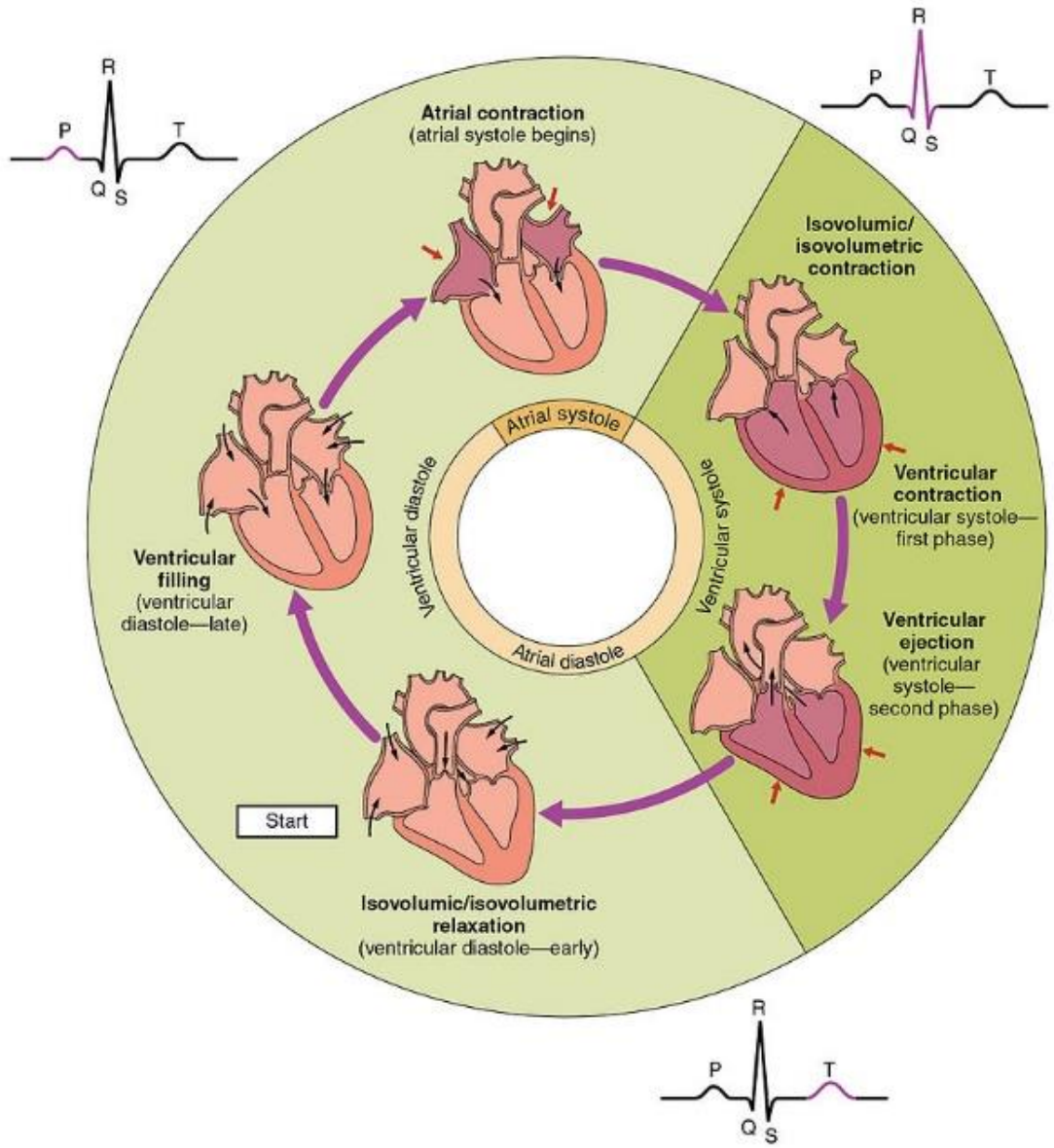
- The pericardium surrounds the heart. It consists of two membranes: an inner serous membrane called the epicardium, and an outer fibrous membrane.
- Blood vessels and nerves reach the cardiac muscle from the epicardium. These help influence the heart rate.
- These enclose the pericardial cavity which contains the pericardial fluid that lubricates the surface of the heart.


Superior vena cava
Aorta
Right atrium
Right coronary artery
Posterior descending artery
Right marginal artery
Right ventricle
Left pulmonary artery
Left pulmonary veins
Left coronary artery
Left circumflex artery
Left marginal artery
Left anterior descending (or interventricular) artery
diagonal branch
Left ventricle

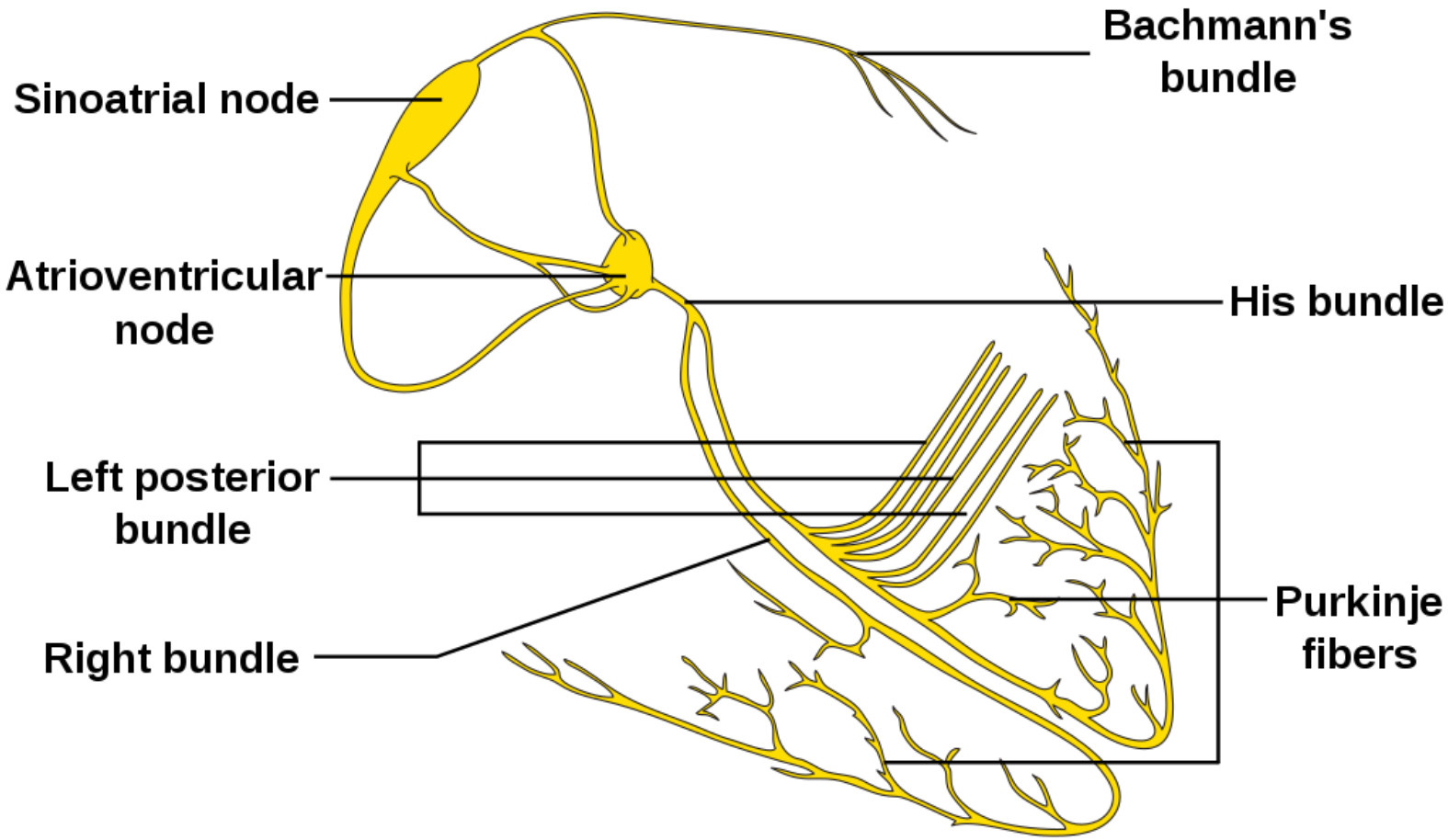

Vagus nerve
(parasympathetic)
decreases heart rate.
Sympathetic cardiac nerves
increase heart rate and
force of contraction.

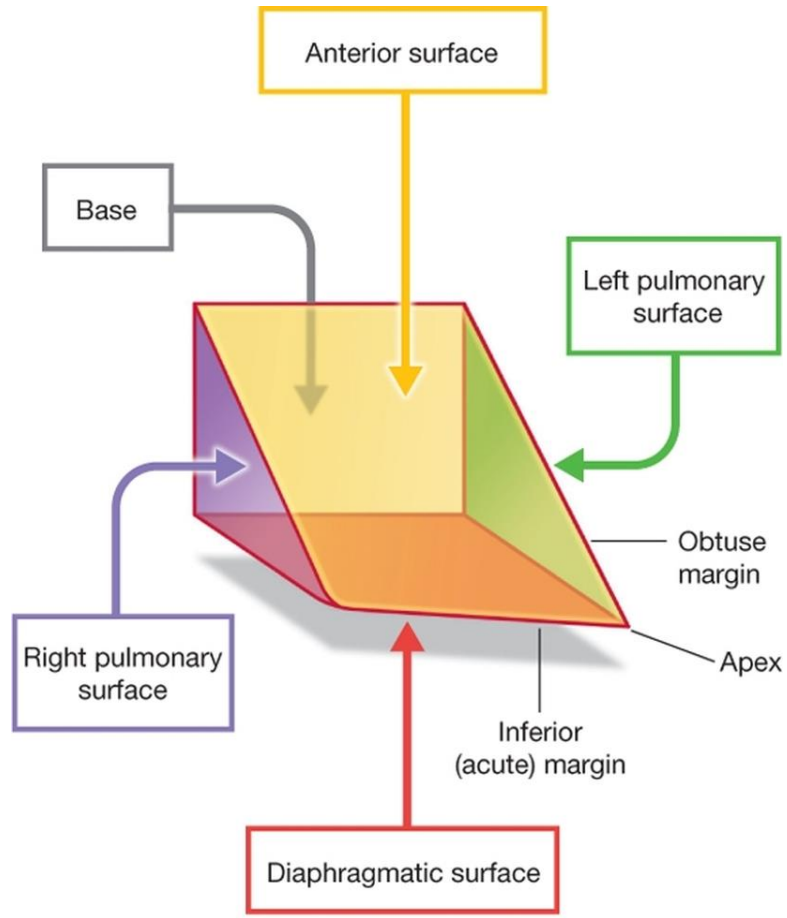

Development of the heart
Head
Cardiogenic area
Primitive blood vessels
Tail
18 days
Blood flow
Endocardial tubes
20 days
Fusion into primitive heart tube
21 days
Truncus arteriosus
Bulbus cordis
Primitive ventricle
Primitive atrium
22 days
Truncus arteriosus
Bulbus cordis
Ventricle
Atrium
Sinus venosus
23 days
Ventricle
Atrium
Sinus venosus
24 days
Aortic arch arteries
Right atrium
Truncus arteriosus
Left atrium
Ventricle
35 days


Partitioning of the heart into four chambers
Septum primum
Atrium
Ventricle
Interventricular septum
Atrioventricular canals
Dorsal endocardial cushion
28 days
Foramen ovale
Right atrium
Left atrium
Tricuspid valve
Mitral valve
Right ventricle
Left ventricle
8 weeks


R
P
T
Q
S
Atrial contraction
(atrial systole begins)
Isovolumic/
isovolumetric
contraction
Ventricular
contraction
(ventricular systole—
first phase)
Ventricular
ejection
(ventricular
systole—
second phase)
Isovolumic/isovolumetric
relaxation
(ventricular diastole—early)
Ventricular
filling
(ventricular
diastole—late)
Start
Atrial systole
Ventricular diastole
Ventricular systole
Atrial diastole

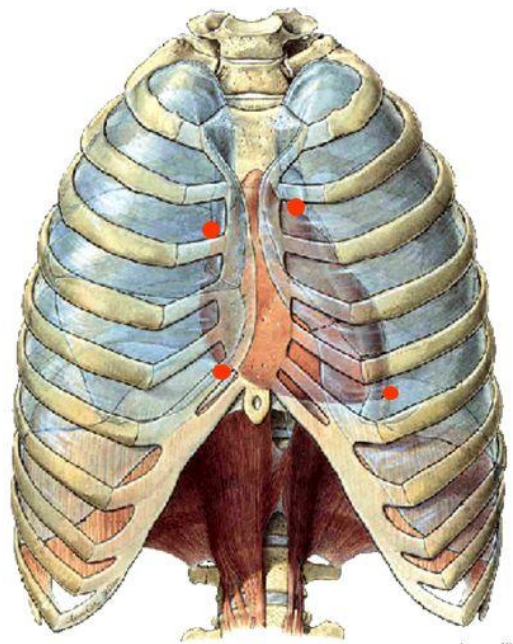
- The sinus rhythm, is established by the sinoatrial node, the heart's pacemaker.
- The sinoatrial node is found in the upper part of the right atrium near to the junction with the superior vena cava.
- It travels to the left atrium via Bachmann's bundle, such that the muscles of the left and right atria contract together.
- The signal then travels to the atrioventricular node. This is found at the bottom of the right atrium in the atrioventricular septum ventricle.
- The septum is part of the cardiac skeleton, tissue within the heart that the electrical signal cannot pass through, which forces the signal to pass through the atrioventricular node only.
- The signal then travels along the bundle of His to left and right bundle branches through to the ventricles of the heart. In the ventricles the signal is carried by specialized tissue called the Purkinje fibers


Bachmann's bundle
Sinoatrial node
Atrioventricular node
His bundle
Left posterior bundle
Right bundle
Purkinje fibers


Anterior surface
Base
Left pulmonary surface
Obtuse margin
Apex
Right pulmonary surface
Inferior (acute) margin
Diaphragmatic surface

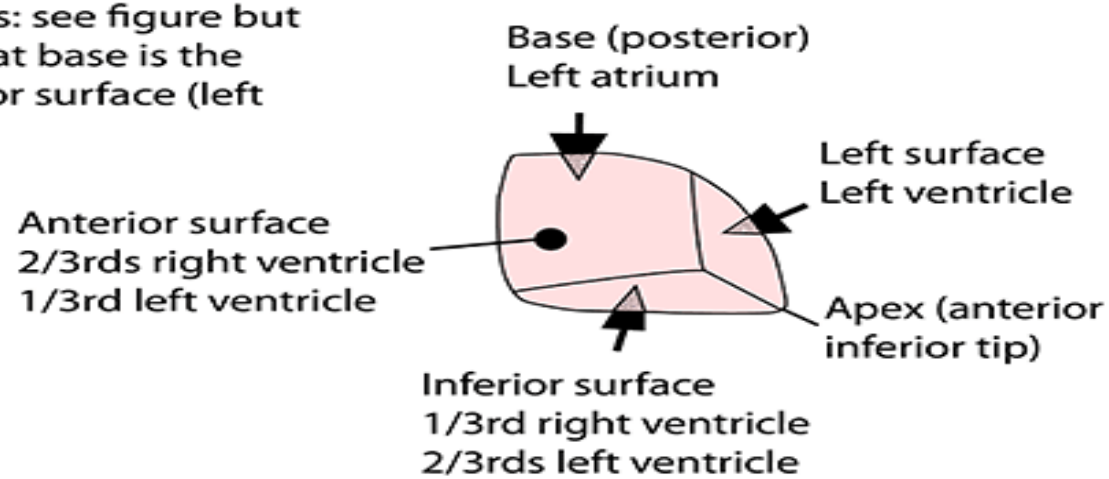
Surface markings of heart

- **R. superior point** - lies on the upper border of right third costal cartilage ±1.2cm from the margin of sternum
- **R. inferior point** - lies on the sixth sternocostal joint
- **L. superior point** - lies on lower border of left second costal cartilage ±1.2cm from sternal margin
- **Cardiac apex** - in the fifth left intercostal space 7~9cm from the midline

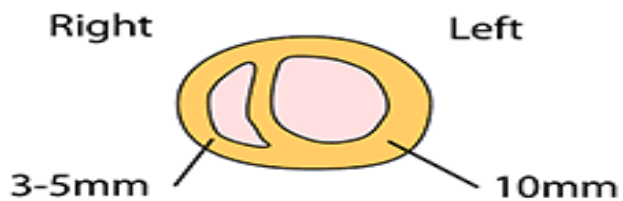


HEART - SURFACES & SEPTUM

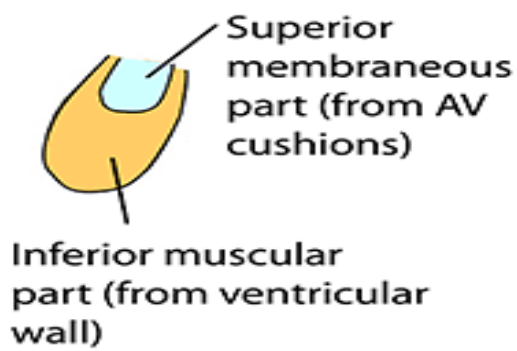
- Midline in middle mediastinum
- Valved muscular pump
- Size of a fist - 300g
- Cone shaped
- Surfaces: see figure but note that base is the posterior surface (left atrium)



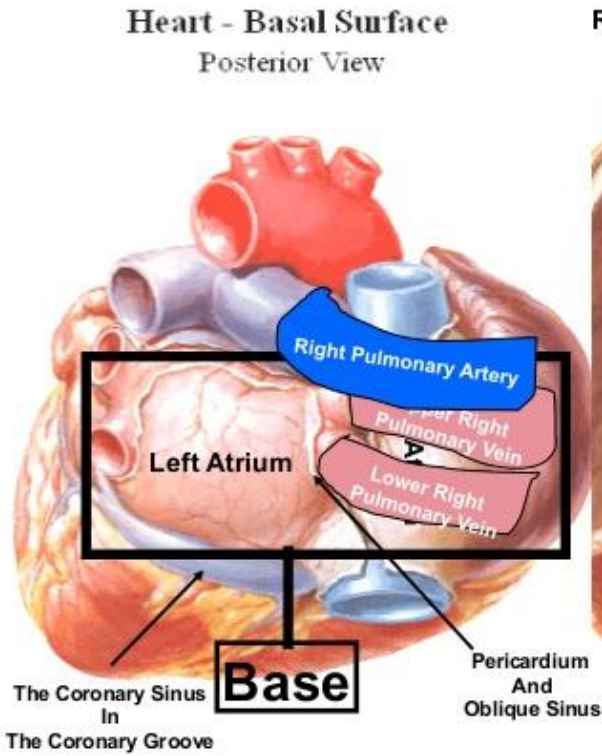
INTERVENTRICULAR SEPTUM

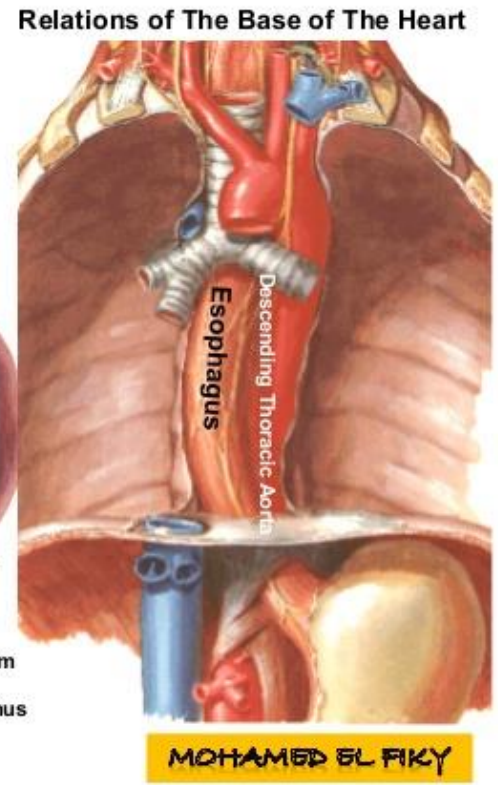


- Bulges to right
- Lies vertically
- In coronal plane
- Attaches to AV rings

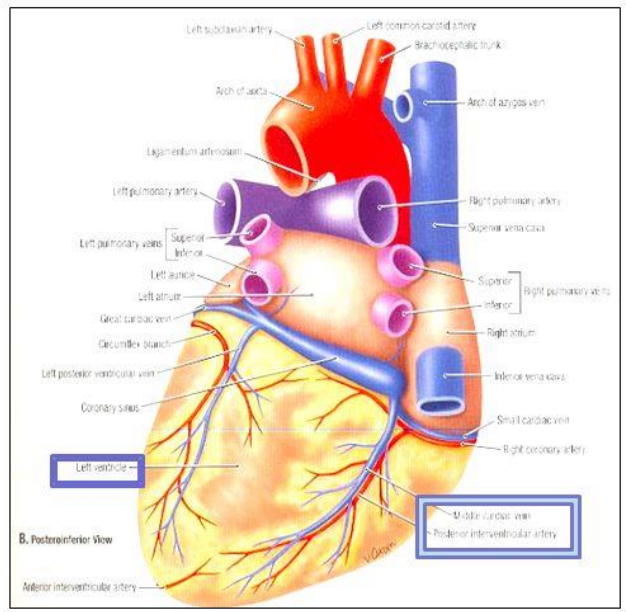


2- The Base The Heart

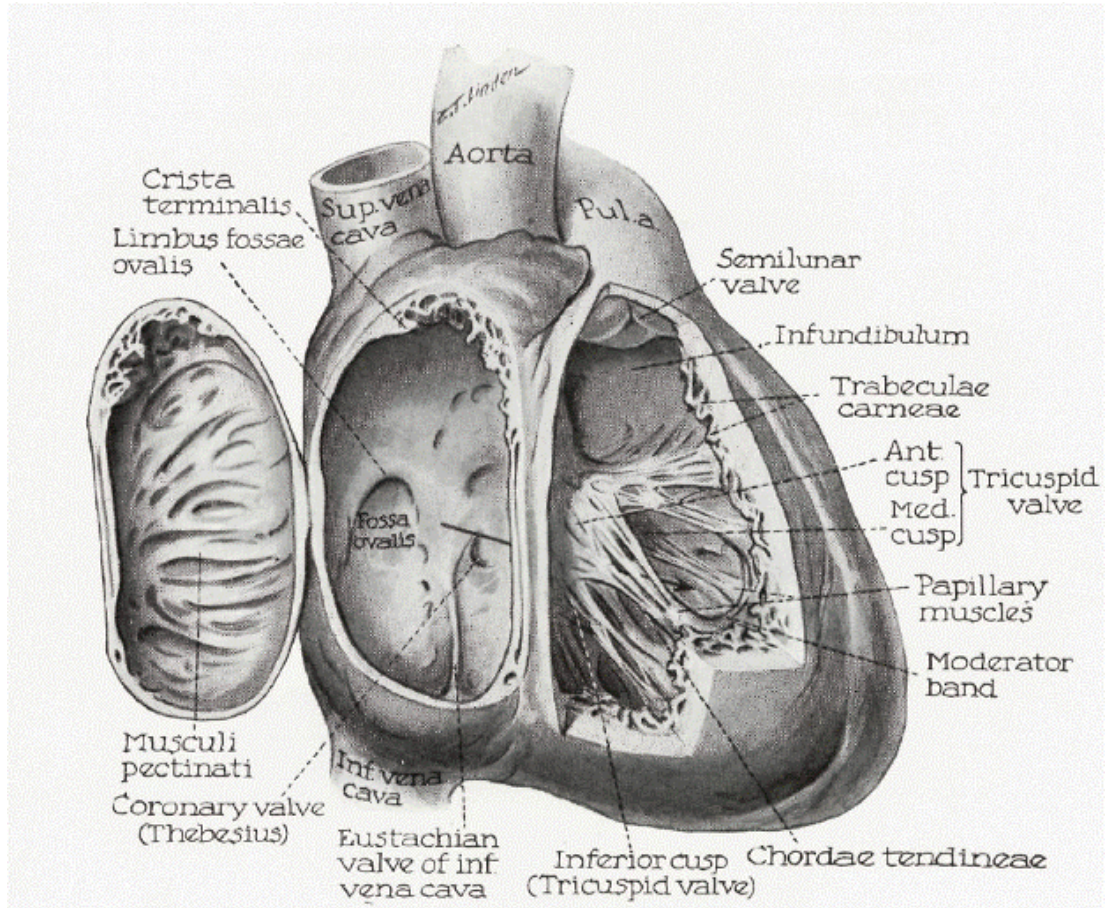




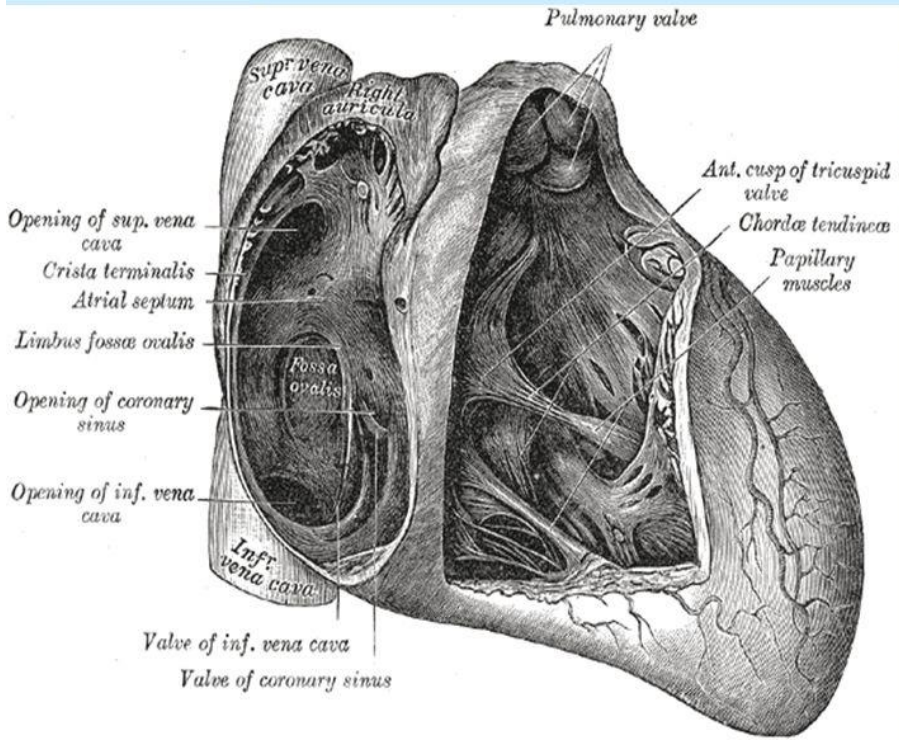
Diaphragmatic (Inferior)surface



- Formed by the 2-ventricles, mainly left ventricle (left 2/3).
- Slightly concave as it rests on diaphragm.
- Directed inferiorly & backward.
- Separated from base of heart by posterior part of coronary sulcus
- The 2-ventricles are separated by posterior interventricular groove <u>which lodges:</u>
  - Posterior interventricular artery
  - Middle cardiac vein


Aorta
Crista terminalis
Sup. vena cava
Pul. a.
Limbus fossae ovalis
Semilunar valve
Infundibulum
Trabeculae carneae
Ant. cusp
Med. cusp
Tricuspid valve
Fossa ovalis
Papillary muscles
Moderator band
Musculi pectinati
Inf. vena cava
Coronary valve (Thebesius)
Eustachian valve of inf. vena cava
Inferior cusp (Tricuspid valve)
Chordae tendineae

Right ventricle



- **inflow tracts**
- **outflow tracts**

(divided by the supraventricular crest)

- pulmonary val
- tricuspid valve
- chordae tendineae
- **papillary muscles(3 group**

CONGENITAL ANOMALIES OF HEART

INTERATRIAL SEPTAL DEFECTS (ASD)
- Secundum - surgical graft
- Primum - Difficult surgery. Often associated with VSD

INTERVENTRICULAR SEPTAL DEFECTS (VSD)
- Usually the upper fibrous part

TETRALOGY OF FALLOT
- Pulmonary stenosis
- Menbran ous interventricular septal defect
- Over-riding aorta (astride the two ventricles)
- Right ventricular hypertrophy

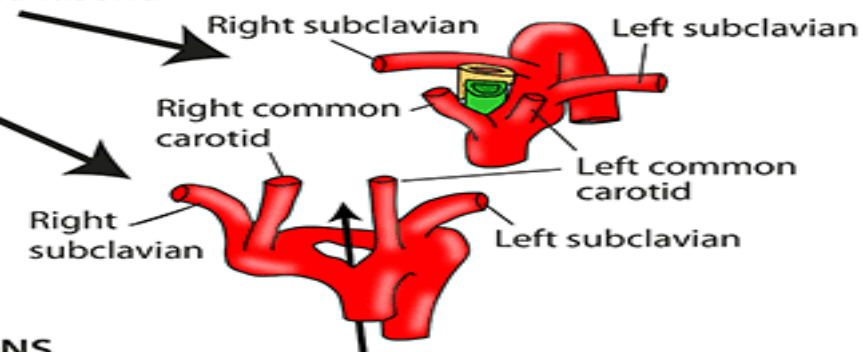
PATENT DUCTUS ARTERIOSUS

CO-ARCTATION OF AORTA
- Hypoplasia of 4th arch with post-stenotic dilatation and notching of ribs. Decreased pulse in left arm and below diaphragm

PERSISTENT RIGHT DORSAL AORTA

RETRO-OESOPHAGEAL RIGHT SUBCLAVIAN ARTERY
- Gives dysphagia lusoria

DOUBLE AORTIC ARCH
- Vascular ring enclosing trachea & oesophagus



CYANOTIC CONDITIONS
- Persistent truncus with VSD
- Transposition of aorta with patent ductus and VSD
- Fallot's tetralogy
- Pumonary atresia with patent ductus
- Tricuspid atresia with ASD

ACYANOTIC CONDITIONS
- Primary/secondary ASD
- Membranous/muscular VSD
- Patent ductus