

Cardiothoracic & Vascular Surgery

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ANATOMY OF THE HEART

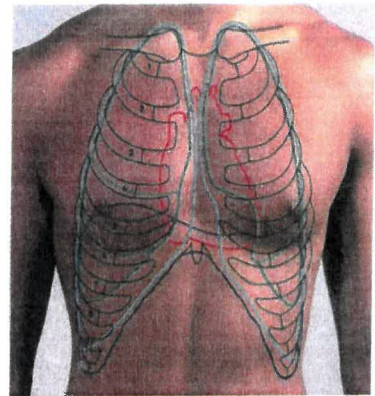
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General anatomy

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Surface marking :

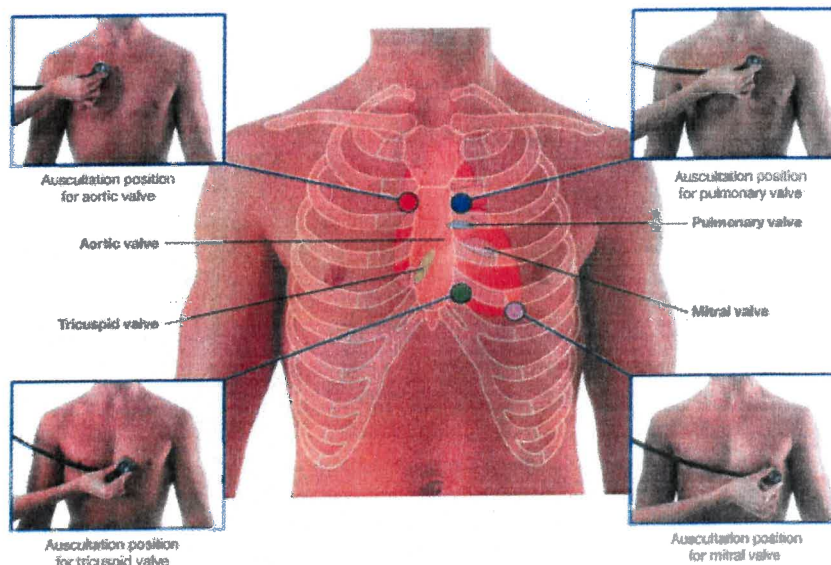
- Extends from 2nd to 5th intercostal spaces.
- Right heart border corresponds to the right sternal border.
- Left heart border corresponds to the apex, located in left 5th ICS in the midclavicular line.



Surface marking

Cardiac valves, positions and auscultatory areas :

- Aortic valve : Right 2nd ICS.
- Pulmonary valve : Left 2nd ICS.
- Tricuspid valve : Left lower sternal border.
- Mitral valve : Left 5th ICS (Apex).



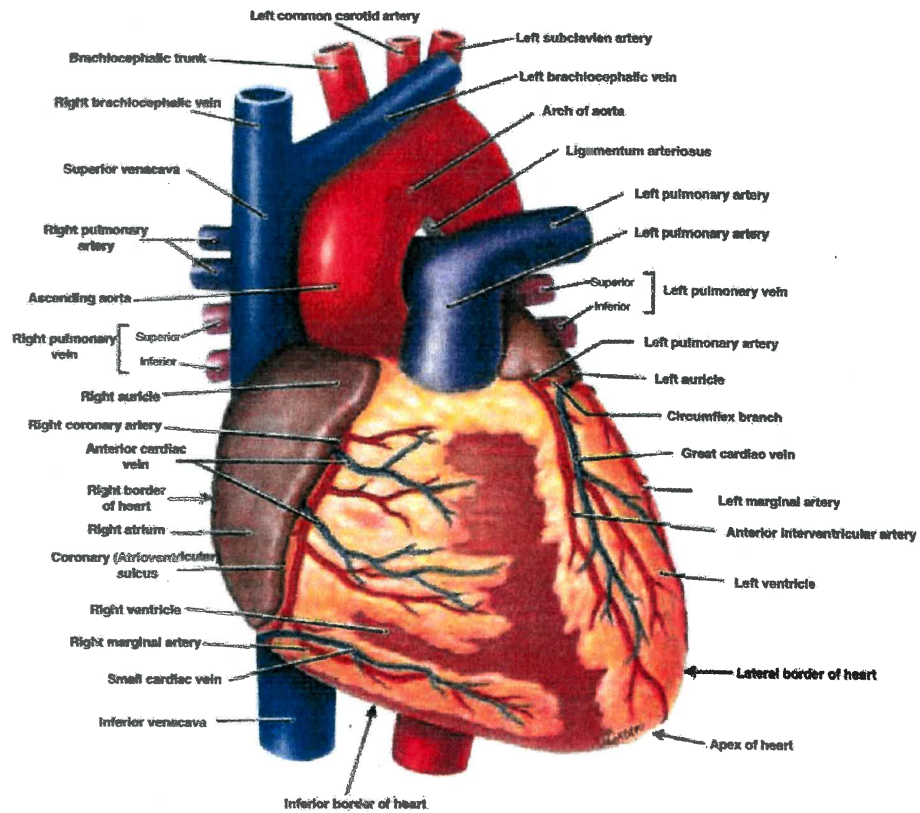
Auscultation

Heart- gross view of surfaces and structures :

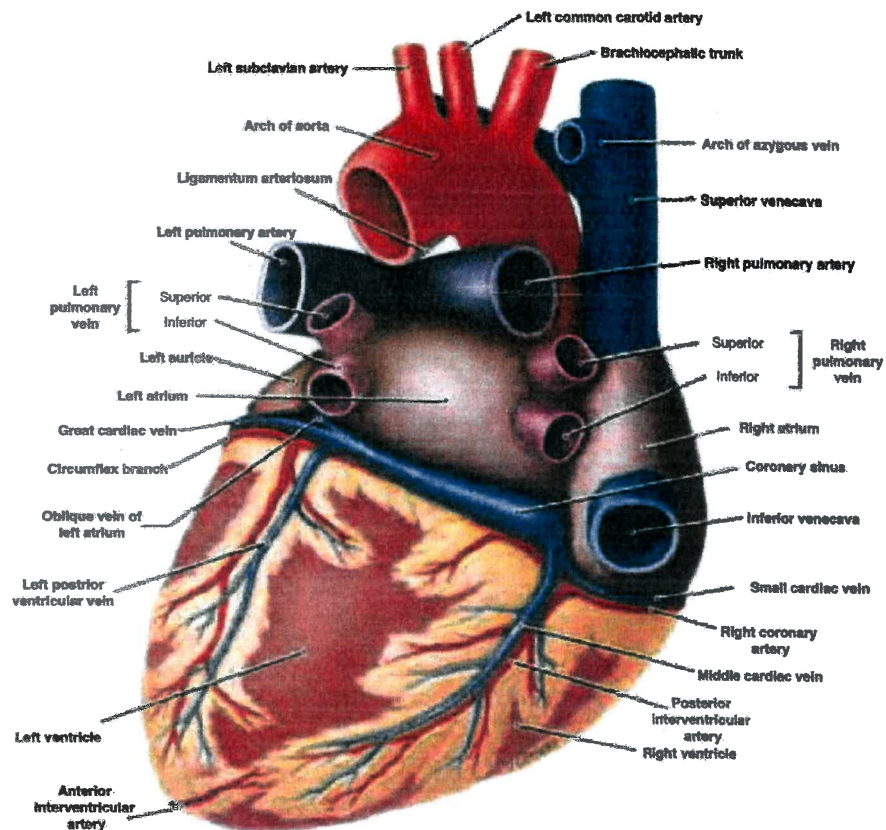
- RA, LA and pulmonary artery : Anterior structures.
- RV, LV and aorta : Posterior structures.

Pulmonary artery → Left and anterior, aorta → Right and posterior.

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Heart : Anterior surface

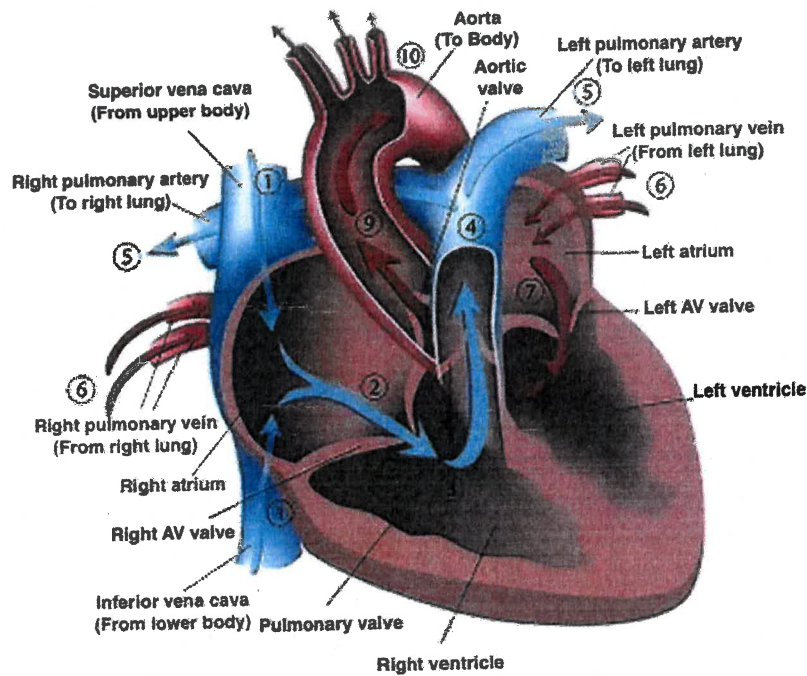


Heart : Posterior surface

Pathway of blood flow through the heart :

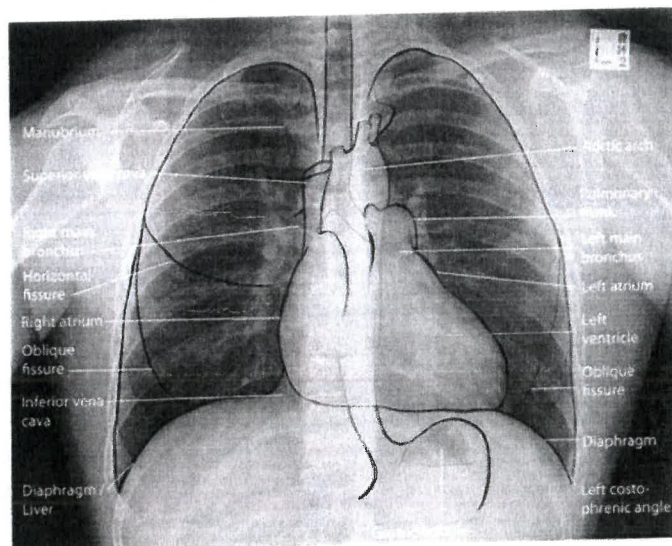
Blood from SVC & IVC → RA → RV → Right & left PA (Deoxygenated blood) →
 Right & left lungs → Right & left PV (Oxygenated blood) → LA → LV → Aorta →
 Supplied to all systems.

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Heart : Blood flow pathway

Structures seen in chest x-ray :



Chest X-ray

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Borders and surfaces of heart :

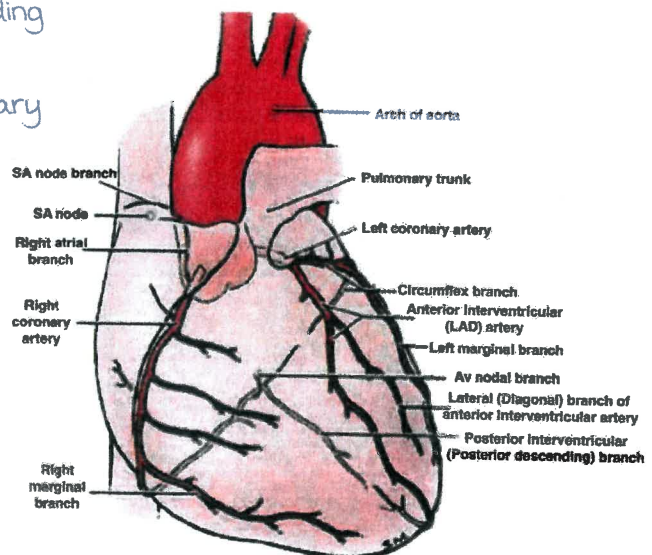
Border	Formed by
Superior	• Aorta • Pulmonary artery
Inferior	• Right ventricle • Left ventricle
Right	• Right atrium
Left	• Pulmonary trunk • Left atrial appendage • Left ventricle
Surface	Formed by
Anterior/sternocostal	• Right ventricle
Inferior/diaphragmatic	• Right ventricle • Left ventricle
Posterior	• Left atrium
Right pulmonary	• Right atrium
Left pulmonary	• Left atrium • Left ventricle

Blood supply of heart

00:08:50

Arterial supply :**Left coronary artery :**

- Arises from left coronary sinus at base of aorta.
- Has a variable length : 2-20 mm.
- Divides into :
 - Left anterior descending artery.
 - Left circumflex coronary artery.

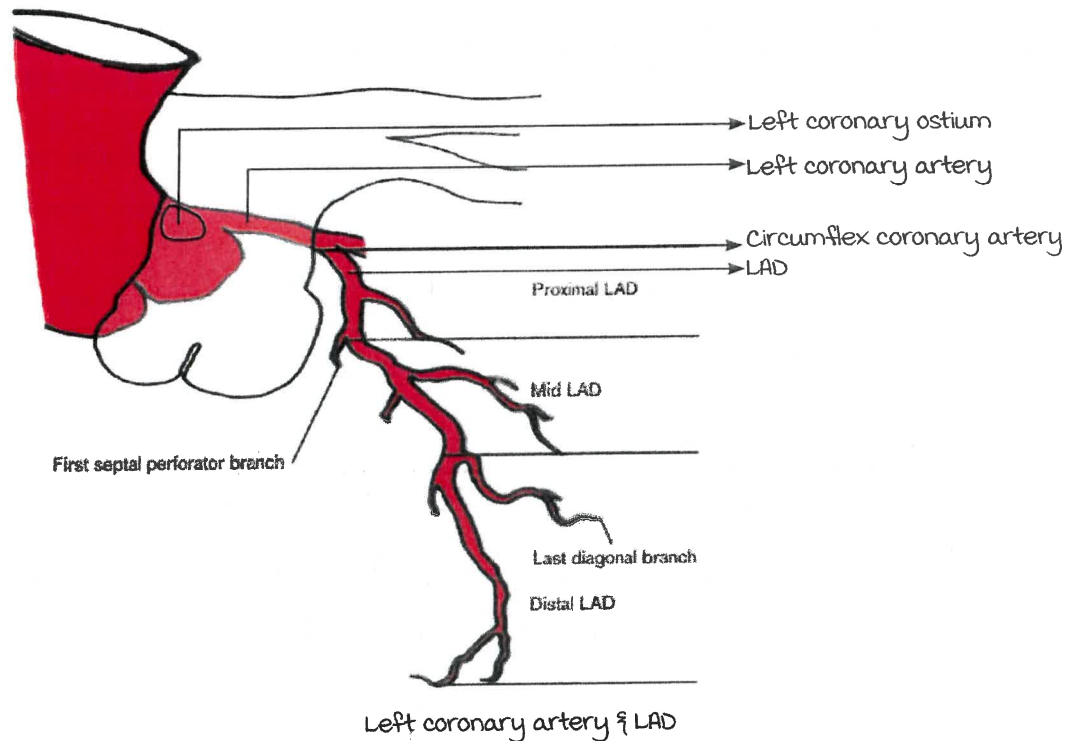


Coronary arteries : Anterior view

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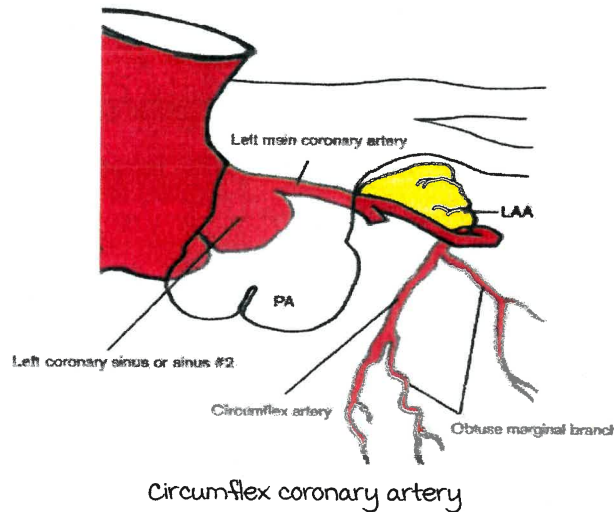
Left anterior descending artery (LAD) :

- LAD descends into the **anterior interventricular groove**.
- During descent, it gives various branches :
 - Septal perforator branches (Perpendicular to the LAD).
 - Diagonal arteries (Surface branches).
- Supplies 55% of the myocardium.
- 1st septal perforator lies in very close relation with the sub pulmonary infundibulum → Great surgical significance : During harvesting of pulmonary root, there is chance of injury to this branch.
- LAD is divided into :
 - Proximal : From the origin to LAD to the 1st septal perforator.
 - mid : From the 1st septal perforator to the last main diagonal branch
 - Distal : After the last diagonal branch till the termination of LAD.

**Left circumflex coronary artery :**

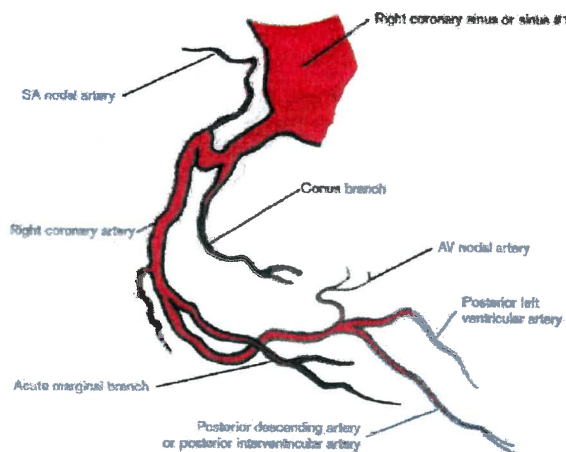
- It goes b/w the pulmonary trunk and left atrial appendage and posteriorly into the **atrioventricular groove**.
- Branches : Obtuse marginal arteries, given to the lateral and posterior surface of the heart.

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Right coronary artery :

- Arises from right coronary sinus.
- Comes down in the **right atrioventricular groove**.
- Gives acute marginal branches and SA nodal artery.
- At inferior surface of heart, can give a branch to AV node and terminates into 2 branches :
 - Posterior left ventricular artery.
 - Posterior descending artery : Travels into **posterior interventricular groove**.



Note :

1. SA nodal artery arises from :
 - Right coronary artery in 55-65% of persons.
 - Circumflex coronary artery in 35-45% of persons.
2. AV nodal artery : Arises from RCA in 85-90% of persons.
3. Accessory AV nodal artery (**Kugels artery**) arises from :
 - Right coronary artery or circumflex coronary artery in 40% of persons.
 - Circumflex coronary artery in 10-15% of patients.

Summary of branches of coronary arteries :

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Artery	Branches
Left main coronary artery	• LAD • Left circumflex coronary artery • Ramus intermedius
Left anterior descending	• Diagonals • Septal perforators
Left circumflex coronary	• Obtuse marginals • Left posterolateral branch
Right coronary	• Acute marginal artery • Posterior descending artery • Right posterolateral artery • SA nodal artery • AV nodal artery • Conal artery
Conal artery : Can have communication with LAD, in cases of thrombotic occlusion, the LAD can get flow distally from this branch → Loop of Vieussens	

Coronary veins :

Great cardiac vein :

- Accompanies LAD and left circumflex arteries.
- Communicates with middle cardiac vein.
- Joined by oblique vein of LA & forms coronary sinus, opens into RA.
- At opening of coronary sinus : Thebesian valve.

middle cardiac vein :

Accompanied by posterior descending artery.
Seen in interventricular groove.

Small cardiac vein :

It runs in the right AV groove, accompanies RCA and acute marginal artery.

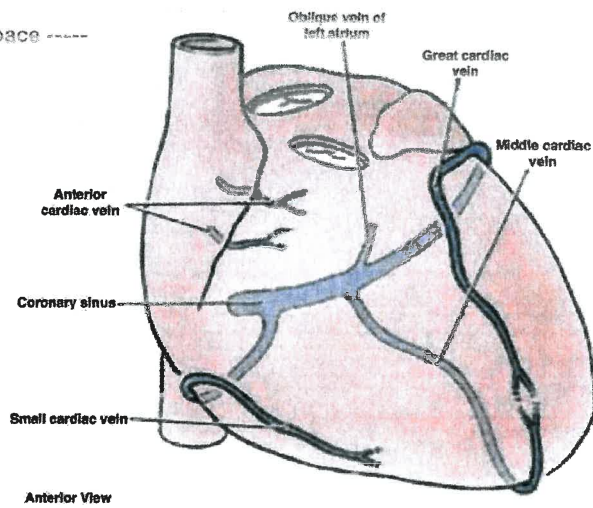
multiple small veins :

- Anterior cardiac veins, Thebesian veins open directly into the RA.
- Some other veins open directly to RV.

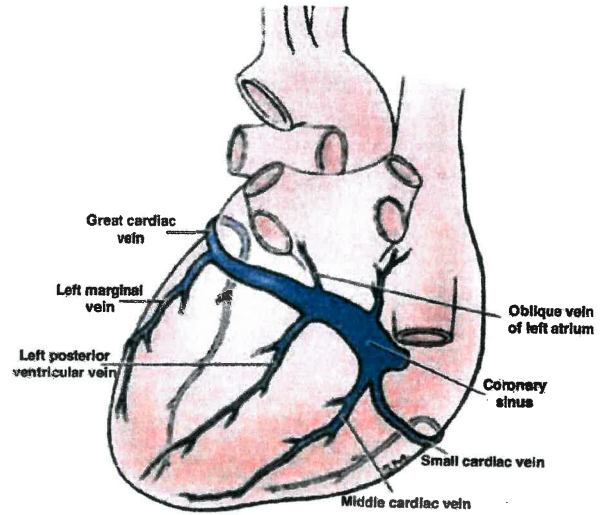
venous drainage :

Coronary vein	Anatomical location	Accompanied by
Coronary sinus	Left atrioventricular groove	• Circumflex artery
Great cardiac vein	Anterior interventricular groove into left atrioventricular groove	• LAD • Circumflex artery
middle cardiac vein	Posterior interventricular groove	• Posterior descending artery
Small cardiac vein	Right atrioventricular groove	• Right coronary artery • Acute marginal artery

----- Active space -----



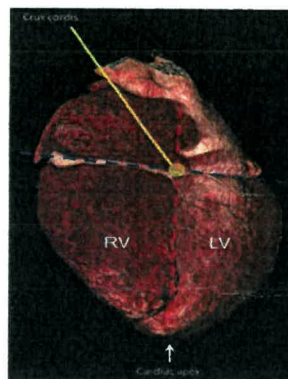
Coronary veins on anterior surface



Coronary veins on posterior surface

Dominance :

- Depends on origin of posterior descending artery.
 - Supply crux of heart.
- Right dominance : 90%.
- Left dominance : 10%.
- Co-dominance can be present in some cases.



Codominance

Right atrium

00:27:25

Features :

- Smooth and rough portions.
- Crista terminalis : Border between smooth and rough surfaces.
- Right atrial appendage : Broad and triangular.
- Sulcus terminalis : Corresponding portion of crista terminalis on the outside.
- IVC valve : Eustachian valve.
- Tendon of Todaro : Fibrous extension of Eustachian valve.

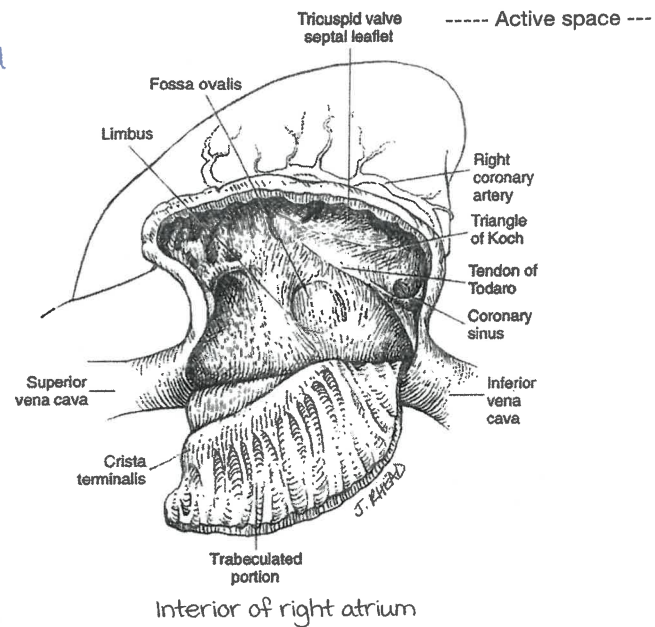
Triangle of Koch :

Border : Tendon of Todaro, septal leaflet of tricuspid valve and coronary sinus.

- Contains AV node.
- AV bundle formed at apex of triangle of Koch.

Note :

- Left atrial appendage : Tube like or finger like, only trabeculated portion of LA.
- No crista terminalis in left atrium.



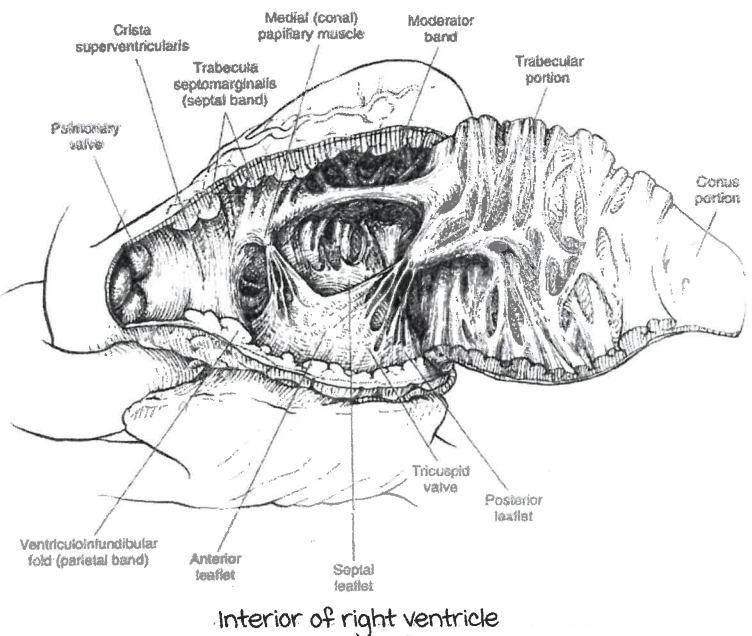
Right ventricle

00:33:13

- Thinner than LV, cut section crescentic in shape.
- Trabeculations : Coarse and big in RV (Smooth & fine in LV).
- Tricuspid valve : 3 leaflets.
 - Septal, anterior, posterior
 - Attached to respective papillary muscles.
- RV wall contain 2 layers of muscle.

3 papillary muscles :

- Anterior (Largest).
- Septal (medial) → muscle of Lancisi/Lushka.
- Posterior (Smallest).



moderator band

Thick muscular band in RV.

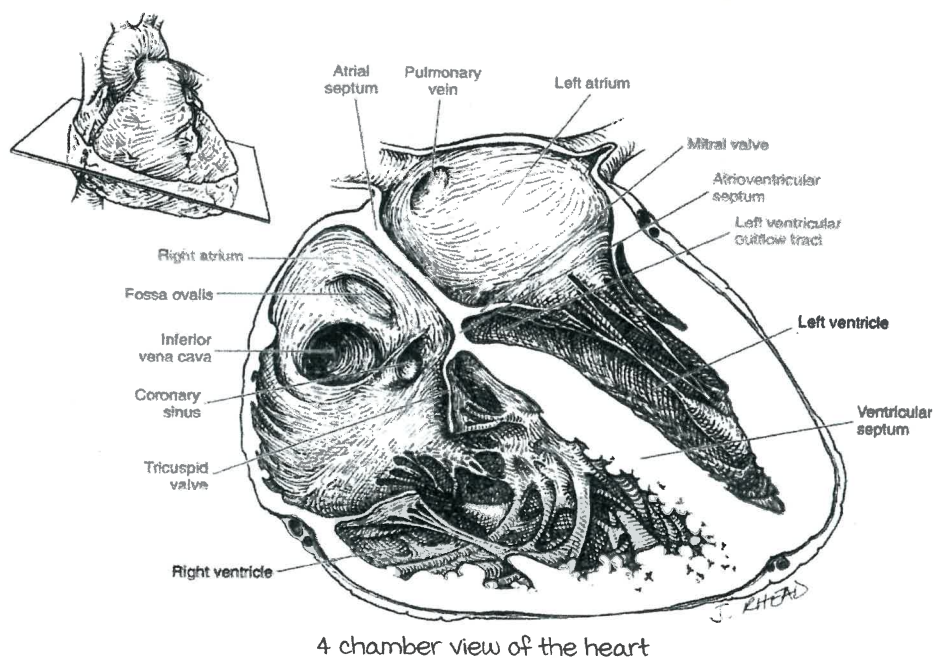
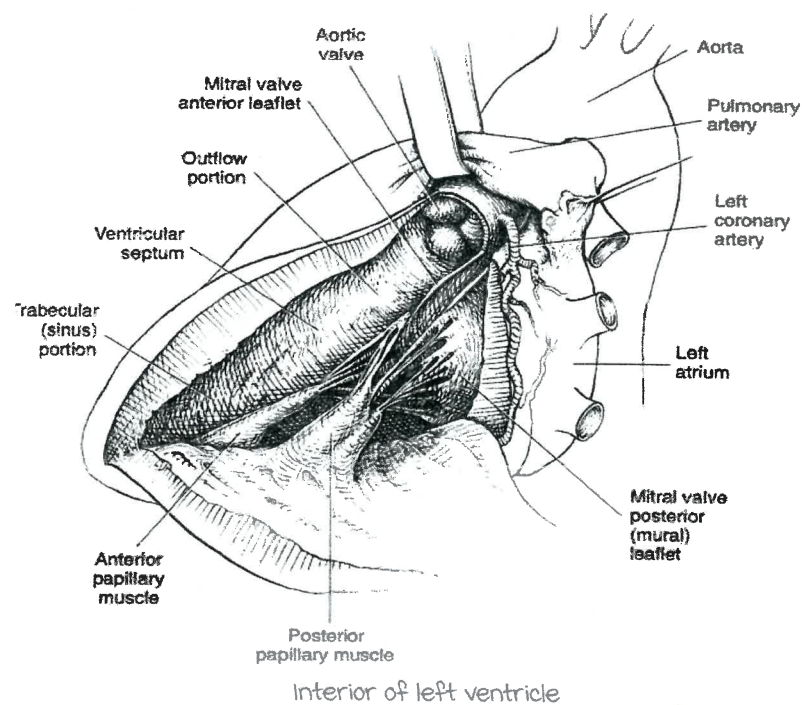
- Gives insertion to anterior papillary muscle.
- Contains right bundle branch.

----- Active space -----

Left ventricle

00:37:10

- Cut section circular in shape.
- 2 papillary muscles.
 - Anterior and posterior
 - Attached to free wall of ventricle
- Trabeculations small and fine in LV.
- LV wall contain 3 layers of muscles.



Conduction bundle

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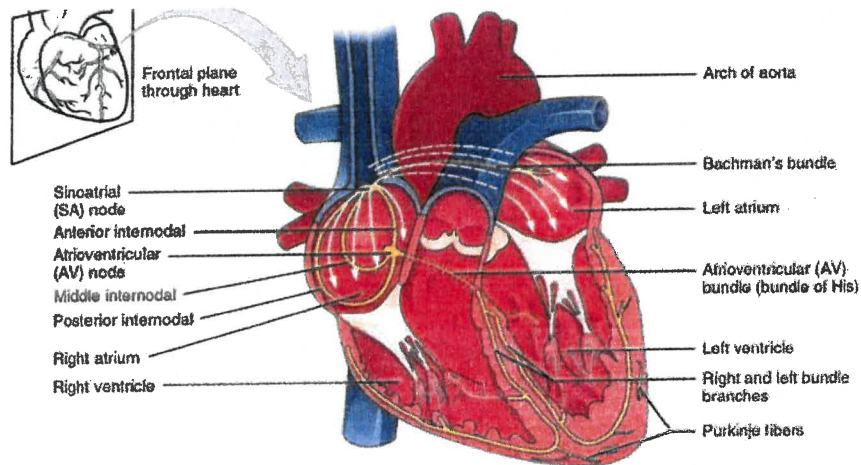
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SA node	AV node
- Natural pacemaker of the heart - Lateral to junction of SVC with right atrium - Subepicardial location	- Located between junction of RA and RV, in triangle of Koch - Subendocardial in location

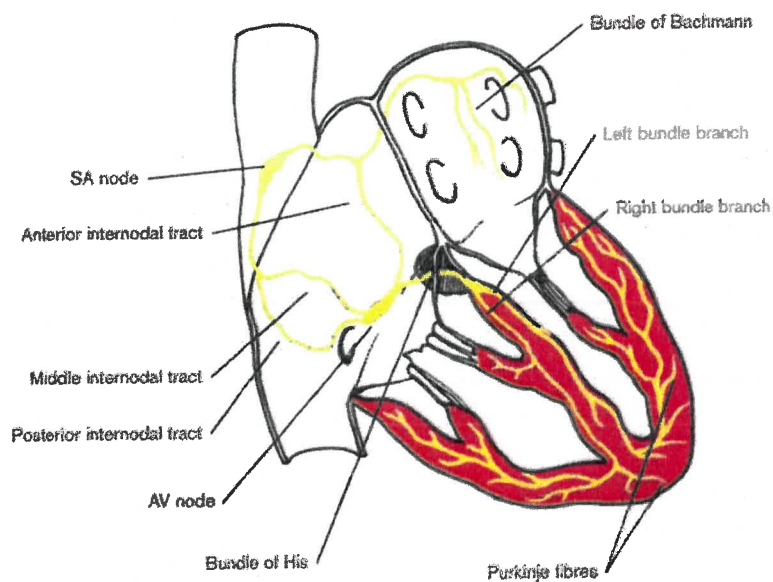
- From RA to LA : Interatrial tract → Bachman's bundle.
- SA node → Internodal branches → AV node → AV bundle/bundle of his → Left and right (In moderator band) bundle branch → Purkinje fiber → muscle fibers.

Note :

During VSD closure injury to AV bundle complete heart block



Conduction bundle



Conduction bundle

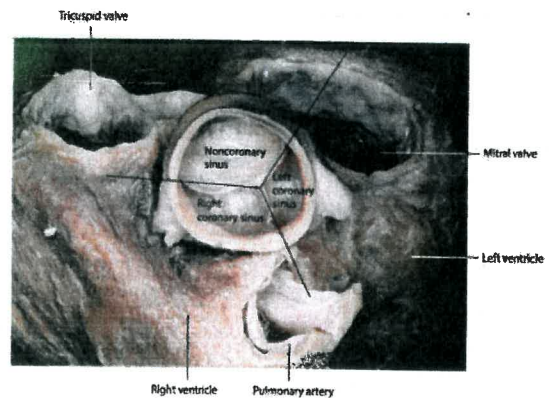
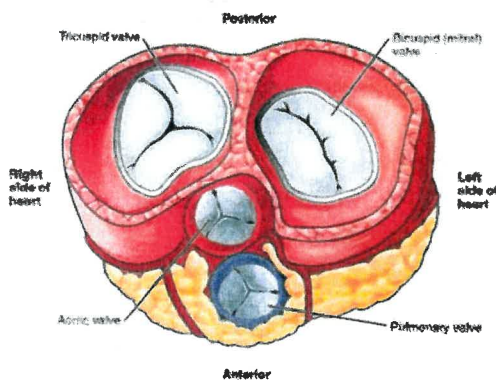
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Valves

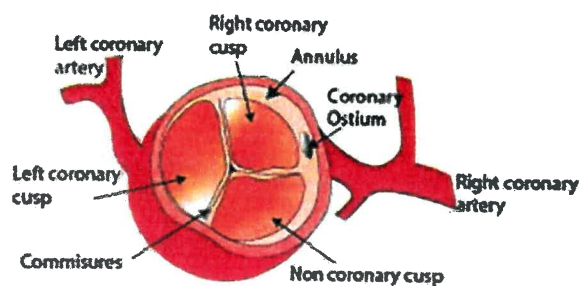
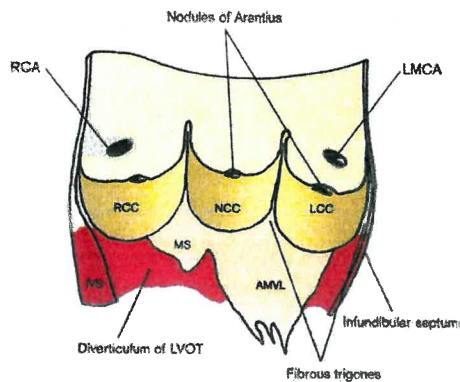
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Aortic valve :

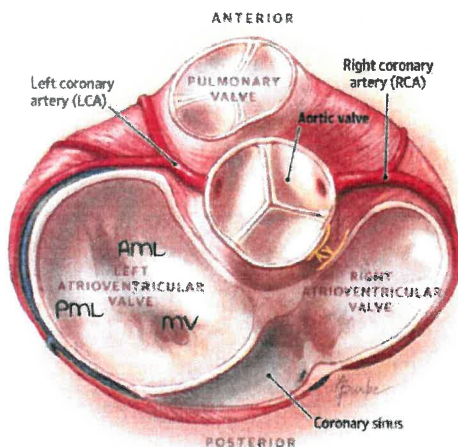
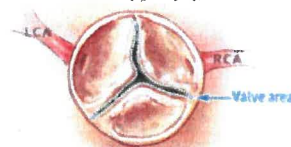
- 3 cusp/sinus : Left coronary cusp, right coronary cusp, non coronary cusp.
 - Commissure in between left & non coronary sinus : Related to mv.
 - Commissure between left & right coronary sinus : Related to PV and passage of AV bundle (Surgical importance)



Conduction bundle



Aortic valve : Cusps and commissures

Degenerative calcific aortic stenosis (elderly [>70 yrs])

Rheumatic aortic stenosis (young and middle-aged adults)



Bicuspid aortic stenosis (young and middle-aged adults)



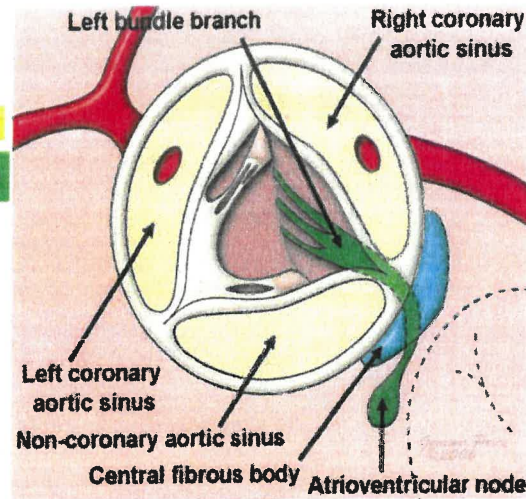
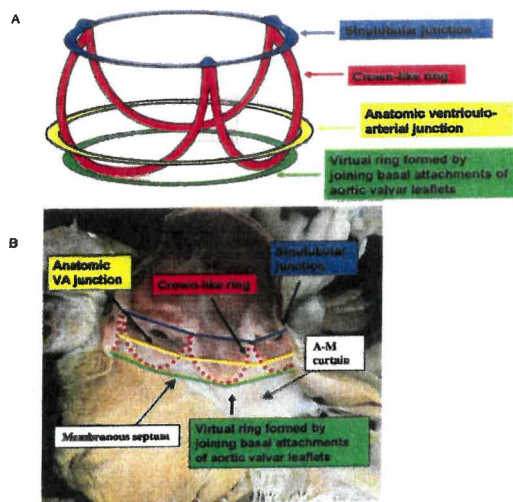
Unicuspid aortic stenosis (infants and children)



Aortic valve : Relation with vessels and involvement in various diseases

Left coronary and non coronary cusp : Aorto-mitral curtain.

----- Active space ----



mitral valve :

2 leaflets :

- Anterior/aortic/septal leaflet : $1/3^{\text{rd}}$ of anulus
- Posterior/mural/ventricular leaflet : $2/3^{\text{rd}}$ of anulus.

Limits of aortomitral curtain (Fibrous thickening)

→ Two trigones.

- Postero medial (Contain bundle of his) and antero lateral

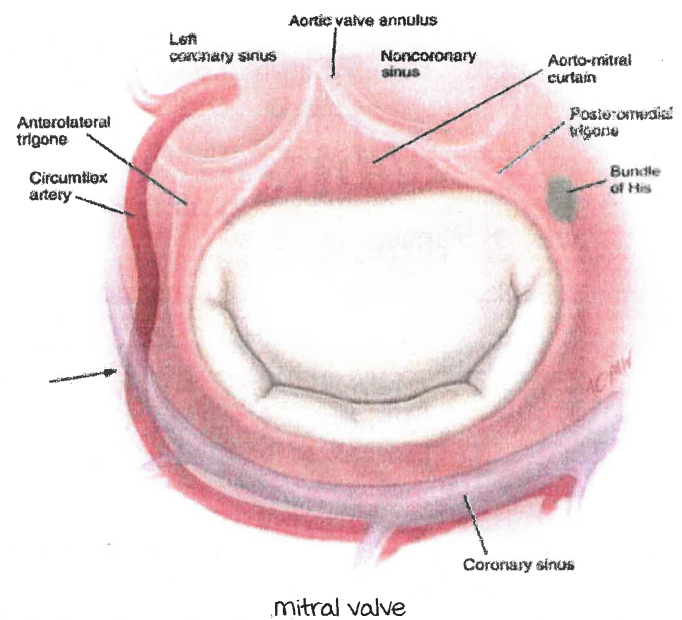
2 commissures : Posteromedial (Bundle of His) and anterolateral.

Chordae → 3 orders :

- First : At the leaflet tip.
- Second : A few mm away.
- Third : At base (Only PML).

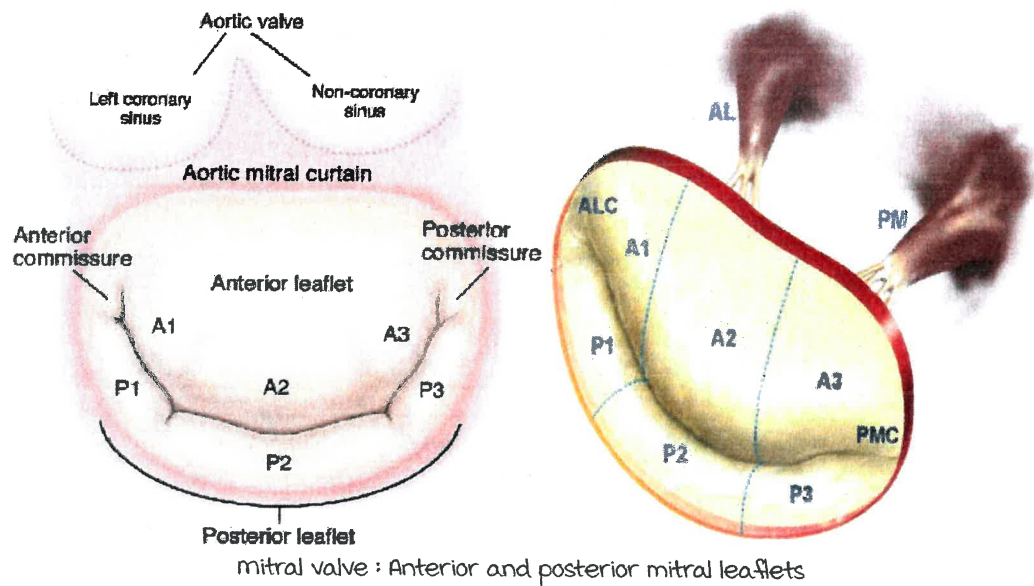
Relations :

- Coronary sinus : In relation with posterior mitral leaflet.
- Left circumflex artery : In relation with anterolateral commissure and trigon.
- Aorto-mitral curtain : Between left and non coronary sinuses.
- Bundle of His : Between right and non coronary sinuses, related to posteromedial commissure..



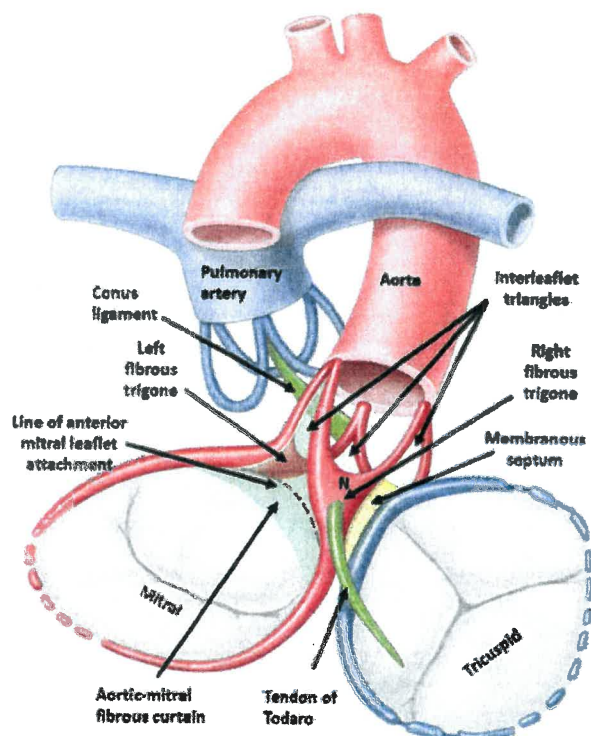
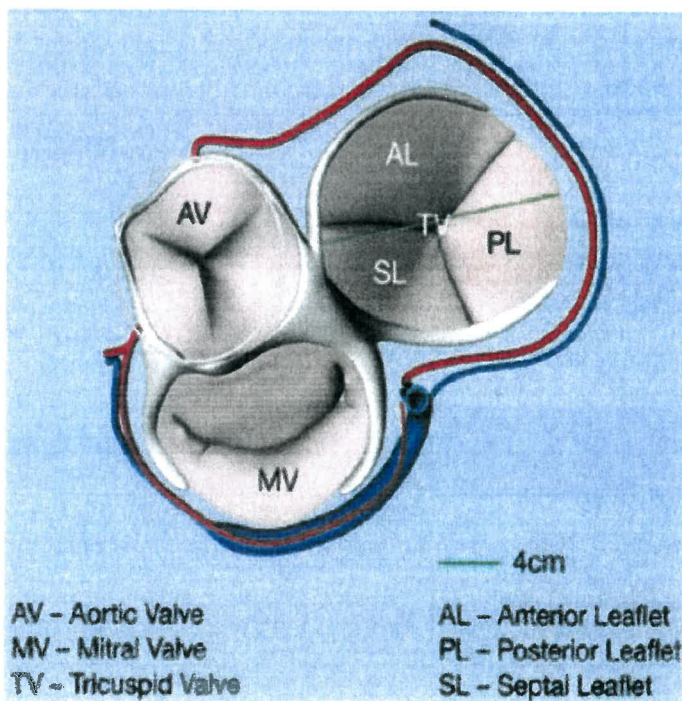
mitral valve

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Fibrous skeleton :

- Part of left coronary and non coronary of aortic valve.
- Anterior mitral leaflet of mitral valve.
- Septal leaflet of tricuspid valve.
- Pulmonary valve : Not involved.



Fibrous skeleton