Typical Ribs

- These ribs have common general features.
- For example: 3rd–9th ribs

Side Determination and Anatomical Position

Hold the rib in such a way that

1. Its anterior end has a concave depression and posterior end has a globular head.
2. Shaft is flat and convex outward.
3. Costal groove and sharp inferior border lie downward.

The convexity of the shaft is directed toward the side of the rib. Tilt the rib so that the posterior end lies at higher level than the anterior end.

Parts (Flowchart 2.4)

Each rib has three parts as follows (Figs 2.5, 2.6):*Viva*

1. Anterior end: It has a small cup-shaped depression.
2. Posterior end: It has head, neck, and tubercle.
3. Shaft: It is a middle flat, elongated, and curved part.

Features

Anterior end

- Anterior end has a small cup-shaped depression (socket) that articulates with corresponding costal cartilage to form a costochondral joint (primary cartilaginous joint).

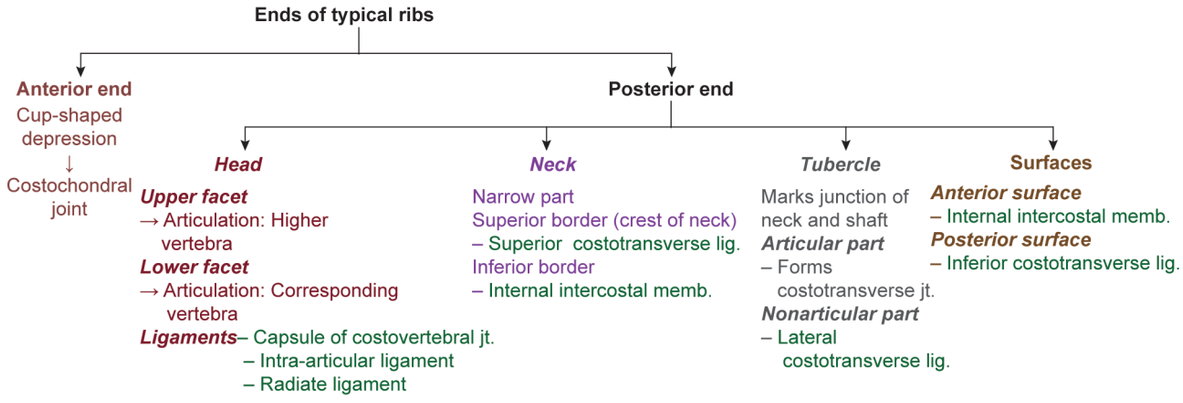
Posterior end

- Posterior end has head, neck, and tubercle.

Head

- It presents two articular facets as follows:
  - *Upper smaller* facet articulates with next higher vertebra.
  - *Lower larger facet* articulates with numerically corresponding vertebra.

Flowchart 2.4: Ends of typical rib



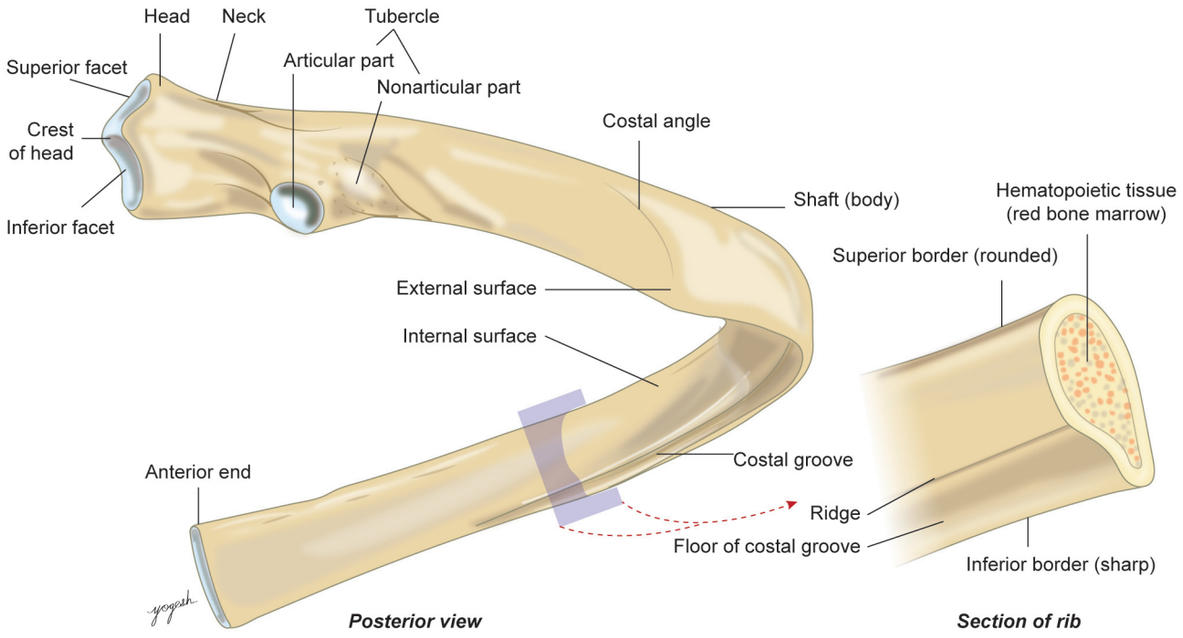


Fig. 2.5: Typical rib (right rib, posterior view and cross-section)

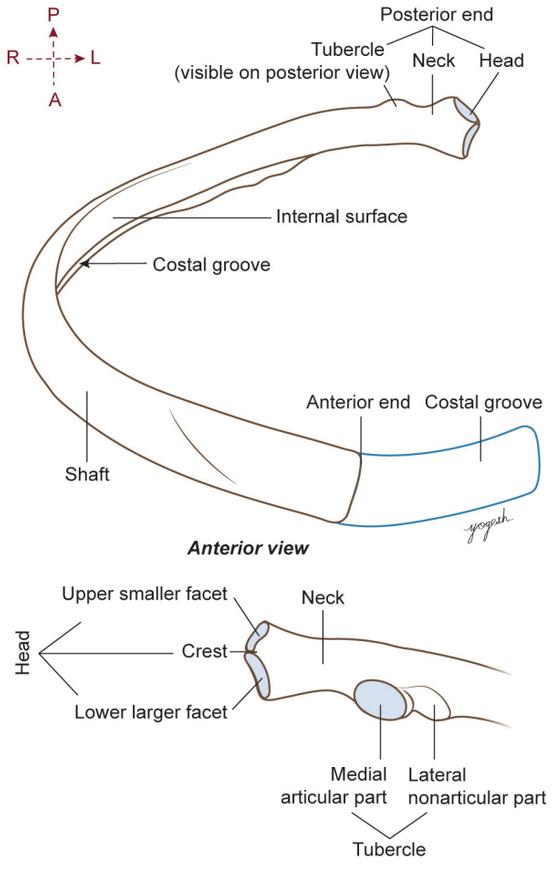


Fig. 2.6: Typical rib (right)

- *Crest of head*: It is the ridge that separates upper and lower facets of the head.
- *Attachments*
  1. Margin of facets of head gives attachment to *capsular ligament* of costovertebral joint.
  2. *Intra-articular ligament* connects crest of head with intervertebral disc.
  3. *Radiate ligament*: It connects head and neck with numerically corresponding vertebra and with vertebra above (Fig. 2.7).

Neck

- It is a narrow, flattened part of the rib.
- It lies in front of the transverse process of numerically corresponding vertebra.
- It has *two borders*
  - *Superior border*: It is sharp and called *crest of neck*.
  - *Inferior border*: It is smooth and rounded.
- It has *two surfaces*
  - Anterior surface: It is smooth.
  - Posterior surface: It is rough and pierced by numerous vascular foramina.
- *Attachments*
  1. *Inferior costotransverse ligament*: It connects the posterior surface of rib to the transverse process of corresponding vertebra.
  2. *Superior costotransverse ligament*: It has two laminae that connect superior border (crest of neck) with the transverse process of the vertebra above.
  3. *Internal/posterior intercostal membrane*: It is attached to the anterior surface of the neck and to the inferior border of the neck of the rib below the intercostal space.

Tubercle

- It is situated on the lateral part of posterior surface of the neck.
- It marks the junction of shaft and the neck.
- Tubercle is divisible into:
  1. Medial articular part: It has smaller *articular facet* that articulates with transverse process of corresponding

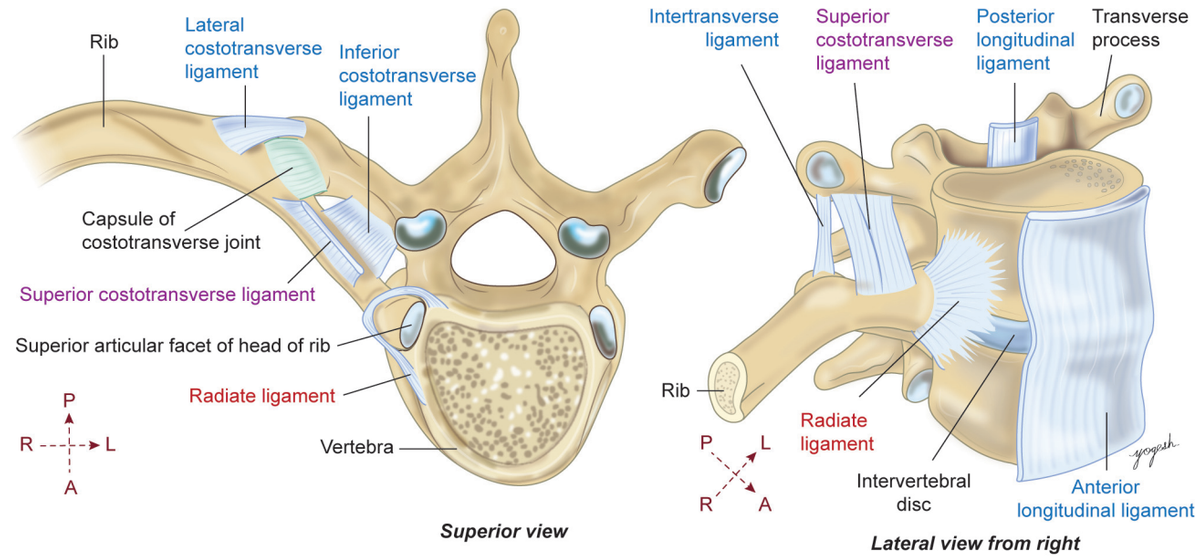


Fig. 2.7: Ligaments between vertebrae and rib (right typical rib and typical vertebrae)

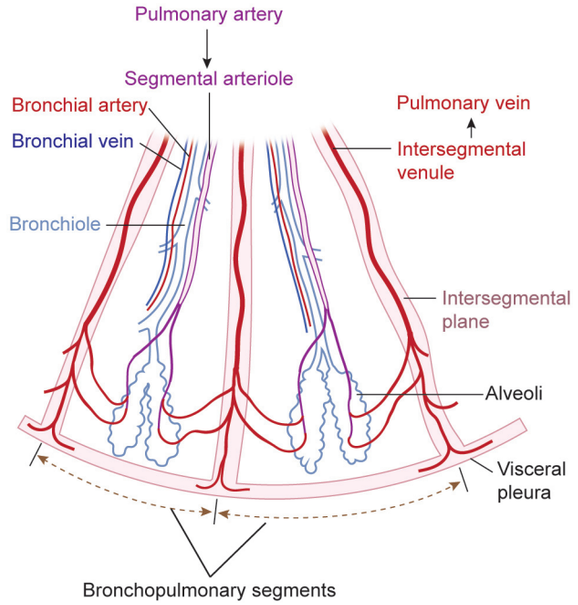


Fig. 9.9: Bronchopulmonary segment – conceptual schematic diagram

- Apex of each segment is directed toward the root of the lung and base is directed toward the surface of the lung.

Features of Bronchopulmonary Segment

- It is supplied by segmental (tertiary) bronchus.
- It is pyramidal or wedge-shaped.
- Its apex is directed toward the hilum of the lung.
- Its base is directed toward the surface of the lung.

Clinical Integration

- *Segmental involvement*:
  Apical segment of lower lobe and posterior segment of upper lobe are common sites of lung abscess.
  It is more common on the right, as aspirated material tends to go on the right bronchus (more vertical right principal bronchus).
- *Segmental resection of lung* (Fig. 9.10):
  As each bronchopulmonary segment is aerated by a single tertiary bronchiole and a branch of pulmonary artery, it can be surgically removed without affecting the adjacent segment.
  Segmental resection is required to remove localized lesion (tumor or tuberculosis lesion).
- *Mendelson's syndrome*: It is the aspiration of fluid or food mostly in unconscious patients. It involves mostly apical segment of the lower lobe and results in aspiration pneumonia (inflammatory infection of lung) (Fig. 9.11).
- *Segmental atelectasis*: It is the collapse of the bronchopulmonary segment due to blockage of air entry to the segmental bronchus.

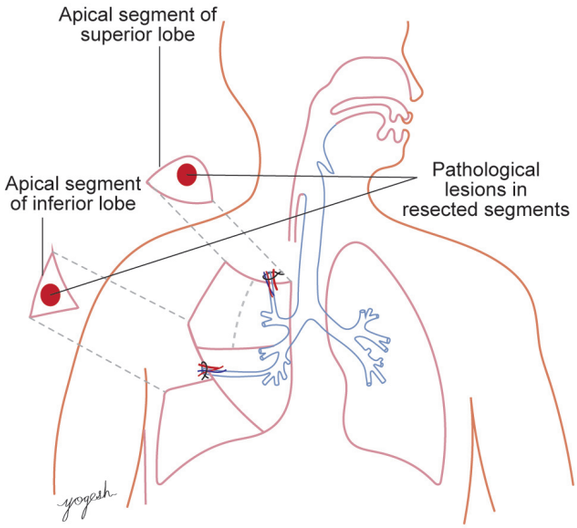


Fig. 9.10: Segmental resection of lung

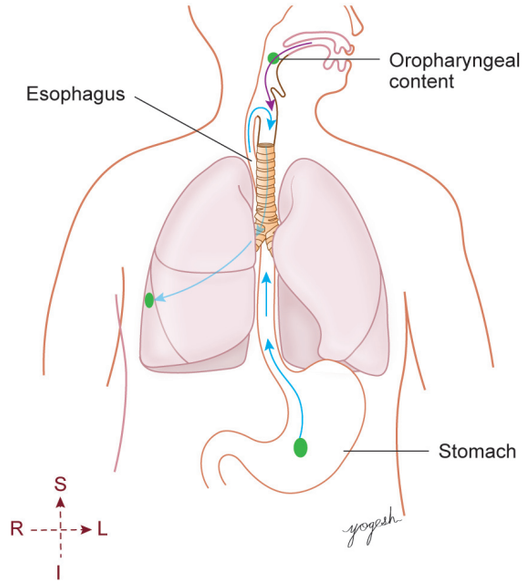


Fig. 9.11: Aspiration pneumonia

Flowchart 9.2: Lobes and bronchopulmonary segments

Bronchopulmonary segments (10 segments in each lung)

Right lung		Left lung	
Lobe	***Segments***	***Lobe***	***Segments***
Superior lobe	Apical segment Posterior segment Anterior segment	***Superior lobe***	Apical segment Posterior segment Anterior segment
Middle lobe	Medial segment Lateral segment		Superior lingular seg. Inferior lingular seg.
Inferior lobe	Apical segment Anterior basal seg. Lateral basal seg. Posterior basal seg. Medial basal seg.	***Inferior lobe***	Apical segment Anterior basal seg. Lateral basal seg. Posterior basal seg. Medial basal seg.

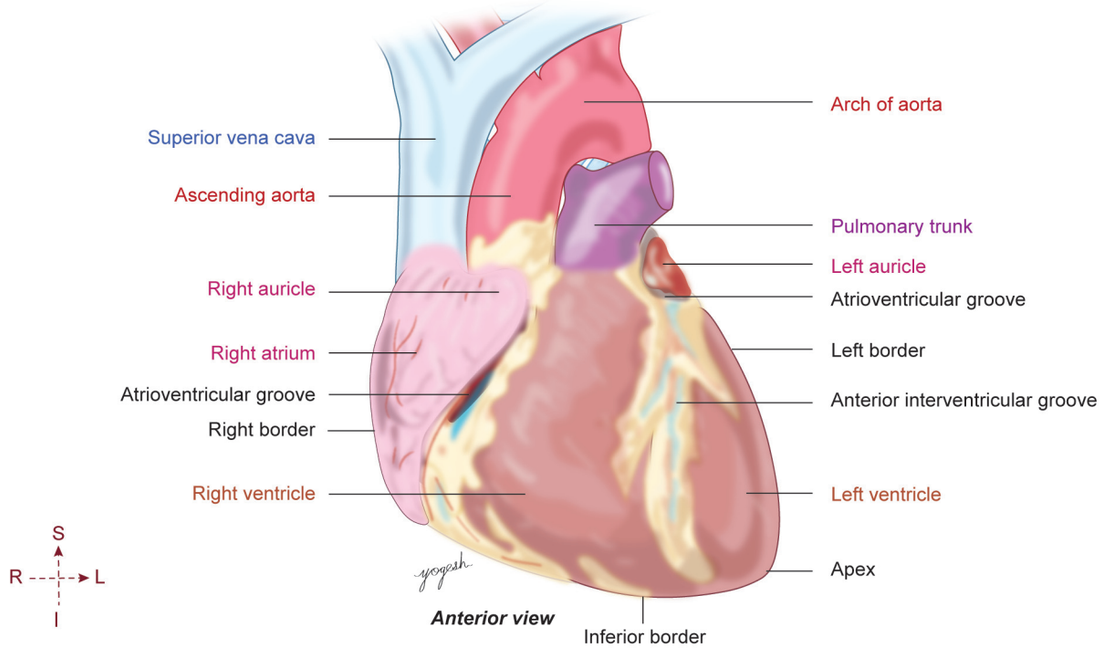


Fig. 12.2: External features of heart

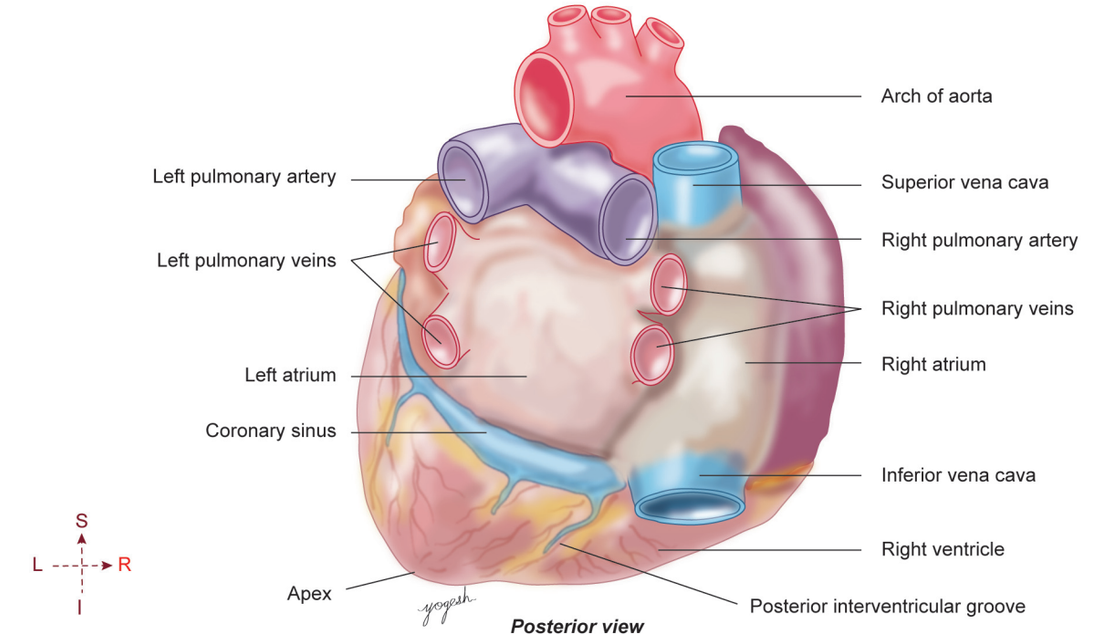


Fig. 12.3: Posterior aspect of the heart

- Inferior or diaphragmatic
- Left surface
- Right surface [*Reference*: 41st edn. Gray's Anatomy]

Apex of the Heart

- It is a *conical* area of the heart.
- It is directed downward, forward, and to the left.
- *Formation*: Formed by the left ventricle.
- It is overlapped by left lung and left pleura.
- *Location*: Fifth left intercostal space, just medial to the midclavicular line (at about 9 cm from midline).

Clinical Integration

Q. Write a short note on apex beat of heart.

- *Apex impulse* is an outer thrust of the apex of the heart during ventricular systole observed in fifth intercostal space just medial to the midclavicular line (Fig. 12.7).

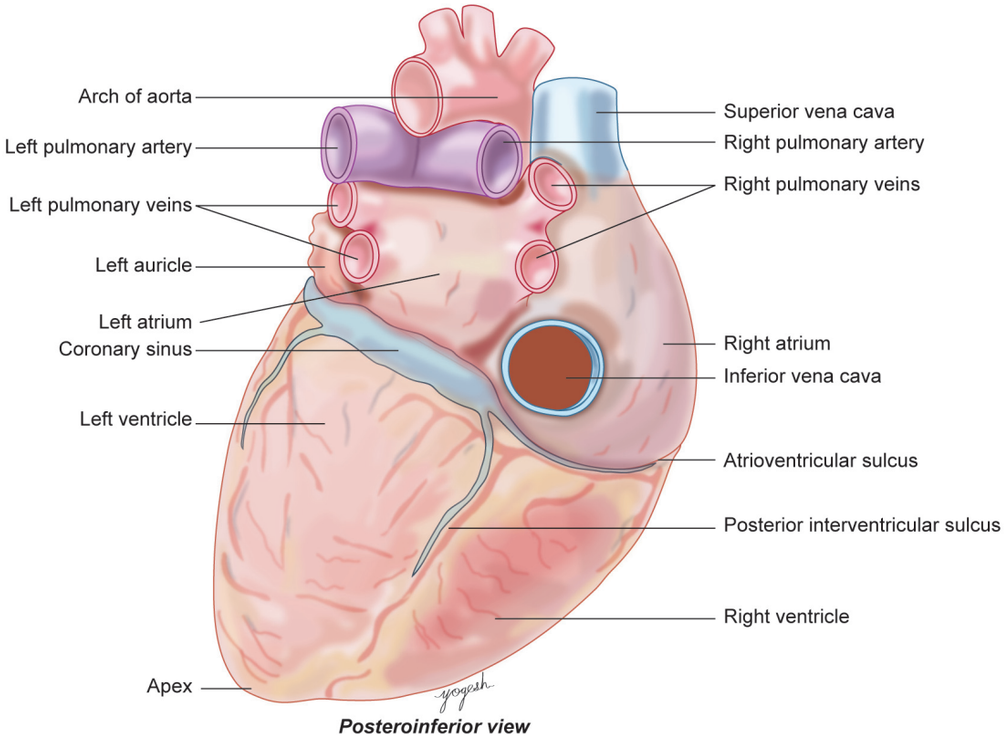


Fig. 12.4: Posteroinferior view of heart

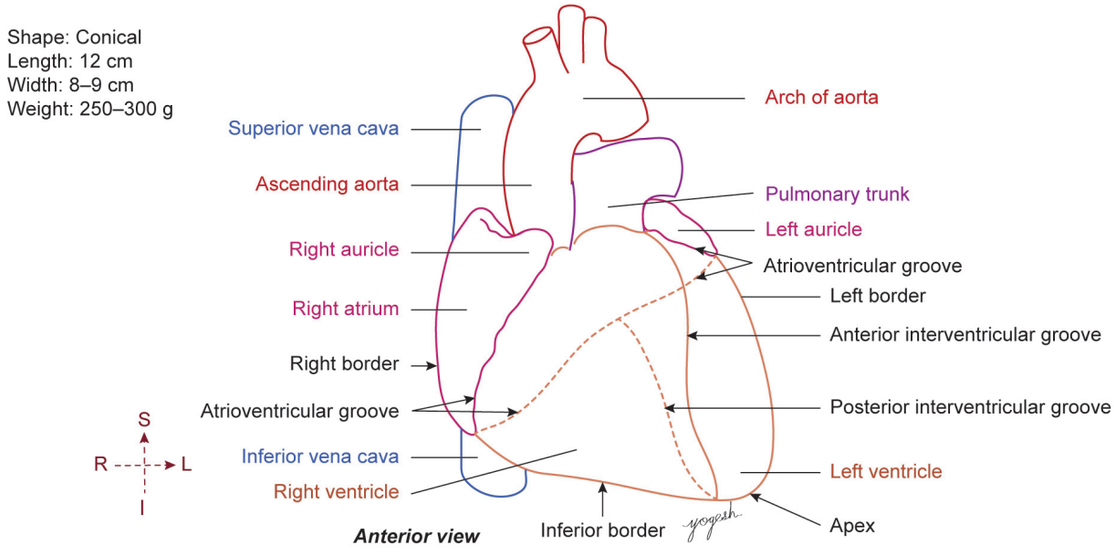


Fig. 12.5: External features of heart

- *Apex beat* can be felt at the site of apex impulse.
- In newborns, the heart lies horizontally; hence, apex beat can be felt in left fourth intercostal space just lateral to the midclavicular line.

Base (Posterior Surface) of Heart

- Base of the heart is directed posteriorly toward the vertebral column (opposite to the apex of the heart).
- It is quadrilateral in shape.
- *Formation*: Its lateral two-thirds is formed by posterior surface of left atrium and medial one-third is by posterior surface of right atrium.[NEXT]
- *Level*: It lies opposite of 6th to 9th thoracic vertebrae in erect posture and 5th to 8th thoracic vertebrae in the lying-down position.
- *Interatrial groove*: A shallow interatrial groove separates right atrium from the left atrium. It indicates posterior attachment of interatrial septum.

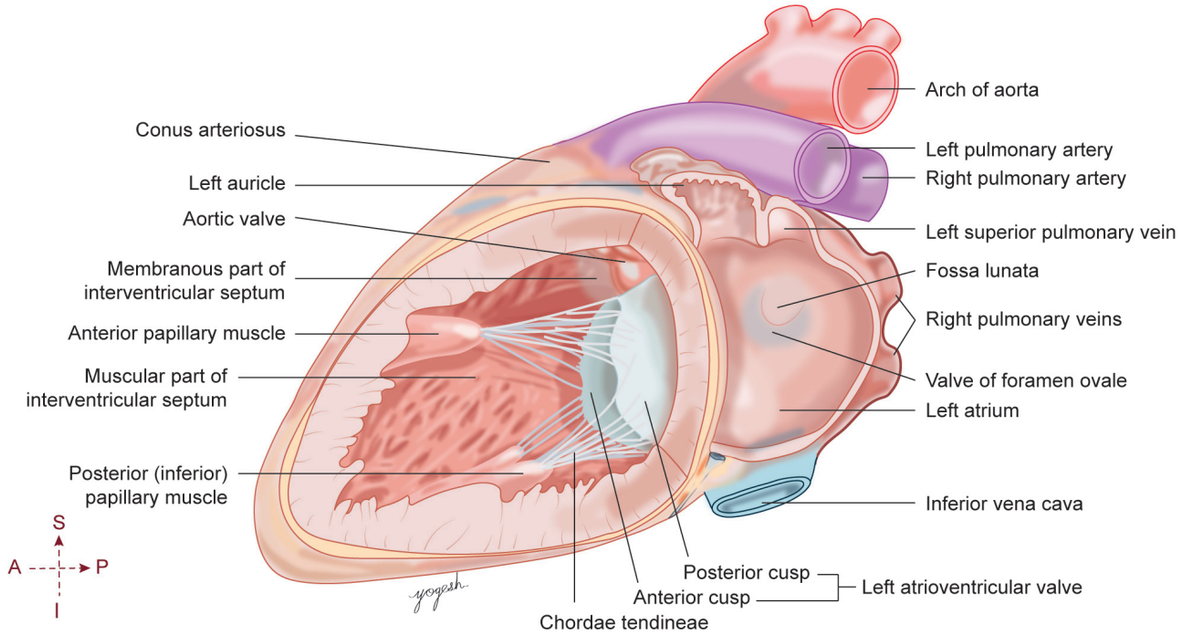


Fig. 12.17: Interior of left atrium and left ventricle (flaps from posterolateral wall of left atrium and left ventricle are removed)

lunata: A shallow fossa that corresponds to fossa ovalis of the right atrium.

- *Posterior surface*: It is related posteriorly to the oblique sinus of pericardium.

Opening in the Left Atrium

1. Four pulmonary veins (right superior, right inferior, left superior, and left inferior) – not guarded by any valve
2. Many venae cordis minimae
3. Left atrioventricular orifice is guarded by mitral valve.

LEFT VENTRICLE

Q. Write a short note on left ventricle.

- The left ventricle is a conical, thick-walled chamber of the heart.
- It receives the oxygenated blood from the left atrium through the left atrioventricular (mitral) valve and pumps the blood in the ascending aorta through the aortic orifice.

External Features (Flowchart 12.8)

- Left ventricle forms: (1) apex of the heart, (2) left one-third of sternocostal surface, (3) left 2/3rd of the inferior surface of heart, and (4) most of the left heart border and surface.
- Left ventricle has three surfaces: Anterior, inferior, and left.

Internal Features

(Figs 12.17, 12.18, Flowchart 12.8)

- The cavity of the left ventricle is circular in cross-section.

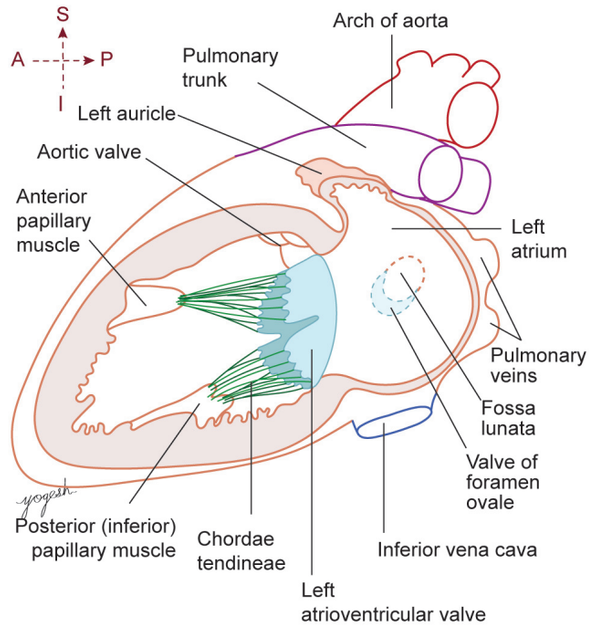


Fig. 12.18: Interior of left atrium and left ventricle

- The interior of the left ventricle is divided into two parts:
  1. Inflowing part
  2. Outflowing part or aortic vestibule

Inflowing part

- It is rough and forms the ventricle proper.
- It develops from the left part of the primitive ventricle.
- It is rough due to the presence of muscular thickening called *trabeculae carneae*.

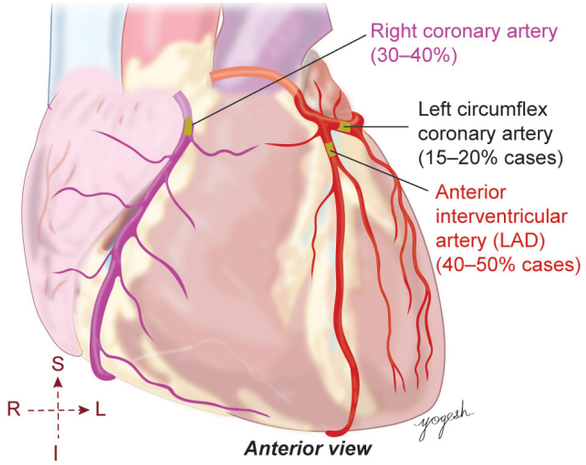


Fig. 14.11: Common sites of coronary occlusions (Other common sites include left coronary artery and inferior or posterior interventricular artery). LAD: Left anterior descending branch

Investigations

Electrocardiography (ECG) (Fig. 14.12)

- ECG is a method of recording a graph that represents myocardial activity.
- ECG shows p, q, r, s, and t waves (for details refer physiology book).
- On ECG, ST segment is elevated. There are many other changes observe based on involvement of specific part of the heart.

Echocardiography (Fig. 14.13)

- It is a method of examination of heart using ultrasonic waves.
- *Uses*: To assess thickness, size, shape, and movements of the heart chambers.

Doppler echocardiography

- It is a method to record the blood flow through the heart chambers and major vessels. It is useful for detection of valvular functions and septal defects.

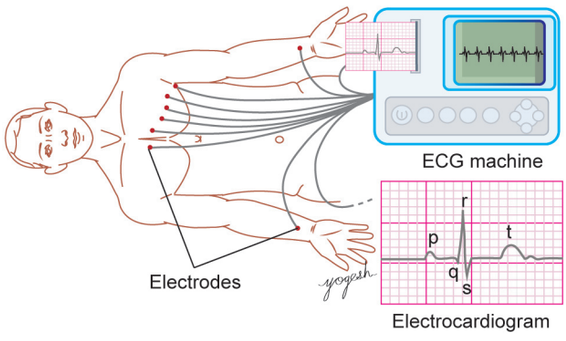


Fig. 14.12: Electrocardiography and electocardiograph. A person lying on the table for the procedure. ECG machine connected with the person through electrodes. The machine is showing electrocardiogram and its print version. ECG shows p, q, r, s, and t waves

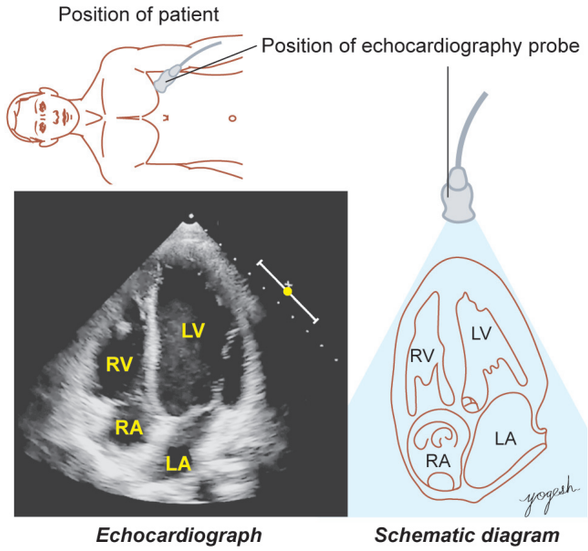


Fig. 14.13: Echocardiography and echocardiogram (four chamber apical view)

Coronary angiography

- It is a radiological procedure to visualize the coronary arteries.
- *Procedure*: A long catheter is inserted through femoral artery in the inguinal region and then it is directed to ascending aorta (femoral artery → external iliac artery → common iliac artery → descending abdominal aorta → descending thoracic aorta → arch of aorta → ascending aorta) (Fig. 14.14).
- A radiopaque dye is injected into coronary artery and radiograph is obtained. This coronary arteriogram shows branching pattern of vessels, and site of block.

Treatment

Coronary angioplasty

- It is a procedure used to open blocked coronary arteries.
- *Procedure* (Figs 14.14, 14.15):

  A *catheter* with inflatable balloon and *stent* (wired-mesh tube) is inserted into the coronary artery through femoral artery. At the site of block, balloon is inflated. Later, balloon is deflated, and catheter is removed leaving behind stretched *stent*. This open up the lumen of blocked vessel. It is performed by *cardiologist*.

Coronary artery bypass grafting (Fig. 14.16)

- It is a surgical procedure used to bypass the blocked segment of coronary artery.
- *Procedure*:
  - A segment of a vessel is connected to ascending aorta or proximal part of coronary artery and to the part of coronary artery distal to the blockage site.

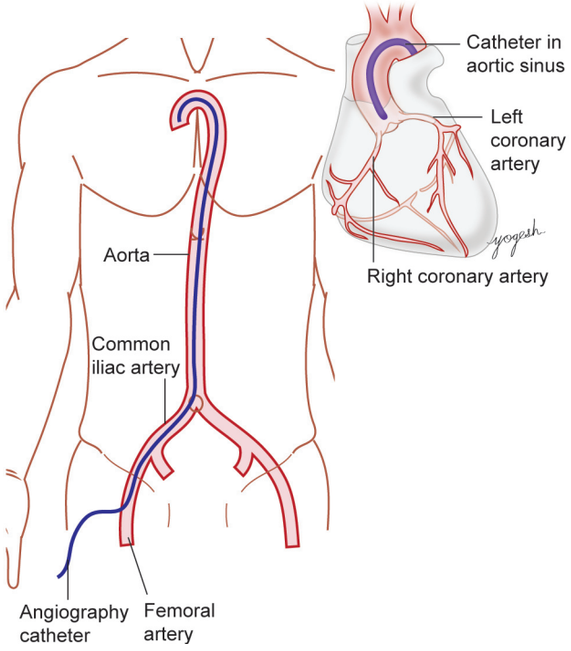


Fig. 14.14: Passage of catheter in coronary angiography and angioplasty

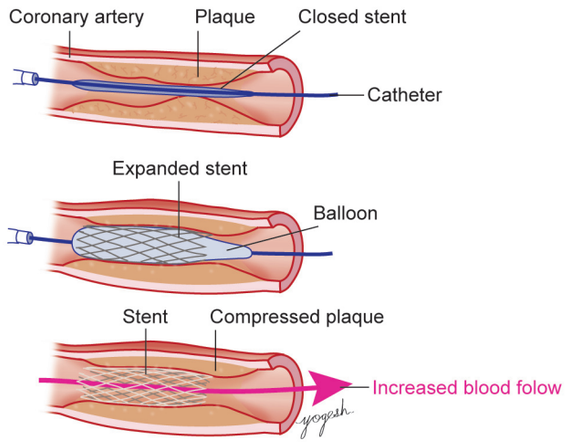


Fig. 14.15: Coronary artery angioplasty

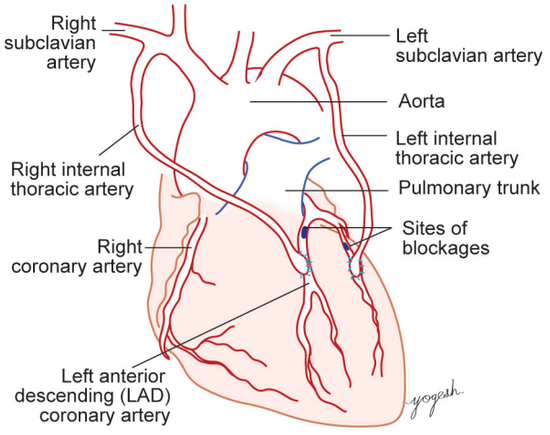


Fig. 14.16: Coronary artery bypass grafting using internal thoracic artery

- Vessels used for bypass grafting: Internal thoracic artery, great saphenous veins, radial artery.[MCQ]
- It is performed by *cardiothoracic surgeon*.

Some Interesting Facts

- Great saphenous vein is preferred vessel for bypass grafting because
  1. Its diameter is similar to coronary vessels.
  2. It can be easily dissected.
  3. It is long and can be used for treatment of multiple blocks simultaneously.
  4. It has very few valves.

VENOUS DRAINAGE OF HEART

Q. Write a short note on venous drainage of heart.

- Venous blood of the heart is drained by the following veins (Figs 14.17 to 14.20, Flowchart 14.3):
  1. Coronary sinus
  2. Anterior cardiac veins
  3. Venae cordis minimae
- About 60% of the venous blood from the heart enters into the right atrium, whereas remaining 40% enters into the different chambers of heart.

Coronary Sinus

Q. Write a short note on ~~blood supply of~~ coronary sinus.

- It is the major vein of the heart.
- *Size*: 2–3 cm long
- *Location*: It is located in the posterior part of the atrioventricular groove.

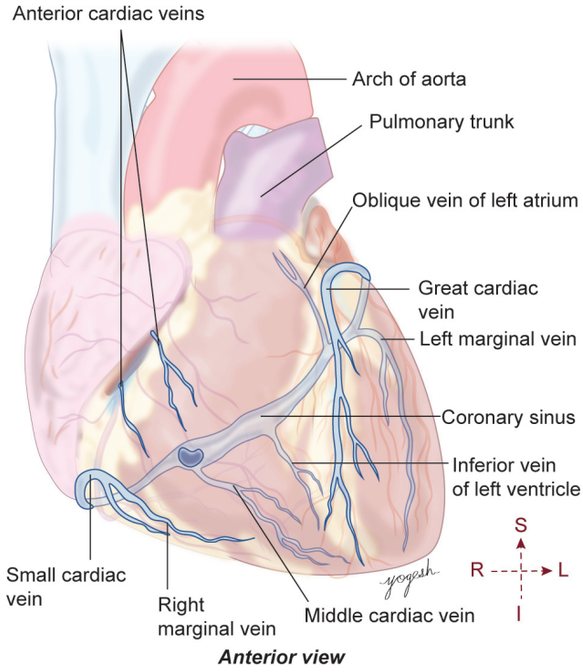


Fig. 14.17: Principal veins of the heart (anterior view)

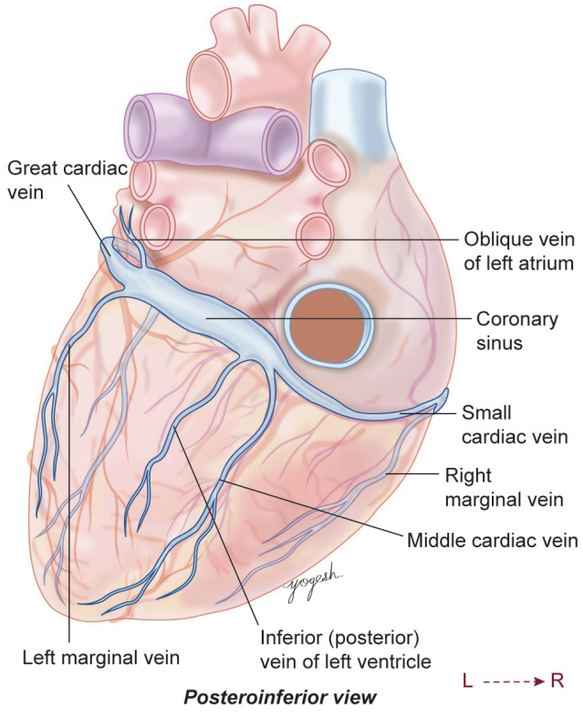


Fig. 14.18: Principal veins of heart (postroinferior view of heart)

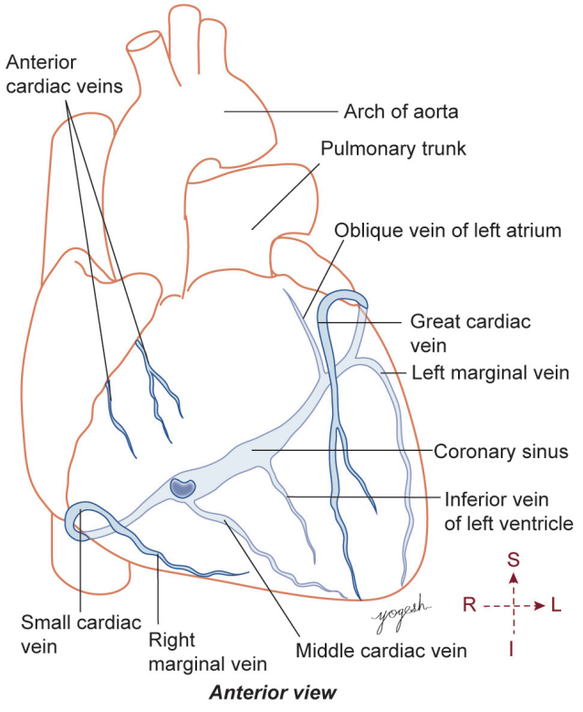


Fig. 14.19: Principal veins of the heart (anterior view)

- *Development*: It develops from the left horn of the sinus venosus and a part of left common cardinal vein.[NEXT]

Beginning

- It begins as the continuation of great cardiac vein in the left part of atrioventricular groove.

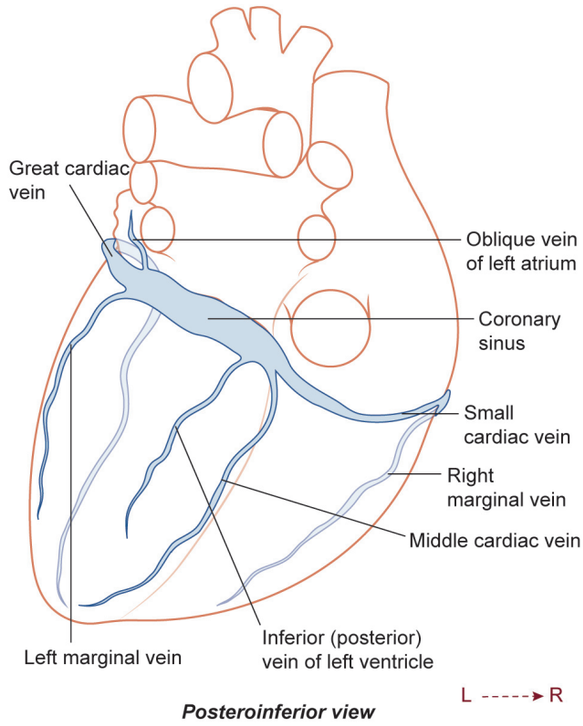
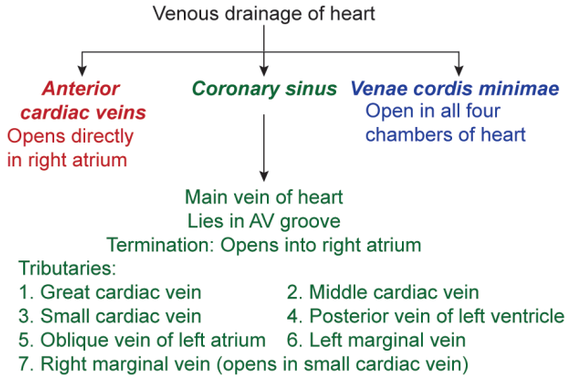


Fig. 14.20: Principal veins of heart (postroinferior view of heart)

Flowchart 14.3: Venous drainage of heart



Termination

- Coronary sinus opens in the right atrium.
- Its opening lies in between the opening of inferior vena cava and right atrioventricular orifice.
- Opening of coronary sinus is guarded by non-functioning, rudimentary thebesian valve.

Tributaries[NEXT]

Coronary sinus receives the following tributaries:

1. *Great cardiac vein*
   - It begins at the apex of heart. It runs upward in anterior interventricular groove.
   - Then, it runs in left part of atrioventricular groove and turns around the left heart border and opens in coronary sinus.
   - It receives blood from left marginal vein.

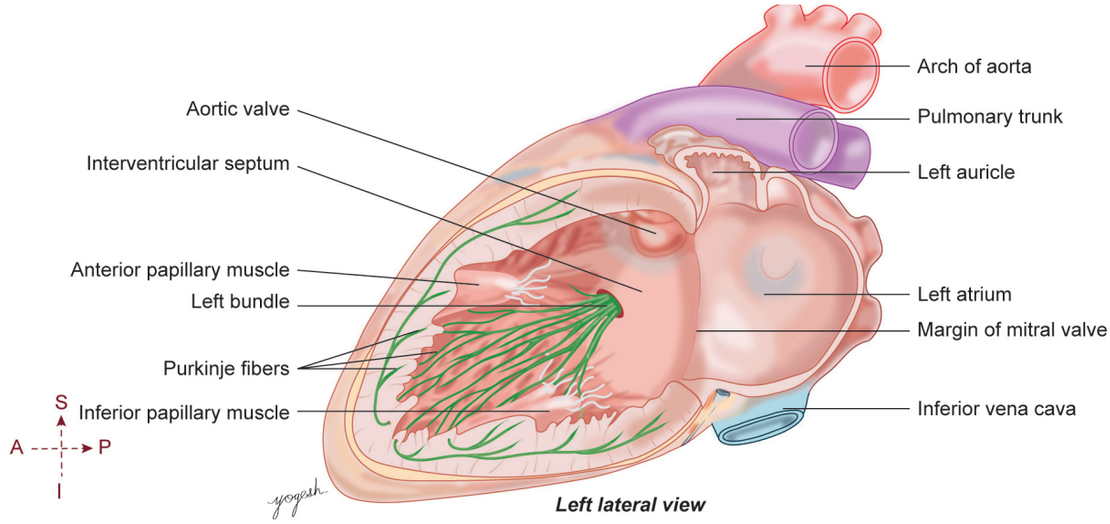


Fig. 15.2: Conducting system of heart: Left bundle branch. Part of wall of left atrium and left ventricle is removed to show the interior of heart

Sinoatrial (SA) Node

- It is also called SA node or node of Keith–Flack or *pacemaker of the heart*.
- It is crescent shaped, elongated zone of cardiac myocytes.
- *Location*: It is situated in the wall of right atrium. It is located in the upper part of sulcus terminalis, just below the opening of superior vena cava (Figs 15.1, 15.3).[NEXT]
- *Length*: 10–20 mm
- *Thickness*: ~1 mm.
- *Blood supply*: It is supplied by SA nodal branch of the right coronary artery.
- *Structure*
  - SA node consists of P-cells or nodal myocytes.
  - P-cells are small, fusiform, pale staining, and highly excitable myocytes.[NEXT]
  - SA node is supplied by right vagus nerve.[NEXT]

Atrioventricular (AV) Node

- It is smaller than SA node.
- *Location*
  - It is located in the lower part of the interatrial septum just above the opening of coronary sinus.
  - It lies subendocardially in the triangle of Koch (bounded by tendon of Todaro above, opening of coronary sinus below, and septal leaflet of tricuspid valve anteriorly).
- *Length*: 8 mm, width 1 mm.
- *Blood supply*: AV nodal branch of right coronary artery.
- It is inferiorly continuous with atrioventricular bundle of His.
- *Structure*:
  - AV node consists of slow conducting transitional cardiac myocytes that help in *conduction delay* in the AV node.
- *Rhythmicity*: AV node can generate impulses at 60 beats/minute.

Internodal Tracts

SA node is connected with AV node by three internodal tracts (Fig. 15.3):

A. *Anterior tract of Bachmann*

- It connects anterosuperior part of SA node with AV node.
- It passes in front of superior vena caval opening and then along the interatrial septum.

B. *Middle tract of Wenckebach*

- It connects posteroinferior part of SA node with AV node.

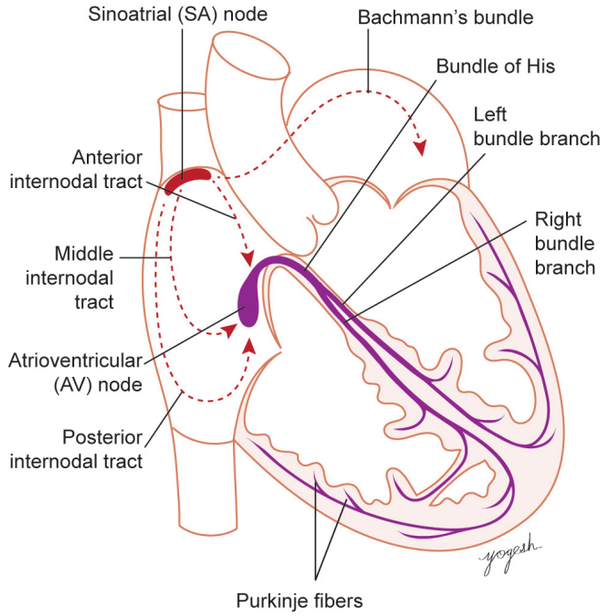
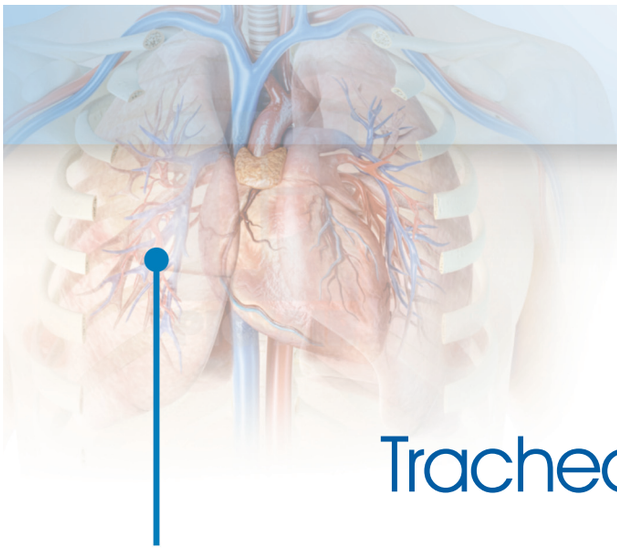


Fig. 15.3: Conducting system of heart



Chapter

17

Trachea and Esophagus

Competencies

AN23.1: Describe and demonstrate the external appearance, relations, blood supply, nerve supply, lymphatic drainage, and applied anatomy of esophagus.

AN24.6: Describe the extent, length, relations, blood supply, lymphatic drainage, and nerve supply of trachea.

TRACHEA

- Trachea (= windpipe) is a wide, flexible, and fibrocartilaginous tube that conveys air from larynx to the lungs.
- C-shaped (16–20 number) rings keep the tracheal lumen open.

Location

- Trachea is located in the lower part of the neck and in the superior mediastinum.

Extent

- It begins as the continuation of larynx at the lower border of cricoid cartilage or lower border of C6 vertebra (Fig. 17.1).[MCQ]
- Trachea divides into right and left principal bronchi at the level of lower border of T6 vertebra (41st Gray's Anatomy). (*Previous concept*: Trachea bifurcates at the lower border of T4 vertebra.)[NEXT]

Dimensions

- Length: 10–11 cm
- External diameter: 2 cm in males, 1.5 cm in females[NEXT]
- Internal diameter (lumen):
  - Smaller in living than in cadaver
  - At one year of age: ~3 mm
  - During childhood – corresponds to age in years
  - In adult: ~12 mm

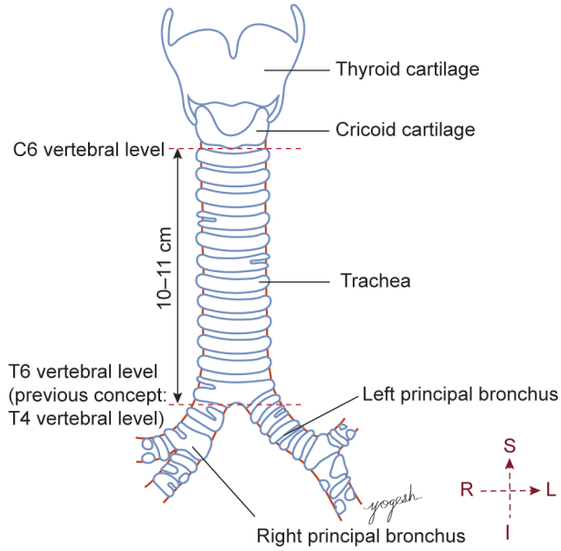


Fig. 17.1: Trachea

Clinical Integration

- Endotracheal tube should be selected according to the age of individual up to the age of 12 years (Fig. 17.2).
- Because luminal diameter increases by 1 mm per year up to the age of 12 years.

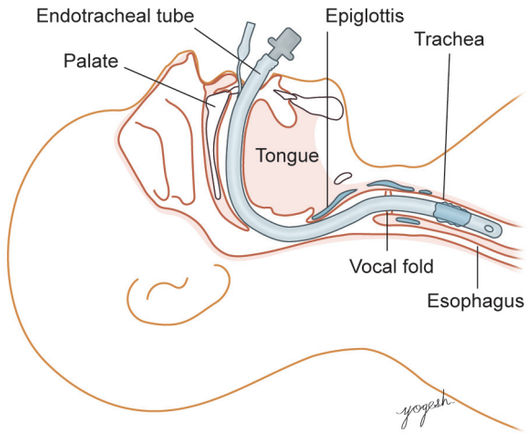


Fig. 17.2: Endotracheal tube intubation