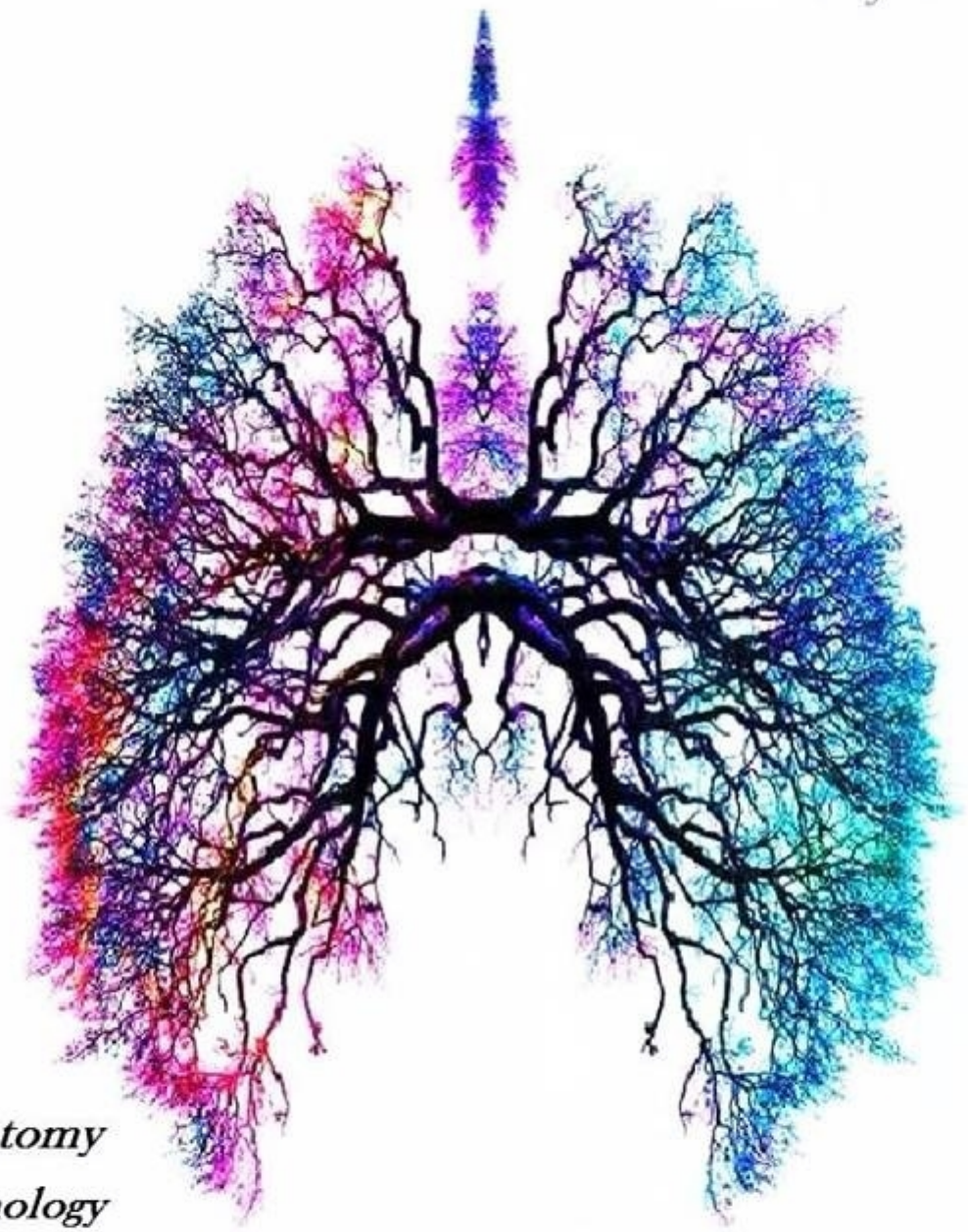
RESPIRATORY SYSTEM

Cover by: Aseil Khatib



- ● Anatomy
- ○ Pathology
- ○ Physiology
- ○ Pharmacology
- ○ Microbiology
- ○ PBL

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Lecture # 7 (5-anatomy)
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Pulmonary Vessels, Bronchial Vessels, and Pleura

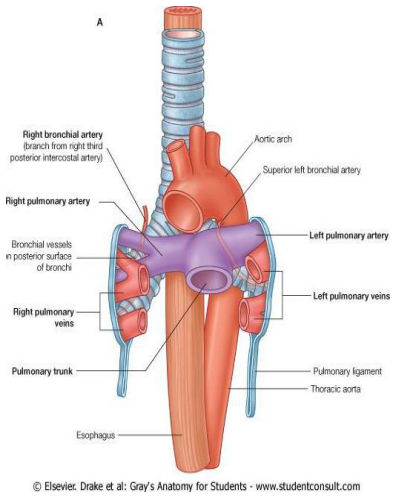
-Pulmonary Arteries and Veins:

As we took before, pulmonary trunk starts from the right ventricle and carries deoxygenated blood to the lungs. It divides below the arch of aorta at the level of **T4** into right pulmonary artery (to the right lung) and left pulmonary artery (to the left lung).

**Bifurcation of pulmonary trunk occurs to the left of the midline just inferior to the level of T4, and anteroinferiorly to bifurcation of trachea. (from slides)

-As shown in the figure, the right pulmonary artery lies anterior to the right main bronchus. It divides within the hilum of the lung into 2 branches (inside the lung).

It's also important to mention that the right main bronchus divides within the hilum into ***eparterial*** (above) and ***hyparterial*** (below) bronchi.



- *Right* pulmonary artery:

- longer than the left, and passes horizontally across the mediastinum.
- Relations :

*Anterior to the right main bronchus.

*Posterior to the ascending aorta, superior vena cava, and upper right pulmonary vein.

- It enters the root of the lung and gives off a large branch to the superior lobe of right lung. The main vessel continues through the hilum, gives off a second (recurrent) branch to the superior lobe, and then divides to supply the middle and inferior lobes.

- *Left* pulmonary artery :

- shorter than the right one since the bifurcation of pulmonary trunk occurs to the left of the midline. It passes through the hilum and branches within the lung.
- Relations :

*Anterior to the descending aorta.

*Posterior to the superior pulmonary vein.

So it's important to know how right & left pulmonary arteries are related to the hilum & bronchi.

Since pulmonary arteries carry deoxygenated blood, they don't supply lung tissue. So, there must be another source of oxygenated blood to supply pulmonary tissues, which is The ***bronchial arteries***.

Blood carried by bronchial arteries (right & left) supplies lung tissue as well as pleura, whereas blood carried by pulmonary arteries enters the lung where it undergoes oxygenation.

-***Superior*** *and* ***inferior*** *pulmonary veins*, which are found in the hilum of the lung, carry oxygenated blood from the lungs back to the heart. They are related to the lower part of the hilum; one is superior and the other is inferior. Both of them eventually open into the left atrium.

-Bronchial Arteries and Veins :

- Begin at the hilum and run on the posterior surfaces of bronchi, then pass towards the pleura.
- Constitute the nutritive vascular system of pulmonary tissues (bronchial walls and glands of large vessels) and visceral pleura.
- They interconnect within the lung with branches of pulmonary arteries and veins.

* On the right side, we have a single right bronchial artery that goes to the right lung, and it's a branch of the ***third posterior intercostal artery.***

*On the left side, we have two left bronchial arteries (superior & inferior) which arise directly from the anterior surface of ***descending thoracic aorta.***

1-*Superior* left bronchial artery >> arises at the level of **T5**.

2-*Inferior* left bronchial artery >> arises inferior to the left bronchus.

-Bronchial Veins (venous drainage) :

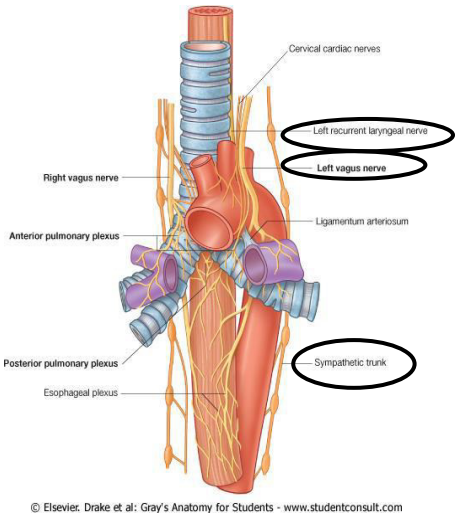
- Receive venous blood from lung tissue and pleura, just opposite to their counterparts (bronchial arteries).
- They meet at the hilum.
- Drain into :

- Either the *pulmonary veins* (since it's venous blood) OR directly into the *left atrium.*

-The *azygos vein* on the **right**, OR into the *superior intercostal vein* or *hemiazygos vein* on the **left**.

-Innervation :

Lungs and visceral pleura are innervated by the autonomous nervous system (ANS) through the visceral afferent and efferent nerve fibers that are distributed anterior and posterior to the end of trachea as ***anterior pulmonary plexus and posterior pulmonary plexus.***



So, at the level of bifurcation of trachea, we have two pulmonary plexuses of nerves (anterior and posterior).

-Origin of these plexuses:

*Sympathetic: from the superior cervical sympathetic ganglia (sympathetic trunk).

*Parasympathetic: from the vagus nerve.

-As shown in the previous Figure, the *left* vagus gives **left recurrent laryngeal nerve**

-The anterior plexus is much smaller than the posterior one.

**Effects of pulmonary plexuses on bronchi :

Vagus nerve (parasympathetic)>> causes *bronchoconstriction*.

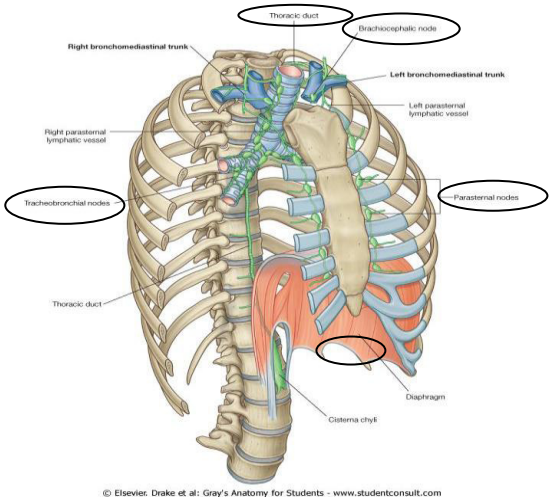
Sympathetic >> causes *bronchodilatation*.

-Lymphatic Drainage :

- We have superficial (subpleural= under the visceral pleura) and deep (inside the lung tissue) lymphatic plexuses that forgather at the hilum of the lung and eventually will reach the mediastinum.

We can see lymph nodes around the roots of lobar and main bronchi, which are called *tracheobronchial* lymph nodes, while those around the trachea are called *paratracheal* lymph nodes.

Also, there are *parasternal* lymph nodes which are distributed around the sternum, and *brachiocephalic* lymph nodes -as shown in the figure.



Therefore, lymphatic drainage starts from superficial and deep lymphatic plexuses, and ends at the hilum firstly as tracheobronchial lymph nodes, and then around the trachea as paratracheal lymph nodes.

-On the left side is the **thoracic duct** which originates from cisterna chyli in the abdomen, it ascends upwards till the level of **T5** where it undergoes *deviation to the left side* behind trachea. It drains the left thorax and ends at the beginning of *left brachiocephalic vein.*

-On the right side we have the **right lymphatic duct** which drains the right thorax. It ends at the beginning of right *brachiocephalic vein* .

So, lymphatic drainage is eventually going to join the venous drainage which will return back to the heart.

-Pleura :

Divided into two major types based on location:

1-**Visceral Pleura :**

- Adheres to and covers the lung (it's firmly attached to lung surface, including both opposed surfaces of the *fissures* that divide the lungs into lobes).
- Composed of simple squamous epithelium, which is also called **mesothelium**.
- Has the same innervation and lymphatic drainage as those of the lung.
- Becomes continuous with parietal pleura at the hilum of each lung, where structures enter and leave the organ.

2-**Parietal Pleura :**

- Lines the thoracic cavity from the inside.

**Parietal pleura can be divided into 4 types whose nomenclature corresponds to the parts of the wall with which they are associated:

a) ***Cervical pleura*** *:*

- Related to the cervical vertebrae.
- Found near the apex.
- Ascends 1 inch above the medial third of clavicle.
- It's a dome-shaped layer that lines the cervical extension.
- Covered by suprapleural membrane, aka, **Sibson's fascia.**

(It's a deep fascia originated from the neck).

b) ***Diaphragmatic Pleura :***

- Lies over the diaphragm (on the inferior (diaphragmatic) surface of the lung).
- It is a distinctive layer as the diaphragm forms a copula, so the border of its inferior surface is sharp. It descends around the copula of diaphragm.

>> *it's the most common site of fluid accumulation* (IMPORTANT)

c) ***Mediastinal Pleura :***

- on the mediastinal surface of the lung
- What's important about it is that visceral and parietal layers unite to form one single layer around the hilum that's adherent to the lung. The terminal end of this layer forms the so called **"pulmonary Ligament"** below the hilum.

d) ***Costal Pleura* :**

- Related to the costal cartilages, ribs, and intercostal spaces.

-Notes: ** Hilum of the lung is located between T5 and T7.

**Mediastinal pleura becomes adherent to visceral pleura around the hilum (between T5 and T7), forming the *pulmonary ligament.*

**Functions of Pleura :

1) Protection of the lung.

2) Produces fluid that allows for lubrication.

Note: pleural cavity is the potential space enclosed between the visceral and parietal pleurae. Normally, it contains a little amount of serous fluid (5-10 mL) that is important for lubrication and facilitation of lungs movement (inflation and deflation).

- In cases of pleuritis (inflammation of pleura particularly in the parietal pleura), there will be friction in the pleura, and patients would have difficult, painful breathing.

- Remember from last lecture when we talked about surface anatomy of the lungs and pleura, we said that pleura descends two spaces below the surface anatomy of the lungs. Also, we mentioned that inflation of the lungs is directed downwards (in the lower space between visceral and parietal pleurae).

>> For this reason, The pleural cavity, especially its lower part, is a site for :

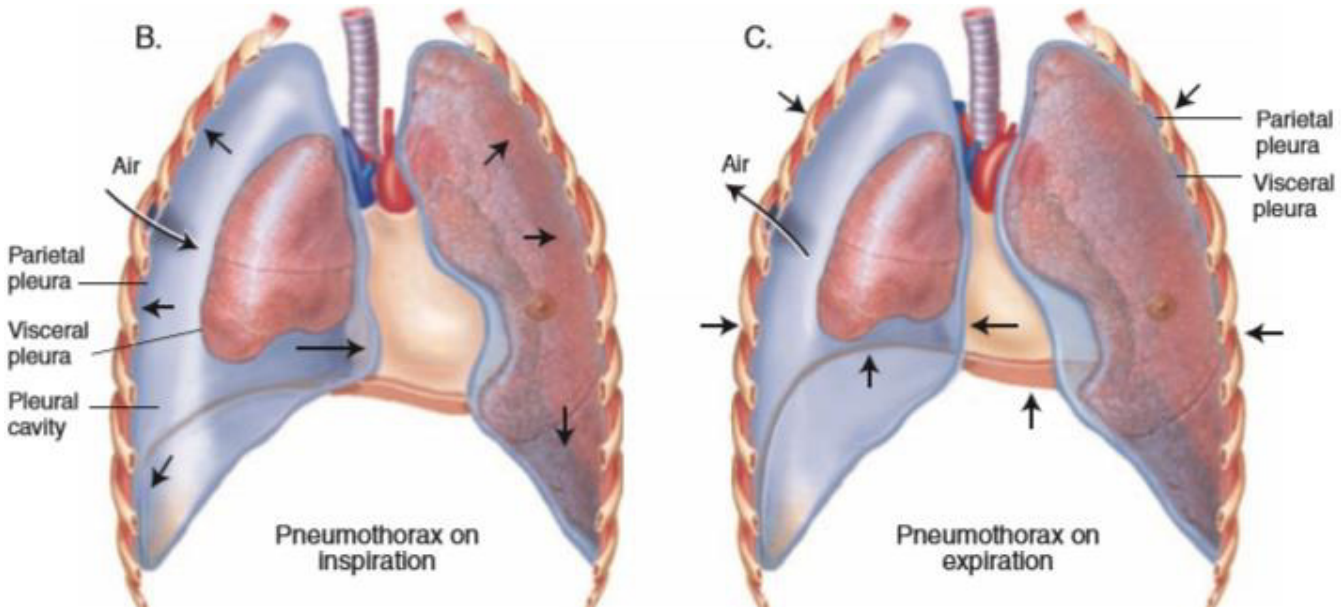
A. Pneumothorax: an abnormal collection of air in the space between visceral and parietal pleurae.

-Any penetration in the parietal pleura would allow air to escape into the pleural cavity, and consequently the lungs will collapse.

Example: when a needle is inserted in the subclavian vein, apex of the lung might be injured. So, the injury may extend to the parietal and visceral pleurae and may reach the lung as well, causing the air to pass from outside into the pleural cavity, thus filling it, and as a result the lungs will collapse.

So the air that's found around the lung is called pneumothorax.

-It's commonly seen in car accidents where a trauma to the ribs causes injury to the parietal pleura >> entrance of air into the pleural cavity >> collapse of the lungs.



B. Pleural Effusion: means a build-up of fluid inside the pleural cavity (space).

This effusion descends downwards, thus filling the space that is located below the surface anatomy of the lungs.

-Examples on pleural effusion:

1- **Empyema/pyothorax:** means the presence of pus inside the pleural cavity.

-Seen after infections, whether acute or chronic.

2- **Haemothorax:** means accumulation of blood in the pleural cavity.

This is important when you need to perform lung aspiration and remove the excess fluid as you should really know where to put the needle.

-If you take the *midclavicular* line, you should insert the needle in the **7th intercostal space**. Why ? Because lung reaches the **6th** intercostal space, whereas pleura reaches the **8th** intercostal space. This means that the needle is inserted between lungs & pleura, where fluids, blood or whatever accumulate.

-If you take the *midaxillary* line, the needle should be inserted in the **9th intercostal space** (between the 8th and 10th intercostal spaces, i.e. between surface anatomy of pleura and surface anatomy of the lung).

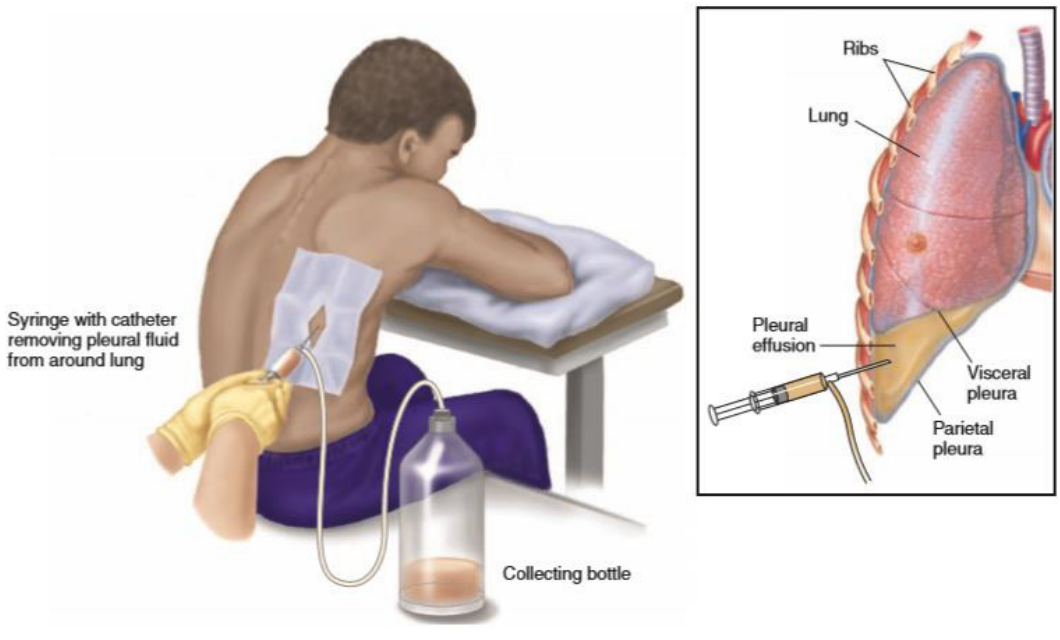


Figure 7-5. Thoracentesis.

-Reflections of peripheral pleura:

- Formed around the base and they mark the extent of pleural cavities.

Our lungs don't completely fill the anterior or posterior inferior regions of pleural cavities. This results in **recesses in which two layers of parietal pleura become opposed.

-Expansion of the lungs into these spaces (recesses) usually occurs only during forced inspiration. They are the deepest after forced expiration and shallowest after forced inspiration.
-These recesses provide potential spaces in which fluids can collect and from which fluids can be aspired.
-They can be found between:

1. Mediastinal and diaphragmatic pleurae >> ***Mediastino-diaphragmatic recess***, where costal and mediastinal pleurae become opposed.

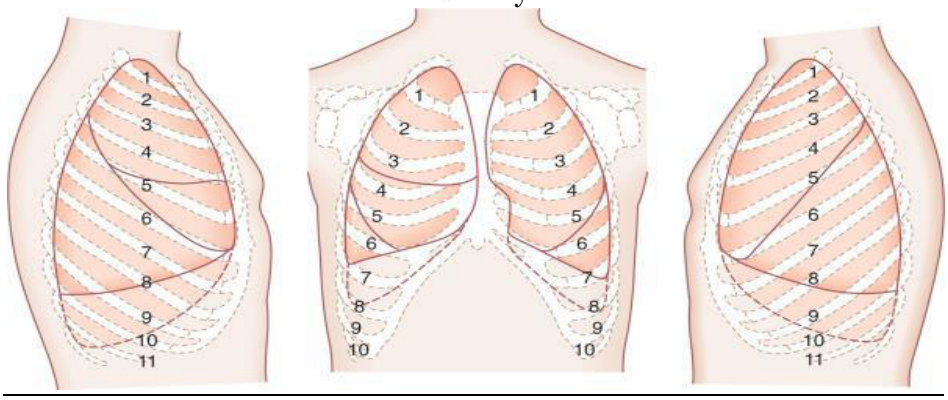
2. Costal and diaphragmatic pleurae >> ***Costodiaphragmatic recess***, which is located between inferior margin of the lung and inferior margin of pleura.

-It extends :
   a. 1 inch in the midclavicular line.
   b. 2 inches in the scapular line posteriorly.
   c. 3 inches in the midaxillary line (the most important)

*Clinically, Costodiaphragmatic recess is more important in lung aspiration procedures (when we insert a needle in intercostal space) since it's a common site for accumulation of fluids. Also, it's important when want to put a midaxillary cannula as we should insert the cannula into this recess; between lungs and pleura (in the 9th intercostal space).

-*Relationships of pleural reflections and lobes of the lung :*

- At the midclavicular line, the recess lies between rib spaces 6 & 8
- At the midaxillary line, it lies between 8 & 10.
- At the paravertebral line, it lies between 10 & 12.



-Surface anatomy of pleura :

At the apex: It lies one inch above the medial third of clavicle, just like the lungs.

Anterior Border: from mediastino-clavicular joint to the midline till it reaches the right side (7th intercostal space or costal cartilage)

Base :

Midclavicular to the 8th intercostal space

Midaxillary: to the 10th intercostal space.

Posteriorly : to the 12th intercostal space.

**So, pleura descends two spaces below the lung.

-Suprapleural Membrane:

- Located above the apex of the lung.
- It's basically a fibrous sheath covering the apex, and has many attachments:

Laterally: to the medial border of the first rib and costal cartilage.

Medially: blends with fascia of the neck (Sibson's Fascia)

Apex: to the tip of the transverse process of the 7th cervical vertebra.

**Actions:

1-Protects the cervical pleura and lung.

2-Resists changes in the intrathoracic pressure during respiration.

Therefore, this membrane (Suprapleural membrane) above and the diaphragm below seal the thoracic cavity in order to keep the intrathoracic pressure in a normal range.

-Clinical Notes :

Aspiration of fluid (pleural effusion) or pneumothorax from the pleural cavity is performed by inserting a needle through the **7th** intercostal space in the midcalvicular line, OR the **9th** intercostal space, or sometimes the **12th** intercostal space.

But keep in mind that the needle is usually put in the lower border of the space, in other words, above the upper border of the rib. WHY?

Because VAN (vein, artery, nerve) is found within the subcostal groove near the lower border of the rib.

*writer's note:

I heard both sections' recordings trying to get that point and I've come up with the following: Intercostal **V**eins, **A**rteries, and **N**erves (**VAN**) are found in the subcostal groove near the lower border of the ***rib***, so in order to avoid injuring those structures you have two ways by which you can insert a needle in the intercostal space without coming in contact with VAN:
Either you put the needle in the *lower* border of the SPACE or in the *upper* part of the RIB.(since VAN is found near the lower border of the rib).

-Pleural Effusion :

- Accumulation of fluid in the plural cavity
- Normally, pleural cavity contains 5-10 ml of clear fluid. But if it increases more than 300 ml, then it indicates pleural effusion.

**Causes :

- Infection
- Injury
- It could be spontaneous (without cause) in some cases.

-Clinical Manifestations Of Pleural Effusion :

- Decrease in lung expansion.
- Decrease in breath sound.
- In percussion, there will be Dullness.

Percussion is a method used in clinical examination. It's done with the middle finger of one hand tapping on the middle finger of the other hand (that's placed over the intercostal space) using a wrist action. It normally gives a resonant sound (tympanic or drum like sound). However, in cases of pleural effusion, a dull sound would be heard due to the presence of fluid in the intercostal space.

- Pain.
- Cough.

-Nerve Supply Of Pleura :

It differs between parietal and visceral pleurae.

****Visceral pleura :***

-Sensitive to stretch

-Insensitive to pain

-Supplied by pulmonary plexus and autonomic nervous system, same as the lungs.

**** Parietal pleura :***

-Sensitive to pain, temperature, and touch.

-Supplied by : (segmentally)

- intercostal nerves >> to the costal pleura.
- Phrenic nerve >> mediastinal pleura and diaphragmatic pleura.
- Lower six intercostal nerves >> to the peripheral pleura.

-Arterial Supply Of Pleura :

****Parietal pleura :***

From arteries that supply the thoracic wall, and they are all peripheral arteries.

1-intercostal arteries (anterior and posterior).

2-Internal thoracic artery.

3-Musculophrenic arteries.

**_Visceral pleura :_

Bronchial arteries, which are branches of the thoracic aorta.

-Venous drainage:

- Veins drain into azygos and internal thoracic veins.

-Lymphatic Drainage Of Pleura :

**_Parietal pleura:_

- Mediastinal Pleura by:

1- Mediastinal Lymph nodes.
2- Tracheobronchial Lymph nodes.
3- Intercostal Lymph nodes.

- Diaphragmatic Pleura by :

1- Parasternal Lymph nodes.
2- Posterior mediastinal Lymph nodes.

Visceral (pulmonary) pleura : along bronchial arteries to the **bronchopulmonary lymph nodes.

THE END

Shout-out to Aseil Khatib ✌

Dedicated to: Marah, Dina, Batool, and the most awesome seat neighbor ever 'sophia'.