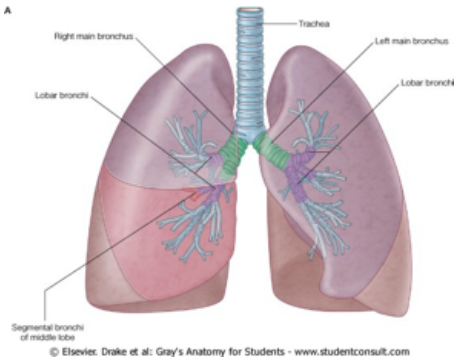
Trachea



- The trachea is a flexible tube, that extends from C6 (The lower border of the cricoid cartilage) to the level between T4 and T5 (The level of the angle of Louis- sternal angle-). Then it bifurcates to give the right main (primary) bronchus and the left main (primary) bronchus.

- Structure of the trachea:
  - ✓ The trachea has 16-20 C-shaped hyaline cartilages (anterior & lateral, absent posteriorly). The function of these C-shaped hyaline cartilages is to keep the trachea open for the passage of air.
  - ✓ Posteriorly, the trachea has a smooth muscle called Trachealis, which is complementary to the C-shaped cartilages and helps in peristaltic movement of esophagus. Since it is a smooth muscle, it is supplied by autonomic nerves (vagus & sympathetic)

- Length and diameter of the trachea: The trachea is 4.5 to 5 inches long and has a diameter equal to that of the index finger. In children, the trachea is very narrow with a diameter of a pencil.
  - ✓ During inspiration, the trachea lengthens and widens. During expiration, it returns to its normal size.

- Carina: cartilage that is covered by a fold of mucosa found at the beginning of the main bronchi or at the end of trachea (T4, at the beginning of the bifurcation). "The trachea ends at the sternal angle (between the 4th and 5th thoracic vertebra), so the carina is found there."
  - ✓ This fold of mucosa is very sensitive; when it is irritated, it causes coughing reflex. During deep inspiration, the trachea elongates, and could reach the 6th thoracic vertebra.

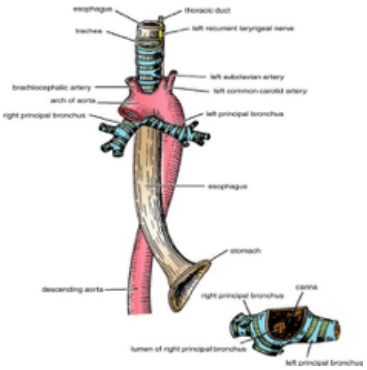
- **Relations of the trachea**: it has relations on the neck & superior mediastinum since it starts at the level of C6 and ends in the

thorax.

✓ Anterior relations:
1- Aortic arch.
2- Thymus gland (behind the sternum): it is rudimentary in adults, so there are only remnants 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 2nd, 3rd, and 4th tracheal rings.
4- The origin of the brachiocephalic artery.
5- Manubrium sterni.

✓ Posterior relations:
1- The esophagus.
2- The left recurrent laryngeal nerve: since it is longer and curves around the arch of the aorta, then ascends between the trachea and oesophagus.
3- Thoracic duct: in the middle of the thorax.

✓ Left side relations:
1- The arch of the aorta.
2- Left subclavian artery.
3- Left common carotid artery.
4- Left vagus nerve.
5- Left phrenic nerve, which anterior to the root of the lung.
6- Left main bronchus.



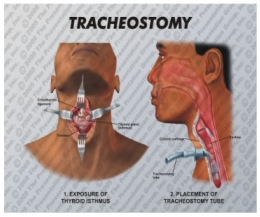
✓ Right side relations:
1- The azygous arch, which drains the venous blood of the right side, ends in the superior vena cava -> right atrium.
2- The brachiocephalic artery.
3- Right vagus nerve: the vagus passes behind the root of the lung.
4- Right phrenic nerve: passes anterior to the root of the lung.
5- Right main bronchus.

- **Notes:**

✓ The Vagus Nerve passes behind the root of the lung (helium), phrenic nerve passes anterior to the root of the lung (hilum).
✓ The Vagus Nerve & phrenic nerve descend from the neck to the thorax.

✓ The phrenic nerve is the main motor nerve for diaphragm which comes from C3,4,5.

- **Clinical Notes:** Tracheostomy & Endotracheal intubation: "mentioned in the previous lecture, here are the important points".



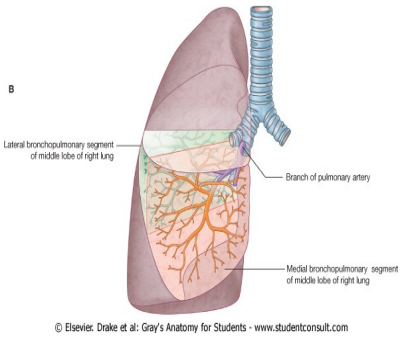
✓ Tracheostomy (or tracheotomy):
✓ Any obstruction in the respiratory tract above true vocal cords, we operate tracheostomy below true vocal cords. It can be done in any membrane below the true vocal cords such as the cricotracheal membrane (which is the best place to do it).
✓ we have 2 types of tracheostomies: surgical and emergency "suprasternal".

✓ Endotracheal Intubation
✓ We have 2 types of endotracheal tube one of them is oral in which we put it inside the mouth until we reach the true vocal cord, we put it in between them to prevent sudden closure of vocal cords during the operation, we mostly use it during surgical operations.
✓ There is a risk of bleeding in this procedure because there are blood vessels in the suprasternal notch, like the inferior thyroid vein (which drains the larynx and goes into left brachiocephalic vein), the jugular arch (Formed between the left and right anterior jugular veins), and sometimes, the thyroid Ima artery (if it was present, because sometimes it is not). But in this situation, we do not worry about the bleeding as much as we worry about the inability to get oxygen to brain cells (the brain cells will die after 2-5 minutes without oxygen). The bleeding here can be easily stopped or may even stop spontaneously on its own, after a few minutes. it should not even be considered, because what is important is to get the patient breathing again.
✓ 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.

Bronchi

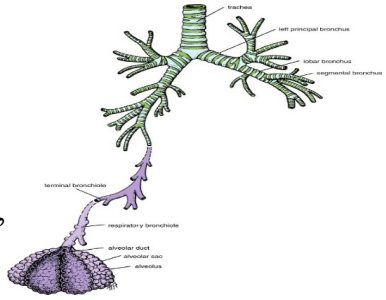
- The trachea bifurcates to give the left and right main bronchi.

- The walls of the bronchi are held open by discontinuous elongated plates of hyaline cartilage, but these are not present in bronchioles.
- 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 imporatnce: 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 rarely to go to the left).

- **The bronchial tree:**
  - ✓ The right and left main bronchi are called the primary bronchi.
  - ✓ The secondary (interpulmonary) bronchi are called lobar bronchi. So, on the right side there are three lobar bronchi, since the right lung has three lobes (upper, middle and lower lobes), and on the left side there are two lobar bronchi, since the left lung has two lobes (upper and lower lobes).

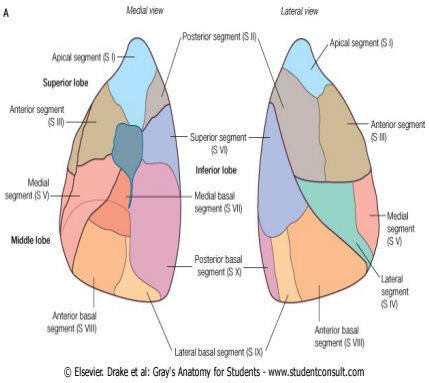


  - ✓ The tertiary bronchi are called bronchopulmonary segments. There are 10 bronchopulmonary segments on the right and 10 on the left in adults.

- **In the right lung:**
  - ✓ in the hilum, the right secondary bronchi branches into aparterial bronchus and hyparterial bronchus.
    1. Aparterial (above the pulmonary artery, which is located in the middle of the hilum): supplies the upper lobe.
    2. Hyparterial: (below the pulmonary artery): supplies 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,

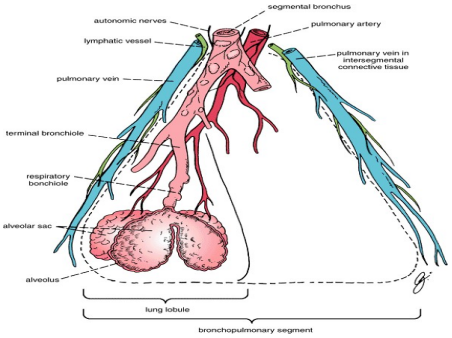
medial, lateral, anterior and posterior.

- **In the left lung:**



  - ✓ The secondary bronchus remains as a single entity (singe bronchus) in the hilum, which then separates into 2 branches supplying the upper and lower lobes.
  - ✓ The upper lobe has a special structure called the lingula, which is made by the cardiac notch.
  - ✓ 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 (apical), 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.



- Bronchopulmonary segment further divides into terminal bronchioles, which give rise to respiratory bronchioles, that end in the pulmonary unit (important in surgery).
  - ✓ Pyramidal in shape, have an apex and a base on the lateral surface of the lung.
  - ✓ The importance of these bronchopulmonary segments - surgically- is that if you need to remove a part of the lung, these segments are removed (Segmentectomy). In the past, the entire lobe was removed.

• *Why are the segments removed now instead of the lobes?*

It is surrounded by connective tissue. These units also have a segmental bronchus, a pulmonary artery and two pulmonary veins. The segmental vein lies in the connective tissue between adjacent bronchopulmonary segments. This unit also has separate lymphatic vessels, nerves and alveoli. So, when a surgeon removes a segment, he/she removes these structures, that are surrounded by 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.

• **Clinical notes:**

✓ When a person is standing, and he/she swallows a foreign body and this foreign body enters the respiratory tract, it will enter the right side (the right bronchus). What segment will it enter? The posterior segment of the lower lobe (base), because it is the lowest in that particular lobe, and it is continuous with the trachea.

✓ When a person goes to the dentist and lays down to have a tooth removed, he/she accidentally swallows the tooth, and the tooth then 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 an adult and in an embryo. The difference is that the embryo has 8 segments 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 and posterior segments join 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 join together forming one segment, called anteromedial segment. After delivery, they are also separated to give the anterior and medial segments.

• **Clinical importance of bronchopulmonary segment:**

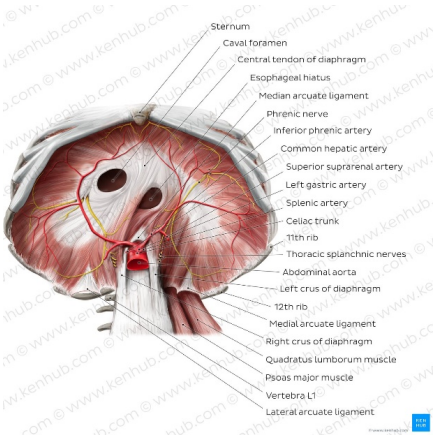
1. They are important during surgery: Nowadays, segments are removed in surgeries instead of lobes. If there is an infection, it stays localized within a certain segment (between the connective tissue that surrounds the

segment.)
2. There is no barrier between the segments, so if the infection spreads, it will affect the other segments, meaning that the surrounding connective tissue does not prevent the spread of infection.
   *since those last 2 points are complete opposite, and both were mentioned by the doctor, just keep in mind that recently, we surgically remove only the infected bronchopulmonary segment rather than the whole lobe.
3. In postural drainage, it is important to drain segments.
4. In bronchoscopy, you observe the segments.

*Be aware that the bronchioles are found inside the segments

- Alveoli is the main site of gas exchange.

Diaphragm



- **Origin:**
  1. Anterior: sternum
  2. Posterior: lumbar vertebrae
  3. lateral: costal cartilage

- **Insertion:**
  1. Central tendon
  2. I.V.C orifice in the central tendon

- **Nerve supply:**
  - ✓ Right & left phrenic nerve which supply right and left cupola, respectively.
  - ✓ Right cupola below the right lung and pleura and above the liver
  - ✓ Left cupola below the left lung and pleura and above the stomach and spleen.
  - ✓ Respiratory centre is located in the medulla oblongata which represents the origin of phrenic n. (C3,4,5), the main motor nerve of the diaphragm.

- **Major Orifices:**
  1. I.V.C (T8): I.V.C & lymphatic duct of upper surface of the liver
  2. Esophageal (T10): oesophagus & 2 vagi
  3. Aortic (T12): Aorta & on the right-side thoracic duct, cisterna chyli, and azygos vein.

- **Minor Orifices:**

1. Greater splanchnic nerve “passing to the celiac ganglia”, lesser, least splanchnic nerves orifices.
2. Sympathetic chain.
3. Phrenic nerve has a minor separate opening.
4. Internal mammary artery and its terminal branch (s.epigastric)

- ***Mechanism of diaphragmatic contraction:***

In inhalation Nerve stimulation causes diaphragm to contract which descends downwards towards the abdomen which results in increasing intra-abdominal pressure and decreasing intra-thoracic pressure under the atmospheric pressure that will result in negative pressure which makes the air flow from outside to inside the lung and causes lung inflation by active processes because it comes from diaphragmatic contraction, in expiration the diaphragm relaxes, lungs deflate and the air will flow passively from inside to outside.

- **Intercostal muscles:**

✓ Muscles of the abdomen

1. external and internal oblique
2. transversus
3. rectus abdominis

✓ intercostal muscles

1. external
2. internal
3. innermost

• Muscles contribution in respiration:

Imagine that your lung is a box with vertical and horizontal axis (anterior, posterior & transverse)

✓ 90% from diaphragm muscle which works in the vertical axis which is the most important one.

✓ 10% from the intercostal muscles which work in the horizontal axis.