

RS ANATOMY



DOCTOR NOTES LECTURE NO. 5

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Trachea and lung

The Trachea is a flexible tube that extends from C6 (lower border of cricoid cartilage/ end of the larynx) to the level of T4 and T5. The end of the trachea is called carina: a very sensitive area.

Structure of the trachea:

- The trachea has 16-20 C-shaped hyaline cartilages (anterior & lateral, absent posteriorly).
- Posteriorly, the trachea has a smooth muscle called Trachealis, which is complementary to the C-shaped cartilages.

Length and diameter of the trachea:

The trachea is 12cm (about 5 inches) long and has a diameter equal to that of the index finger (almost 1 inch). In children, the trachea is very narrow with the diameter of a pencil. So, tracheostomy is hard on children.

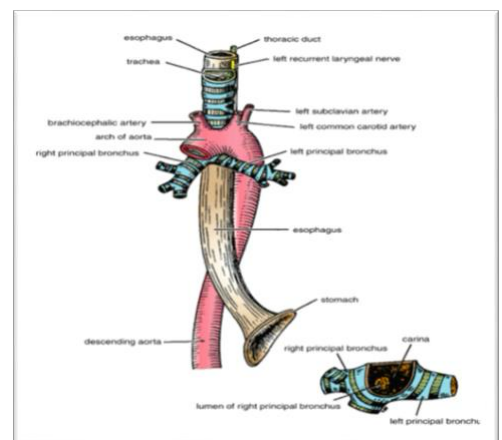
Relations:

Anterior:

1. Arch of aorta (anterior then to the left)
2. Thyroid gland (especially the isthmus which is anterior to 2nd, 3rd, and 4th tracheal rings)
3. Remnants of the thymus in adults
4. Manubrium sterni (First part of the sternum)
5. The origin of the brachiocephalic artery (anterior then to the right)

Posterior:

1. Esophagus
2. The left recurrent laryngeal nerve: since it is longer than the right branch and curves around the arch of the aorta. Then it ascends between the trachea and oesophagus. *Right recurrent laryngeal appears only in the neck (right and left sides) but here in the chest only the left is present
3. thoracic duct (begins from cisterna chyli at the right side of the opening of abdominal aorta ascends to the right of esophagus crosses to be posterior to both esophagus and trachea then ascends to the left to open at the beginning of left brachiocephalic vein)



The esophagus & descending thoracic aorta cross each other. The esophagus then opens one inch to the left in the stomach through esophageal orifice while the descending thoracic aorta goes to the midline at the level of T12.

Left:

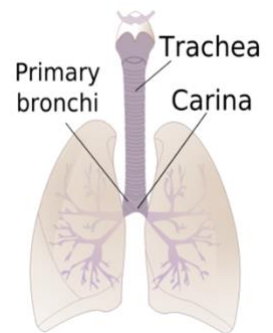
1. arch of the aorta
2. LCCA
3. Left subclavian
4. Left phrenic n (anterior to the lung hilum)
5. Left vagus n (posterior to lung hilum)
6. left main bronchus

Right:

1. The azygous Arch: which drains the venous blood drainage of the right side of the chest, ends in the svc --> rt atrium
2. The brachiocephalic artery
3. Right main bronchus
4. Right phrenic nerve (anterior to hilum)
5. Right vagus nerve (posterior to hilum)

Carina:

Cartilaginous ridge covered by a fold of mucosa (inside the tracheal tube). It is an overly sensitive area that causes coughing reflex in bronchoscopy, which affects the results. It descends from T4 to T6 in deep inspiration.



Tracheostomy= tracheotomy: opening through the trachea by a sharp object.

We operate below true vocal cords.

- In emergencies it's done suprasternally at the level of 5th, 6th & 7th rings which can be palpated.

It is only done in emergencies because we have BVs there (Veins: inferior thyroid, anterior jugular)

(arteries: thyroid ima, if present). But still bleeding isn't life-threatening.

- During surgeries:

1. Cricothyroid ligament: in the infraglottic space, below the true vocal cords.
2. Cricotracheal: between the lower border of cricoid and the first tracheal ring
3. Between 1st and 2nd tracheal rings

When we make an opening during tracheotomy the air will flow passively as a result of lung collapsing from suffocation, which results in negative pressure inside the lungs, which drives the air from outside to inside

Avoid:

1. between the area between 2nd to 4th rings because we have the ismuth.
2. thyrohyoid membrane because it's above the true vocal cords

Intubation:

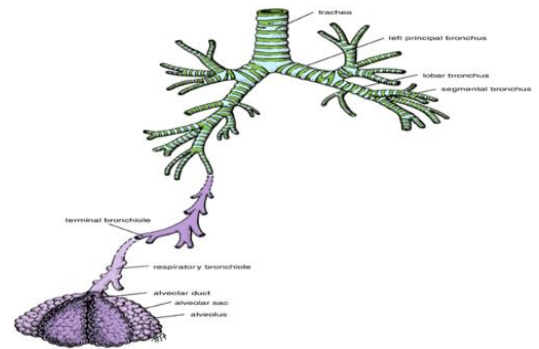
We have 2 types of endotracheal tubes: oral and nasal. The oral tube is put and pushed inside the mouth until we reach the true vocal cord. It is placed in between them to prevent sudden adduction (closure) of vocal cords after anesthesia, we mostly use it during surgical operations.

Special Cases of Intubation: Laryngeal Cancer or Permanent Damage to the Larynx

If the larynx is damaged or removed, a permanent tracheostomy tube might be placed directly into the trachea to maintain the airway.

Bronchi:

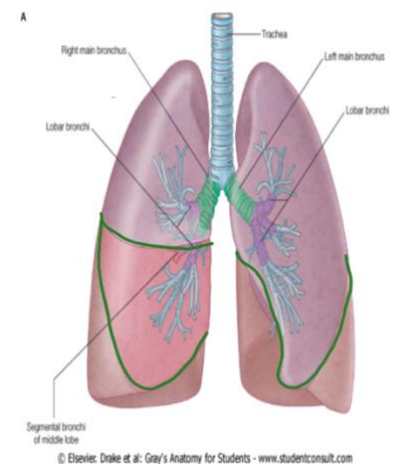
- ✓ The right and left main extrapulmonary bronchi are called the **primary bronchi**.
- Walls of bronchi are held open by discontinuous **plates** of hyaline cartilage, not c-shaped like in trachea.
- The left bronchus is always narrower, more horizontal and longer (around 2 to 3 inches) than the right. The right is wider, more vertical, and shorter (by around 1 inch) than the left.



Clinical importance:

considering that 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 to go to the left).

- ✓ The **secondary** (intrapulmonary: surrounded by lung tissue) bronchi are called lobar bronchi.
- In the right lung these secondary bronchi appear directly at the hilum, making the branching obvious outside the lung.
- However, in the left lung, primary bronchi do not branch into at the hilum. The division occurs inside the lung.
- ✓ The **tertiary bronchi** are called bronchopulmonary segments.
- There are 10 bronchopulmonary segments on the right and 10 on the left in adults. Each one gives five to seven bronchioles.
- Right lung: 3 upper 2 middle 5 lower segments
- Left lung: 5 upper, 5 lower segments
- **They have cartilage but only one to three pieces each.**



Bronchopulmonary segments:

- Each segment has a base (on the lung surface), and an apex (where segmental bronchus enters and continues to divide into terminal bronchioles, respiratory bronchioles then alveoli).

Why do surgeons do segmentectomy now instead of lobectomy?

Each bronchopulmonary segment is surrounded by connective tissue and functions as an independent unit. It includes a segmental bronchus, a pulmonary artery, and two pulmonary veins. The segmental vein is located within the connective tissue separating adjacent segments. Additionally, each segment has its own lymphatic vessels, nerves, and alveoli. When a surgeon removes a segment, they remove all these structures within the connective tissue boundaries. Essentially, all structures between the two segmental veins are removed, **making these veins critical landmarks for segmentectomy procedures.**

right lung:

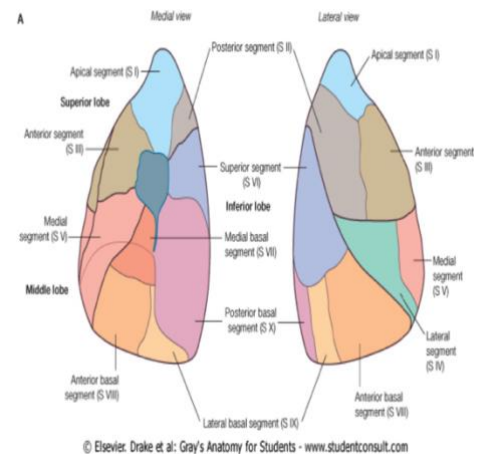
In the hilum, the **right main** bronchus branches into:

1. **Eparterial bronchus** (above the pulmonary artery, which is located in the middle of the hilum):

As a secondary lobar bronchus to the upper lobe.

2. **Hyparterial bronchus:** (posterior to and below the pulmonary artery): **branches into two lobar bronchi to the middle and lower lobes.**

- ✓ The upper lobe has three bronchopulmonary segments: Apical, anterior and posterior.
- ✓ The middle lobe has two bronchopulmonary segments: medial “mediastinal” and lateral.
- ✓ The lower lobe (the basal) has five segments: apicobasal, medial, lateral, anterior and posterior.



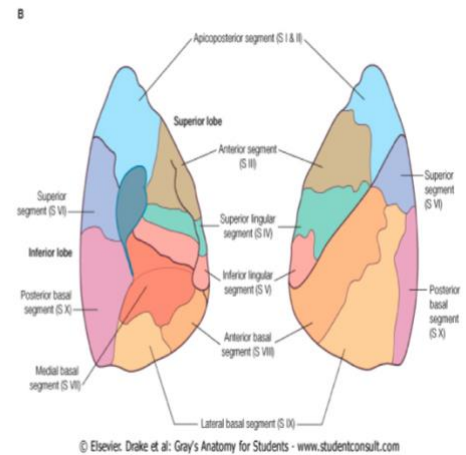
left lung:

It differs from the right lung by having superior and inferior lingular segments, which supply the lingula. The lingula is formed due to the cardiac notch, created during heart development when the growing heart pushes against the left lung.

- ✓ The upper lobe has 5 bronchopulmonary segments: Apical, anterior, posterior, superior lingual and inferior lingual.
- ✓ The lower lobe (the base) has 5 bronchopulmonary segments: apicobasal, anterior, posterior, medial, and lateral.

Notes:

- Apical segment is directed towards the apex.
- Anterior segment is directed towards the anterior border.
- Posterior segment is directed towards the posterior border.
- Medial is directed towards the medial surface.
- Lateral is directed towards the lateral wall.
- Apicobasal is the most superior segment in the lower lobe and directed posteriorly.
- Anterior border is sharp, posterior is rounded.



Why is this important?

As mentioned before, foreign bodies typically enter through the right bronchus due to its wider diameter and more vertical orientation. From there, they move into the lower bronchus and segments where lodgment usually occurs.

- If the person is in an **erect** position, the foreign body tends to lodge in the **posterior segment of the lower lobe** (the base), as it is the lowest point in that position.
- If the person is in a **lying down** position, such as during a **dental procedure** when an extracted tooth is accidentally swallowed, the foreign body is likely to lodge in the **apicobasal segment of the lower lobe**. (Extra: In the supine position, the apicobasal segment is located posterior to the lung hilum, making it a common site for foreign body lodgment in this posture.)

In both cases we perform bronchoscopy to extract the foreign body after a specific detection of the exact location of this body.

Brief touch on embryology:

Before birth, during the formation of bronchopulmonary segments:

- The left lung has 8 segments:

The apical and posterior segments fuse into one segment called the apicoposterior segment, which separates after birth into distinct apical and posterior segments.

The anterior and medial segments also fuse into one segment called the anteromedial segment, which separates after birth into the anterior and medial segments in the lower lobe.

- The right lung has 10 segments, and no changes occur after birth.

So After delivery, the left lung increases to 10 segments.

Clinical importance of bronchopulmonary segment:

1. They are important during surgery (discussed before)
2. If there is an infection, it starts within a certain segment.

But there is no real barrier between the segments, so the infection can spread to other segments. meaning that the surrounding connective tissue does not prevent the spread of infection.

Bronchioles:

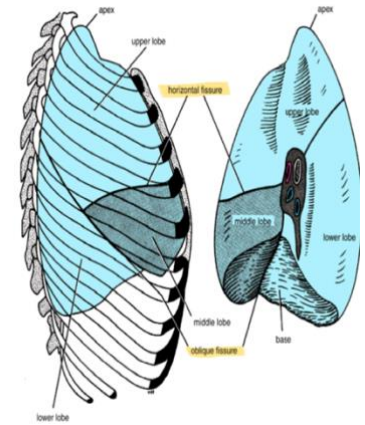
Conducting/ terminal zone	Respiratory zone
No cartilage present	No cartilage present
contains an excess of smooth muscle cells that spiral around the lumen	Smooth muscle is arranged in knob-like shapes and becomes fewer in number.
lined with simple columnar or cuboidal epithelium, with cilia	<u>Initially</u> lined with simple cuboidal epithelium and cilia, which becomes non-ciliated. Then becomes simple squamous.
Glands and goblet cells gradually disappear	
Fewer Clara cells	higher number of Clara cells

*changes are gradual not abrupt

Lungs:

Each lung weighs between 600 to 800 grams, with approximately 90% of the lung composed of air within the alveoli, and 10% consisting of lung tissue made up of elastic and reticular fibers of connective tissue.

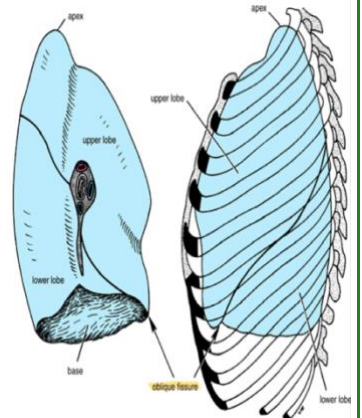
The right lung is shorter and wider than the left because the liver pushes the diaphragm upwards, pressing on the right lung. It consists of three lobes and has two fissures: the oblique and horizontal fissures.



In terms of surface anatomy:

- ✓ The oblique fissure runs backwards, about 4 centimeters away from the dorsal spine of T3-T4, crosses the 5th intercostal space, and continues along the 6th rib.
- ✓ The horizontal fissure starts anteriorly at the 4th intercostal space, passes along the 5th rib, and crosses the 6th rib to meet the oblique fissure.

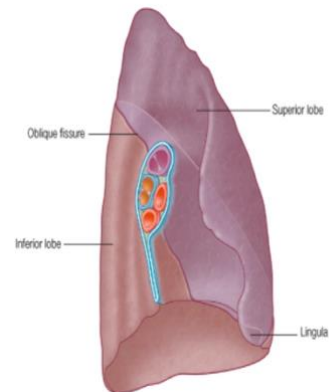
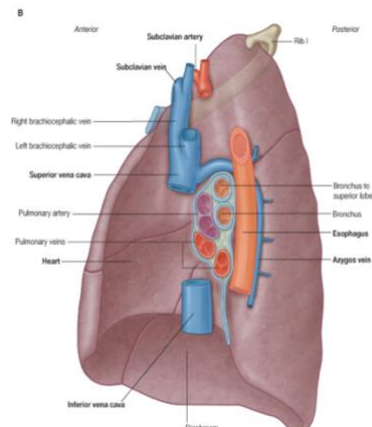
The left lung is longer and narrower, consisting of two lobes separated by a single oblique fissure. This fissure begins 4 centimeters from the dorsal spine at T3-T4, extends backwards, descends toward the back, crosses the 5th intercostal space, and ends at the 6th rib anteriorly.



The lungs have an apex, base, anterior and posterior borders, and mediastinal and costal surfaces.

- It has its apex located at the root of the neck, about one inch above the medial third of the clavicle
- The base is the diaphragmatic surface, resting over the cupola of the diaphragm, with a sharp downward edge, the doctor referred to it as the inferior border.
- 2 surfaces: The mediastinal surface, where the hilum is located. The costal surface, which is related to the costal cartilages.
- 2 borders: the anterior border which is sharp and shorter, while the posterior border is rounded and longer.

The hilum:



In the **right** lung, the hilum contains **two bronchi**:

- The eparterial bronchus, which is positioned above the pulmonary artery
- The hyparterial bronchus, located posteriorly.

In the **left** lung, there is only **one bronchus** at the hilum, which then divides. The most superior structure at the hilum (left lung) is the pulmonary artery, followed by the superior and inferior pulmonary veins.

It's important to remember that the pulmonary artery contains deoxygenated blood, while the pulmonary veins contain oxygenated blood.

The lung is surrounded by the **pleura**: The parietal pleura lines the thoracic cavity, and the visceral pleura is tightly adherent to the lung. These two pleural layers are joined together around the hilum of the lung.

At the hilum, there is a single layer, but below the hilum, the pleura forms the **pulmonary ligament**.

At the root and hilum of the lung, the pulmonary ligament extends inferiorly from the two pleural layers.

The structures at the hilum include:

- 1 pulmonary artery
- 2 pulmonary veins
- Bronchi: 2 in the right lung, and 1 in the left lung.

Additionally, the bronchial vessels supply blood to the lung tissue. The lungs also have nerves (both sympathetic and parasympathetic), and lymphatic vessels with lymph nodes for drainage.

Surface anatomy of the lung:

It is the same as the surface anatomy of visceral pleura but for parietal pleura, it is different.

- How to identify the apex?

1 inch above the medial third of the clavicle/ (3-4cm) above the first costal cartilage.

- How to identify the anterior border? we draw a line from the apex to the middle of the sternal angle. Then it descends in 2 ways:

In the right lung: reaches the 6th costal cartilage in the midline.

In the left lung: Between the 4th and 6th costal cartilage (1cm) to the left, where a semicircle cardiac notch is found.

In case of cardiac tamponade (fluid accumulation in the pericardium), you must insert the needle in the cardiac notch to avoid injury to the lung or pleura.

- How to identify the base? (3 points)

1st intersection: midclavicular line with the 6th cc

2nd intersection: midaxillary line with the 8th rib

3rd intersection: scapular/paravertebral line with the 10th thoracic vertebra

*scapular line is 4cms away from the dorsal spine of the 10th thoracic vertebra= 4cms away from midline

- How to identify the posterior border?

from the apex posteriorly towards the 10th thoracic vertebra

Most important surface anatomy is that of the base for comparison of the parietal pleura:

The surface anatomy of the parietal pleura follows the same pattern as the lung for the apex, anterior, and posterior borders. However, the base differs from the lung:

- Along the midclavicular line, it reaches the 8th rib instead of the 6th rib.
- Along the midaxillary line, it reaches the 10th rib instead of the 8th rib.
- Posteriorly, it extends to the 12th rib instead of the 10th rib.

This difference in space is due to the lung's ability to expand downward into these areas during inflation.

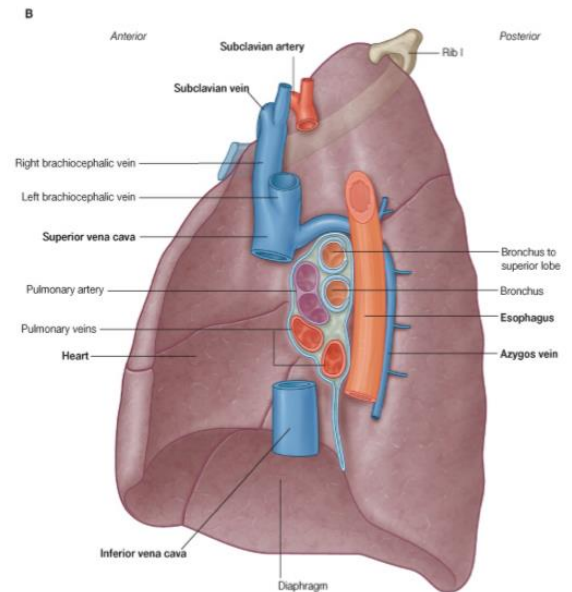
Right lung impressions: in bold

- The **right atrium** is located anterior to the hilum.
 - a) The **SVC** is positioned above the hilum, with the right bronchiocephalic vein leading to the subclavian vein.

Above the hilum, the **subclavian artery** creates an impression.

The **IVC** is located below the hilum.

- The **arch of the azygos vein** is situated superior to the hilum.
- The **first rib** creates an impression on the anterior border of the right lung.
- The **trachea** forms an impression at the apex of the right lung. (This is unique to the right lung, as the trachea is slightly deviated to the right.)
- The **esophagus** is located at the apex of both the right and left lungs, as it lies on the midline, unlike the trachea.



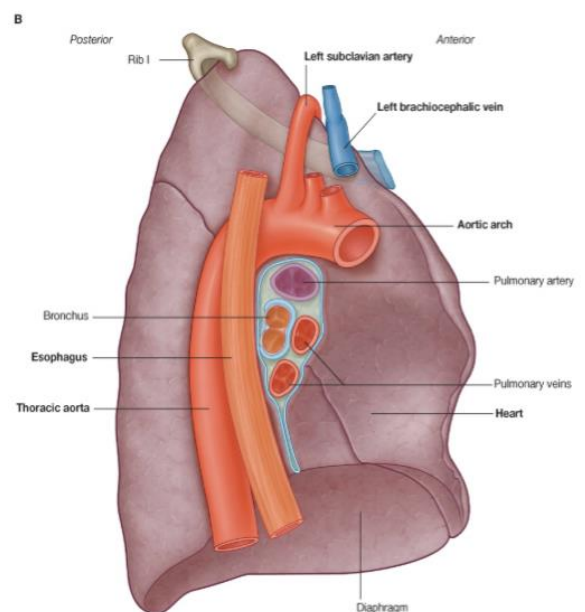
Left lung impressions:

First, remember that:

1. the left lung has a lingula (formed by the cardiac notch)
2. The hilum of the left lung has the pulmonary artery most superiorly, followed by 2 pulmonary veins and the bronchus.
3. There is no tracheal impression

- **Impressions in bold**

- The heart's **left ventricle**. It is covered by the pericardium, found anterior to the hilum and involved in oxygenated blood circulation.



- The **descending thoracic aorta** lies posterior to the hilum. (A branch from 3 **aortic arch** branches)
- The **esophagus** is located at the apex of both lungs and descends anterior to the thoracic aorta, deviating to the left to pass through the diaphragm and reach the stomach.
- The **first rib** creates an impression on the costal surface and anterior border of the left lung, which is associated with oxygenated blood.

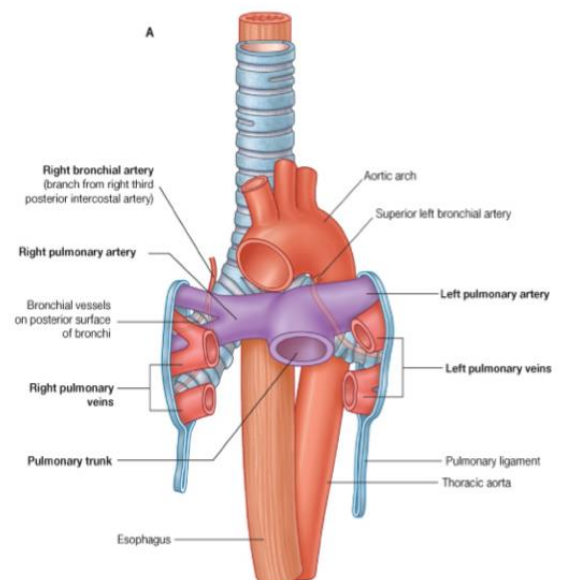
Lungs blood supply:

Pulmonary Arteries:

The pulmonary arteries originate from the **pulmonary trunk**, which divides at T4 into the right and left pulmonary arteries for the right and left lungs. These arteries arise from the right ventricle through the pulmonary valve, moving upwards and to the left. They are located at the hilum of each lung and have different relationships on each side:

- On the right side, the pulmonary artery is anterior to the bronchus and posterior to the pulmonary veins, positioned between them.
- On the left side, the pulmonary artery is anterior to the descending thoracic aorta and posterior to the left pulmonary veins.

The right pulmonary artery is longer than the left, as the pulmonary trunk is deviated to the left, passing through the root of the hilum. These arteries carry deoxygenated blood to the lungs and enter at the hilum.



Pulmonary Veins:

The pulmonary veins are 4 in number, carrying oxygenated blood to the left atrium. Each lung has superior and inferior pulmonary veins at the hilum.

Bronchial Blood supply:

- ✓ On the right side, there is a single bronchial artery, which originates from the third posterior intercostal artery.
- ✓ On the left side, there are superior and inferior bronchial arteries, which arise from the descending thoracic aorta.

These arteries are small in size, entering the hilum and then distributing blood to the lung tissue and visceral pleura.

For venous drainage, bronchial veins carry deoxygenated blood:

- ✓ On the right side, the blood drains into the azygos vein.
- ✓ On the left side, it drains into the hemiazygos vein, both of which lead to the arch of the azygos and eventually to the superior vena cava.

However, the bronchial veins may travel with the pulmonary veins to the left atrium, even though they carry deoxygenated blood (as opposed to the oxygenated blood carried by the pulmonary veins). It's okay since the percentage is small.

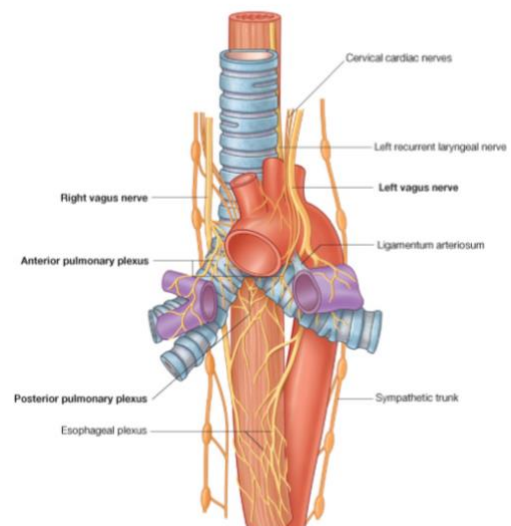
Innervation of the lungs:

It is controlled by a plexus of nerves, located anterior and posterior to the end of the trachea.

Parasympathetic fibers, originating from the vagus nerve, reach the bronchi, causing bronchoconstriction.

Sympathetic fibers, arising from the sympathetic chain, cause bronchodilation and vasoconstriction. These fibers have opposite effects on blood vessels compared to their action on the bronchi.

In cases of asthmatic attacks, adrenaline (sympathetic) is administered in the emergency department to induce bronchodilation.



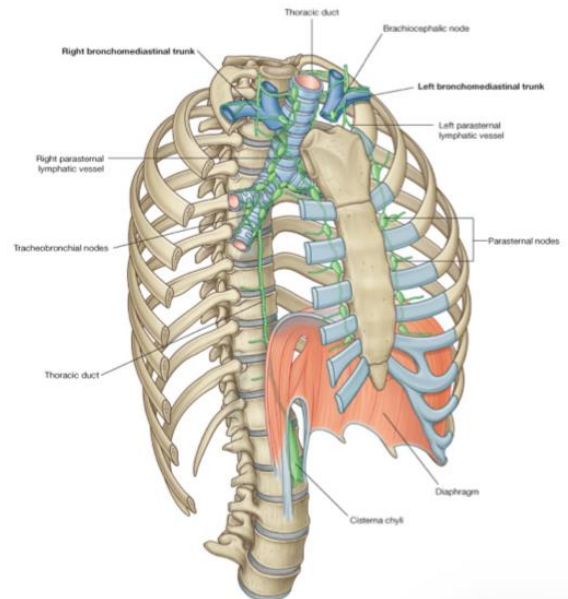
Lymphatic Drainage: involves three plexuses:

1. Superficial plexus, located below the visceral pleura.
2. Subpleural plexus, also below the visceral pleura.
3. Deep plexus, within the lung tissue.

All three plexuses collect lymph at the hilum, where the nodes are called **tracheobronchial nodes**, situated between the trachea and bronchi at the hilum.

Lymphatics have the following pathways:

- ➔ Parasternal lymphatics, which run parallel to the sternum
- ➔ Paratracheal lymphatics, running parallel to the trachea
- ➔ Mediastinal lymphatics.



These lymphatics all drain into the thoracic duct on the left side of the chest and into the right lymphatic duct on the right side.

The thoracic duct originates from the cisterna chyli near the aortic orifice on the right side of the aorta. It ascends upwards, crossing the esophagus and trachea posteriorly before emptying into the left brachiocephalic vein. Meanwhile, the right lymphatic duct drains into the right brachiocephalic vein, where both ducts empty their contents into the venous bloodstream.

<p>Page 5 of 14:</p> <p>1. In the hilum, The right main bronchus ✓ The right secondary bronchus ✗</p>	<p>Page 3 of 14</p> <p>4. We added: "it descends from T4 to T6 in deep inspiration"</p>
<p>2. Posterior and below pulmonary art (Added post)</p>	<p>11 of 14</p> <p>Posterior to the hilum ✗ Above the hilum ✓</p>
<p>3. Changed the phrasing for better understanding: supplies upper lobe ✗ As a secondary lobar bronchus to the upper lobe ✓ Supplies middle & lower lobes ✗ Branches into two lobar bronchi to the middle and lower lobes ✓</p>	<p style="text-align: center;"><u>V3</u></p>