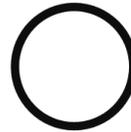


# RESPIRATORY SYSTEM

Anatomy



Sheet



Slide

Number:

-5

Done by:

محمود الحربي-

Corrected by:

ابراهيم النصر-

Doctor:

د. محمد المحتسب-

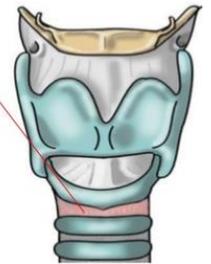
# Trachea and lungs

-**The Cricotracheal membrane:** this membrane can be used to do tracheostomy, especially during an operation.

{Tracheostomy: an incision in the windpipe made to relieve an obstruction to breathing.}

THE CRICOTRACHEAL MEMBRANE

- connects the most superior tracheal cartilage with the inferior border of the cricoid cartilage



## Trachea

The trachea is a flexible tube. It extends from C6 (the lower border of the cricoid cartilage) to the level between T4 and T5 (to the level of the angle of Louis (the sternal angle)). After that the trachea reaches the sternal angle and gives the right main bronchus and the left main bronchus.

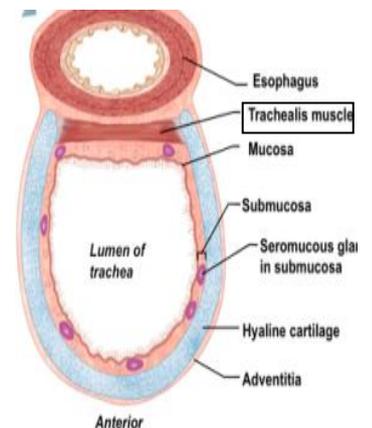
### ❖ Structures of the trachea:

The trachea has 16-20 C-shaped hyaline cartilages. The function of these C-shaped hyaline cartilages is to keep the trachea open for the passage of air unlike the oesophagus. The oesophagus is always collapsed until a bolus of food descends downwards then it opens.

Posteriorly, the trachea has a smooth muscle called trachealis muscle. The trachealis muscle is complementary to the C-shaped cartilages. The muscle is anterior to the oesophagus. Since it is a smooth muscle, it is supplied by autonomic nerves. This muscle helps the oesophagus push the bolus of food downwards.

### ❖ Length and diameter of the trachea:

The trachea is 4.5 to 5 inches long and has a diameter equal to the diameter of the index finger. In children, the trachea is very narrow with a diameter of a pencil. This is why tracheostomy is hard to perform on children. In inspiration, the trachea lengthens and widens. In expiration it returns to its normal size.



## ❖ Relations of the trachea:

As mentioned before, the trachea descends in the neck and ends at the level of the sternal angle. When looking at the trachea in an x-ray, you will see a column of black air. This column of air is deviated to the right as the trachea is normally deviated to the right.

\*The recurrent laryngeal nerve ascends between the trachea and oesophagus.

-The oesophagus is deviated to the left because it opens in the left copula of the diaphragm at the level of T10 one inch to the left.

-The trachea gives the right main bronchus and the left main bronchus. The left is always narrower, more horizontal and longer than the right. The right is wider, more vertical and shorter than the left.

### • Anterior relations:

1- Aortic arch.

2-Thymus gland: it is rudimentary in adults, so there are only **remains** of thymus.

3-Thyroid gland, especially the isthmus (which connects the right lobe with the left lobe of the thyroid). It is usually found in front of the 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> tracheal rings.

4-The origin of the brachiocephalic artery.

5-Manubrium sterni.

### • Left side relations:

1-The arch of the aorta: the arch begins anterior to the trachea then becomes on the left side because the arch is directed backwards and to the left.

2-Left subclavian artery.

3-Left common carotid artery {the left subclavian is more posterior than the left common carotid}.

4- Left vagus: the vagus nerve passes **behind** the root of the lung and gives the recurrent laryngeal nerve below the aortic arch level.

5- Left phrenic nerve which passes **anterior** to the root of the lung.

6-The left main bronchus.

- **Right side relations:**

1-The azygous arch which ends in the superior vena cava.

2-The brachiocephalic artery.

3-Right vagus nerve: the vagus passes **behind** the root of the lung.

4-Right phrenic nerve: passes **anterior** to the root of the lung.

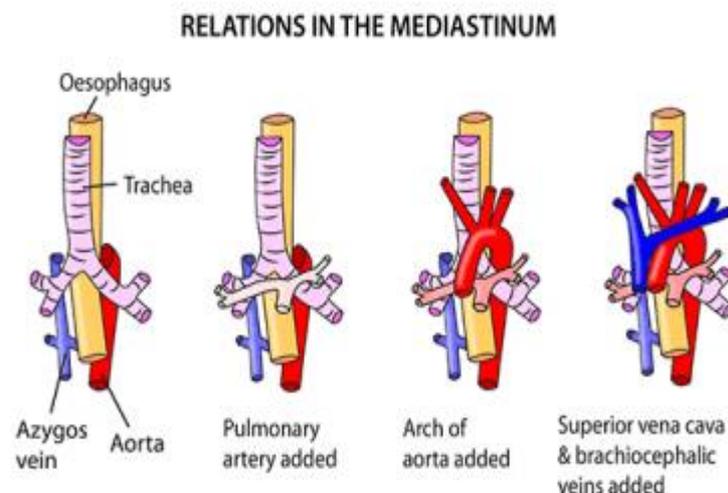
5-The right main bronchus.

- **Posterior relations:**

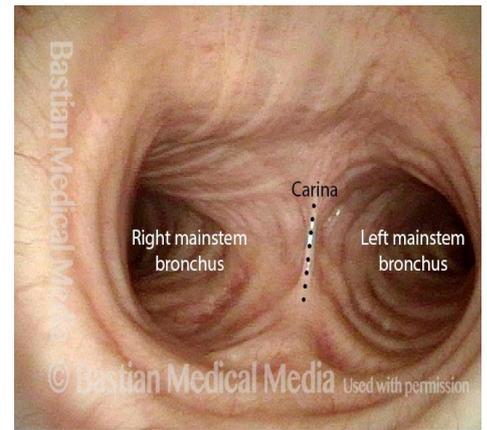
1-The esophagus.

2-The left recurrent laryngeal nerve.

3-Thoracic duct: it is a lymphatic duct that starts from the opening of the abdominal aorta in the diaphragm and ascends in the chest. It starts on the right side of the esophagus then it becomes behind the esophagus at the level of T5 and it ends at the beginning of the left brachiocephalic vein.



❖ **Carina:** it is a fold of mucosa found at the beginning of the main bronchi (at the beginning of the bifurcation). This fold is very sensitive, so when it is irritated it causes coughing. The trachea ends at the sternal angle (between the 4<sup>th</sup> and 5<sup>th</sup> thoracic vertebra) so the carina is found there. When taking a deep inspiration the trachea elongates and it may reach the 6<sup>th</sup> thoracic vertebra.



### ❖ **Tracheostomy (or tracheotomy) and intubation:**

**-Intubation:** it is the process in which a tube is inserted through the trachea downwards to the lung. This tube can be used in patients with permanent damage in their larynx to breathe. This tube must be below the true vocal cords because they adduct. In surgery, when the patient is under anaesthesia, the tube is put through the mouth, passes between the true vocal cords and enters the trachea. In this case, the tube is called endotracheal tube. So the difference between intubation and the endotracheal tube is that the first is inserted below the larynx by opening the trachea below the larynx (so it is basically tracheostomy) and the second is inserted through the mouth or the nose.

**-Tracheostomy:** it is the opening of the trachea to relieve an obstruction to breathing.

**There are 2 types of tracheostomy:**

**1- Emergency tracheostomy** (also called low or suprasternal tracheostomy)

In an **emergency** outside the hospital when a person has an obstruction in the airway passage and his color becomes blue because of his inability to take up oxygen, you make a **suprasternal** opening to allow him to breathe through this opening. You feel the tracheal rings above the suprasternal notch and make an opening between two rings. Air will automatically enter through this opening and the patient will breathe.

There is a risk of bleeding in this procedure because there are blood vessels in the suprasternal notch like the **inferior thyroid vein, the anterior**

**jugular arch** formed between the left and right anterior jugular veins and sometimes the **thyroid ima artery** is present. But in this situation, we do not worry about the bleeding here as much as we do for the inability to get air (the brain cells will die after 2-5 minutes without oxygen), the bleeding here can be easily stopped or might even stop alone after few minutes. it should not even be considered because what is important is to get the patient breathing again.

## 2-High tracheostomy:

If there is **no emergency**, the opening is not necessarily done in the suprasternal notch. If you are performing a thyroidectomy and you made a bilateral partial cut in the recurrent laryngeal nerve, vocal cords will adduct. So in this case when performing a tracheostomy, the opening is done below the vocal cords. The best place to do it is in the membrane between the cricoid cartilage and the trachea (Cricotracheal membrane).

## ❖ Bronchi

Between the beginnings of both bronchi is the carina. There is a left main bronchus and a right main bronchus. The left is always narrower, more horizontal and longer (around 2 to 3 inches) than the right. The right is wider, more vertical and shorter (around 1 inch of length) than the left. This is important clinically. Because the right bronchus is wider and more vertical, any foreign body that enters the respiratory tract will usually go to the right bronchus, not the left (very rare). So in an emergency, when using a bronchoscope, you view the right bronchus first because it is more likely to have the foreign body in the right than the left.

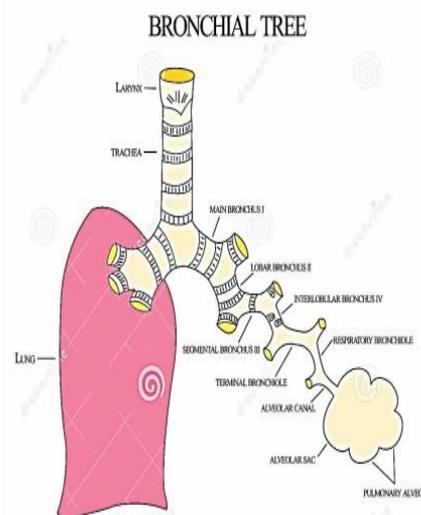
	<b>Right main bronchus</b>	<b>Left main bronchus</b>
<b>Length</b>	Shorter (1")	Longer (2-3")
<b>Lumen</b>	Wider	Narrower
<b>Alignment</b>	More vertical (almost parallel to the trachea, with a small deviation)	More horizontal
<b>IMPORTANT</b>	In the hilum of the right lung, it divides into: <ul style="list-style-type: none"> <li>- <b>Eparterial bronchus</b> (above pulmonary artery)</li> <li>- <b>Hyparterial bronchus</b> (below pulmonary artery)</li> </ul>	In the hilum of the left lung, it remains as one main bronchus.

## ❖ The bronchial tree

-The right and left **main bronchi** are called the **primary** bronchi.

-The **secondary** bronchi are called **lobar bronchi**. So, on the right side there are three lobar bronchi because the right lung has three lobes (upper, middle and lower lobes) and on the left side there are two lobar bronchi because the left lung has two lobes (upper and lower lobes).

-The **tertiary** bronchi are called **bronchopulmonary segments**. There are 10 bronchopulmonary segments on the right and 10 on the left in the adult.

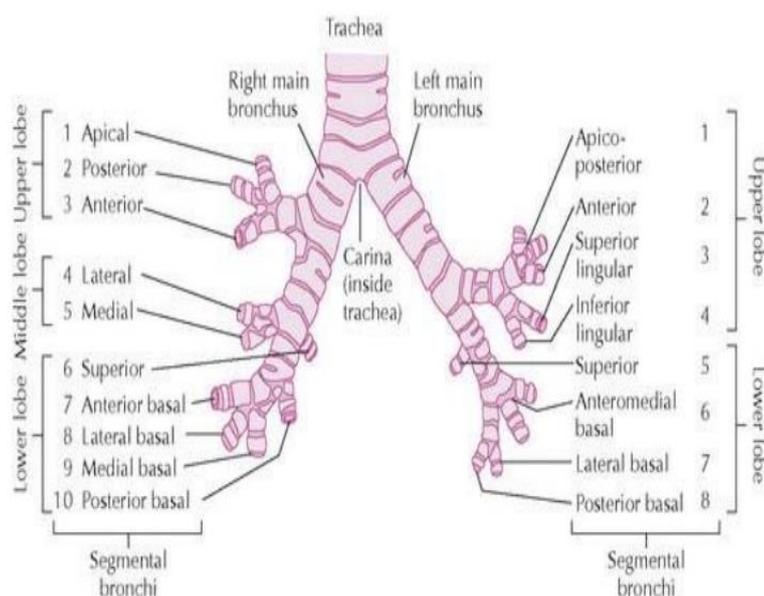


### • In the right lung:

1-The upper lobe has three bronchopulmonary segments; apical, anterior and posterior.

2-The middle lobe has two segments; medial and lateral.

3-The lower lobe (the base) has five segments; apicobasal (or apical), medial, lateral, anterior and posterior.



### • In the left lung:

{The upper lobe has a special structure called the lingula and it is made by the cardiac notch}.

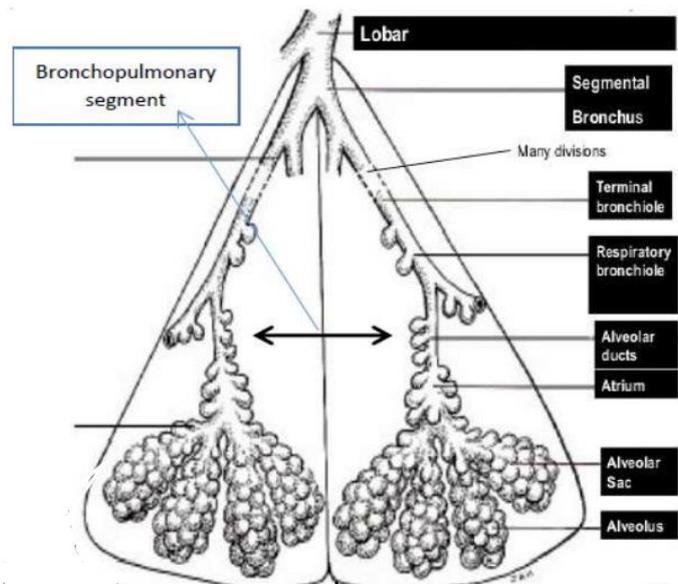
1-The upper lobe has 5 bronchopulmonary segments; apical, anterior, posterior, superior lingular and inferior lingular.

2-The lower lobe (the base) has 5 bronchopulmonary segments; apicobasal (apical), anterior, posterior, medial and lateral.

- **Bronchopulmonary segment** further divide into terminal bronchioles & these into respiratory bronchioles which end in the pulmonary unit.

- Pulmonary unit consist of alveolar ducts, atria, air sacs and pulmonary alveoli.

-The importance of these segments surgically is that if you need to remove a part of the lung, these segments are removed (segmental sergury). In the past, the entire lobe was removed.



Why are the segments removed now instead of the lobes? Because it was found that they are units that have an apex and a base on the lateral surface of the lung. So instead of removing a whole lobe, you can remove a smaller unit. These units have a segmental bronchus with cartilages surrounding them, a pulmonary artery and two pulmonary veins. All of this structure is surrounded by a connective tissue. The segmental vein lies in the connective tissue between adjacent bronchopulmonary segments. This unit also has lymphatic vessels, nerves and alveoli. So when a surgeon removes a segment, he removes these structures that are surrounded with connective tissue. In other words, all the structures that are between the two veins are removed making these two veins a landmark for this surgery.

**-A clinical points:**

\* When a person is standing up and swallows a foreign body and this foreign body enters the respiratory tract, it will enter to the right side (the right bronchus). What segment will it enter? The posterior segment of the lower lobe because it is the lowest in that lobe and it is continuous with the trachea.

\*When a person goes to the dentist and lays down to remove a tooth, he accidentally swallows the tooth and enters the respiratory tract. It will enter the right side. What segment will it enter? The apicobasal segment.

- **In the embryo**

-There is a difference between the number of bronchopulmonary segments in adults and in embryos. The difference is that the embryo has 8 in the left lung instead of 10. After delivery, they become 10 in number. Why is there a difference? In the upper lobe in the embryo, the apical segment and the posterior segment are joined together as one segment called apicoposterior. After delivery they are separated to give the apical and posterior segments. In the lower lobe (the base), the anterior segment and the medial segment are joined together as one segment called anteromedial. After delivery they are separated to give the anterior and medial segments.

- **Clinical importance of bronchopulmonary segment**

1-They are important in surgery: these days, segments are removed in surgeries instead of lobes.

2-If there is an infection, it stays localized inside the segment between the connective tissue that surrounds the segment.

3-There is no barrier between the segments, so if the infection spreads, it will affect other segments.

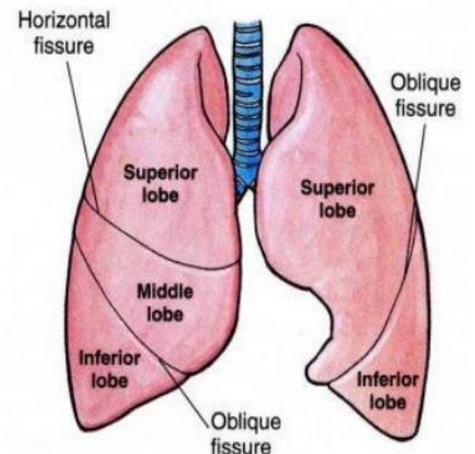
4-In postural drainage, it is important to drain segments.

5-In bronchoscopy, you look at the segments.

\*Be aware that the bronchioles are found inside the segments

# Lungs

There are two lungs; one right and one left. Each lung has an apex and a base. The base sits on the diaphragm. We know that the diaphragm has two copula, and these copula are shaped like a dome. So the right lung has its base on the right copula and the left lung has its base on the left copula. The anatomical relation between the lungs and the diaphragm is that the lungs are anterior, posterior and superior to the diaphragm.



## ❖ Difference between the right and left lungs:

**1-In the dimensions:** the right lung is shorter and wider than the left. This is because the liver pushes the diaphragm upwards on the right side causing the right lung to be shorter and wider. The left lung is longer and narrower than the right lung.

**2-In the lobes:** the right lung has three lobes; upper, middle and lower lobes. The left lung has two lobes; upper and lower lobes.

**3-In the fissures:** the left lung has an oblique fissure only. The right lung has oblique and horizontal fissures.

**4-The left lung** has a structure called **lingula** and a **cardiac notch**.

**5-The left lung** has an artery called **apical artery** which is found at the apex.

## ❖ Generally speaking about the lungs

-Fissures can be identified on the body using surface anatomy. They are important when using the stethoscope to know which lobe you are listening to.

-The color of the lungs is reddish in normal people, while in smokers it will become black and black dots are found because of the nicotine.

-Lungs are filled with elastic tissue. This elastic tissue surrounds the alveoli

-The apexes of the lungs extend above the clavicles and the first ribs. They are usually 1 inch above the medial third of the clavicle. This may be dangerous when encountering a stab wound at the root of the neck. The apex may be damaged and air will go inside the lung which will cause its deflation and collapse.

-The lungs weight 600-800gm, 90% air & 10% tissue.

### ❖ The function of the lung:

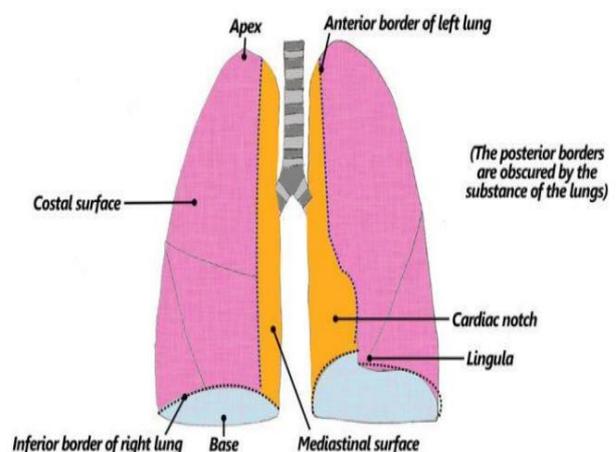
Lungs receive blood from the right and left pulmonary artery. Both of those arteries originate from the pulmonary trunk which bifurcates into both of them. These arteries reach the lung through the hilum. When air reaches the alveoli, oxygen moves to the blood to make it oxygenated. After that, oxygenated blood returns to the left atrium through the pulmonary veins. Pulmonary veins are 4 in number; 2 on the right and 2 on the left. After the blood reaches the left atrium, it goes to the left ventricle then to the aorta. In the end, blood reaches the cells to give them oxygen. So in the end, the main function of the lungs is to oxygenate the blood.

### ❖ Borders and surfaces

-Lungs have **anterior, posterior** and **inferior borders**.

-The anterior border isn't similar in both lungs. The left lung has the cardiac notch on its anterior border between the 4<sup>th</sup> and 6<sup>th</sup> costal cartilages. This cardiac notch makes a shape of a semicircle with a length of 1 inch.

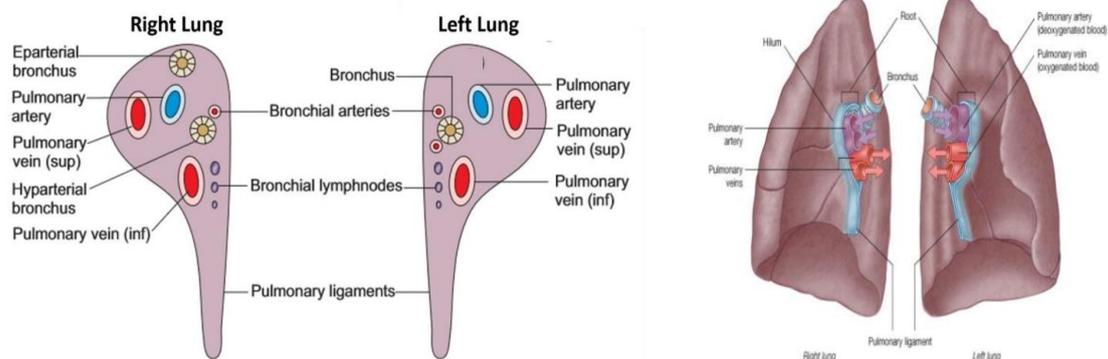
-The inferior border is sharp and has the diaphragm beneath it.



- Lungs have a **costal surface** and a **mediastinal surface**.
- The costal surface lies immediately adjacent to the ribs and intercostal spaces.
- The mediastinal surface lies against the mediastinum anteriorly and the vertebral column posteriorly. {Don't forget that the mediastinum is the space between the two lungs}.

### ❖ **The hilum:**

The lung also contains a comma shaped hilum through which structures enter and leave.



- **Components of the right hilum:**

One pulmonary artery, two pulmonary veins (upper and lower) and the right bronchus. {You can identify the bronchi in the laboratory by identifying the cartilage that surrounds them}.

- The Bronchus that passes through the right hilum separate into **ib-arterial bronchus** (above the pulmonary artery) and **hib-arterial bronchus** (below the pulmonary artery).

- **Components of the left hilum:**

One pulmonary artery, two pulmonary veins (upper and lower) and the left bronchus. The difference in the left lung is that the bronchus doesn't separate into **ib-arterial** and **hib-arterial** bronchi.

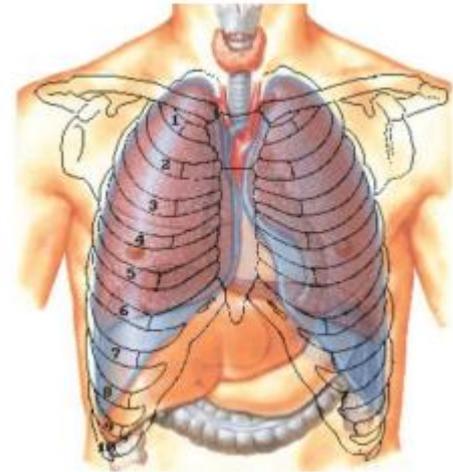
### ❖ **The pleura:**

- The pleura has two layers, visceral and parietal.
- The two layers are adherent at the apex of the lung and at the base they have a space between them.

-The visceral and parietal layers of the pleura on the mediastinal surface around the hilum are pledged together to form one membrane. They surround the content of the hilum. Below the hilum they make the pulmonary ligament.

### ❖ **Surface anatomy of the lung:**

Surface anatomy means to identify structures in the body by using landmarks found on the surface of the body.



- **How to identify the apex:** the apex is found 1 inch above the medial end of the clavicle. This is important clinically; when inserting a cannula into the subclavian vein (which is found on the upper surface of the first rib) to administer drugs to the patient, a mistake can happen by inserting the cannula into the apex instead of the vein. This collapses the lung. So always after the cannula is inserted, the patient is x-rayed to make sure that the cannula didn't go through the apex.
- **How identify the posterior border:** it starts from the apex and descends posteriorly until it reaches T12.
- **How to identify the anterior border:** it starts from the apex, then to the sternoclavicular joint, then to the sternal angle. It descends down until it reaches the 7<sup>th</sup> costal cartilage in the midline.  
There's a difference between the right & left lungs' anterior border: in the left lung, between the 4<sup>th</sup> and 6<sup>th</sup> costal cartilage 0.5-1 inch (2cm) to the left, there is a semicircle cardiac notch at the anterior border.
- **How to identify the base:** at the end of expiration: the base crosses the midclavicular line at the 6<sup>th</sup> rib, crosses the midaxillary line at the 8<sup>th</sup> rib, and posterior at the level of T10. This is not fixed. When there is inhalation and expansion of the lung, the base may reach the level of T12.

- **How to identify the oblique fissure:** start from the dorsal spine of T4, then go along with the 6<sup>th</sup> rib until reaching anteriorly.
- **How to identify the horizontal fissure:** start from the 4<sup>th</sup> intercostal space anteriorly and then go along the 5<sup>th</sup> rib.
- **How to identify the pleura:** the visceral layer is always adherent to the lung. The parietal layer is the layer that changes. Identifying the parietal layer at the apex is the same as identifying the apex itself since the two layers are adherent at the apex. At the anterior border, it reaches the 6<sup>th</sup> or 7<sup>th</sup> rib (the same as the lung). The difference is at the base. The parietal layer reaches two more spaces at the base. So at the midclavicular line it will reach the 8<sup>th</sup> rib instead of the 6<sup>th</sup>, at the midaxillary line it will reach the 10<sup>th</sup> rib instead of the 8<sup>th</sup>, and it is at the level of T12 instead of T10. This difference between the lung and the pleura in the surface anatomy is important to keep the lung surrounded by the pleura during expansion.

### ❖ **The root and hilum**

-Within each root and located in the hilum are:

1-Pulmonary artery. 2-Two pulmonary veins.  
3-Lymph nodes and vessels. 4-Nerves (sympathetic and parasympathetic). 5-Bronchial vessels. 6-Bronchus. 7-Ligaments.

-The bronchial vessels are the vessels that supply the lung tissue not the pulmonary artery or the pulmonary veins!!!!!!!!!!!!

-As mentioned before, the bronchus in the right hilum separates into two bronchi and in the left hilum it stays as a single bronchus.

-The root of the lung is found between T5 and T7

### ❖ **Impressions on the visceral surface of the right lung**

1-Impression for the right atrium and the associated superior vena cava and inferior vena cava

2-The esophagus has an impression posterior to the hilum and reaches the apex.

3-Trachea has an impression anteriorly.

4-Impressions caused by the contents of the hilum (2 pulmonary veins, pulmonary artery, ib-arterial hib-arterial bronchi)

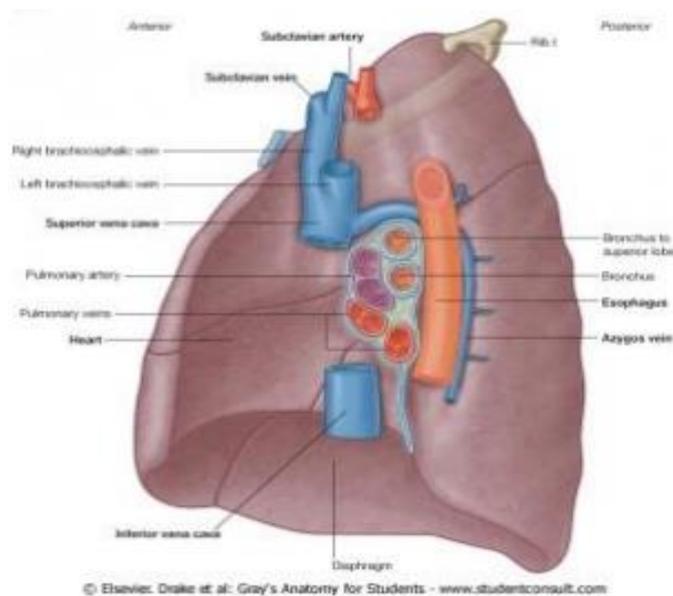
## ❖ Impressions on the visceral surface of the left lung

1-Impression for the left ventricle.

2-Impression for the descending aorta and the arch of the aorta with its branches.

3-The esophagus has an impression anterior to the descending aorta in the lower part of the lung because it goes through the diaphragm one inch to the left, so it crosses the descending aorta

\*The trachea doesn't have an impression on the left lung.



**Good luck**

**Sorry for any mistake**