

Thorax, Part II: Thoracic Cavity

A nice story, do not miss.

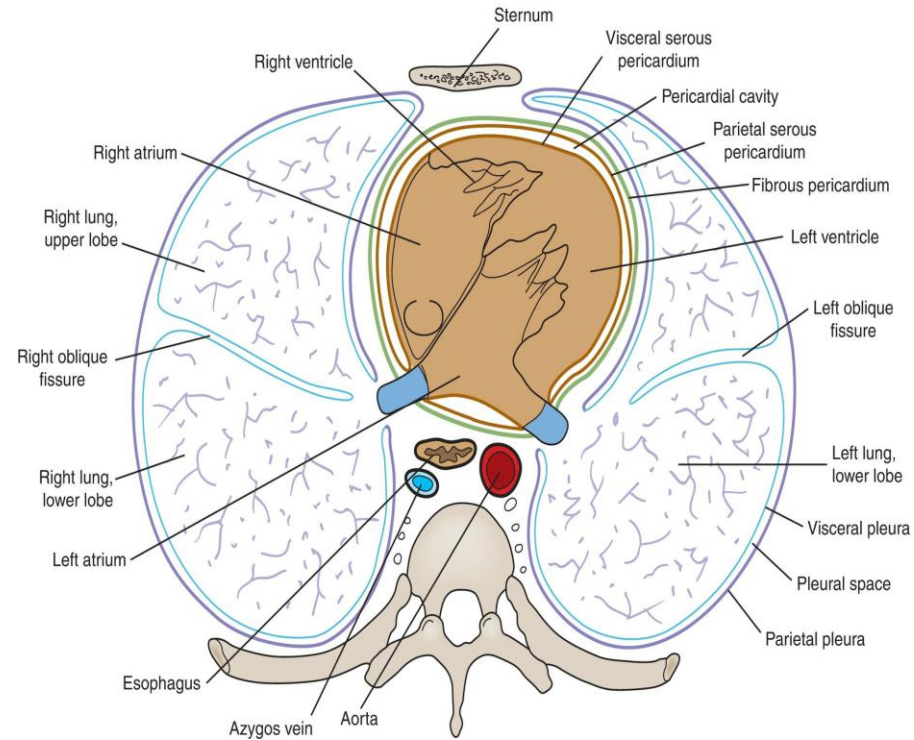
A 54-year-old woman visited the emergency department with a complaint of a sudden excruciating knifelike pain in the front of her chest. During the course of examination, she said she could also feel the pain in her back between the shoulder blades. On close questioning, she said she felt no pain down the arms or in the neck. Her blood pressure was 200/110 mm Hg in the right arm and 120/80 mm Hg in the left arm. The evaluation of chest pain is one of the most common problems facing an emergency physician. The cause can vary from the simple to one of life-threatening proportions. The severe nature of the pain and its radiation to the back made a preliminary diagnosis of aortic dissection a strong possibility. Myocardial infarction commonly results in referred pain down the inner side of the arm or up into the neck. Pain impulses originating in a diseased descending thoracic aorta pass to the central nervous system along the path of sympathetic nerves and are then referred along the somatic spinal nerves to the skin of the anterior and posterior chest walls. In this patient, the aortic dissection had partially blocked the origin of the left subclavian artery, which would explain the lower blood pressure recorded in the left arm.

Thoracic Cavity

The thoracic cavity can be divided into:

1. **Median** part, called the **mediastinum**, and
2. **Lateral** part, formed by **pleural membranes and lungs (pleural cavities)**.

The **pleural membrane** covers each lung (**visceral pleura**) passes from each lung at its root and continues onto the inner surface of the thoracic wall (**parietal pleura**), this arrangement of the pleura forms two independent membranous sacs called the **pleural cavities**, one on each side of the thorax, between the lungs and the thoracic walls.

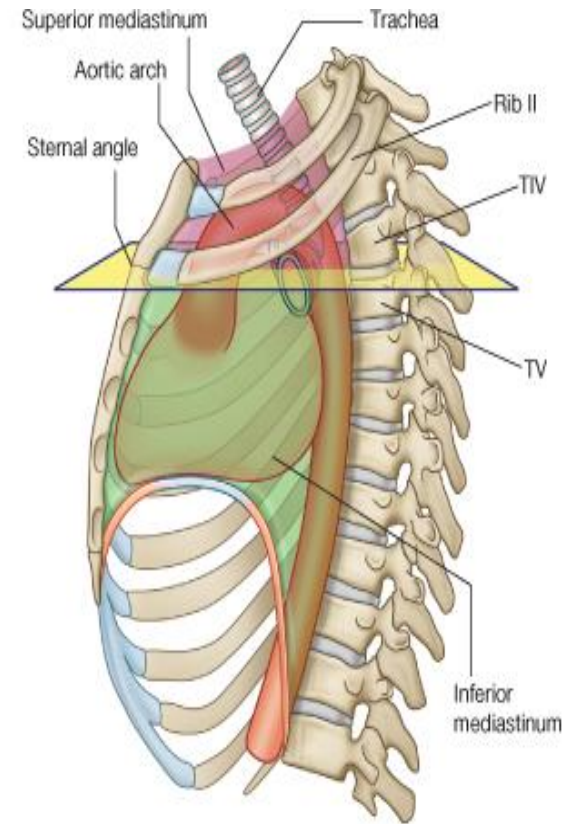


The MEDIASTINUM

The mediastinum is the area of thoracic cavity located between the sternum anteriorly, the two pleural cavities laterally, the vertebral column posteriorly, the thoracic outlet and the root of the neck superiorly, and the diaphragm inferiorly. It contains

1. the thymus, 2. the heart and large blood vessels, 3. the trachea, 4. esophagus, 5. the thoracic duct, 6. lymph nodes, 7. the vagi, 8. phrenic nerves, and the 9. sympathetic trunks.

The mediastinum is divided into **superior** and **inferior mediastina** by an imaginary plane passing from the sternal angle anteriorly to the intervertebral disc between 4th and 5th thoracic vertebrae.

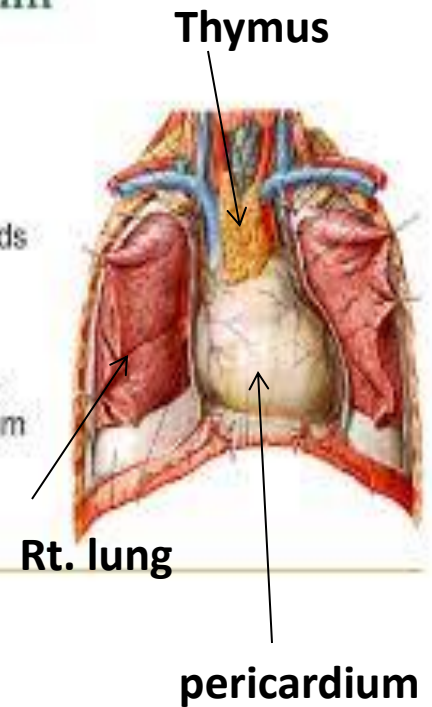


The imaginary plan that separate the **superior and inferior mediastinum** represent an important landmark in that it marks several key structures. From anterior to posterior, these are

- 1) **The manubriosternal joint**
- 2) **Second costosternal joint**
- 3) **Demarcation between the ascending aorta and the arch of the aorta,**
- 4) **Demarcation between the arch of the aorta and the descending thoracic aorta,**
- 5) **Bifurcation of the trachea,**
- 6) **Level of the left main bronchus,**
- 7) **intervertebral disc between T4 and T5 vertebrae.**

The Mediastinum

Concept all of organs between the left and right mediastinal pleurae is called mediastinum. It extends from the sternum in front to the vertebral column behind, and from the thoracic inlet above to the diaphragm below.

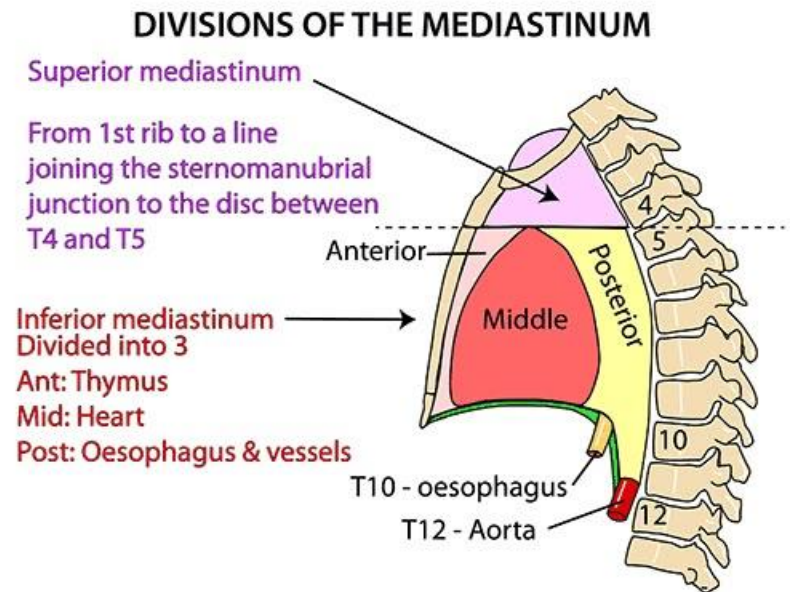


The inferior mediastinum is further subdivided into the **middle mediastinum**, which consists of the **pericardium and heart**; the **anterior mediastinum**, which is a space between the pericardium and the sternum; and the **posterior mediastinum**, which lies between the pericardium and the vertebral column.

The major mediastinal structures are arranged in the following order from anterior to posterior.

Superior Mediastinum

1)Thymus, (2) large veins, (3) large arteries, (4) trachea, (5) esophagus and thoracic duct, and (6) sympathetic trunks. The superior mediastinum is bounded in front by the manubrium sterni and behind by **the first four thoracic vertebrae** .



MEDIASTINUM

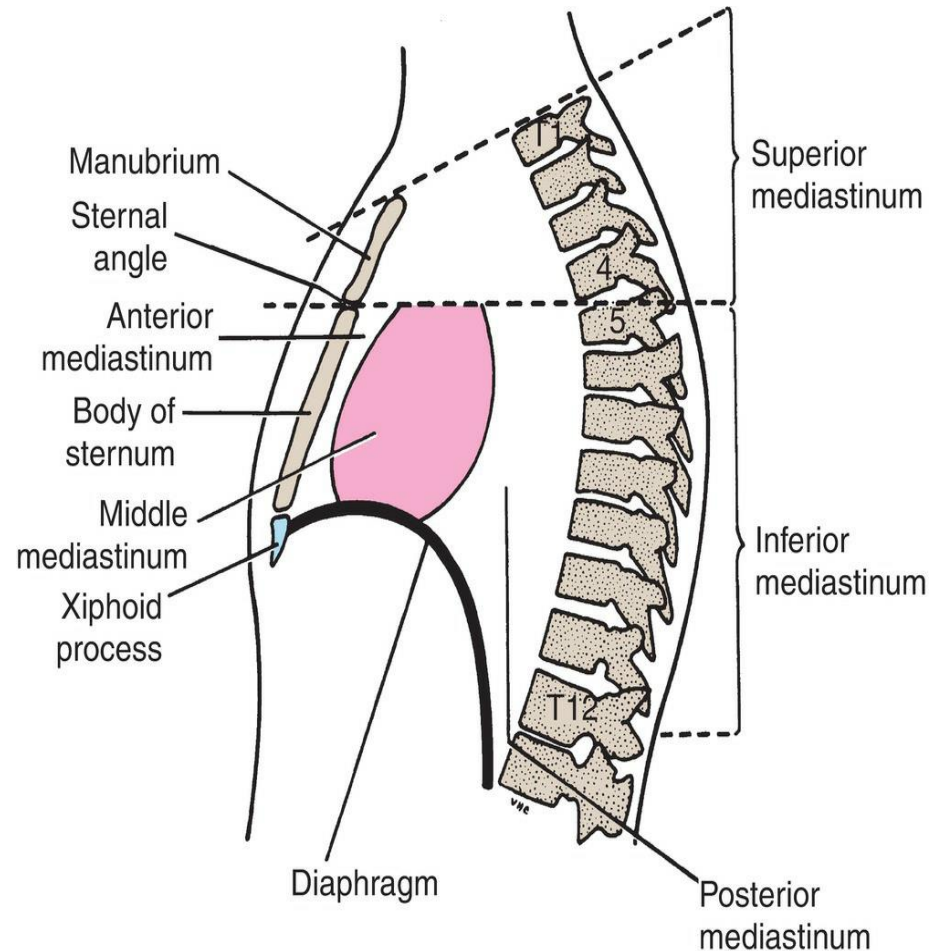
The area in the thorax that lies between the lungs. Note that although the lungs reach up above the front of the 1st rib, the mediastinum does not.

The great vessels lie in the superior mediastinum, the thymus and fat in the anterior part of the inferior, the heart in the middle and the oesophagus & aorta in the posterior parts of the inferior mediastinum

Inferior Mediastinum

- (1) Thymus,
- (2) heart within the pericardium with the phrenic nerves on each side,
- (3) esophagus and thoracic duct,
- (4) descending aorta, and
- (5) sympathetic trunks.

The inferior mediastinum is bounded in front by the body of the sternum and behind by the lower eight thoracic vertebrae



Summary of mediastinum

DIVISIONS OF THE MEDIASTINUM

Superior mediastinum

From 1st rib to a line joining the sternomanubrial junction to the disc between T4 and T5

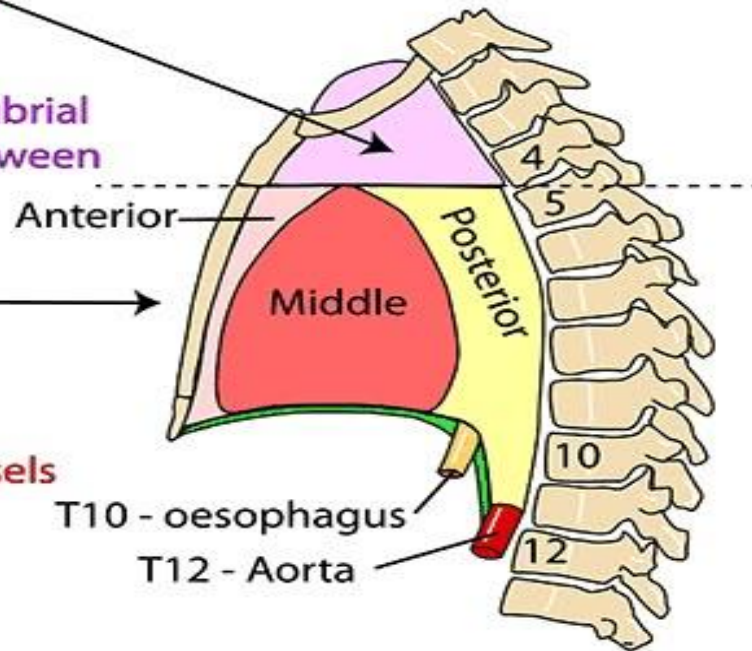
Inferior mediastinum

Divided into 3

Ant: Thymus

Mid: Heart

Post: Oesophagus & vessels



MEDIASTINUM

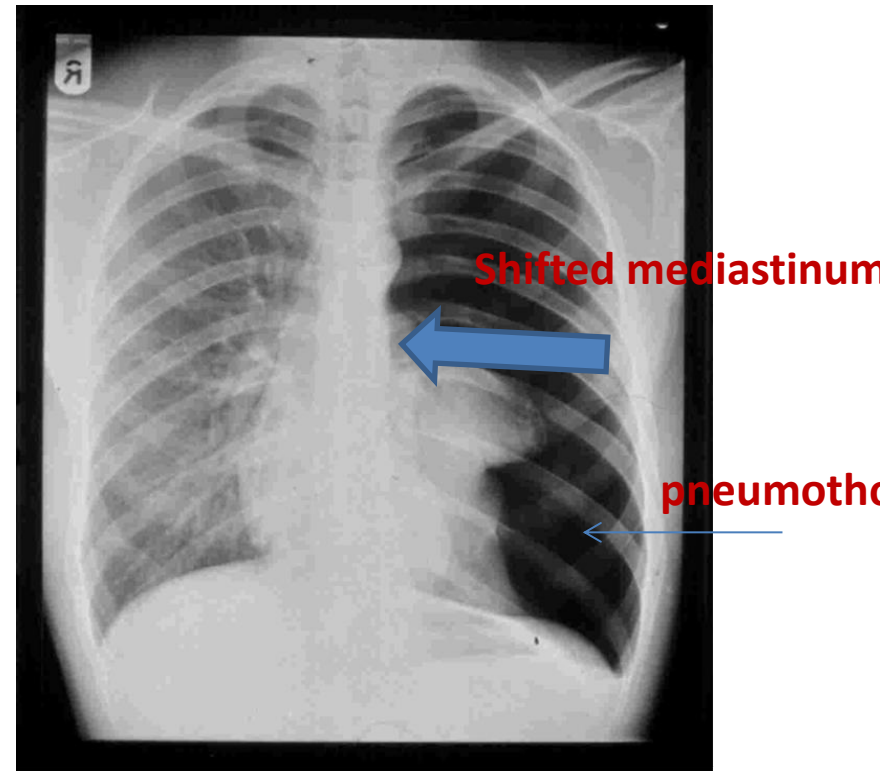
The area in the thorax that lies between the lungs. Note that although the lungs reach up above the front of the 1st rib, the mediastinum does not.

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Clinical Notes

Deflection of the Mediastinum (mediastinal shift)

If air enters the pleural cavity, due to stab wound or fractured rib, (a condition called **pneumothorax**), the lung on that side immediately collapses and the mediastinum is displaced to the opposite side. This condition reveals itself by the patient being breathless and in a state of shock; on examination, the trachea and the heart are displaced to the opposite side.

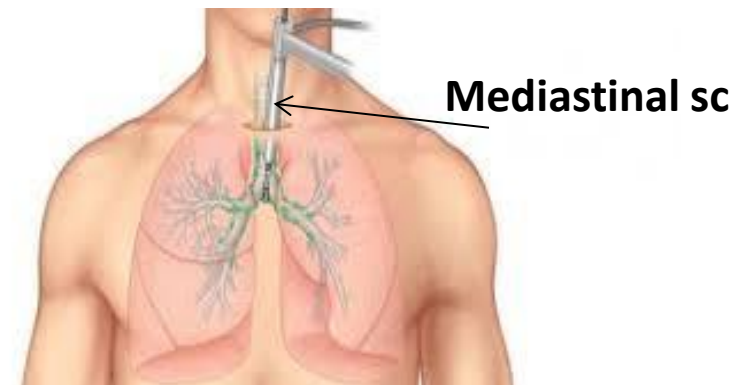
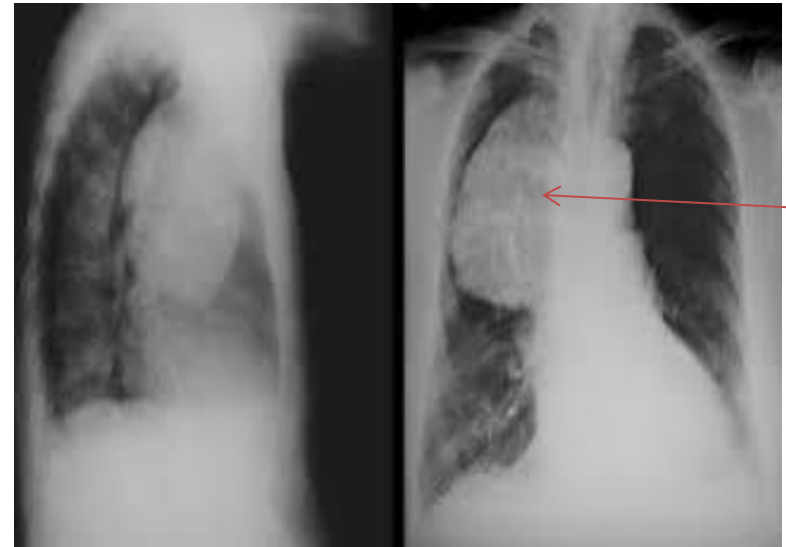


Mediastinal Tumors or Cysts

A tumor of the left lung can rapidly spread to involve the mediastinal lymph nodes, which on enlargement may compress the left recurrent laryngeal nerve, producing paralysis of the left vocal fold. An expanding cyst or tumor can partially occlude the superior vena cava, causing severe congestion of the veins of the upper part of the body.

Mediastinoscopy

Mediastinoscopy is a diagnostic procedure whereby specimens of tracheobronchial lymph nodes are obtained without opening the pleural cavities. A small incision is made in the midline in the neck just above the suprasternal notch, and the superior mediastinum is explored down to the region of the bifurcation of the trachea. The procedure can be used to determine the diagnosis and degree of spread of carcinoma of the bronchus (bronchogenic carcinoma).



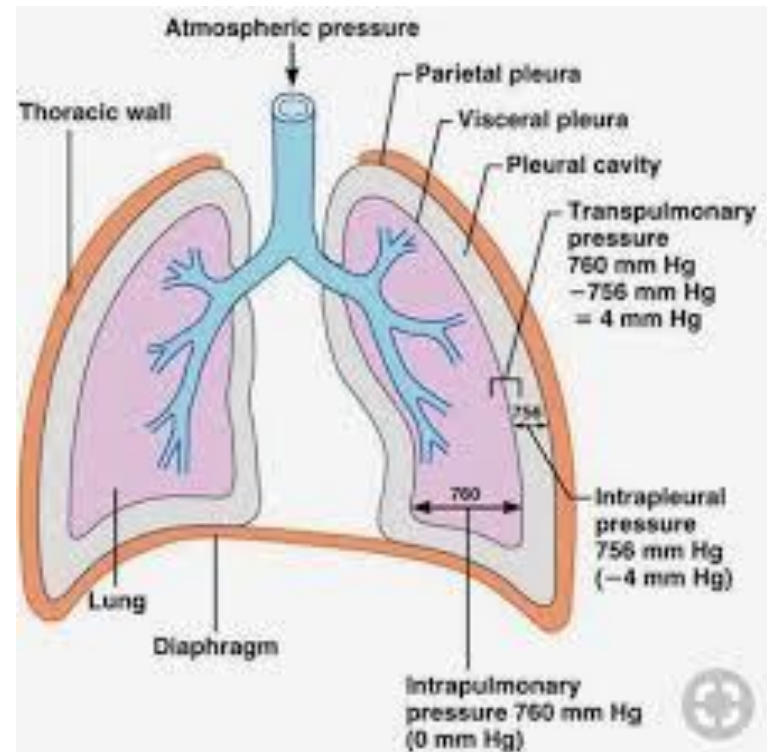
The PLEURAE

The pleurae and lungs lie on either side of the mediastinum within the thoracic cavity. Each pleural membrane has two parts: a

The parietal layer and a **visceral layer**.

The parietal layer lines the thoracic wall, covers the thoracic surface of the diaphragm and the lateral aspect of the mediastinum, and extends into the root of the neck to line the undersurface of the **suprapleural** membrane at the thoracic outlet.

The visceral layer completely covers the outer surface of the lung and extends into the depths of the interlobar fissures. It is thinner than the parietal layer.

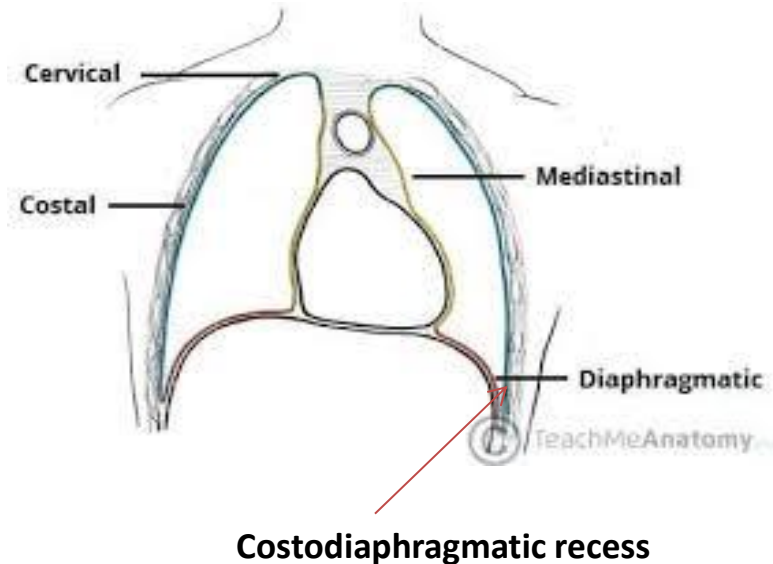


The parietal pleura is divided according to the region in which it lies or the surface that it covers .

The cervical pleura (cupula) extends up into the neck, lining the undersurface of the suprapleural membrane. It reaches a level of 2.5 to 4 cm above the medial third of the clavicle.

The 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.

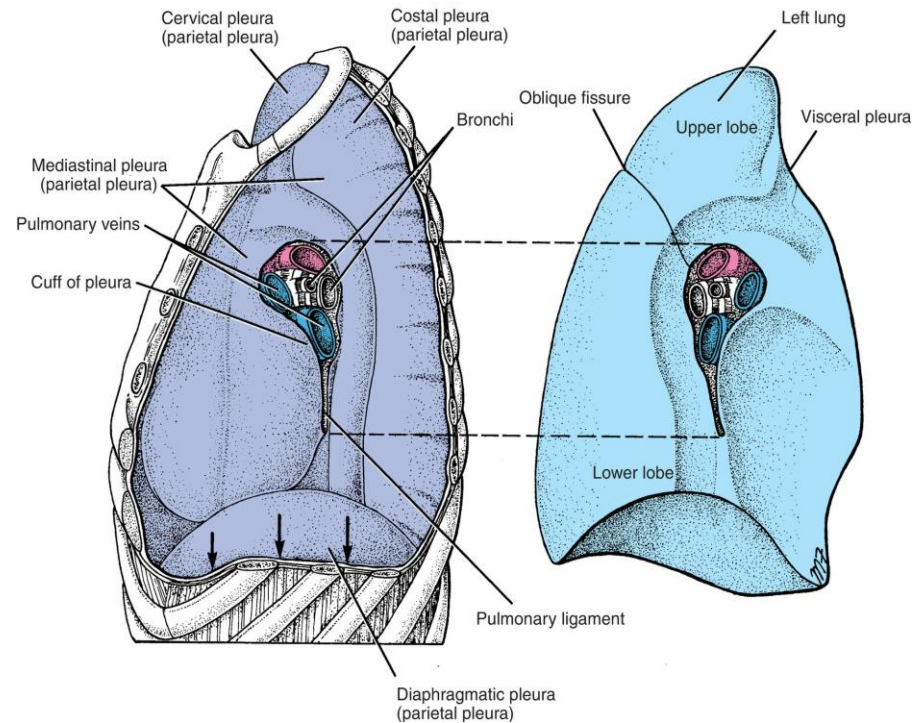
The diaphragmatic pleura covers the thoracic surface of the diaphragm. In quiet respiration, the costal and diaphragmatic pleurae are in apposition to each other below the lower border of the lung. In deep inspiration, the margins of the base of the lung descend, and the costal and diaphragmatic pleurae separate. This lower area of the pleural cavity into which the lung expands on inspiration is referred to as the **costodiaphragmatic recess**.



Layers and Cavity of pleura

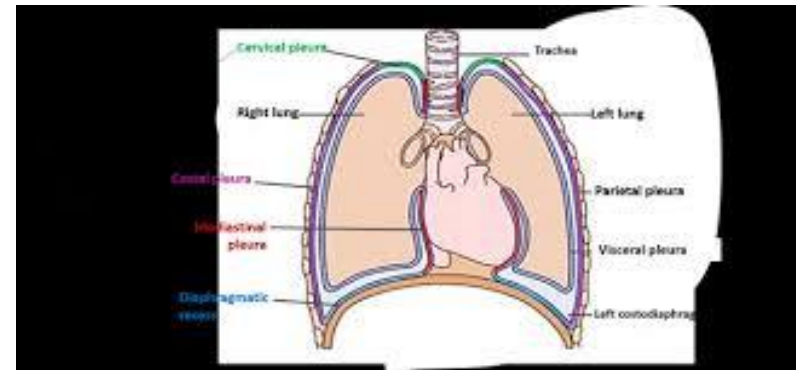
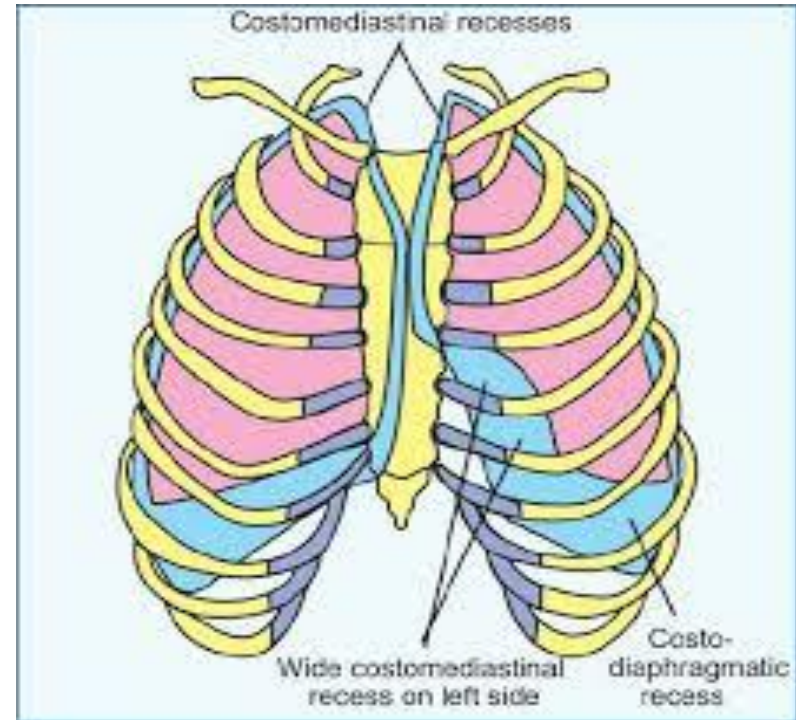
The two layers of pleura are continuous with one another **via a cuff of pleura** that surrounds the **structures entering and leaving the lung at the hilum of each lung**. This cuff hangs down as a loose fold called the **pulmonary ligament** and allows for movement of the pulmonary vessels and large bronchi during respiration.

The parietal and visceral layers of pleura are separated from one another by a slit-like space, the **pleural cavity**. The pleural cavity normally contains only a small amount of fluid, the **pleural fluid**. Pleural fluid lubricates surfaces of the pleura as a thin film, and permits them to move on each other with minimal friction. Thus, the pleural cavity is a potential space under normal conditions.



The **mediastinal pleura** covers and forms the lateral boundary of the mediastinum. It reflects as a cuff around the vessels and bronchi at the hilum of the lung and here becomes continuous with the visceral pleura. In deep inspiration, the margins of the base of the lung descend, and the costal and diaphragmatic pleurae separate. This lower area of the pleural cavity into which the lung expands on inspiration is referred to as the **costodiaphragmatic recess**

The **costomediastinal recesses** are situated along the anterior margins of the pleura. They are slit-like spaces between the costal and mediastinal parietal pleurae, which are separated by a thin layer of pleural fluid. During inspiration and expiration, the anterior borders of the lungs slide in and out of the recesses.



Nerve Supply of pleura

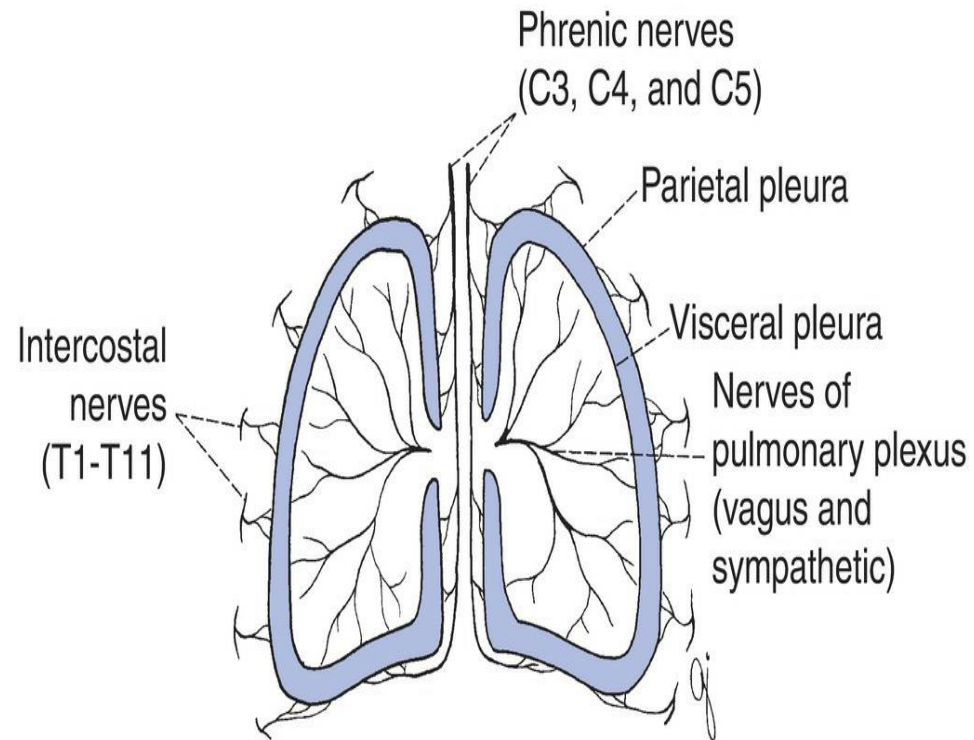
The pleural layers are innervated differently despite being a continuous membrane. Somatic sensory nerves supply of the parietal pleura which is sensitive to pain, temperature, touch, and pressure comes from:

1. The intercostal nerves segmentally supply the costal pleura.

2. The phrenic nerve supplies the mediastinal pleura and the diaphragmatic pleura over the dome.

3. The lower intercostal nerves supply the periphery of the diaphragmatic pleura.

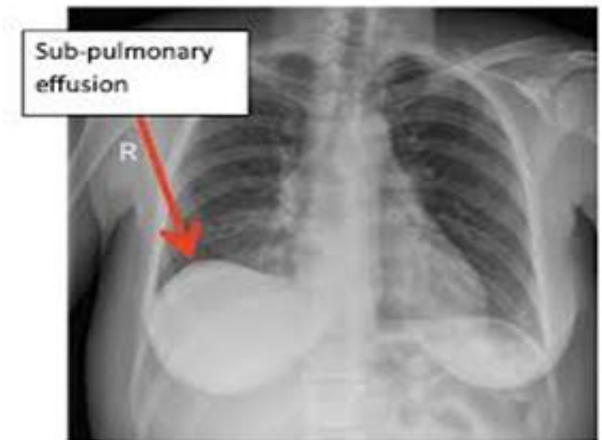
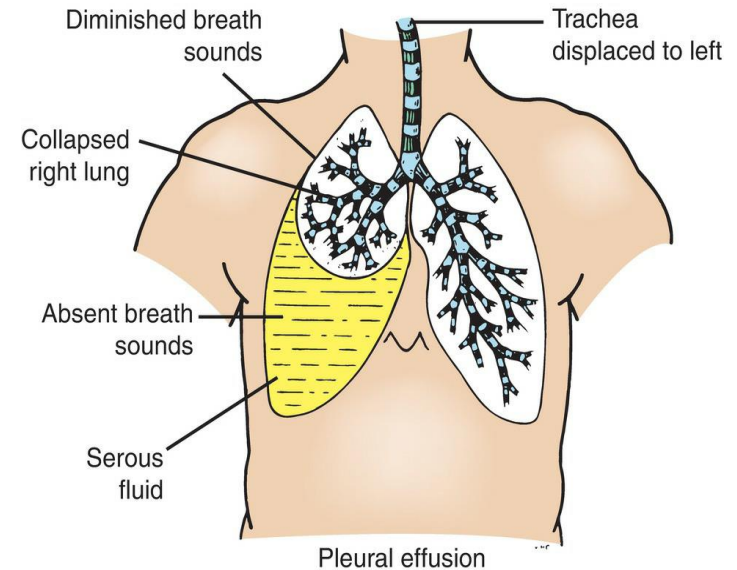
Visceral afferent nerves supply the visceral pleura, which is sensitive to stretch but is insensitive to common sensations such as pain and touch. These nerves run in company with **autonomic nerves from the pulmonary plexus**



Clinical notes

Pleural Fluid (pleural effusion)

The pleural cavity normally contains 5 to 10 mL of clear fluid, which lubricates the apposing surfaces of the visceral and parietal pleurae during respiratory movements. **Hydrostatic and osmotic pressures stimulate formation of the fluid.** Because the hydrostatic pressures are greater in the capillaries of the parietal pleura than in the capillaries of the visceral pleura (pulmonary circulation), the capillaries of the visceral pleura normally absorb the pleural fluid. **Any condition that increases the production of the fluid (e.g., inflammation, malignancy, congestive heart disease) or impairs the drainage of the fluid (e.g., collapsed lung) results in abnormal accumulation of fluid, called a pleural effusion.**

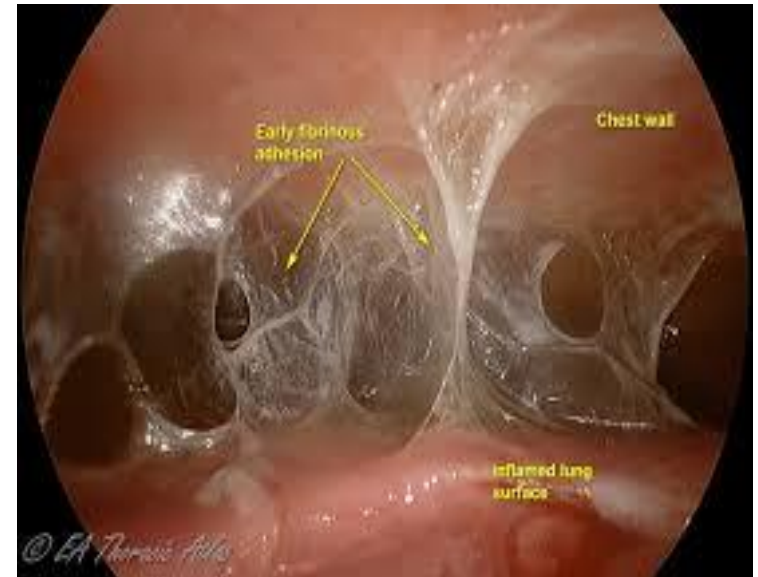


The presence of 300 mL of fluid in the **costodiaphragmatic recess** in an adult is sufficient to enable its clinical detection. **The clinical signs include decreased lung expansion on the side of the effusion, with decreased breath sounds and dullness on percussion over the effusion.**

Pleurisy Inflammation of the pleura (pleuritis or pleurisy), secondary to

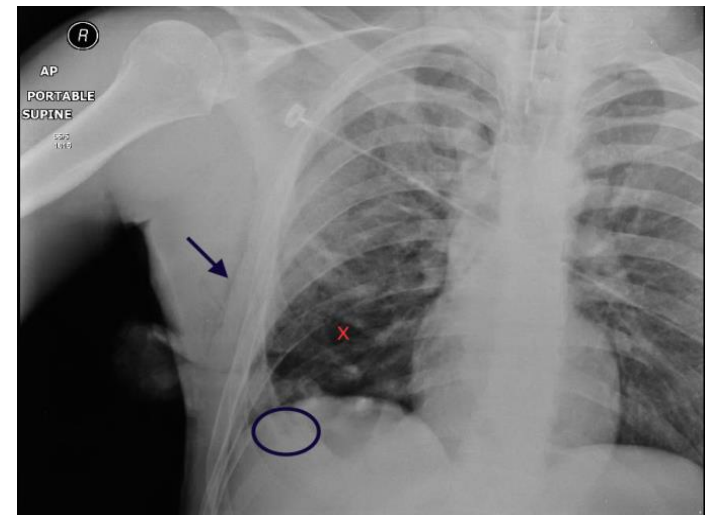
inflammation of the lung (e.g., pneumonia), results in inflammatory exudate covering the pleural surfaces, which causes roughening of the surfaces. This roughening produces friction, which can be heard with the stethoscope as a

pleural rub on inspiration and expiration. Fibroblasts often invade the exudate, resulting in deposition of collagen and formation of **pleural adhesions** that bind the visceral pleura to the parietal pleura.



Pneumothorax, Empyema, and Pleural Effusion.

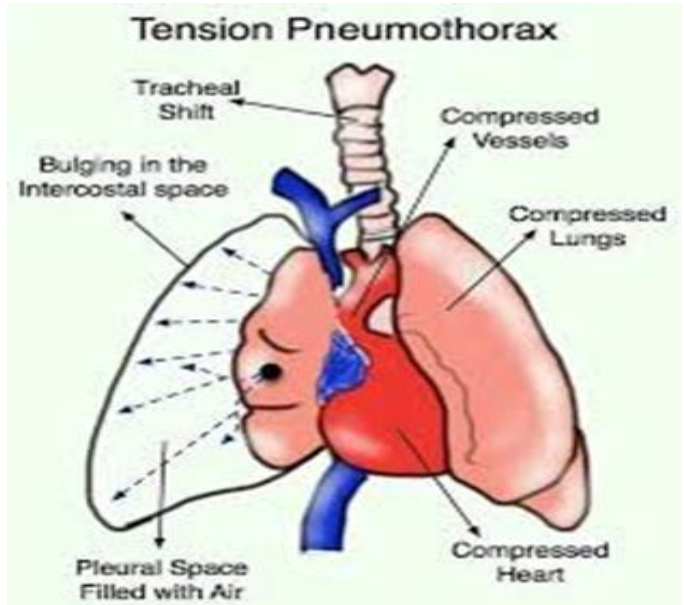
A **pneumothorax** is an abnormal collection of air in the pleural space between the lung and the chest wall. Symptoms typically include sudden onset of sharp, one-sided chest pain and shortness of breath. Air can enter the pleural cavity from the lungs or through the chest wall. Wounds that penetrate the thoracic wall (e.g., stab wounds) may pierce the parietal pleura so that the pleural cavity is open to the outside air. This condition is called **open pneumothorax**. Sometimes, the clothing and the layers of the thoracic wall combine to form a valve so that air enters on inspiration but cannot exit through the wound.



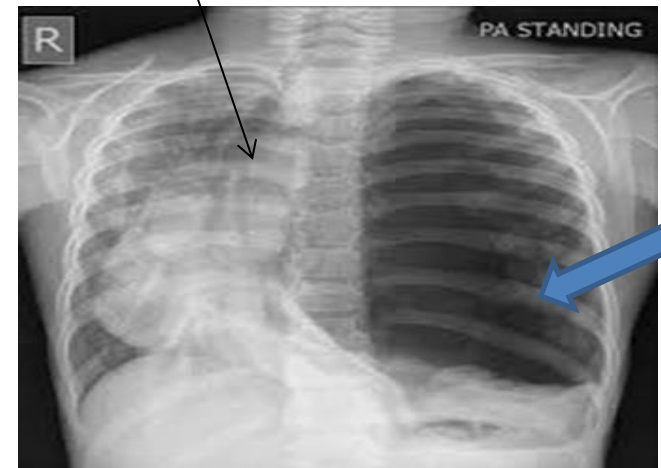
Open pneumothorax

In these circumstances, the air pressure increase gradually on the wounded side and pushes the mediastinum toward the opposite side. In this situation, a collapsed lung is on the injured side, and the opposite lung is compressed by the deflected mediastinum. This dangerous condition is called a **tension pneumothorax**.

When the air enters the pleural cavity suddenly without obvious cause, the condition is called **spontaneous pneumothorax**. Investigation usually reveals that air has entered from a diseased lung and a bulla (bleb) has ruptured.



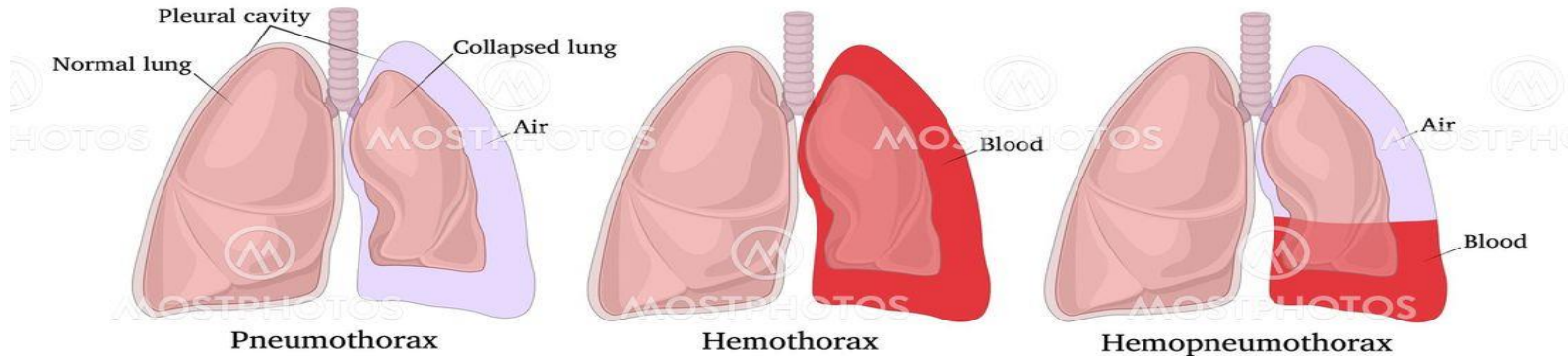
Shifted mediastinum



X-ray of the chest tension pneumothorax

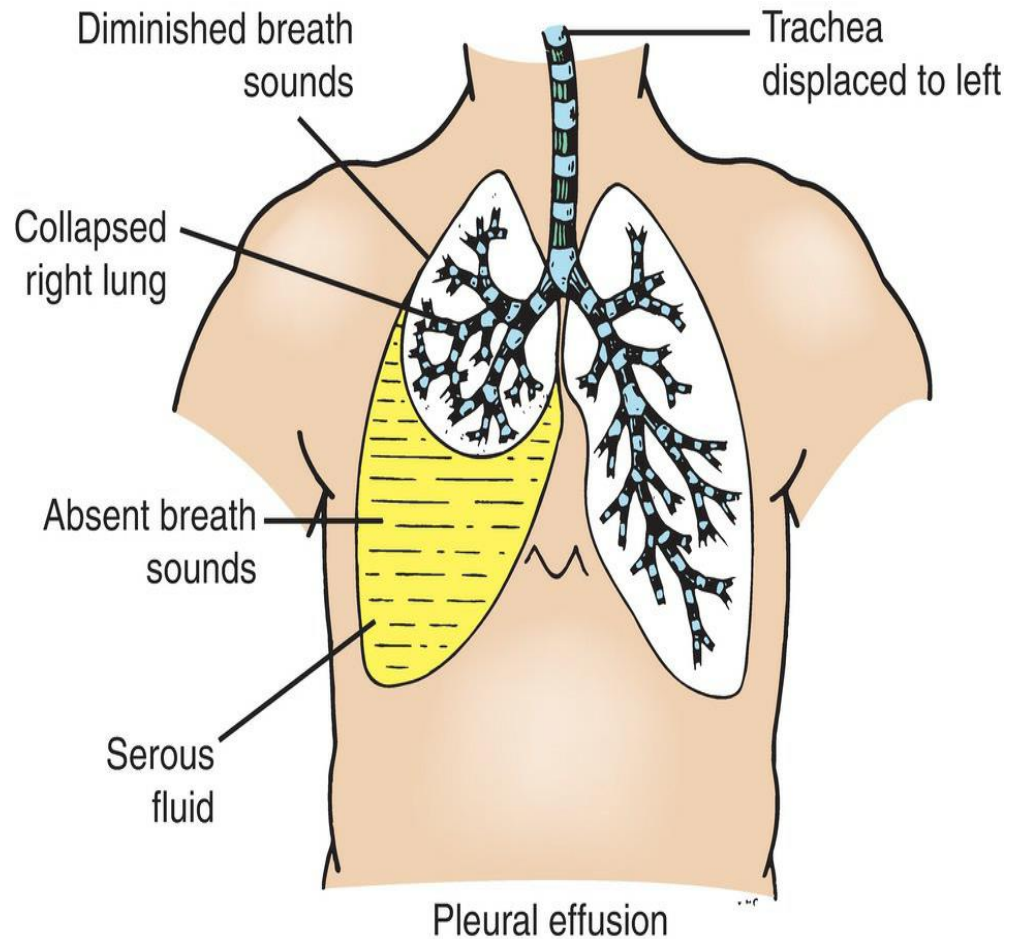
Air in the pleural cavity associated with serous fluid is known as **hydropneumothorax**, associated with pus as **pyopneumothorax**, and associated with blood as **hemopneumothorax**. In hemopneumothorax, trauma to the chest may result in bleeding from blood vessels in the chest wall, from vessels in the chest cavity, or from a lacerated lung. A collection of pus (without air) in the pleural cavity is called an **empyema**.

Pneumothorax, Hemothorax and Hemopneumothorax



The presence of excess serous fluid in the pleural cavity is referred to as a **pleural effusion**. Fluid (serous, blood, or pus) can be drained from the pleural cavity **through a wide-bore needle, needle thoracostomy**).

A case of a right-sided pleural effusion. The mediastinum is displaced to the left, the right lung is compressed, and the bronchi are narrowed. Auscultation would reveal only faint breath sounds over the compressed lung and absent breath sounds over fluid in the pleural cavity.

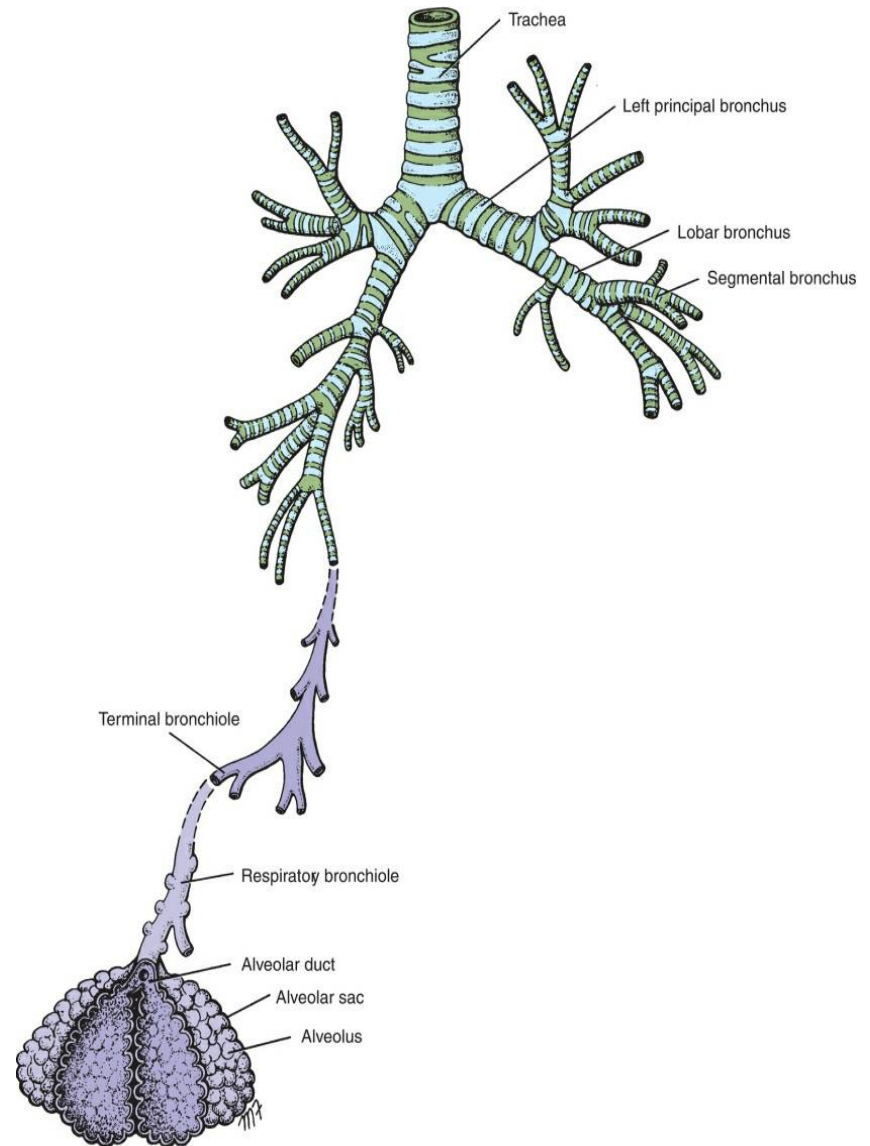


LOWER RESPIRATORY TRACT

The respiratory tract (respiratory tree) is the network of airways that supplies air to the lungs. It consists of two parts:

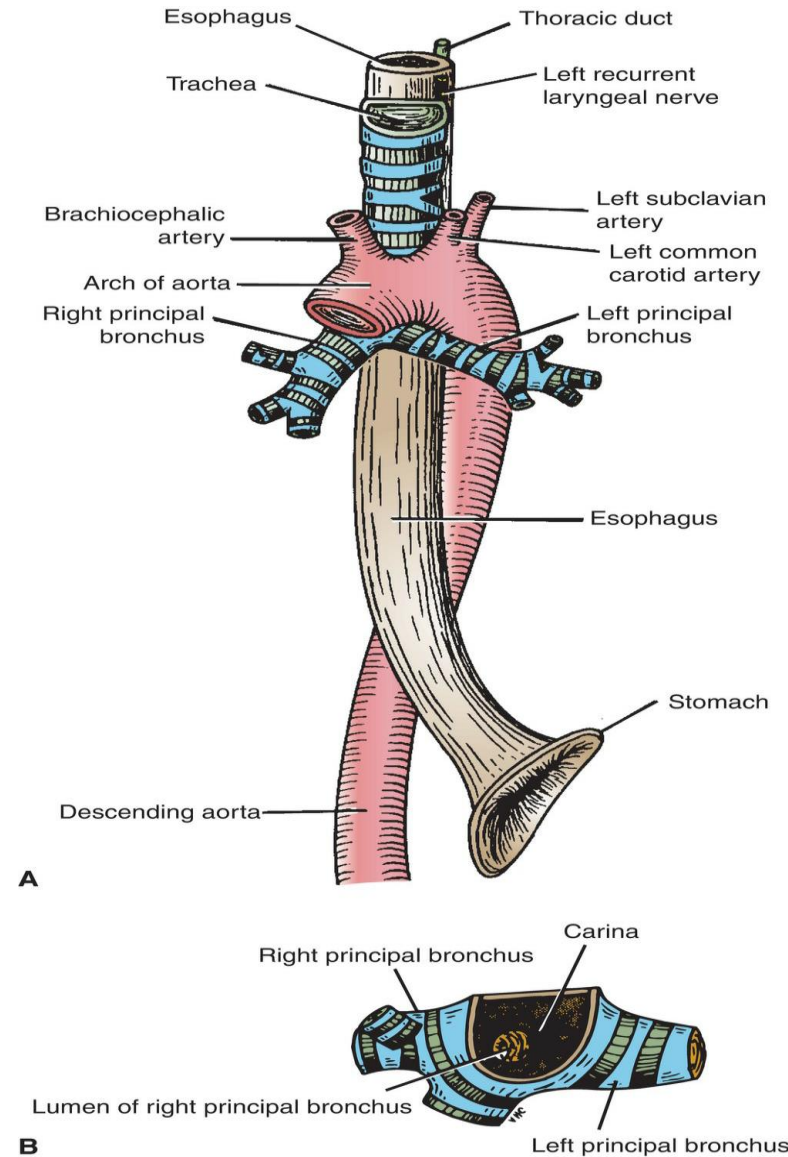
The upper respiratory tract includes the nasal passages and sinuses, pharynx, larynx, and upper portion of the trachea.

The lower respiratory tract (tracheobronchial tree) includes the trachea, bronchi, bronchioles, alveolar ducts, alveolar sacs, and alveoli. Note the path taken by inspired air from the trachea to the alveoli.



Trachea

The trachea is a mobile cartilaginous and membranous tube. It begins in the neck as the continuation of the larynx at the lower border of the **cricoid cartilage** at the level of the **sixth cervical vertebra**. It descends in the midline of the neck. In the thorax, the **trachea runs through the superior mediastinum**, in approximately the **midline**. It ends by **dividing into right and left principal (main) bronchi at the level of the sternal angle** (opposite the disc between the fourth and fifth thoracic vertebrae). During expiration, the bifurcation rises by about one vertebral level and during deep inspiration may lower as far as the sixth thoracic vertebra. In adults, the trachea is about 11.25-cm) long and 2.5 cm in diameter.

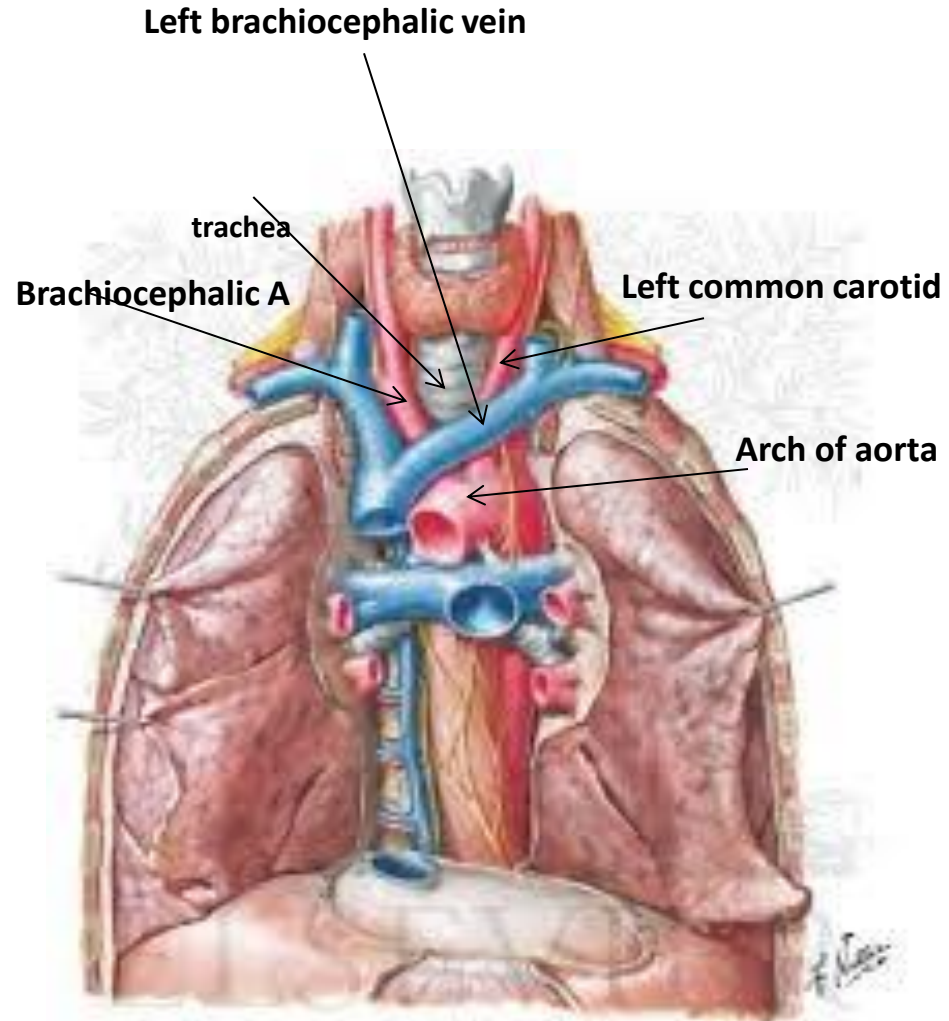


The trachea is formed by U-shaped bars of hyaline cartilages called tracheal rings, these cartilages support and maintain the patency of the trachea. The posterior free ends of the U-shaped cartilage are connected by **trachealis muscle which is a smooth muscle**. The posterior discontinuity of the tracheal rings permit the esophagus to expand into the trachea during swallowing.

The anatomical relations of the trachea:

in the superior mediastinum of the thorax are as follows:

Anteriorly: The sternum, the thymus, the left brachiocephalic vein, the origins of the brachiocephalic and left common carotid arteries, and the arch of the aorta.



Right side: The azygos vein, the right vagus nerve, and the pleura.

Left side: The arch of the aorta, the left common carotid and left subclavian arteries, the left vagus and left phrenic nerves, and the pleura.

Posteriorly: The esophagus and the left recurrent laryngeal nerve.

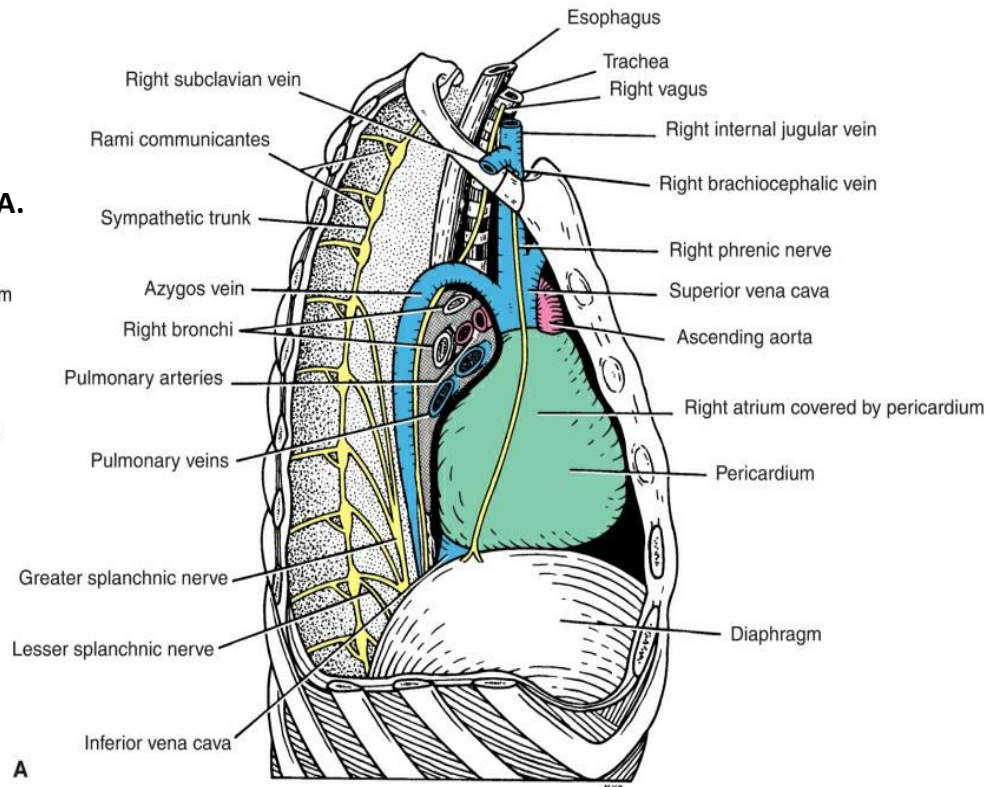
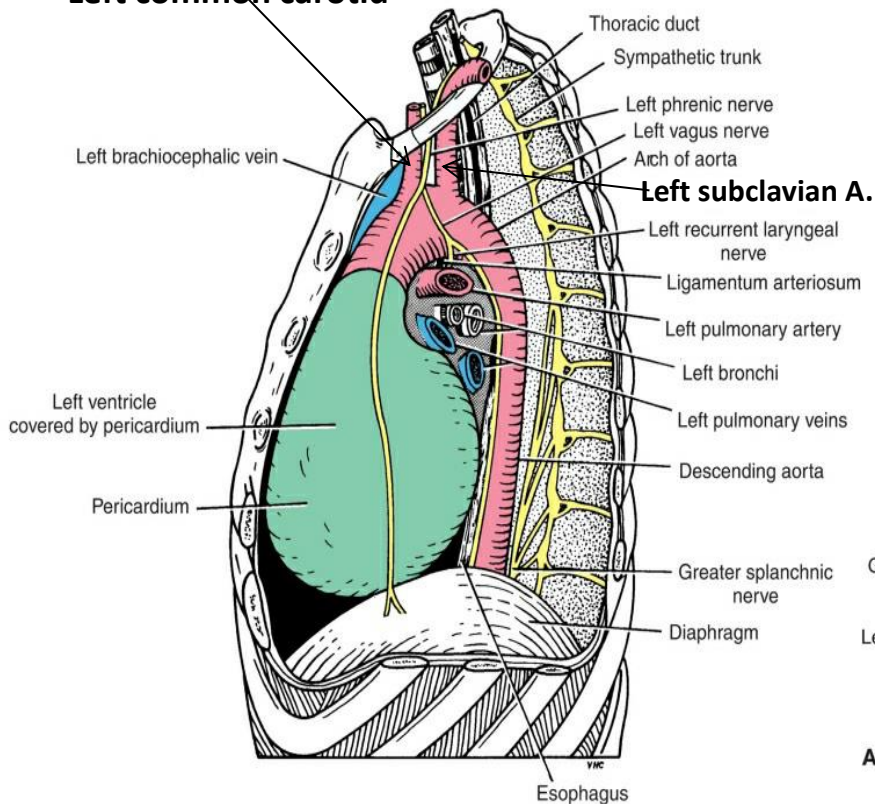
Blood Supply The inferior thyroid arteries (branches of the subclavian arteries) supply the upper two thirds of the trachea, and the bronchial arteries (branches of the thoracic aorta) supply the lower third.

Lymph Drainage The lymph drains into the pretracheal and paratracheal lymph nodes and the deep cervical nodes.

Nerve Supply

The vagus and recurrent laryngeal nerves carry the sensory nerve supply. Sympathetic nerves supply the trachealis muscle.

Left common carotid



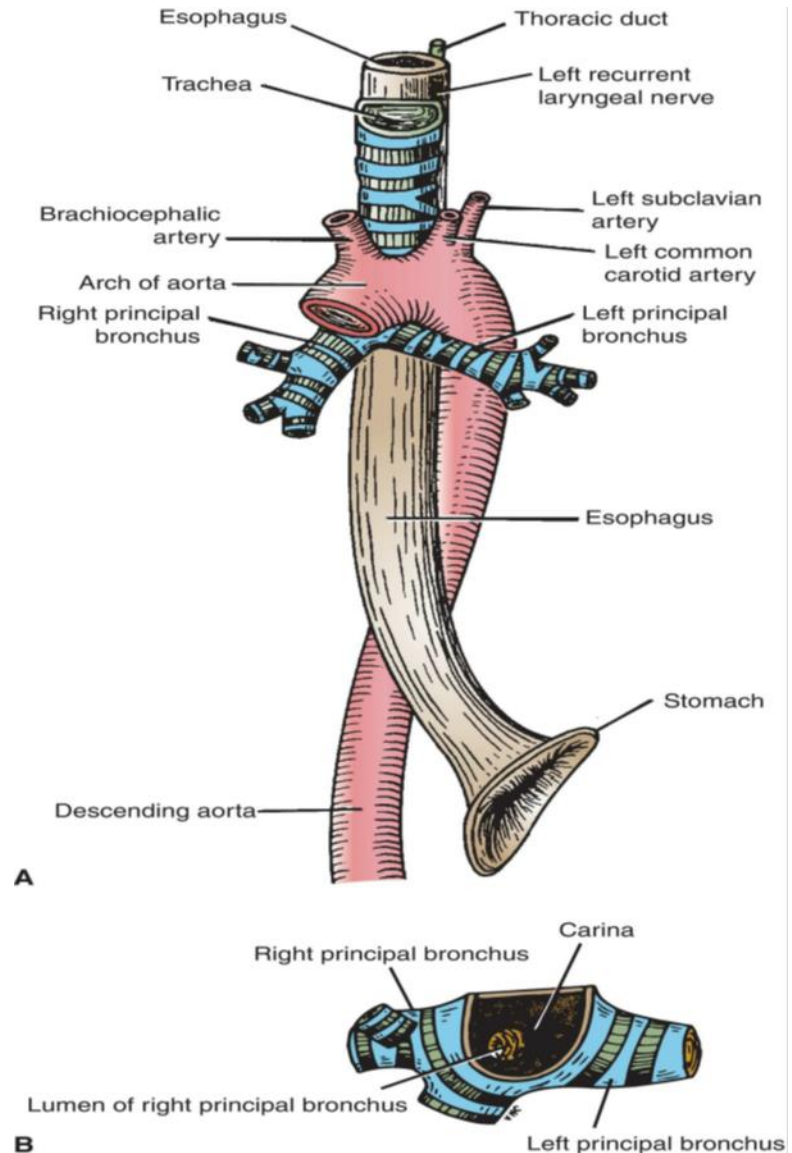
A

VHC

B

Bronchi

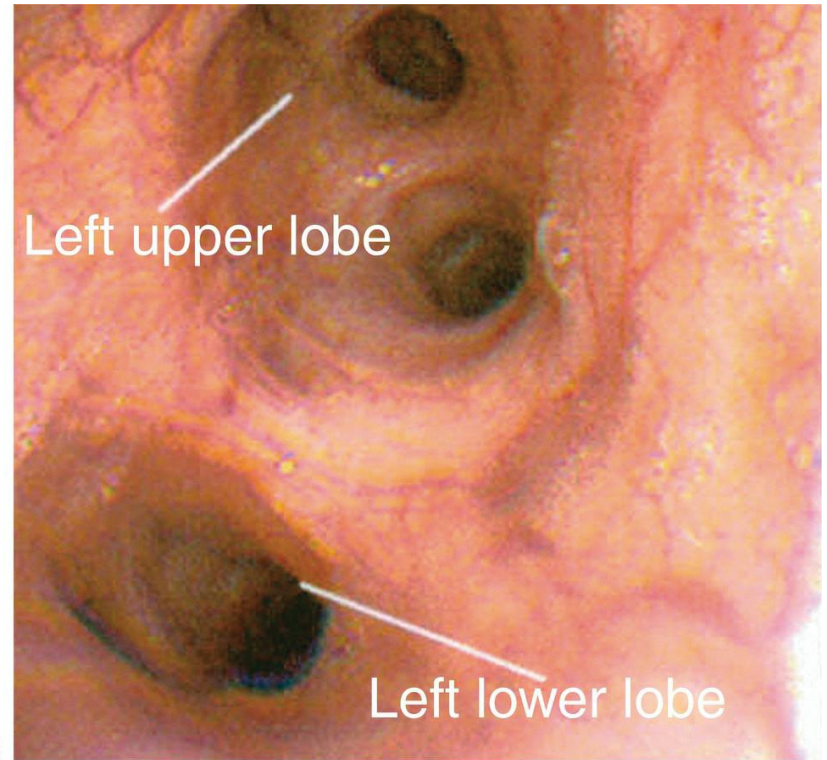
The trachea bifurcates behind the arch of the aorta into the **right and left principal (primary or main) bronchi**. The **carina** is a small ridge at the inferior end of the junction of the trachea and the principal bronchi that separates the openings of the bronchi. The bronchi divide **dichotomously and** eventually give rise to several million **terminal bronchioles** that terminate in **one or more respiratory bronchioles**. Each respiratory bronchiole divides into **2 to 11 alveolar ducts** that enter the **alveolar sacs**. The **alveoli** arise from the walls of the sacs as diverticula.



The interior of the bronchial tree as seen through an operating bronchoscope. **A.** The bifurcation of the trachea. Note the ridge of the carina in the center and the opening into the right main bronchus on the right, which is a more direct continuation of the trachea. **B.** The left main bronchus. The openings into the left upper lobe bronchus and its division and the left lower lobe bronchus are indicated.



A

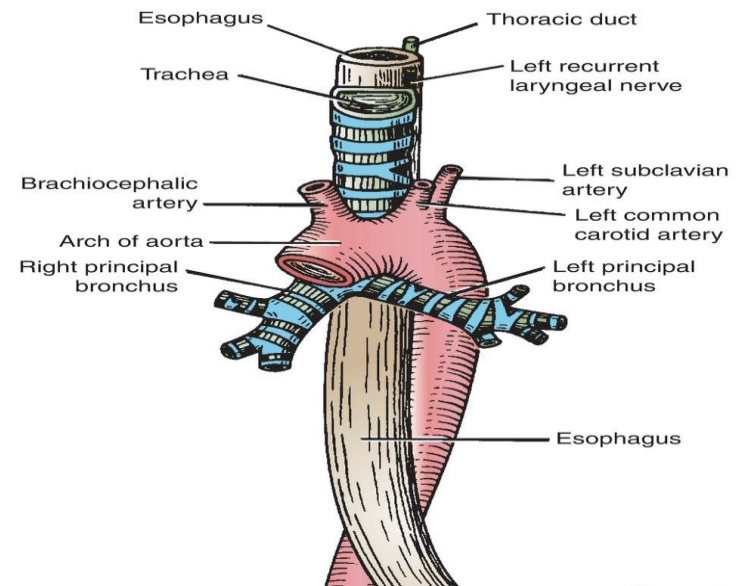
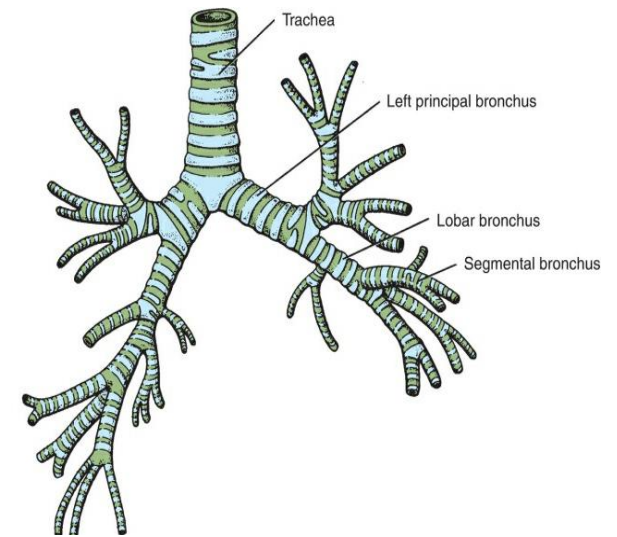


B

Each principal bronchus supplies an entire lung .

The right principal (main) bronchus is wider, shorter, and more vertical than the left and is about 2.5-cm long. Before entering the hilum of the right lung, the principal bronchus gives off the **superior lobar bronchus**. On entering the hilum, it divides into a **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. It passes to the left **below the arch of the aorta** and in front of the esophagus entering the hilum of the left lung, the principal bronchus divides into a **superior** and an **inferior lobar bronchus**.



Compression of the Trachea

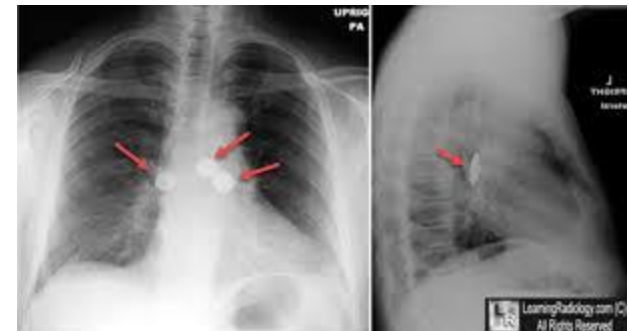
In the neck, a unilateral or bilateral **enlargement of the thyroid gland** can cause gross displacement or compression of the trachea. A dilatation of the aortic arch (e.g., **an aneurysm**) can compress the trachea. With each cardiac systole, the pulsating aneurysm may pull at the trachea and left bronchus, **a clinical sign that can be felt by palpating the trachea in the suprasternal notch.**

Tracheitis or Bronchitis

The recurrent laryngeal nerves innervate the mucosa lining much of the trachea. A **tracheitis or bronchitis** gives rise to a cold, burning sensation felt deep to the sternum instead of actual pain.

Foreign Body Aspiration

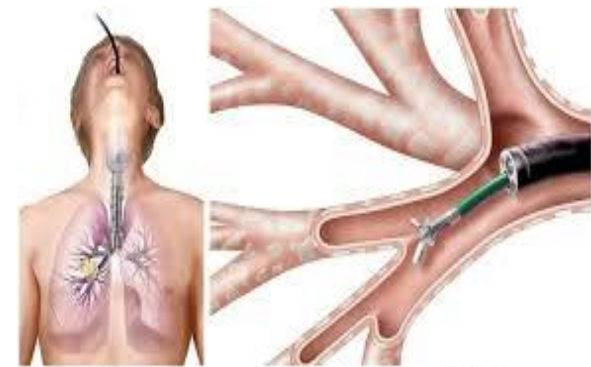
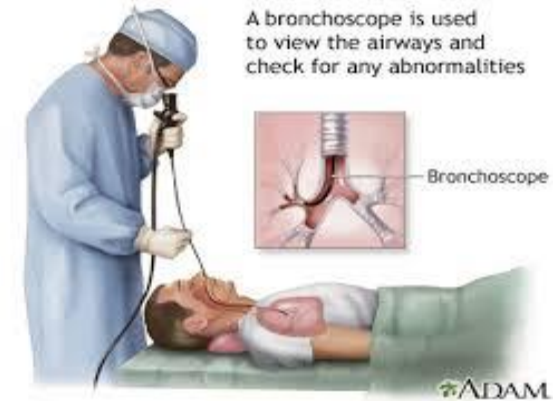
Inhalation of foreign bodies into the lower respiratory tract is common, especially in children. Pins, screws, nuts, bolts, peanuts, and parts of chicken bones and toys have all found their way into the bronchi. Parts of the teeth may be inhaled while a patient is under anesthesia during a difficult dental extraction



Because the right principal bronchus is the wider, more vertical, and more direct continuation of the trachea, foreign bodies tend to enter the right instead of the left main bronchus. From there, they usually pass into the middle or inferior lobar bronchi. Large aspirated objects commonly lodge in the right main bronchus, whereas small objects tend to stop in the right inferior lobar bronchus.

Bronchoscopy

Bronchoscopy enables a physician to examine the interior of the trachea, its bifurcation, the carina, and the main bronchi. With experience, it is possible to examine the interior of the lobar bronchi and the beginning of the first segmental bronchi. This procedure also facilitates obtaining biopsy specimens of mucous membrane and removal of inhaled foreign bodies (even an open safety pin). Lodgment of a foreign body in the larynx or edema of the mucous membrane of the larynx secondary to infection or trauma may require immediate relief to prevent asphyxiation. Tracheostomy is a method commonly used to relieve complete obstruction.



Thank you