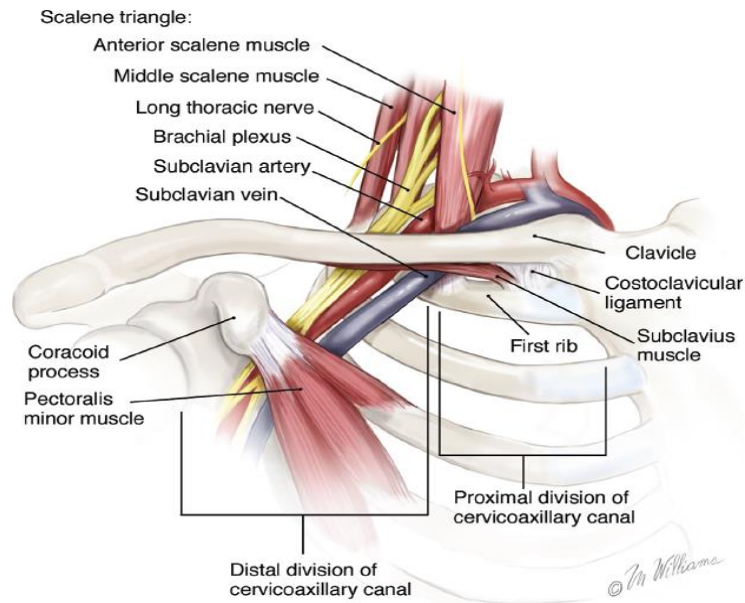


THORAX OVERVIEW

(FROM SNELL'S ANATOMY)

- The adult sternum consist of three parts: Manubrium, body and xiphoid process
- The suprasternal notch is easily palpable, concave notch in the superior border of manubrium
- The sternal angle is an important landmark for thoracic anatomy because it marks:
 1. The manubriosternal joint
 2. Attachment points of second costal cartilage
 3. Horizontal line that typically projects posteriorly onto the T4 intervertebral disc
 4. Plane of separation between the superior and inferior mediastina
- RIBS:
 - True Ribs (Pairs 1 to 7) – connected directly to sternum via costal cartilage
 - False Ribs (Pairs 8 to 10) – connected to sternum via individual costal cartilages that join together and attach collectively to seventh costal cartilage
 - Floating Ribs (Pairs 11 and 12) – do not attach to sternum
- Typical Rib Anatomy:
 - Head – posterior (vertebral) end of the rib having two facets for articulation with the numerically corresponding vertebral body and that of vertebra immediately above
 - Neck – flattened, slightly constricted portion situated between the head and the tubercle
 - Tubercle – A prominence on outer posterior surface of the rib at the junction of the neck with the body. It has a facet for articulation with the transverse process of numerically corresponding vertebra.
 - Body (Shaft) – A long, thin, flattened and twisted part that extends from tubercle to anterior (sternal) end
 - Costal groove – Elongate depression along the inferior aspect of internal surface of shaft of rib. This holds the intercostal vessels and nerve.
 - Angle – The point at which the body of the rib bends sharply and turns from a lateral to a more anteriorly directed orientation
 - Anterior (sternal) end has a depression for costal cartilage
- FIRST RIB
 - Anterior scalenus muscle attached to upper surface and inner border of first rib
 - Subclavian vein crosses the rib anterior to scalenus anterior
 - Subclavian artery and lower trunk of brachial plexus cross the rib posterior to scalenus anterior and lie in contact with the bone



- The costal cartilages contribute significantly to the elasticity and mobility of the thoracic walls. In old age, the costal cartilages tend to lose some of its flexibility as a result of significant calcification.
- **COSTAL FACETS OF VERTEBRAE**
 - Typical thoracic vertebrae (2 to 8) have two costal facets on each side i.e. superior costal facet and inferior costal facet
 - These are the sites where the heads of the ribs articulates with the body
 - Because of each of these facets carries half of the rib articulation, each is commonly called a demifacet
 - T₁ vertebra have full costal facet for head of first rib, plus an inferior demifacet for the superior half of head of second rib
 - The T₁₁ and T₁₂ vertebrae each have full costal facets instead of demifacets and articulate only with their own individual ribs
- **TRANSVERSE COSTAL FACETS**
 - Small articular surfaces on the transverse processes
 - These are the sites where tubercle of each rib articulates with transverse process
 - Not present on T₁₁ and T₁₂ vertebrae
- **JOINTS**
 1. Manubriosternal Joint
 - cartilaginous joint between manubrium and body of sternum
 - small amount of angular movement possible during respiration
 2. Xiphisternal Joint
 - Cartilaginous joint between xiphoid process and body of sternum
 - Xiphoid process usually fuses with body of sternum during middle age
 3. Joints of heads of ribs

- Rib 1 and Rib 10, 11, 12 have a single synovial joint between their corresponding vertebral body
 - From ribs 2 to 9, the head articulates by means of a synovial joint with the corresponding vertebral body and that of vertebra above it
- 4. Joints of tubercles of ribs
 - Synovial joint between tubercle of rib and transverse process of corresponding vertebra
 - This joint is absent on 11th and 12th rib
- 5. Joints of ribs and costal cartilages
 - Cartilaginous joints
 - No movement permitted
- 6. Joints of costal cartilages with sternum
 - First costal cartilage articulate with manubrium by cartilaginous joints that do not permit movement
 - 2nd to 7th costal cartilages articulate with lateral border of sternum by synovial joints
 - 6th to 10th costal cartilages articulate with one another along their borders by small synovial joints
 - 11th and 12th ribs do not articulate with sternum and are embedded in abdominal musculature

- **Superior Thoracic Aperture or Thoracic Outlet** – The narrow opening through which chest cavity communicates with the root of the neck

BOUNDARIES:

- Posteriorly – body of first thoracic vertebra
- Laterally – medial edges of first ribs and their costal cartilages
- Anteriorly – superior margin of manubrium sterni

CONTENTS:

- Esophagus
 - Trachea
 - Several vessels and nerves
 - **Inferior Thoracic Aperture** – A large opening through which thoracic cavity communicates with the abdomen
- BOUNDARIES:**
- Posteriorly – body of 12th thoracic vertebra
 - Laterally – curving costal margin
 - Anteriorly – xiphisternal joint

The diaphragm closes the inferior aperture. Structures passing between thoracic and abdominal cavities (e.g. esophagus, aorta) must either pierce the diaphragm or go around the diaphragm.

- **Suprapleural Membrane** – A dense fascial layer that closes the thoracic outlet. It protects the underlying cervical pleura and resists the changes in intrathoracic pressure occurring during respiratory movements.

BOUNDARIES:

Laterally – medial border of first rib and costal cartilage

Medially – fascia investing the structures passing from thorax into neck

Apex – tip of transverse process of C₇ vertebra

- **Endothoracic Fascia** is a thin layer of loose connective tissue that separates the parietal pleura from the thoracic wall. The suprapleural membrane is a thickening of this fascia.

- **Intercostal spaces** are the gaps between adjacent ribs.

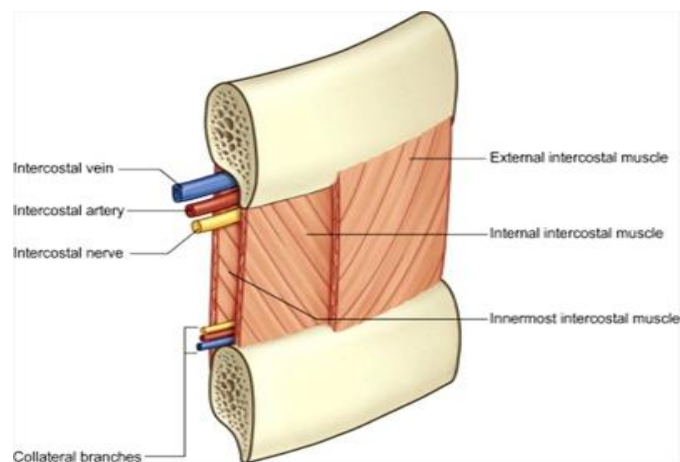
Structural layers of intercostal spaces (from superficial to deep):

1. Skin
 2. Superficial fascia
 3. Deep fascia
 4. Intercostal muscles
 - a. External intercostals
 - b. Internal intercostals
 - c. Innermost intercostals
 5. Endothoracic fascia
 6. Extrapleural fatty layer
 7. Parietal pleura
- The intercostal nerves and blood vessels run between the middle and innermost layer of intercostal muscles.

They are arranged in following order from above downward:

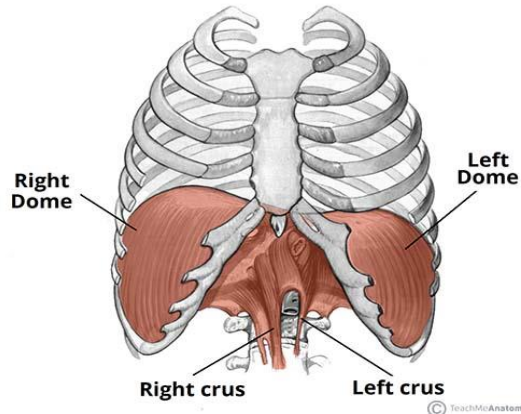
(Mnemonic VAN)

- Intercostal vein
- Intercostal artery
- Intercostal nerve

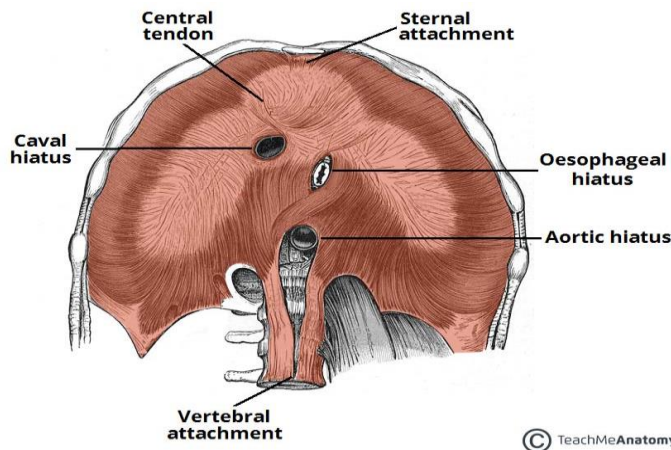


- Origin of diaphragm can be divided into three parts
 1. **Sternal part** arising from posterior surface of xiphoid process
 2. **Costal part** arising from deep surfaces of lower six rib and their costal cartilages
 3. **Vertebral part** arising by vertebral columns (crura) and from the arcuate ligaments

- The **right crus** arises from sides of the bodies of first three lumbar vertebrae and the intervertebral discs
- The **left crus** arises from sides of bodies of the first two lumbar vertebrae and the intervertebral discs
- Lateral to the crura, the diaphragm arises from **medial and lateral arcuate ligaments**.

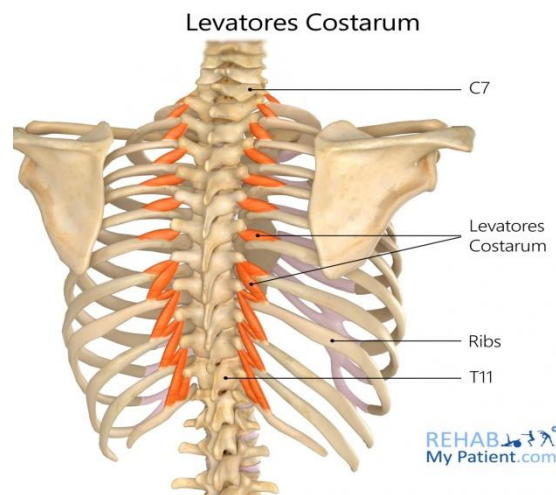


- The diaphragm inserts into a central tendon which is shaped like three leaves. Some of the fibers of the right crus pass up to the left and surround the esophageal orifice in a slinglike loop. These fibers appear to act as a sphincter and possibly assist in the prevention of regurgitation of the stomach contents into the thoracic part of esophagus.

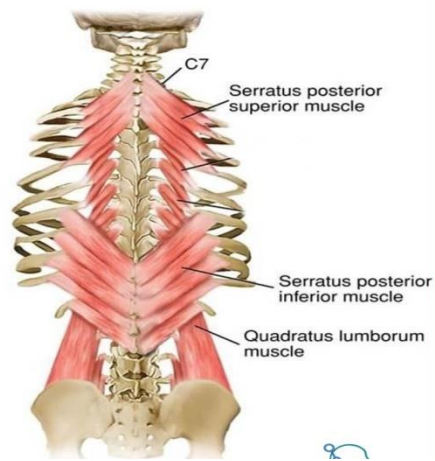


- The right dome reaches as high as upper border of the fifth rib
- The left dome may reach the lower border of fifth rib
- The central tendon lies at level of xiphisternal joint
- The domes support the right and left lungs, whereas the central tendon supports the heart
- NERVE SUPPLY OF DIAPHRAGM
 - Motor nerve supply comes from right and left phrenic nerves (C₃, C₄, C₅)
 - For sensory nerve supply, the phrenic nerves supply the parietal pleura and peritoneum covering central surfaces of diaphragm
 - The lower six intercostal nerves supply the periphery of diaphragm
- DIAPHRAGM OPENINGS

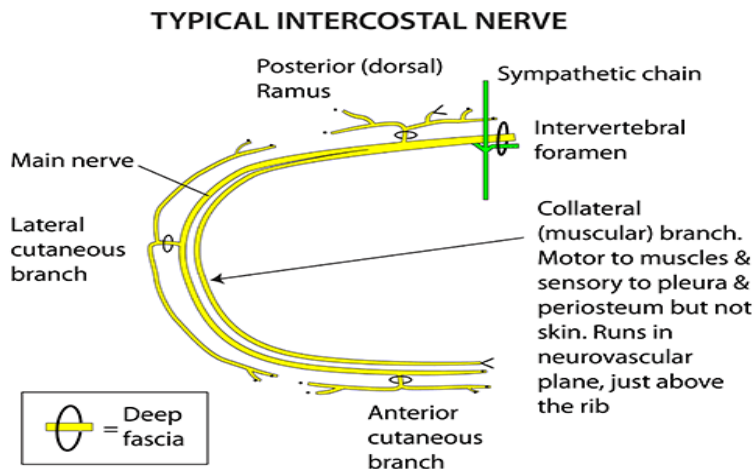
1. Aortic opening
 - Lies anterior to the body of 12th thoracic vertebra and between the crura
 - It transmits:
 - Aorta
 - Thoracic duct
 - Azygos vein
2. Esophageal opening
 - Lies at level of 10th thoracic vertebra in a sling of muscle fibers derived from right crus
 - It transmits:
 - Esophagus
 - Right and left vagus nerves
 - Esophageal branches of left gastric vessels
 - Lymphatics from lower third of esophagus
3. Caval opening
 - Lies at level of 8th thoracic vertebra, in the central tendon
 - It transmits:
 - Inferior vena cava
 - Right phrenic nerve
- Levatores Costarum muscles
 - Comprise 12 pairs
 - Each is triangular in shape and inserts into rib below its origin

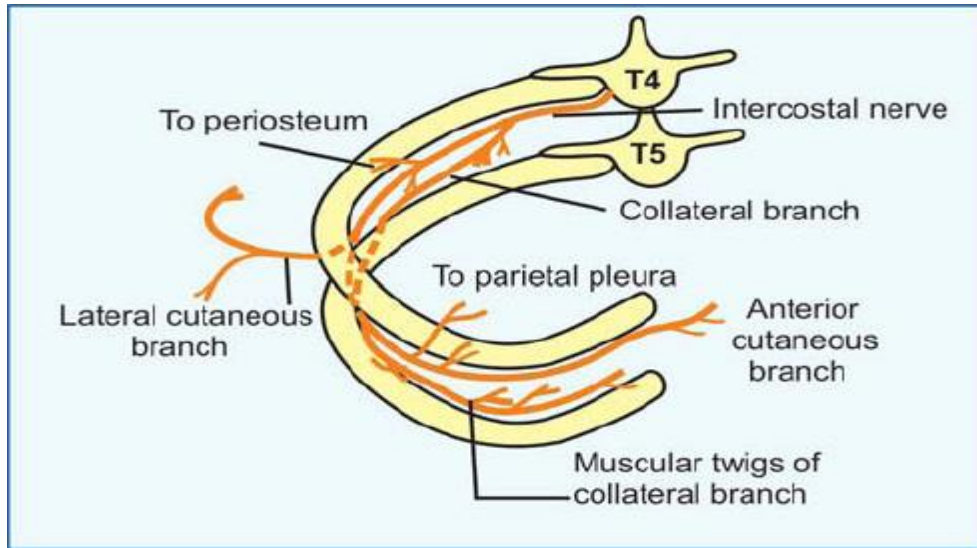


- Serratus Posterior muscles
 - The **serratus posterior superior** and **serratus posterior inferior** are thin, flat muscles that comprise the intermediate layer of muscles of the back
 - The superior muscle passes downward and laterally and inserts into the upper ribs.
 - The inferior muscle passes upward and laterally and inserts into the lower ribs.



- The **intercostal nerves** supply the entire thoracic wall. These nerves are the anterior rami of the first 11 thoracic spinal nerves.
- Branches of intercostal nerves:
 1. **Rami communicantes** – connects intercostal nerve to ganglion of sympathetic trunk
 2. **Collateral branch** – runs forward inferiorly to the main nerve on the upper border of the rib below
 3. **Lateral cutaneous branch** – reaches skin on side of chest. It is divided into anterior and posterior branch
 4. **Anterior cutaneous branch** – the terminal portion of main trunk, reaches the skin near midline. It divides into medial and lateral branch
 5. **Muscular branches** – run to intercostal muscles
 6. **Pleural sensory branches** – goes to parietal pleura
 7. **Peritoneal sensory branches** (7th to 11th intercostal muscles only) – run to parietal peritoneum





- The **first intercostal nerve** joins the brachial plexus by a large branch that is equivalent to the lateral cutaneous branch of typical intercostal nerves.
- The **second intercostal nerve** joins the medial cutaneous nerve of the arm by a large branch named **intercostobrachial nerve**, which is equivalent to lateral cutaneous branch of other nerves. Therefore, the second intercostal nerve supplies skin of armpit and upper medial side of arm. *In coronary artery disease pain is referred along this nerve to medial side of arm.*
- The first six intercostal nerves supply:
 - Skin and parietal pleura covering outer and inner surface of each intercostal space
 - Intercostal muscles of each intercostal space
 - Levatores costarum
 - Serratus posterior muscles
- 7th to 11th intercostal nerves supply
 - Skin and parietal peritoneum covering the outer and inner surfaces of abdominal wall
 - Anterolateral abdominal wall muscles which include external oblique, internal oblique, transversus abdominus, and rectus abdominus muscles.

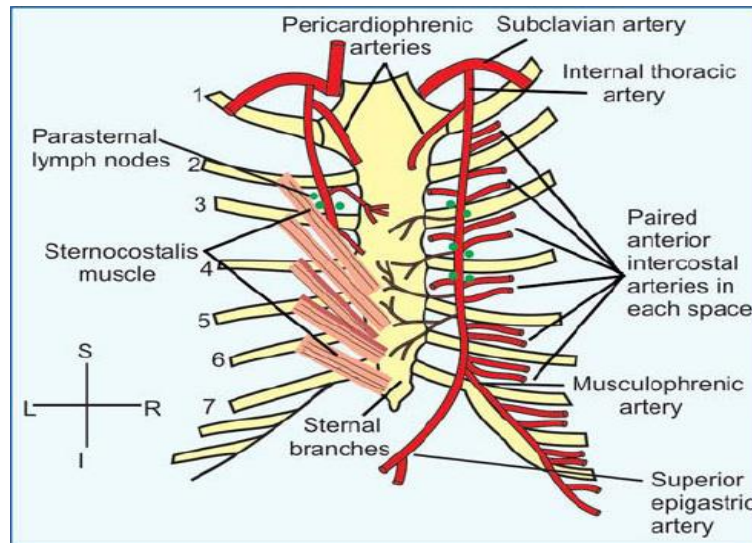
- The **supraclavicular nerves** (C3 and C4) provide the cutaneous innervation of the anterior chest wall above the level of sternal angle.

Below this level, the **anterior and lateral cutaneous branches** of the intercostal nerves supply oblique bands of skin in regular sequence.

The skin on the posterior surface of chest wall is supplied by **posterior rami of spinal nerves**.

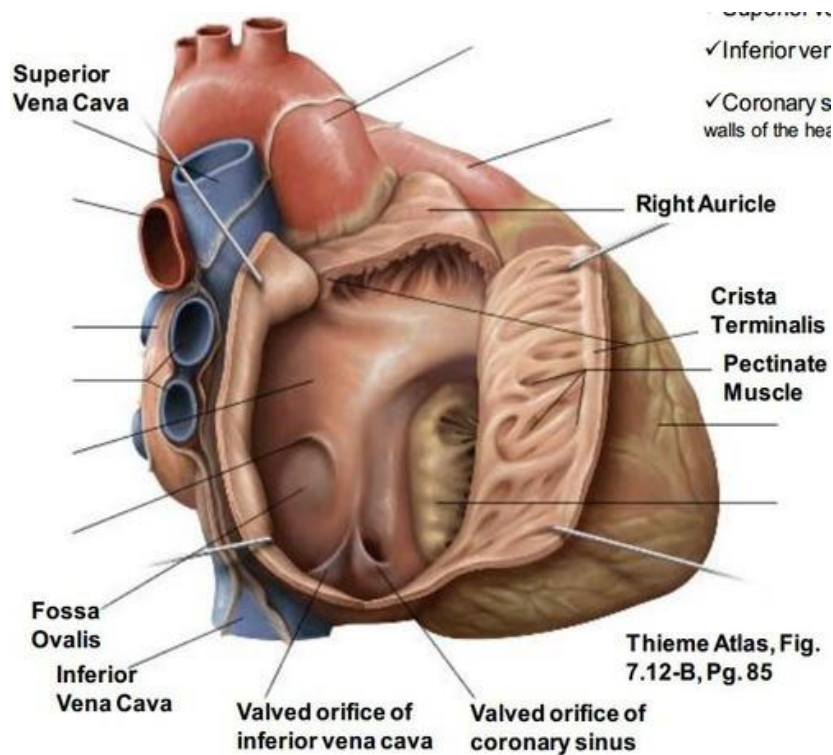
- **ARTERIES SUPPLYING THORACIC WALL**
 - The subclavian artery, axillary artery and thoracic aorta supplies the thoracic walls.
 - The subclavian artery provides blood through its superior intercostal and internal thoracic branches
 - The axillary artery supplies via its superior thoracic and lateral thoracic branches
 - The thoracic aorta gives off posterior intercostal and subcostal branches
- **Internal Thoracic Artery**
 - Supplies anterior wall of body from clavicle to umbilicus

- It is a branch of first part of the subclavian artery in the neck
 - It descends vertically on the pleura behind the costal cartilages, a fingerbreadth lateral to the sternum and ends in sixth intercostal space by dividing into superior epigastric and musculophrenic arteries
- Branches of Internal Thoracic Artery
 - **Anterior intercostal artery** – supply upper six intercostal spaces
 - **Perforating arteries** – accompany the terminal branches of corresponding intercostal nerves
 - **Mediastinal arteries** – supply contents of anterior mediastinum (e.g. the thymus)
 - **Superior epigastric artery** – enters the rectus sheath of the anterior abdominal wall and supplies the rectus muscle as far as the umbilicus
 - **Musculophrenic artery** – runs around costal margin of diaphragm and supplies the lower intercostal spaces and diaphragm

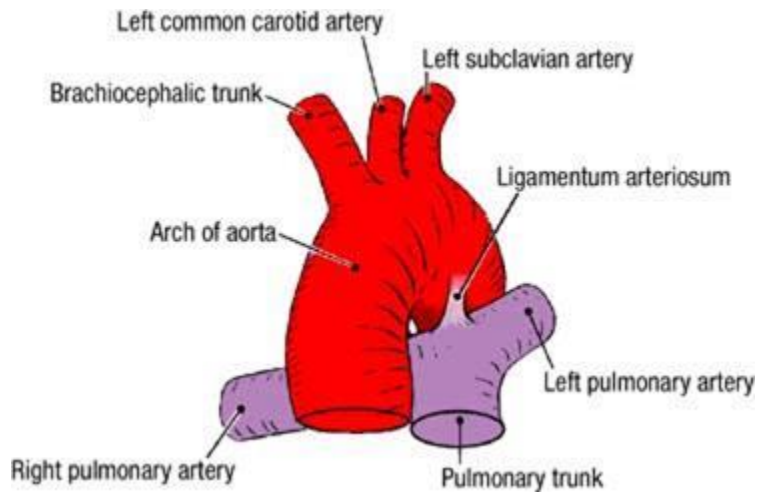


- The **internal thoracic vein** accompanies the internal thoracic artery and drains into brachiocephalic vein on each side.
- Intercostal arteries and veins
 - Each intercostal space contains a large single posterior intercostal artery and two small anterior intercostal arteries
 - The posterior intercostal arteries of the first two spaces are branches from superior intercostal artery, a branch of costocervical trunk of subclavian artery. The posterior intercostal arteries of lower nine spaces are branches of the descending thoracic aorta
 - The anterior intercostal arteries of the first six spaces are branches of the internal thoracic artery, which arise from the first part of subclavian artery. The anterior intercostal arteries of lower spaces are branches of musculophrenic artery, one of the terminal branches of internal thoracic artery.
 - The posterior intercostal veins drain posteriorly into azygos and hemiazygos veins

- The anterior intercostal veins drain anteriorly into internal thoracic and musculophrenic veins.
- Manubriosternal joint → cartilaginous joint
- Xiphisternal joint → cartilaginous joint
- Branches of internal thoracic artery
 - Two anterior intercostal arteries
 - Perforating arteries
 - Pericardiophrenic artery
 - Mediastinal arteries
 - Superior epigastric artery
 - Musculophrenic artery
- Sternal angle
 - Joint between manubrium and body of sternum
 - Second costosternal joint
 - Demarcation between ascending aorta and arch of aorta
 - Demarcation between arch of aorta and descending thoracic aorta
 - Bifurcation of trachea
 - Level of left primary bronchus
 - T₄ intervertebral disc
- Main characteristics of bronchopulmonary segments
 - It is subdivision of a lung lobe
 - It is surrounded by connective tissue
 - It has a centrally located segmental (tertiary) bronchus
 - It has a segmental artery that accompanies the segmental bronchus
 - It has inter-segmental veins located in connective tissue walls between adjacent bronchopulmonary segments
 - It has its own lymph vessels and autonomic nerves
 - Because it is a structural unit, a diseased segment can be removed surgically
- Diaphragm contraction increases the vertical diameter of thoracic cavity
- Anteroposterior diameter of thorax is increased by raising of ribs and sternum
- Contraction of external intercostals increase the transverse diameter of thorax
- Borders of heart
 - Right border – right atrium
 - Left border – left auricle and left ventricle
 - Inferior border – right ventricle
- Tricuspid valve – three cusps
- Bicuspid valve – two cusps
- Aortic valve – three cusps
- Pulmonary valve – three cusps
- Crista terminalis marks the inner boundary between right atrium proper and auricle.
- Crista terminalis is not present in left atrium



- SA node is located in the wall of the right atrium at the junction of crista terminalis and superior vena cava
- AV node is located on the right, lower side of the atrial septum, between the attachment of septal cusp of the tricuspid valve and the opening of coronary sinus
- Coronary sinus lies in the posterior part of atrioventricular groove
- Great cardiac veins drain most of the areas of heart supplied by left coronary artery
Middle and small cardiac veins drain most of the areas normally supplied by right coronary artery
- Anterior cardiac veins drain the anterior surface of heart and empty directly into right atrium
- Branches of ascending aorta
 1. Right coronary artery
 2. Left coronary artery
- Branches of aortic arch
 1. Brachiocephalic artery
 2. Left common carotid artery
 3. Left subclavian artery
- Branches of brachiocephalic artery
 1. Right subclavian artery
 2. Right common carotid artery
- The ligamentum arteriosum is a fibrous band that connects the bifurcation of the pulmonary trunk to the lower concave surface of the aortic arch



- The two brachiocephalic veins join to form the superior vena cava
 The azygos vein joins the posterior aspect of the superior vena cava just before it enters the pericardium
- The upper third of esophagus is supplied by the inferior thyroid artery
 Middle third by esophageal branches from descending thoracic aorta
 Lower third by branches from left gastric artery