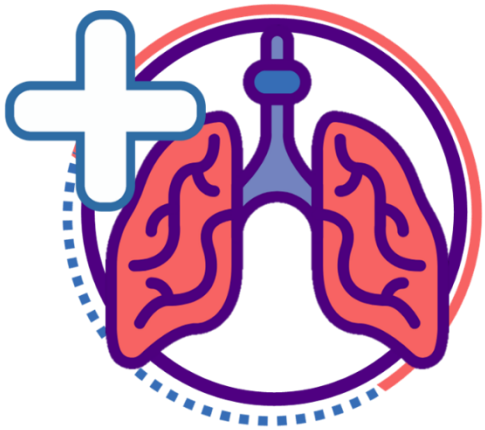


RESPIRATORY SYSTEM

Anatomy

Sheet Slide

Number:	- 7
Done by:	- Dana Alrafaiah
Corrected by:	- Moayyad Al-Shafei
Doctor:	**-Mohammad H. Al-Mohtaseb**

Quick recap:

Both lungs have an apex, base, mediastinal and costal surfaces, anterior and posterior borders. The right lung, which is related to the deoxygenated blood and veins, has an impression of the right atrium, while the left lung, which is related to the oxygenated blood and arteries, has an impression of the left ventricle, in addition to being related to the arch of the aorta and the descending aorta.

Pulmonary vessels

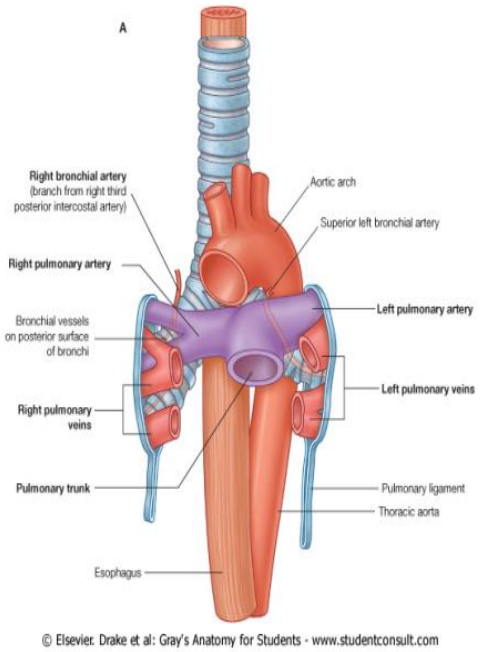
Pulmonary vessels are the pulmonary arteries - originating from the pulmonary trunk- and pulmonary veins.

Pulmonary arteries

The pulmonary trunk starts from the pulmonary valve in the right ventricle, and it ascends upwards to the level of T4 where it divides into the *right and left pulmonary arteries* below the arch of the aorta. Those arteries carry *deoxygenated* blood *to* the lungs and enter through its hilum.

<u>Right pulmonary artery:</u>

The right pulmonary artery is longer than the left because the division of the pulmonary trunk occurs on the left side. It passes the mediastinum horizontally to enter the hilum, where it lies **between** the eparterial and hyparterial bronchi(branches of the right main bronchus). It also lies slightly **inferior** to the tracheal bifurcation and **anterior** to the right main bronchus. Finally, it is **posterior** to the ascending aorta, superior vena cava and upper right pulmonary vein.



From the slides: • The main vessel continues through the hilum of the lung, gives off a second (recurrent) branch to the superior lobe, and then divides to supply the middle and inferior lobes

Left pulmonary artery:

The left pulmonary artery is shorter than the right. It lies **anterior** to the descending aorta and **posterior** to the superior pulmonary vein (lies between them). In the hilum of the left lung it is the most superior structure.

Pulmonary veins

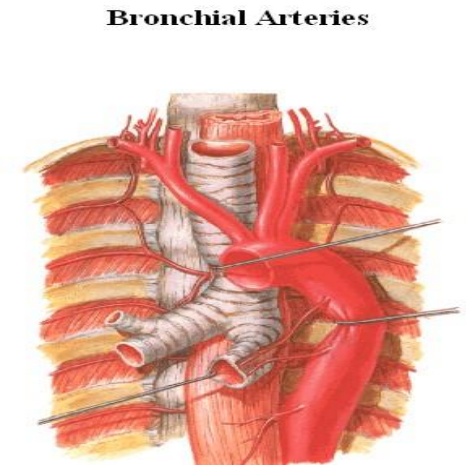
There are two on each side; superior and inferior. They carry *oxygenated* blood from the lungs to the left atrium, and they are the only veins in the body to do so.

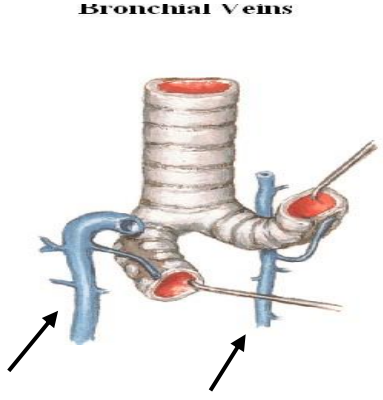
Bronchial arteries and veins

Bronchial arteries

They are the main nutritive blood supply to the lungs and visceral pleura. There's one on the right side and two on the left; superior and inferior. The right bronchial artery originates from the third posterior intercostal artery, which is a branch of the descending thoracic aorta. While both left bronchial arteries arise *directly* from the anterior surface of the descending thoracic aorta; the superior arising at the level of T5 while the inferior arising inferior to the left bronchus.

From the slides: The bronchial arteries run on the posterior surfaces of the bronchi and ramify in the lungs to supply pulmonary tissues.



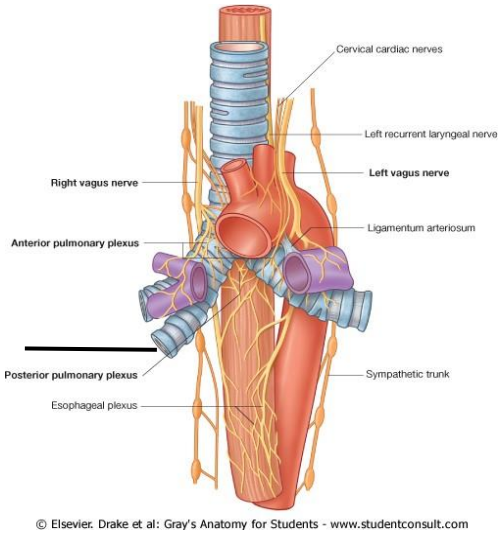


Bronchial veins

The superficial bronchial veins in the right side drain into the azygous vein, while those in the left side drain into the superior intercostal vein or the hemizygous vein.

On the other hand the deep bronchial veins eventually drain into the pulmonary veins or the left atrium(notice that it is a small amount of the deoxygenated blood will be mixed with the oxygenated blood).

Innervation



The lungs and visceral pleura are innervated by the pulmonary plexus; which lies at the end of the tracheal bifurcation anteriorly and posteriorly. It contains visceral efferent parasympathetic (from the vagus nerve) and sympathetic (from the sympathetic trunk and ganglia) fibres. *This autonomic innervation means they are sensitive to <u>stretch only</u>.*

<u>Effect on respiratory tract:</u>

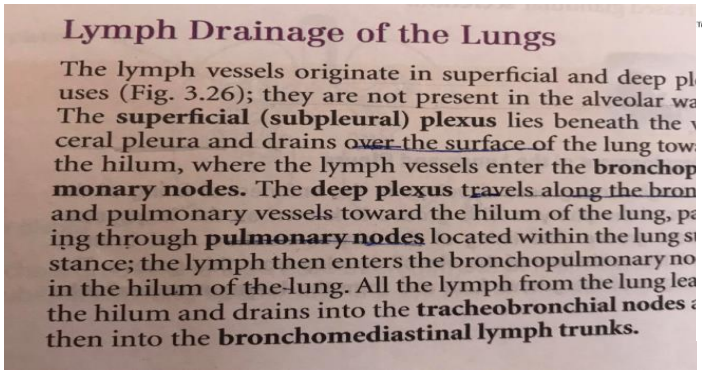
The parasympathetic fibers **constrict** the bronchi and bronchioles (particularly as they have a smooth muscles).

The sympathetic fibers **dilate** the bronchioles.

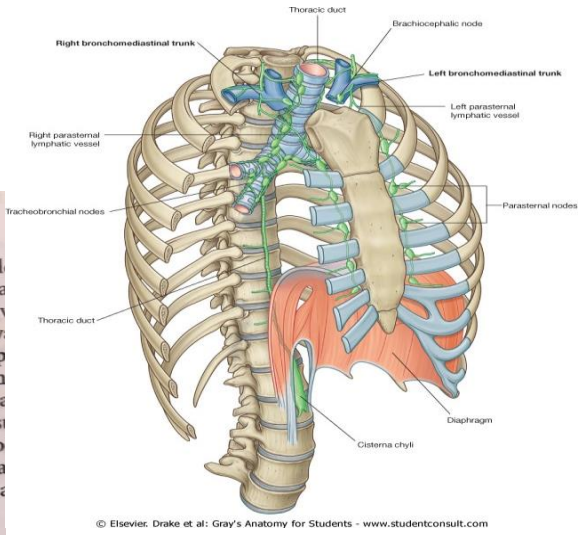
Note: This is why in severe cases of asthma we administer adrenaline(subcutaneously); it will mimic the effects of the sympathetic fibers on the lungs and dilate the bronchioles relieving the symptoms.

Lymphatic drainage

In more details from Snell:.


Lymph Drainage of the Lungs

The lymph vessels originate in superficial and deep pl
uses (Fig. 3.26); they are not present in the alveolar wa
The **superficial (subpleural) plexus** lies beneath the v
ceral pleura and drains over the surface of the lung tow
the hilum, where the lymph vessels enter the **bronchop**
monary nodes. The **deep plexus** travels along the bron
and pulmonary vessels toward the hilum of the lung, pa
ing through **pulmonary nodes** located within the lung s
stance; the lymph then enters the bronchopulmonary no
in the hilum of the lung. All the lymph from the lung lea
the hilum and drains into the **tracheobronchial nodes**
then into the **bronchomediastinal lymph trunks.**



-Lymph nodes from the left side of the chest such as parasternal, tracheobronchial (usually located at the hilum), mediastinal and

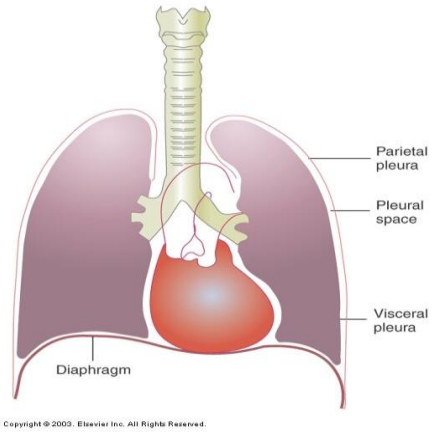
broncho-mediastinal lymph nodes will drain into the thoracic duct. The thoracic duct starts from the abdominal aortic opening in the diaphragm to the right of the abdominal aorta and ascends upward to the right of the esophagus. At the level of T5 it deviates to the left side and ends in the left brachiocephalic vein in the root of the neck. The right side of the chest drains into the right lymphatic trunk.

Pleura

It is a sac that covers the lungs, composed of two layers: the parietal pleura, which lines the thoracic cavity, and the visceral pleura which is adherent to the lungs. Between these two layers is a potential space known as the pleural cavity. This space is filled with a small amount of serous fluid for lubrication purposes during respiration.

Functions of pleura:

1- Protection of the lungs provided by its two membranes.
2- Production of fluid that allows for lubrication between lungs and pleura during respiration (frictionless inflation and deflation).



Abnormality in the function of pleura as well as difficult painful breathing, can be seen in **pleuritis** (inflammation of the pleura). In this case, with each breath there's severe pain at the site of inflammation. This could lead us to conclude that the parietal pleura – unlike the visceral- is very sensitive to **pain**, touch and temperature. Remember the visceral pleura is sensitive to stretch only, just like the lungs (autonomic innervation).

<u>Pathological cases related to the pleural cavity</u>:

-Sometimes an injury, like a stab wound, that penetrates the pleura (particularly the parietal) could lead to air coming in and filling the pleural cavity. This is known as **pneumothorax**, which could lead to collapse of the lungs.

-The pleural cavity can also be filled with fluid leading to **pleural effusion**, or **haemothorax** in case this fluid was blood. In both cases this fluid must be drained to allow for proper inflation, and this is carried out in a procedure known as ***underwater seal drainage***. In this procedure we use a tube and a bottle that sucks the air to drain the fluid. This tube is placed between the surface anatomy of the pleura and the lungs in the lower part:

- Midclavicular line: between T6 (level of the lungs) and T8 (level of the pleura); in the 7th intercostal space.
- Midaxillary line: between T8 and T10; 9th intercostal space. This is the easiest approach to do, due to the largest recess which is present there (further explained).
- Scapular(posterior) line: between T10 and T12; 11th intercostal space.

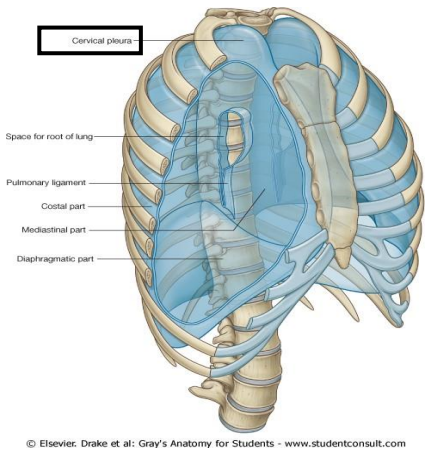
Remember: there's a "two space difference" between the surface anatomy of the lungs and pleura.

-Pus accumulation in the pleural cavity following a severe infection is known as **Empyema**.

Types of parietal pleura

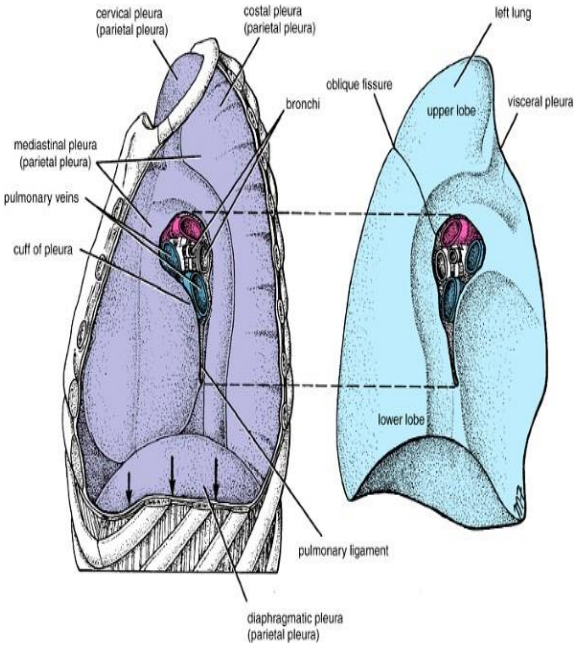
These types are according to the site of the pleura. Notice in the figure how the pleura is placed around the apex, costal and mediastinal surfaces as well as the diaphragm. Accordingly, the parietal pleura are divided into:

1- Cervical pleura: also known as dome of pleura or pleural cupola, covers the apex. The parietal pleura here is adherent to the visceral pleura and the lungs, which means there's no pleural space. In addition, the deep fascia of the neck descends and forms a membrane called the **suprapleural membrane** (also called Sibson's fascia) which covers this pleura.



2- Costal pleura: related to costal cartilage and ribs.
3- Diaphragmatic pleura: covers the lower surface and the diaphragm.
4- Mediastinal pleura: covers the mediastinal surface of the lungs, this part of the pleura, in which the two pleura layers become adherent around the hilum, forms the **pulmonary ligament** below the hilum.

Surface anatomy of the pleura:



The **apical pleura** is exactly like the apex of the lung; 1 inch(2.45 cm) above the medial 1/3 of the clavicle or 3-4 cm above the first costal cartilage (the 1 cm difference between the clavicle and first CC is because the clavicle is higher). Remember this is because it is adherent to it and there's no space in between.

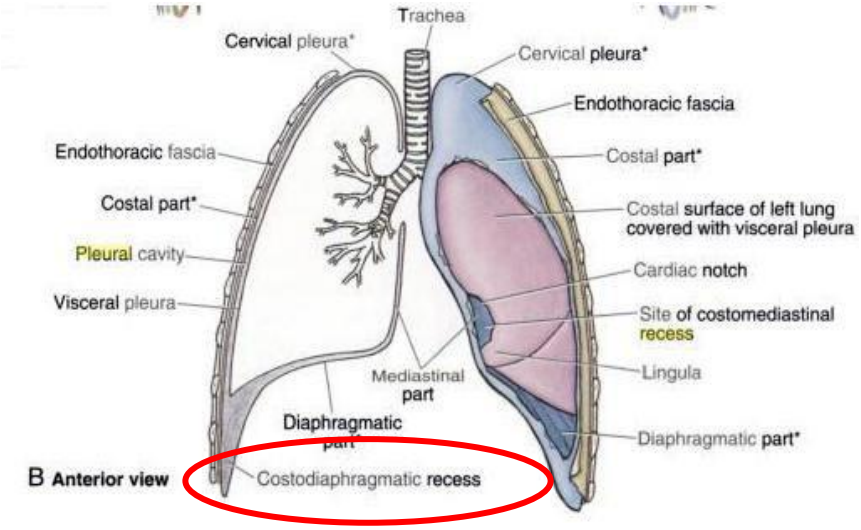
The **anterior border** goes towards the sternocostal cartilage, then to the angle of Lewis all the way to the 7th costal cartilage. One difference between the right and left side is that the anterior border on the right side goes to the midline, while the left side goes along cardiac notch, which takes on the same shape as the lungs: a circle with a radius of 0.5 inch.

At the the hilum of the lung is between T5 to T7, the visceral pleura adheres to the parietal forming **pulmonary ligament**.

The surface anatomy of **the base (lower border) of** the pleura differs from the lungs due to the two-space difference we mentioned before. So, in the midclavicular line it crosses the 8th rib, in the midaxillary the 10th and posteriorly the 12th rib. This is very important as those spaces are filled during inflation of the lungs, especially in deep inspiration.

Peripheral reflections:

The pleura is a sac, so the continuation of each part of this sac with the next will form reflections or “recesses”: an angle between two types of parietal pleura. For example:



1- Costal pleura and diaphragmatic pleura junction, between the inferior margins of the lungs and pleural cavity, will form costo-diaphragmatic recess.
2- Costal and mediastinal pleura junction will form costo-mediastinal recess.
3- Mediastinal and diaphragmatic pleura will form mediastaino-diaphragmatic recess.

The largest and clinically most important is the **costodiphragmatic** recess. This is because when the pleura is injured and air or fluid (serous or blood) accumulate within the pleural cavity, drainage is through this recess from the lateral side in the midaxillary line, as it provides a 3-inch space to carry it out (more space, easier entry).

Note: we can do this procedure through the midclavicular line (1 inch) or the scapular (2 inches) but it won’t be carried out as easily due to the limited space.

Those recesses will be located as follows:

1- In the midclavicular line: between rib space 6 and 8.
2- In the midaxillary line: between 8 and 10.
3- In the paravertebral(scapular/posterior) line: between 10 and 12.

So in short, they lie at the two space difference between the surface anatomy of the lungs and the pleura.

Suprapleural membrane

This is a fibrous sheath which covers the apex(dome) of the lungs, as mentioned before, it is a continuation of the deep fascia of the neck.

Attachments:

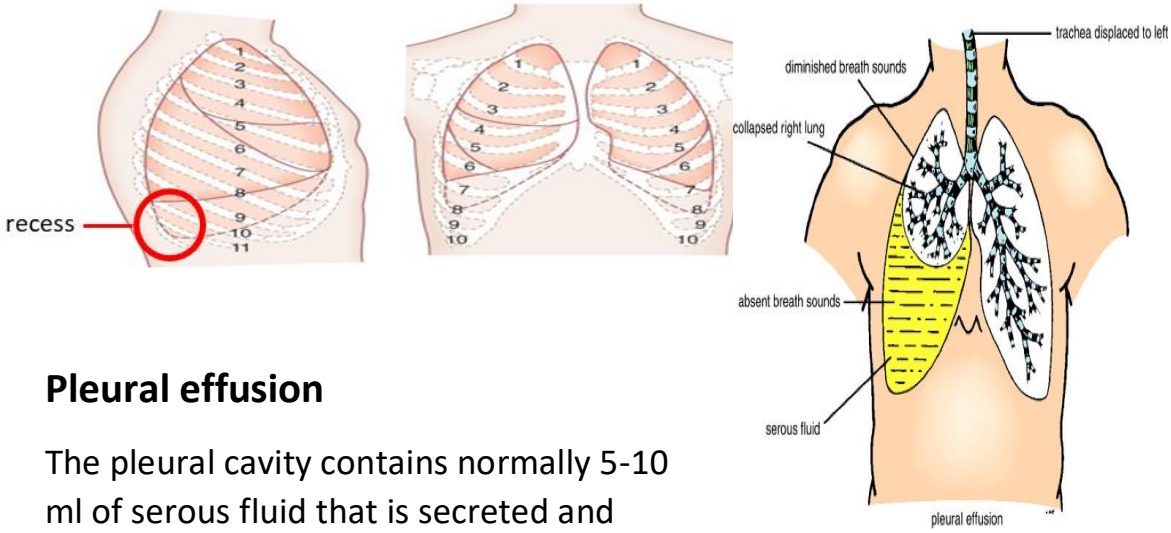
1- Laterally to the medial border of 1st rib and costal cartilage.
2- Medially blends with the deep fascia of the neck.
3- Apex is attached to the transverse process of the 7th cervical vertebra.

Function:

1- Protection of the apex of the lung and the cervical pleura.
2- Maintenance of the intrathoracic pressure and resistance to changes in it. Respiration leads to descent of the diaphragm downwards which increases the area and so decreases the intrathoracic pressure, this will cause the air to rush in and inflate the lungs (opposite happens in expiration). The suprapleural membrane holds the diaphragm up when it descend, and holds it downwards when it ascends to control the changes in pressure produced by this movement.

Visceral pleura

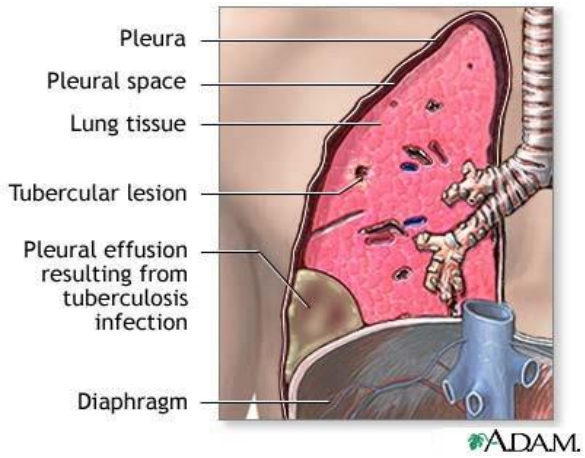
It is adherent to the lungs and descends with its fissures (oblique/ horizontal) which divide the lungs into lobes, so these fissures are lined by visceral pleura too. The visceral pleura however doesn't line the thoracic cage only the parietal does.



Pleural effusion

The pleural cavity contains normally 5-10 ml of serous fluid that is secreted and absorbed normally by the pleura. Pleural effusion happens where there's abnormal accumulation of fluid **more than 300 ml** in the pleural cavity and particularly in the costodiphragmatic recess. Which can be caused by:

1- Infection(Tb is an example)
2- Injury
3- Tumor
4- Spontaneously (no obvious cause)
5- Defect in the circulation between the lungs and the heart.



<u>Clinical manifestations:</u>

1- Decrease in lung expansion (most important).
2- Decreased lung sound: a stethoscope is placed on the lobes of the lungs and the patient is asked to breath in and out, the sounds heard will be decreased and abnormal.
3- Dullness upon percussion: percussion is placing your fingers between the ribs on the patient and taping it; if resonance "drum" is heard then underlying substance is air. However, if fluid is present within the cavity dullness can be heard (if there's solid tissue it can be heard as well).

4- Pain.
5- Cough due to irritation.

Clinical note:

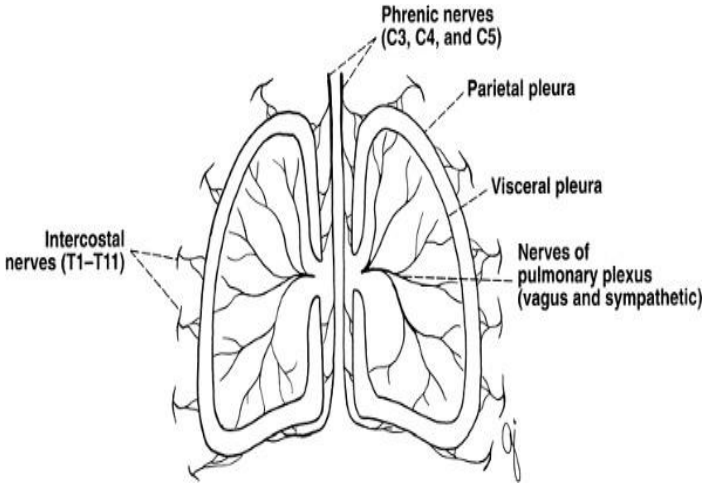
Aspiration of the fluid in pleural effusion or air in pneumothorax is done by inserting a needle in the 7th intercostal space in the midclavicular line, or the 9th space in the midaxillary or the 11th space in the posterior line. This needle is inserted at the lower border of the space (upper border of lower rib) to avoid injuring the intercostal vessels (NAV: nerve, artery and vein) as they're present in a costal groove at the lower border of the rib.

Nerve supply of the pleura

Parietal pleura is sensitive to pain, temperature, touch and pressure, and is innervated as follows:

- All costal pleura is innervated segmentally by intercostal nerves; the 3rd intercostal nerve will innervate the 3rd intercostal space and pleura and so on.
- Mediastinal and diaphragmatic pleura are innervated by the phrenic nerve.
- Peripheral pleura is innervated by lower 6 intercostal nerves.

Visceral pleura is adherent to the lungs and so has the same sensation. This means it is sensitive to **stretch only** and insensitive to pain, temperature or touch. It is supplied by the autonomic nervous system through the pulmonary plexus which has parasympathetic and sympathetic fibers in it.



Arterial supply of the pleura

-The parietal pleura is supplied by anterior and posterior intercostal arteries. The posterior arteries are branches of the descending aorta and supply the posterior aspect. The anterior arteries supply the anterior aspect and are branches of the internal thoracic(mammary) artery and the musculophrenic artery, both of which are branches of the subclavian artery.

-The visceral pleura is supplied by right and left bronchial arteries which are branches of the thoracic aorta (remember these branches are the main nutritive supply to lungs too).

Venous drainage of the pleura

Into the azygous and internal thoracic veins.

Lymphatic drainage of pleura

-Parietal pleura:

Mediastinal pleura drains into:

- Mediastinal nodes.
- Tracheobronchial nodes.
- Intercostal nodes.

Diaphragmatic pleura drains into:

- Parasternal nodes.
- Post-mediastinal nodes.

-Visceral pleura follows the lungs and drains into bronchopulmonary nodes, then broncho-mediastinal nodes and finally into the thoracic duct.

All these groups will drain into the right lymphatic duct in the right side, and in the left side into the *thoracic duct*.

The end