

The thorax (or chest) is the region of the body between the neck and the abdomen. It is flattened in front and behind but rounded at the sides. The framework of the walls of the thorax, which is referred to as the **thoracic cage**, is formed by the vertebral column behind, the ribs and intercostal spaces on either side, and the sternum and costal cartilages in front. Superiorly, the thorax communicates with the neck, and inferiorly it is separated from the abdomen by the diaphragm. The thoracic cage protects the lungs and heart and affords attachment for the muscles of the thorax, upper extremity, abdomen, and back.

The cavity of the thorax can be divided into a median partition, called the **mediastinum**, and the laterally placed pleurae and lungs.

### Structure of the Thoracic Wall

The thoracic wall is covered on the outside by skin and by muscles attaching the shoulder girdle to the trunk. It is lined with parietal pleura.

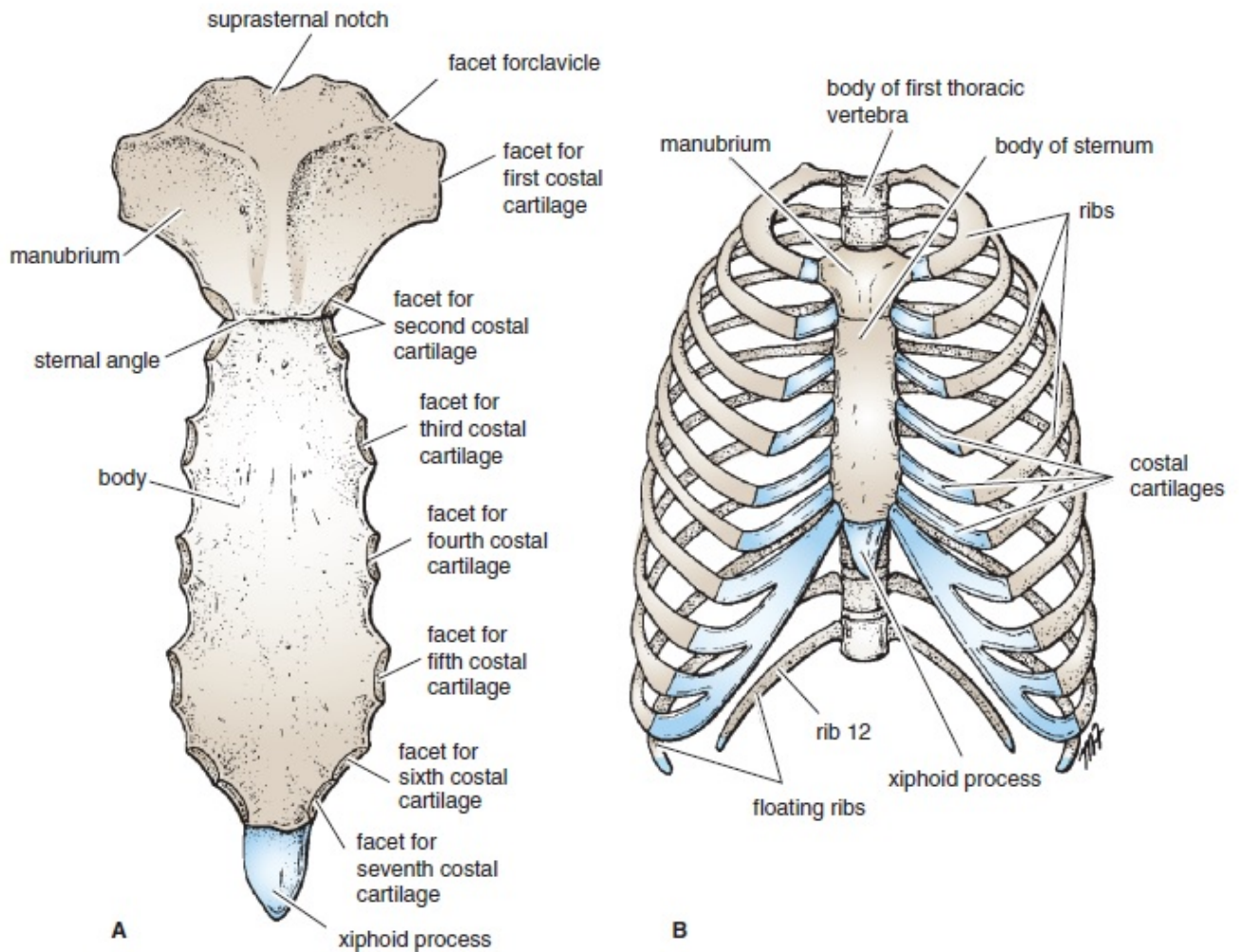
The thoracic wall is formed posteriorly by the thoracic part of the vertebral column; anteriorly by the sternum and costal cartilages; laterally by the ribs and intercostal spaces; superiorly by the suprapleural membrane; and inferiorly by the diaphragm, which separates the thoracic cavity from the abdominal cavity.

#### ❖ Sternum

The sternum lies in the midline of the anterior chest wall. It is a flat bone that can be divided into three parts: manubrium sterni, body of the sternum, and xiphoid process.

- The **manubrium** is the upper part of the sternum. It articulates with the body of the sternum at the manubriosternal joint, and it also articulates with the clavicles and with the 1st costal cartilage and the upper part of the 2nd costal cartilages on each side.
- The **body of the sternum** articulates above with the manubrium at the **manubriosternal joint** and below with the xiphoid process at the **xiphisternal joint**. On each side, it articulates with the 2nd to the 7th costal cartilages.
- The **xiphoid process** is a thin plate of cartilage that becomes ossified at its proximal end during adult life. No ribs or costal cartilages are attached to it.

The **sternal angle** (angle of Louis), formed by the articulation of the manubrium with the body of the sternum. The sternal angle lies opposite the intervertebral disc between the 4th and 5th thoracic vertebrae.



A. Anterior view of the sternum. B. Sternum, ribs, and costal cartilages forming the thoracic skeleton.

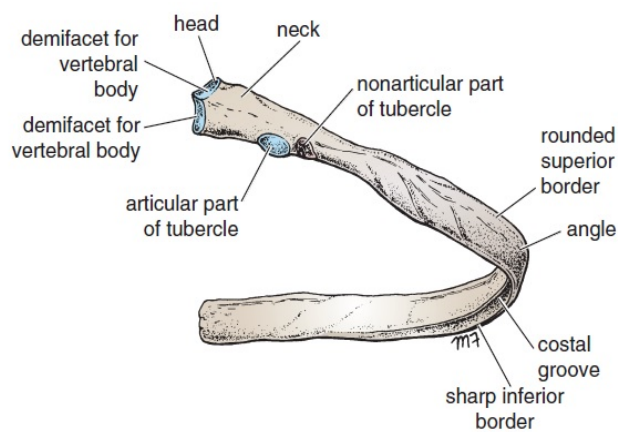
### ❖ Ribs

There are 12 pairs of ribs, all of which are attached posteriorly to the thoracic vertebrae. The ribs are divided into three categories:

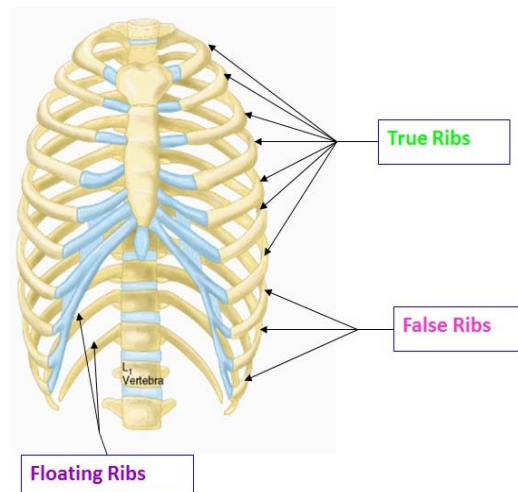
**True ribs:** The upper seven pairs are attached anteriorly to the sternum by their costal cartilages.

**False ribs:** The 8th, 9th, and 10th pairs of ribs are attached anteriorly to each other and to the 7th rib by means of their costal cartilages and small synovial joints.

**Floating ribs:** The 11th and 12th pairs have no anterior attachment.



Fifth right rib, as seen from the posterior aspect.



## Typical Rib

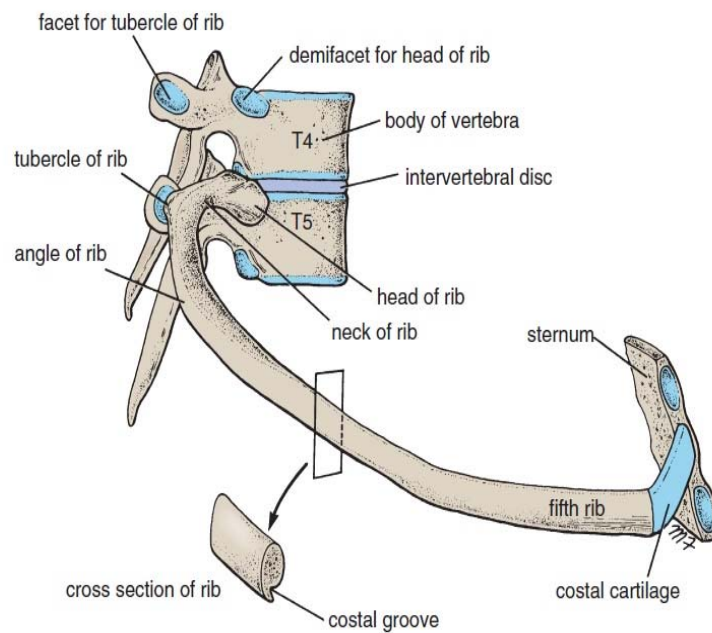
A typical rib is a long, twisted, flat bone having a rounded, smooth superior border and a sharp, thin inferior border. The inferior border overhangs and forms the **costal groove**, which accommodates the intercostal vessels and nerve. The anterior end of each rib is attached to the corresponding costal cartilage.

A rib has a **head, neck, tubercle, shaft, and angle**. The **head** has two facets for articulation with the numerically corresponding vertebral body and that of the vertebra immediately above. The **neck** is a constricted portion situated between the head and the tubercle. The **tubercle** is a prominence on the outer surface of the rib at the junction of the neck with the shaft. It has a facet for articulation with the transverse process of the numerically corresponding vertebra. The **shaft** is thin and flattened and twisted on its long axis. Its inferior border has the costal groove. The **angle** is where the shaft of the rib bends sharply forward.

### ❖ Costal Cartilages

Costal cartilages are bars of cartilage connecting the **upper seven ribs** to the lateral edge of the sternum and the **8th, 9th, and 10th ribs** to the cartilage immediately above. The cartilages of the **11th and 12th ribs** end in the abdominal musculature.

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 their flexibility as the result of superficial calcification.



Fifth right rib as it articulates with the vertebral column posteriorly and the sternum anteriorly. Note that the rib head articulates with the vertebral body of its own number and that of the vertebra immediately above. Note also the presence of the costal groove along the inferior border of the rib.

## Joints of the Chest Wall

### ❖ Joints of the Sternum

The **manubriosternal joint** is a cartilaginous joint between the manubrium and the body of the sternum. A small amount of angular movement is possible during respiration. The **xiphisternal joint** is a cartilaginous joint between the xiphoid process (cartilage) and the body of the sternum. The xiphoid process usually fuses with the body of the sternum during middle age.

### ❖ Joints of the Ribs

#### ▪ Joints of the Heads of the Ribs

The 1st rib and the three lowest ribs have a single synovial joint with their corresponding vertebral body. For the 2nd to 9th ribs, the head articulates by means of a synovial joint with the corresponding vertebral body and that of the vertebra above it. There is a strong **intraarticular ligament** that connects the head to the intervertebral disc.

#### ▪ Joints of the Tubercles of the Ribs

The tubercle of a rib articulates by means of a synovial joint with the transverse process of the corresponding vertebra. (This joint is absent on the 11th and 12th ribs.)

#### ▪ Joints of the Ribs and Costal Cartilages

These joints are cartilaginous joints. No movement is possible.

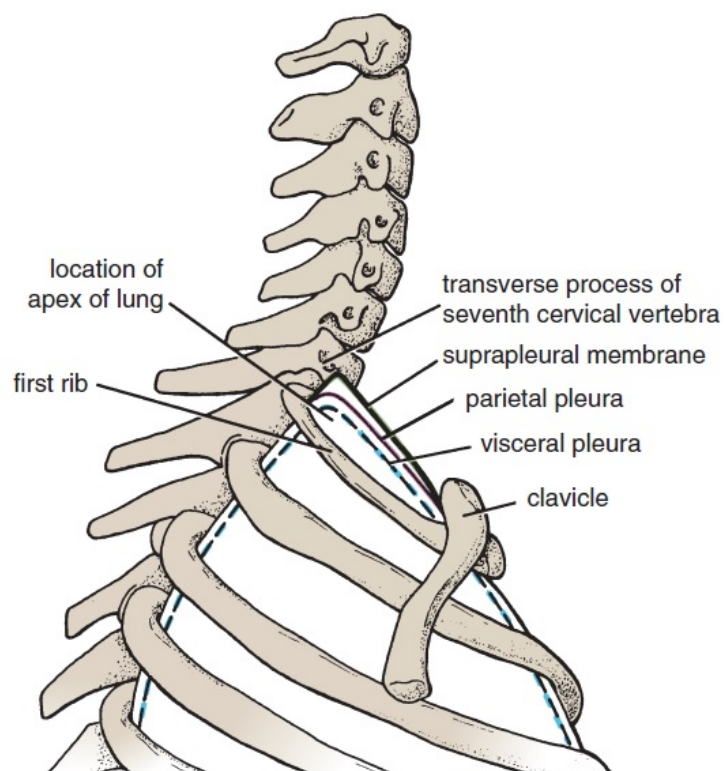
### ▪ Joints of the Costal Cartilages with the Sternum

The 1st costal cartilages articulate with the manubrium, by cartilaginous joints that permit no movement.

The 2nd to 7th costal cartilages articulate with the lateral border of the sternum by synovial joints. In addition, the 6th, 7th, 8th, 9th, and 10th costal cartilages articulate with one another along their borders by small synovial joints. The cartilages of the 11th and 12th ribs are embedded in the abdominal musculature.

### ❖ Suprapleural Membrane

Superiorly, the thorax opens into the root of the neck by a narrow aperture, the **thoracic outlet**. The outlet transmits structures that pass between the thorax and the neck (esophagus, trachea, blood vessels, etc.) and for the most part lie close to the midline. On either side of these structures, the outlet is closed by a dense fascial layer called the **suprapleural membrane**.



### ❖ Diaphragm

The diaphragm is a thin muscular and tendinous septum that separates the chest cavity above from the abdominal cavity below. It is pierced by the structures that pass between the chest and the abdomen.

The diaphragm is the most important muscle of respiration.

It is dome shaped and consists of a peripheral muscular part, which arises from the margins of the thoracic opening, and a centrally placed tendon.

The origin of the diaphragm can be divided into three parts:

- A **sternal part** arising from the posterior surface of the xiphoid process.
- A **costal part** arising from the deep surfaces of the lower six ribs and their costal cartilages.
- A **vertebral part** arising by vertical columns

### ▪ Shape of the Diaphragm

As seen from in front, the diaphragm curves up into *right and left domes*. The **right dome** reaches as high as the upper border of the 5th rib, and the **left dome** may reach the lower border of the 5th rib. (The right dome lies at a higher level, because of the large size of the right lobe of the liver.) The central tendon lies at the level of the xiphisternal joint. The domes support the right and left lungs, whereas the central tendon supports the heart.

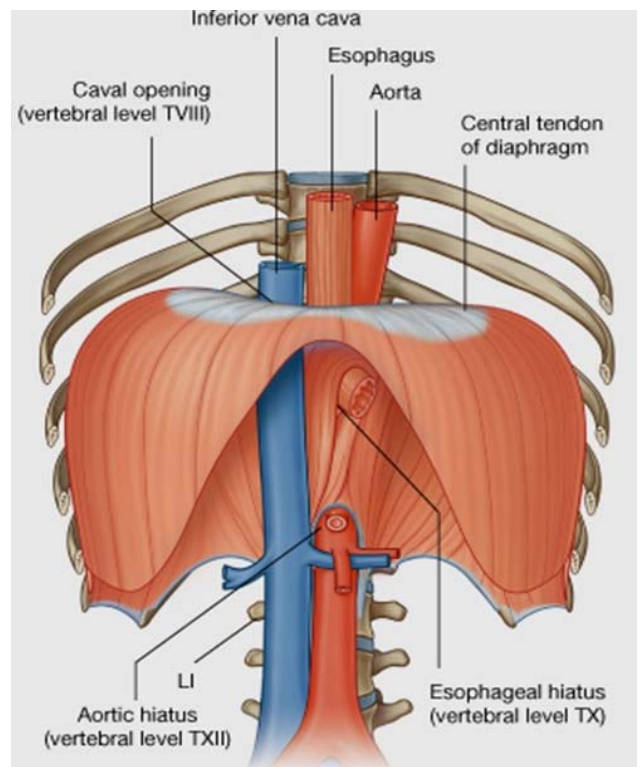
### Action of the Diaphragm

On contraction, the diaphragm pulls down its central tendon and increases the vertical diameter of the thorax.

### Openings in the Diaphragm

The diaphragm has three main openings:

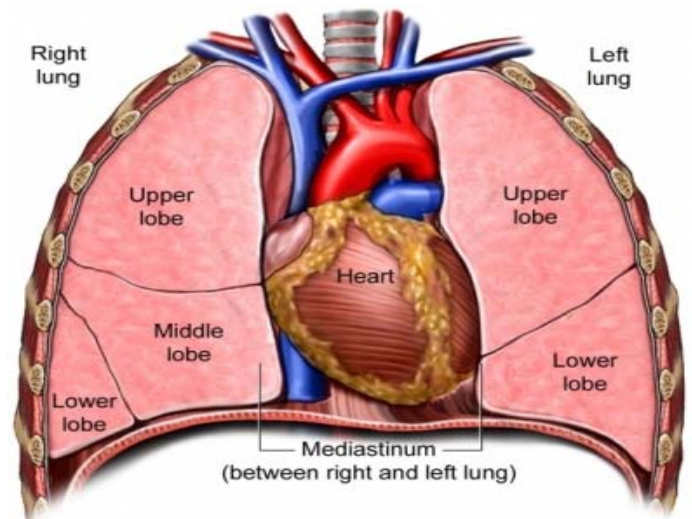
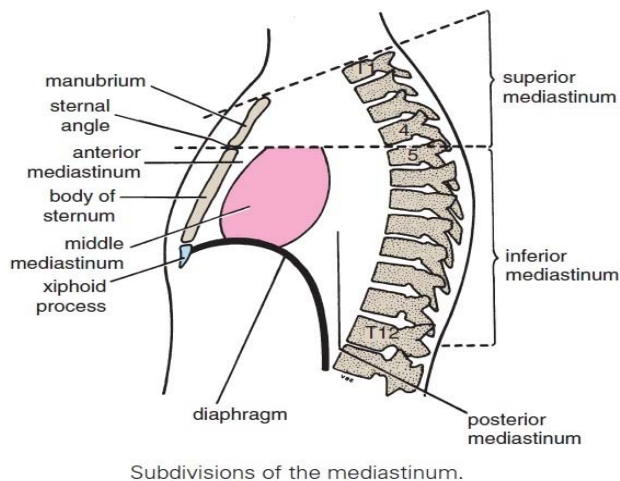
- 1) **The aortic opening** lies anterior to the body of the 12th thoracic vertebra. It transmits the aorta, the thoracic duct, and the azygos vein.
- 2) **The esophageal opening** lies at the level of the 10th thoracic vertebra. It transmits the esophagus, the right and left vagus nerves.
- 3) **The caval opening** lies at the level of the 8th thoracic vertebra in the central tendon. It transmits the inferior vena cava and terminal branches of the right phrenic nerve.



### Mediastinum

The mediastinum, though thick, is a movable partition that extends superiorly to the thoracic outlet and the root of the neck and inferiorly to the diaphragm. It extends anteriorly to the sternum and posteriorly to the vertebral column. It contains the remains of the thymus, the heart and large blood vessels, the trachea and esophagus, the thoracic duct and lymph nodes, the vagus and phrenic nerves, and the sympathetic trunks.

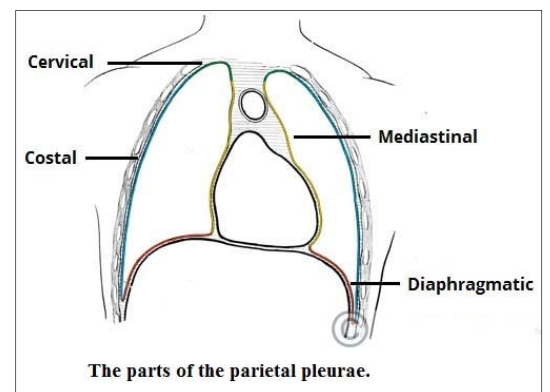
The mediastinum is divided into **superior** and **inferior mediastina** by an imaginary plane passing from the sternal angle anteriorly to the lower border of the body of the 4th thoracic vertebra posteriorly. The inferior mediastinum is further subdivided into the **middle mediastinum**, which consists of the pericardium and heart; the **anterior mediastinum**, which is a space between the pericardium and the sternum; and the **posterior mediastinum**, which lies between the pericardium and the vertebral column.



## ■ Pleurae

The pleurae and lungs lie on either side of the mediastinum within the chest cavity. Each pleura has two parts: a **parietal layer** and a **visceral layer**.

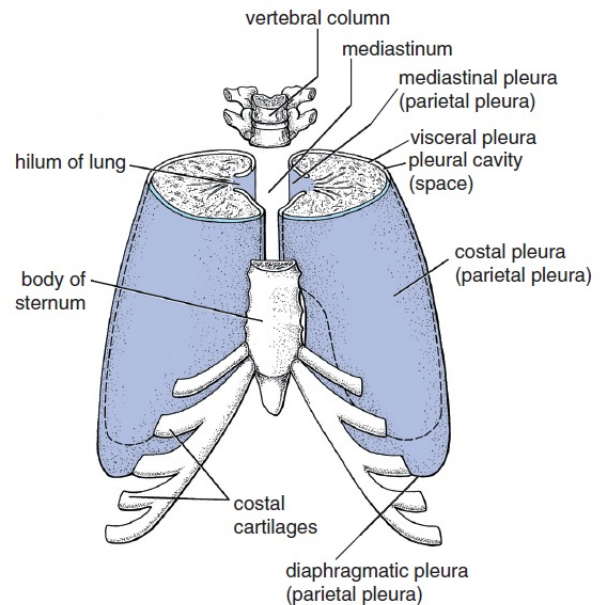
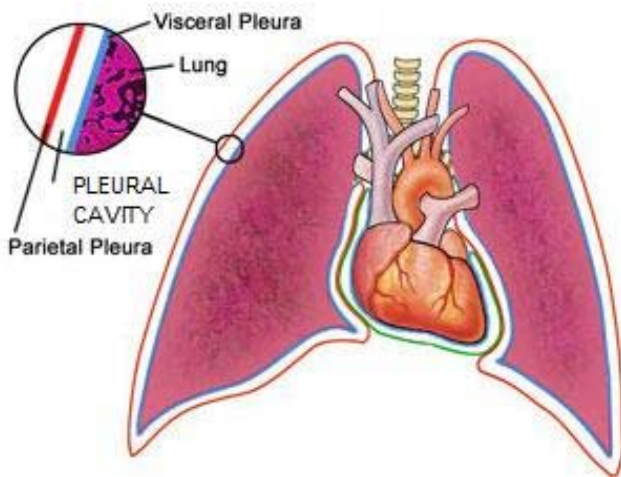
- **Parietal layer** which lines the thoracic wall, divided according to the region in which it lies or the surface that it covers:
  1. **Cervical pleura** extends up into the neck, lining the undersurface of the suprapleural membrane.
  2. **Costal pleura** lines the inner surfaces of the ribs, the costal cartilages, the intercostal spaces, the sides of the vertebral bodies, and the back of the sternum.
  3. **Diaphragmatic pleura** covers the thoracic surface of the diaphragm.
  4. **Mediastinal pleura** covers and forms the lateral boundary of the mediastinum.
- **Visceral layer** which completely covers the outer surfaces of the lungs and extends into the depths of the interlobar fissures.



The two layers become continuous with one another by means of a cuff of pleura that surrounds the structures entering and leaving the lung at the hilum of each lung.

The parietal and visceral layers of pleura are separated from one another by a slitlike space, the **pleural cavity or pleural space**.

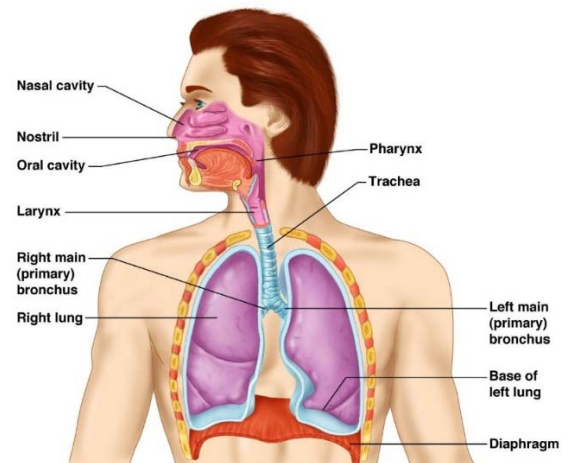
The pleural cavity normally contains a small amount of tissue fluid, the **pleural fluid**, which covers the surfaces of the pleura as a thin film and permits the two layers to move on each other with the minimum of friction.



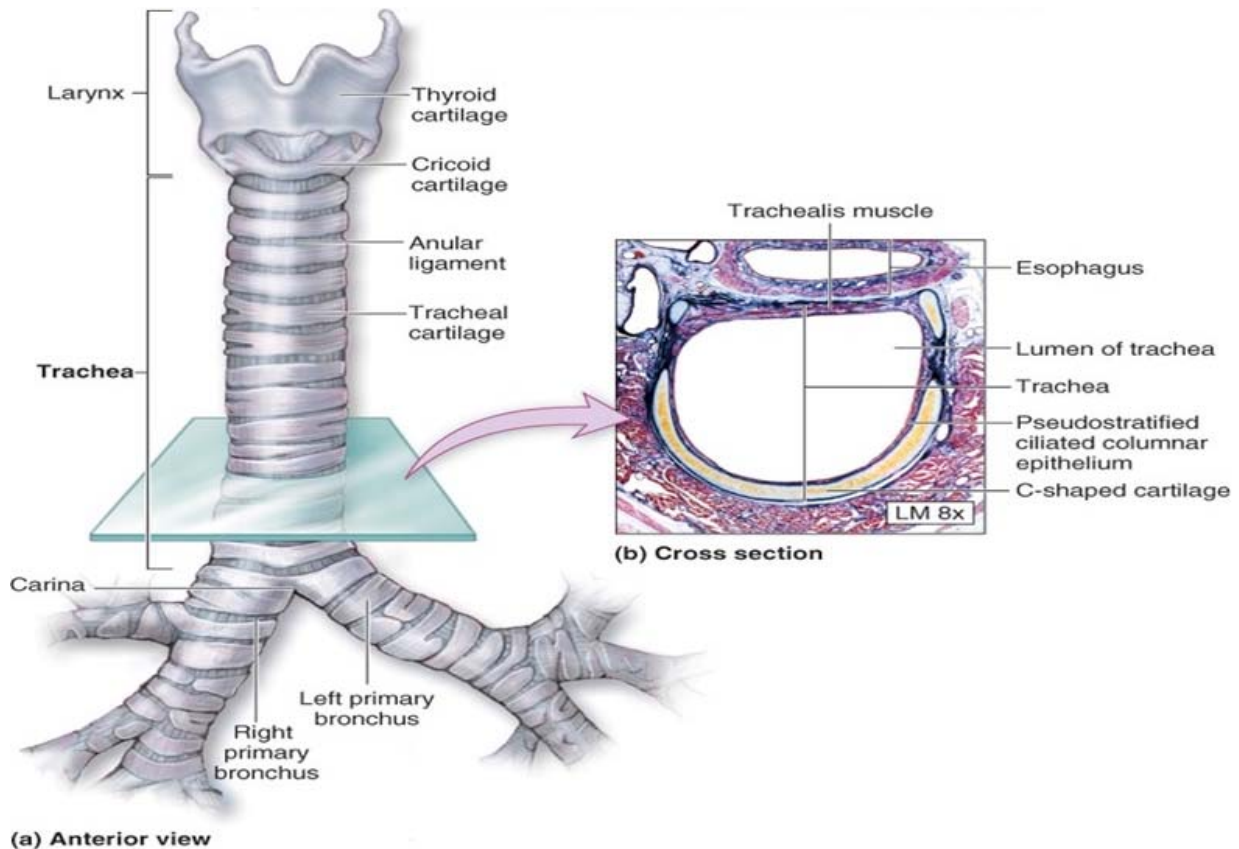
## ▪ Trachea

The trachea is a mobile cartilaginous and membranous tube. It begins in the neck as a continuation of the larynx at the level of the 6th cervical vertebra. It descends in the midline of the neck. In the thorax, the trachea ends below at the **carina** by dividing into right and left principal (main) bronchi at the level of the sternal angle (opposite the disc between the 4th and 5th thoracic vertebrae).

In adults, the trachea is about (11.25 cm) long and (2.5 cm) in diameter. The fibroelastic tube is kept patent by the presence of U-shaped bars (rings) of hyaline cartilage embedded in its wall. The posterior free ends of the cartilage are connected by smooth muscle, the **trachealis muscle**.







### Blood Supply of the Trachea

- Upper two thirds → the inferior thyroid arteries
- Lower third → the bronchial arteries.

### Nerve Supply of the Trachea

Sensory nerve supply → from the vagi and the recurrent laryngeal nerves.  
 Sympathetic nerves → supply the trachealis muscle.

### ▪ The Bronchi

The trachea bifurcates behind the arch of the aorta into the **right and left principal (primary or main) bronchi**. The bronchi divide dichotomously, giving rise to several million terminal bronchioles that terminate in one or more respiratory bronchioles.

### Principal Bronchi

- The **right principal (main) bronchus** is wider, shorter, and more vertical than the left and is about (2.5 cm) long. The right principal bronchus gives off the **superior lobar bronchus**, **middle** and an **inferior lobar bronchus**.
- The **left principal (main) bronchus** is narrower, longer, and more horizontal than the right and is about (5 cm) long.

The left principal bronchus divides into a **superior** and an **inferior lobar bronchus**.

