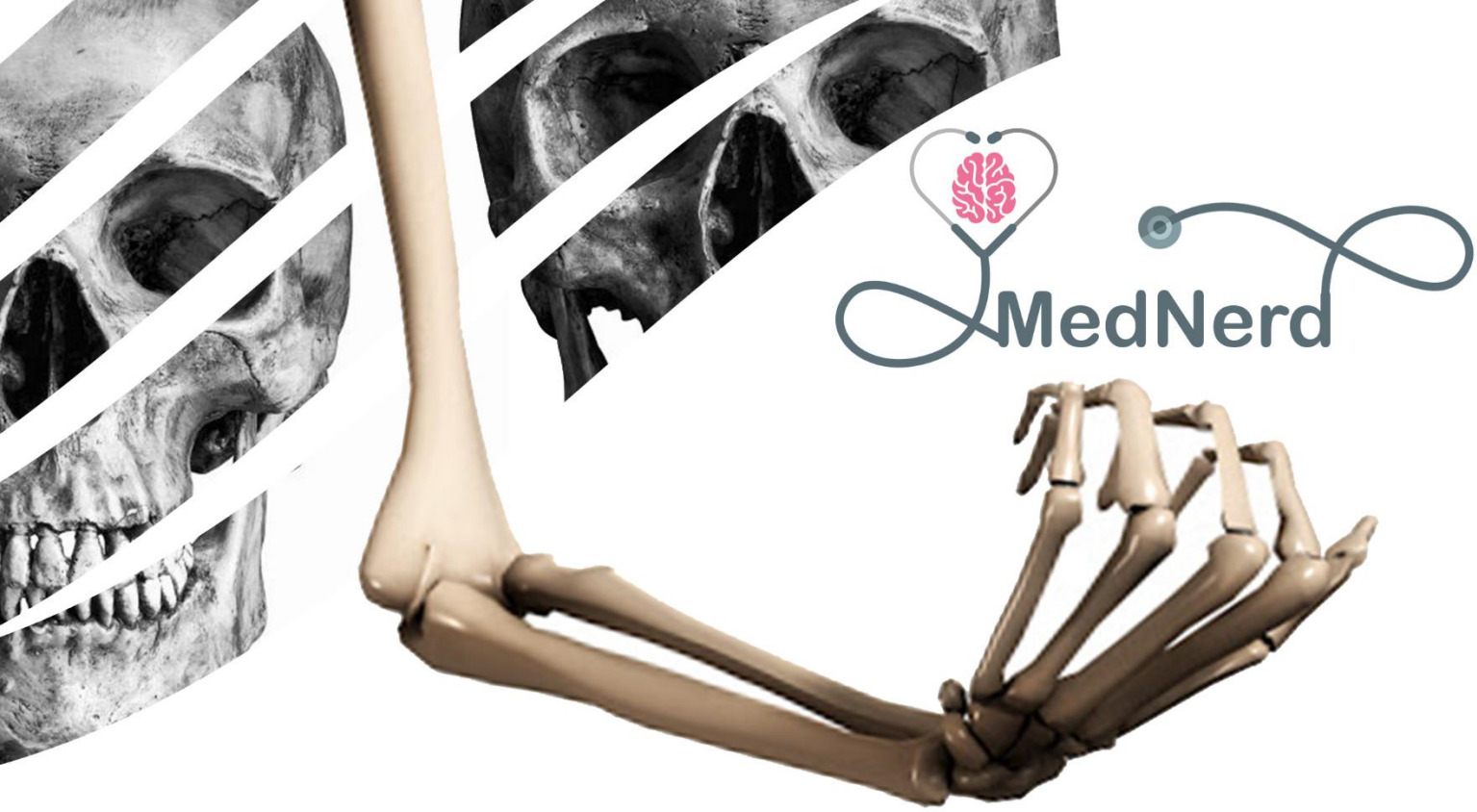


MedNerd

Human Anatomy & Embryology

Lecture: Respiratory System

Done by: Ibrahim Shehada

Editied by: Mahmoud Obeidat

#20

Respiratory System

introduction

- The respiratory system is a biological system consisting of specific organs and structures used for gas exchange.
- The respiratory system is divided physiologically into:

1- Conducting part:

- consists of cavities and tubes (any part which has no alveoli is a Conducting part).
- no exchange of gases.

2- Respiratory part:

- consists of respiratory bronchioles and alveolar sacs contain alveoli.
- there is where gas exchange happens.

- Respiratory system divides into upper RS and lower RS, they are separated by vocal cords (a part of upper RS).

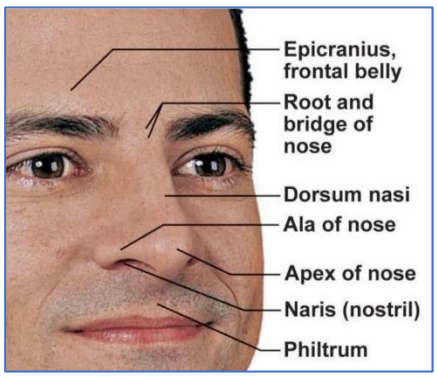
Upper RS

- composed of Nose, Pharynx, and Larynx.

Nose

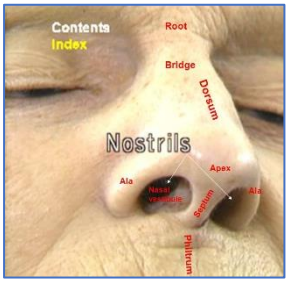
- first part of upper RS.
- The nose has a skeleton made of bones and cartilages.
- nasal cavity is divided into two cavities: right and left, separated by nasal septum.
- The nose is divided into External nose (seen in face) and Internal nose (inside the skull).

1. External Nose:



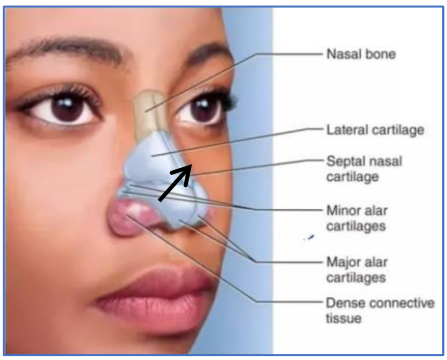
-features and structures:

1- **Root and bridge of the nose**: area between eyebrows.
2- **Dorsum nasi**.
3- **Ala**: most lateral part of external naris.
4- **Apex**: tip of the nose.
5- **External Naris** (nostril): opening of the nose to outside. It is covered by alar cartilage, and has hair in the **nasal vestibule.**
6- **Philtrum**: below the nasal septum (part of upper lip).



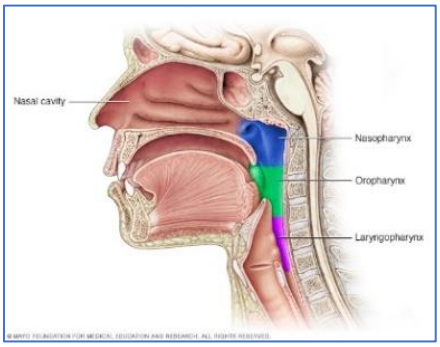
➢ External nose is made of a bone and cartilages.

-The bone is the 2 **nasal bones**.



- The cartilaginous part consist of:

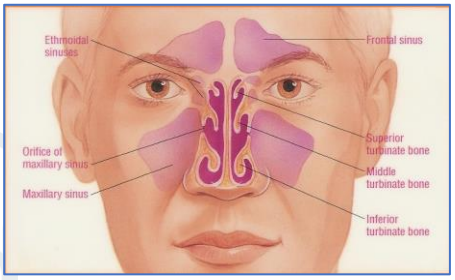
✓ **Upper lateral cartilage**: inferior to lacrimal bone, it's the large one.
✓ **Lower lateral cartilage**: Anterior part of naris, also large.
✓ some small cartilages.
✓ **Greater (major) alar cartilage**.



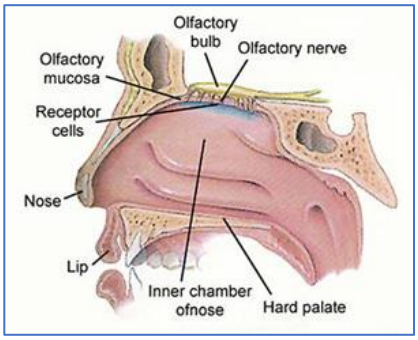
2. Internal nose:

- the nasal cavity inside the skull, and has internal naris (internal openings) that open into nasopharynx.

❖ Nasal cavity:

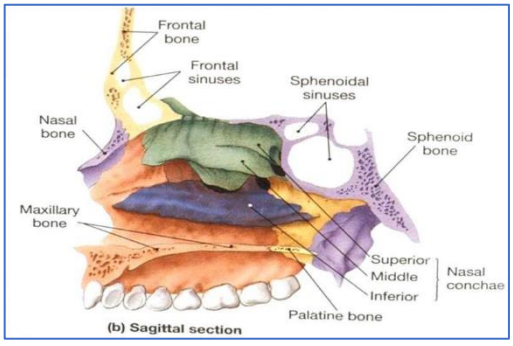


- Shape: pyramidal. Has **Roof** and **floor**.
  - ➢ **Roof**: dome shaped, made of cartilage + nasal bones + cribriform plate of ethmoid (containing **olfactory mucosa** and receptors) until the sphenoid.
  - ➢ **Floor**:
    - The floor of nasal cavity (hard palate) is made by:
      1- Palatine process of maxilla anteriorly.
      2- part of palatine bone posteriorly (also it makes part of lateral wall).
    - Nasal floor also forms the roof of oral cavity.



- Nasal cavity has 3 bony projections made by bones of the lateral wall:
  a. **superior turbinate (Concha):** origin: ethmoid bone.
  b. **middle turbinate (Concha):** origin: ethmoid bone.
  c. **inferior turbinate (Concha):** independent bone.(largest).

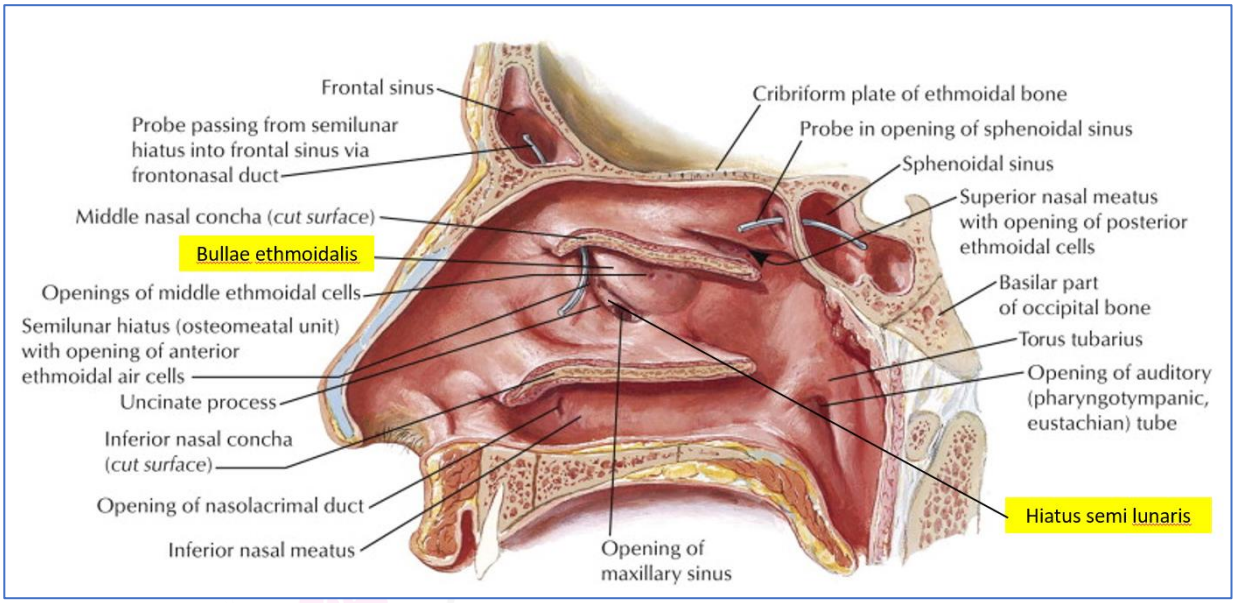
  - superior and middle conchae meet anteriorly then separate posteriorly.



- **Meatus:** space underneath each turbinate bone, they're named **superior**, **middle**, and **inferior meatuses**.

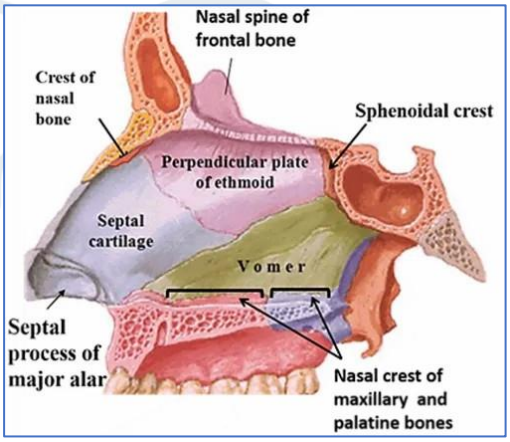
- **Bullae Ethmoidalis** (Ethmoidal Bulla): a bulging or swelling in the middle meatus, made by middle air sinuses.
- **Hiatus Semi Lunaris:** a sulcus underneath bullae ethmoidalis, where maxillary and frontal sinuses open into. [semi lunaris because it looks like half a moon].

- Sphenoid sinus opens in the superior space above the superior concha.



❖ **Nasal septum** consists of:

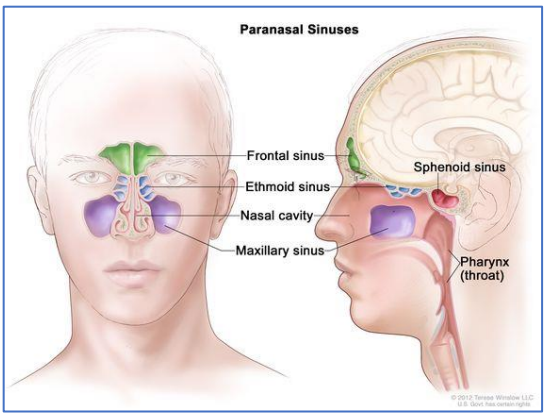
1- Ethmoid bone posteriorly superiorly.
2- Vomer bone posteriorly inferiorly.
3- Septal cartilage making the anterior part.
4- Alar cartilage making most anterior and lower part.



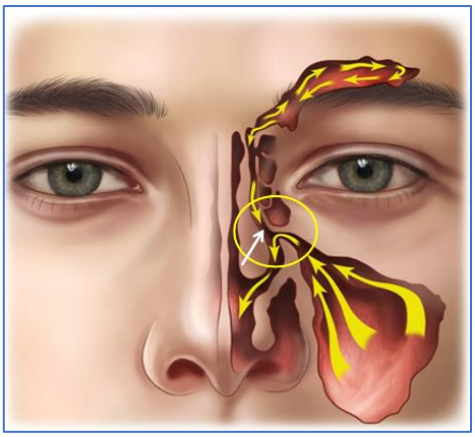
❖ **Sinuses**:

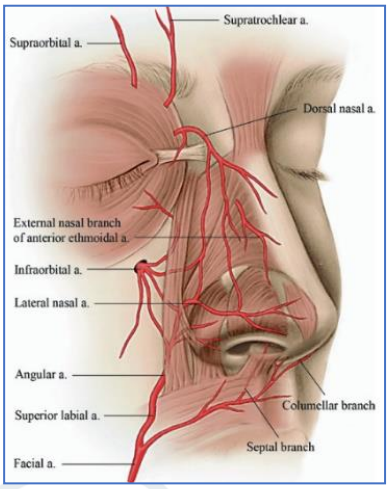
are cavities in the cranial and facial bones; which are an extensions of nasal cavity, they're called **paranasal sinuses.** And they are:

1- Frontal sinus.
2- ethmoidal sinus.
3- sphenoid sinus.
4- maxillary sinus (The most trouble making sinus).



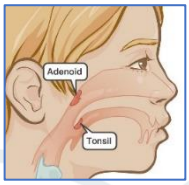
❖ Why maxillary sinus is troublesome?
-Because if you look into to yellow circle you can see maxillary sinus opens into hiatus semi lunaris (in the middle meatus), therefore if there is any inflamation or any pus or fluid collection, its going to accumulate in the sinus and cause alots of pain and discomfort. Its not drained at the most dependent part.





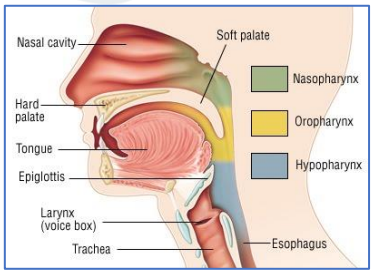
- lateral wall of the nasal cavity has multiple arteries, so if there is a wound in the wall, the nose is going to bleed.
- There are intrinsic muscles of the nose, which are rudimentary in human. They are not working and rarely present.

❖ **Adenoid:** at the end of the nasal cavity at the beginning of nasopharynx, which is a collection of lymphoid tissue.



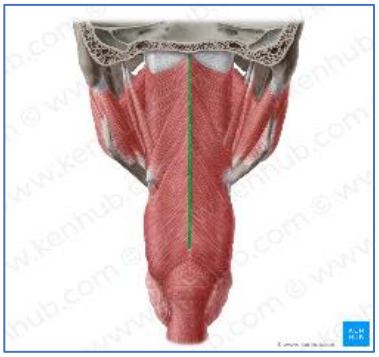
Cut here

Pharynx

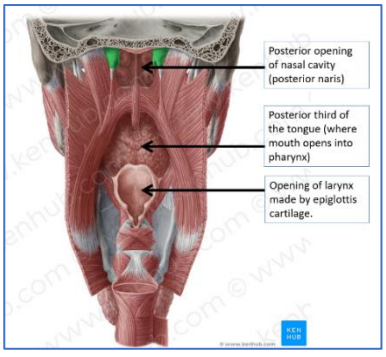


➢ consists of 3 areas:

- **Nasopharynx**: upper area of pharynx, nasal cavity opens here. It is inferior to base of skull, posterior to nose.
- **Oropharynx**: middle area of pharynx, oral cavity opens here.
- **Laryngopharynx**: lower part of pharynx, It is posterior to larynx and opens into it.

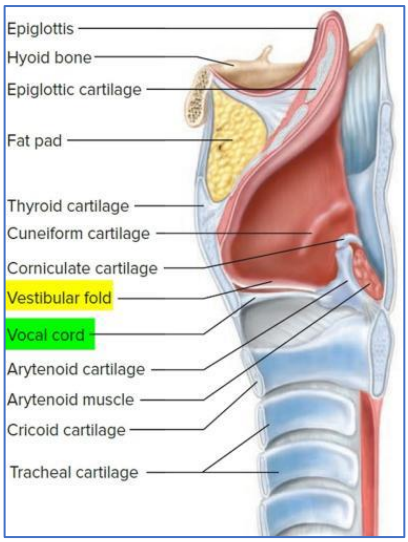


This is a posterior view of the pharynx showing that it is made of 3 constrictor muscles. They meet posteriorly in the midline which is called "**Pharyngeal Raphe**".



➢ This is a posterior view of pharynx. Structures can be seen:
- ✓ Posterior (internal) naris.
- ✓ Mouth opening (+ posterior 3rd of tongue).
- ✓ Opening into larynx (gated by epiglottis).

Larynx

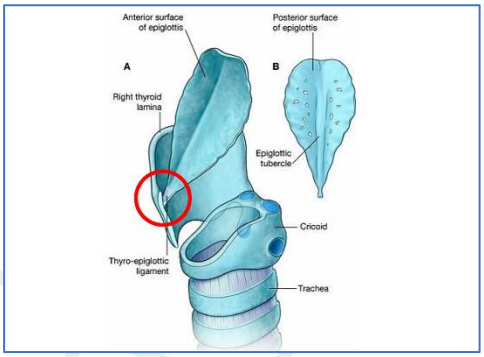


- Larynx, also called voice box, is a hollow, tubular structure connected to the top of the windpipe (trachea); air passes through the larynx on its way to the lungs. The larynx also produces vocal sounds and prevents the passage of food and other foreign particles into the lower respiratory tracts.

- Structures and parts: epiglottis, vocal cords, [thyroid, cricoid, arytenoid] cartilages.

Epiglottis

The epiglottis is a leaf-shaped flap located behind the tongue, at the top of the larynx. It prevents food from entering the windpipe and the lungs. It stays open during breathing, allowing air passage into the larynx.

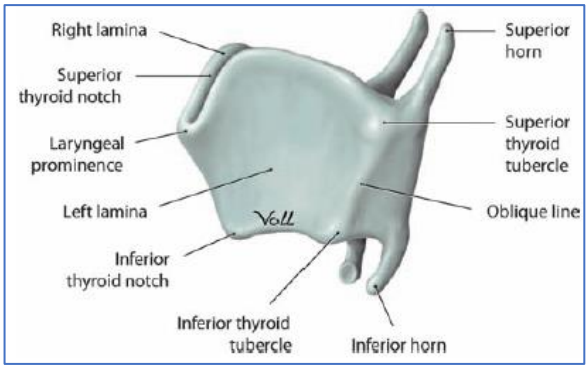


attachment of the epiglottis: The inferior pointed part will attach to the inner surface of the midline of thyroid cartilage.

When you see the epiglottis in this position it means that the larynx is opened.

Thyroid cartilage

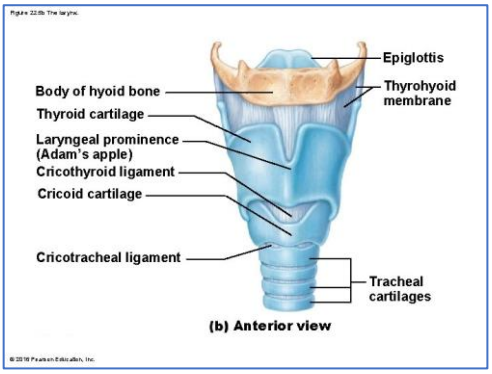
- The thyroid cartilage is a large, prominent structure which is easily visible in adult males. It is composed of two sheets (laminae), which join anteriorly to form the laryngeal prominence (Adam's apple).



- This is a view of the thyroid cartilage. Its parts:

1) **lamina**: lateral wall and widest part of thyroid cartilage.
2) **superior thyroid notch**: between the 2 laminae superiorly anteriorly.
3) **laryngeal prominence (Adam's apple)**: inferior to superior notch, most prominent part.

4) **inferior thyroid notch**: between the 2 laminae inferiorly anteriorly.
5) **superior horn**: a process extending superiorly.
6) **inferior horn**: it is going to articulate with the cricoid cartilage by a facet on its lateral broad side.
7) **oblique line**: a prominent line between the 2 horns on the posterior part of the lamina.



- thyroid cartilage sets and articulates with the cricoid cartilage by the inferior horn that goes down to articulate with cricoid.
- Thyroid cartilage is attached to hyoid bone by thyrohyoid membrane.

Cricoid cartilage

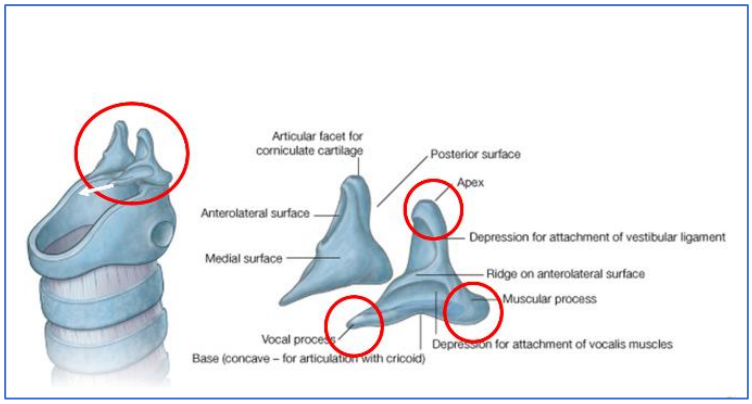
- The cricoid cartilage is a ring-shaped structure that sits just below the thyroid cartilage. It is the only complete cartilaginous ring of the whole airway.
- Cricoid inferiorly sets on the 1st ring of trachea and superiorly it articulates with the thyroid cartilage.
- it forms the base of larynx.

Arytenoid cartilage

❖ The arytenoid cartilages are a pair of small three-sided pyramids which form part of the larynx, to which the vocal cords are attached. These allow and aid in the vocal cords' movement.

- Processes of arytenoid:

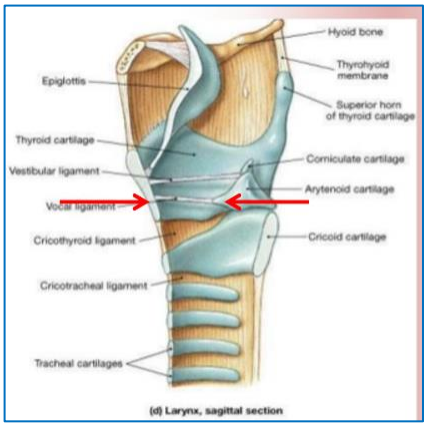
1) Vocal Process: anterior, for vocal cords attachment.
2) Muscular Process: muscles insert here to move arytenoid cartilages to move vocal cords.
3) Apex.



- Arytenoid cartilage sets on cricoid cartilage by putting its articular facets on the superior broad part of cricoid cartilage.

Vocal cords

The vocal cords (also called vocal folds) are two bands of smooth muscle tissue found in the larynx (voice box). The vocal cords vibrate and air passes through the cords from the lungs to produce the sound of your voice. [this was extra info that doctor hasn't mentioned].



➢ vocal cords separate upper respiratory tract from lower respiratory tract.

➢ In the image:

- right arrow: vocal process of arytenoid cartilage.
- left arrow: inner surface of midline of thyroid cartilage.
- vocal cords extend between these 2 points.

▪ in this image:

✓ epiglottis is turned up/opened (for air passage).

✓ vocal cords are opened (respirating state -not producing voice-).

▪ in this image:

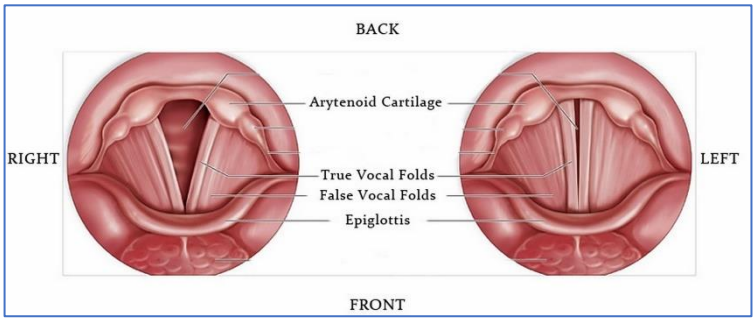
✓ epiglottis is turned up/opened (for air passage).

✓ vocal cords are partially closed (producing-voice state).

- if vocal cords are totally closed, air passage is then prevented (لما تحبس نفَسك).

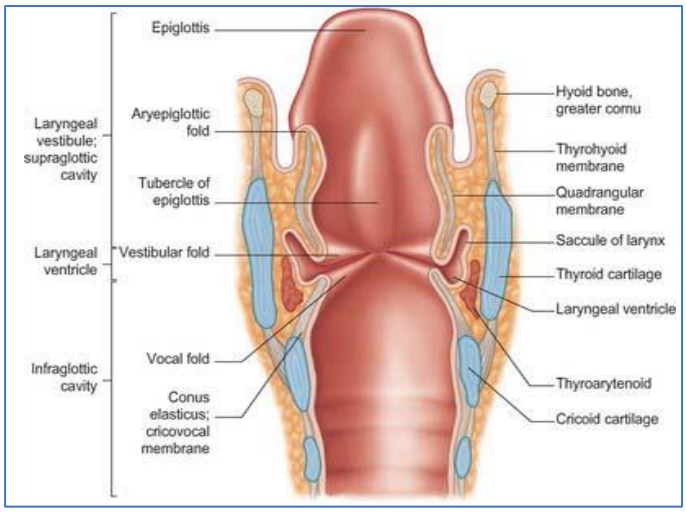
❖ Vestibular fold (false vocal fold):

- fold of mucus membrane.
- lies between vocal cords and point of epiglottis attachment.



- This is an opened larynx. it has:

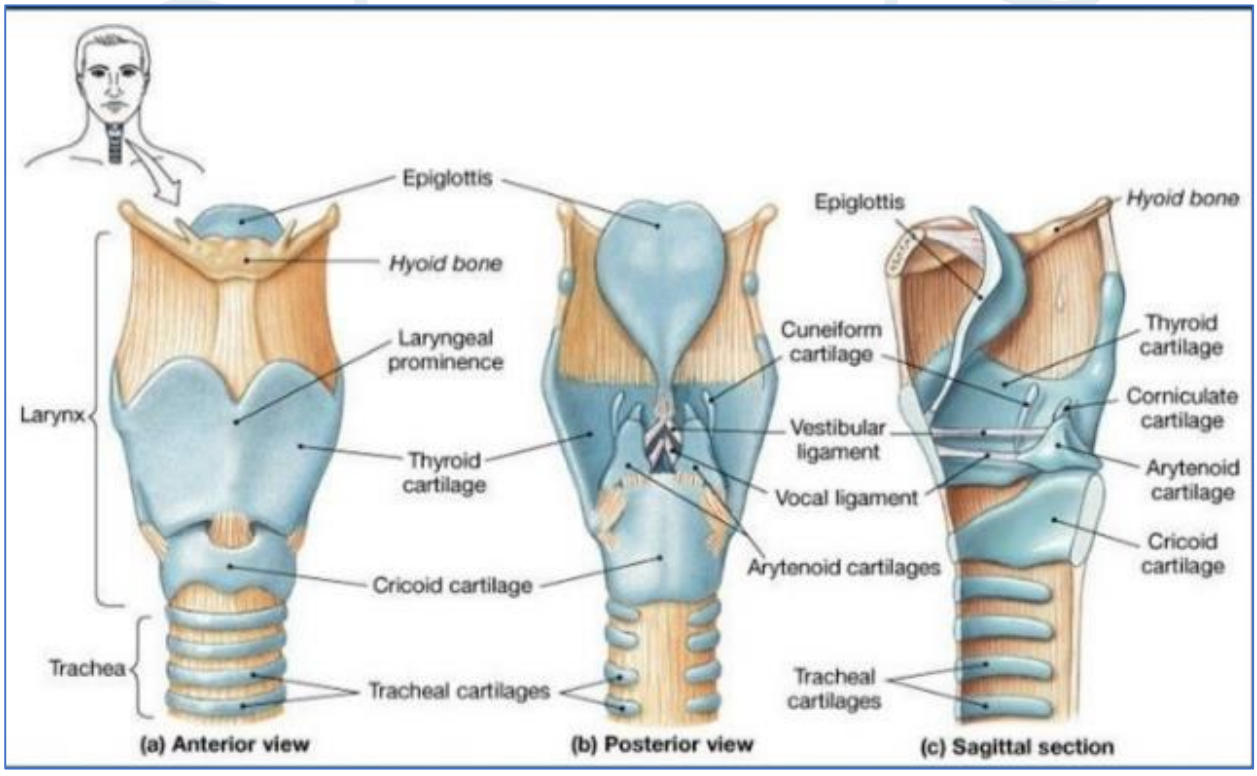
1) True vocal fold (فولد أو كورد نفس الاشي).
2) Vestibular fold (false vocal fold).
3) Ventricle: space between true and false folds which is a deep recess that has lots of mucous glands that secretes mucous which wets the vocal cords because air is going “in and out in and out” rapidly on the vocal cords and they get dry very easily, so they are lubricated by secretions of mucous glands in the ventricle.



- large larynx structures (hyoid bone, thyroid cartilage, and cricoid cartilage) are connected via fibrous membranes.

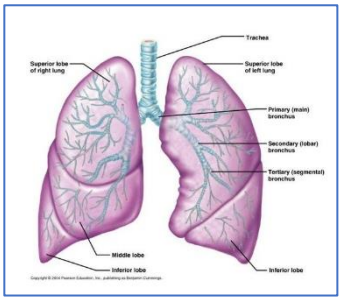
- Nomenclature of these membranes:
  a word composed of names of the 2 structures that membrane connecting them + “membrane” word.

- ex: membrane name that connects hyoid bone with thyroid cartilage = thyrohyoid membrane.



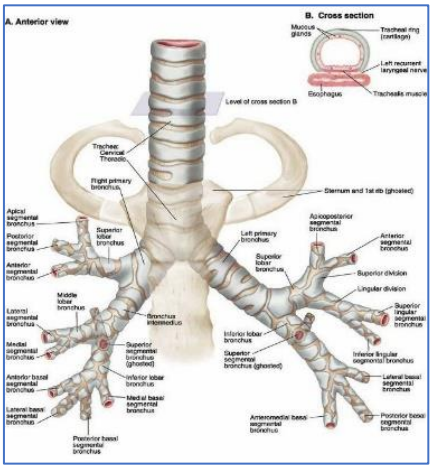
Lower RS

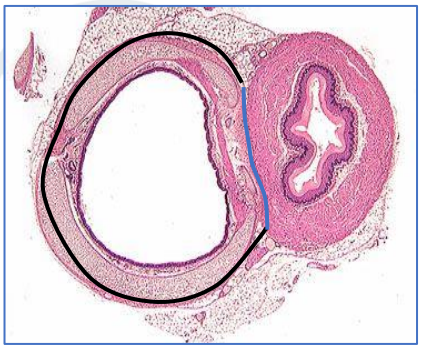
The lower respiratory tract begins below the vocal cords and consists of:
1- Trachea (called windpipe).
2- Main bronchi and Lungs.

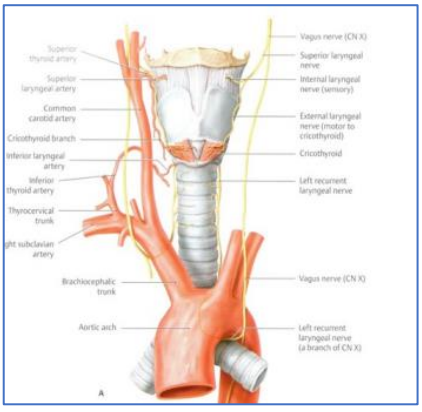


Trachea

- The trachea, also known as the windpipe, is a cartilaginous tube that connects the larynx to the bronchi of the lungs, allowing the passage of air.
- It is The first part of lower respiratory system.
- It starts immediately below the cricoid cartilage.
- starts from C6 vertebra level, descends in the neck then divides in the superior mediastinum at level of T4-T5 intervertebral disc (same level of sternal angle) to right and left main (primary) bronchi.
- Trachea it is a midline (median) structure.
- made of Incomplete cartilaginous rings (Incompleteness is posterior), gaps are closed by **trachealis** muscle.
- Esophagus is posterior to trachea.
- Esophagus is collapsed tube that dilate when the bolus cross down.
- Incomplete rings help in dilation of esophagus.







❖ the story with Aorta:
- ✓ Ascending aorta is anterior to left primary broncus.
- ✓ Aortic arch turns around and above left main bronchus going posteriorly.
- ✓ Descending aorta is posterior to left main bronchus.

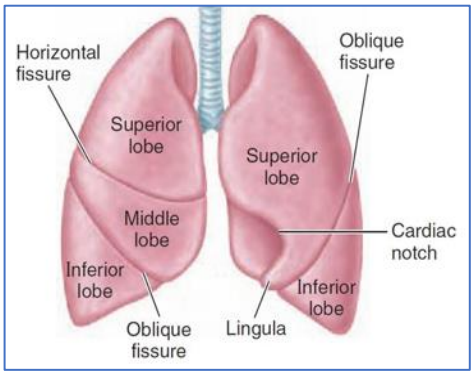
Carina: The point of bifurcation (branching) is a very sensitive area to foreign bodies and excessive secretions, and it stimulates heavy coughing.

Lungs

❖ Intro

The lungs are a pair of spongy, air-filled organs located on either side of the chest (thorax). They are responsible for gas exchange between outer air and blood.

❖ Surface anatomy



As we see in the picture:
- right lung divides into three lobes (superior, middle, and inferior lobes).
- between its lobes there are fissures which is deep indentation of lung tissue:

- Right lung:

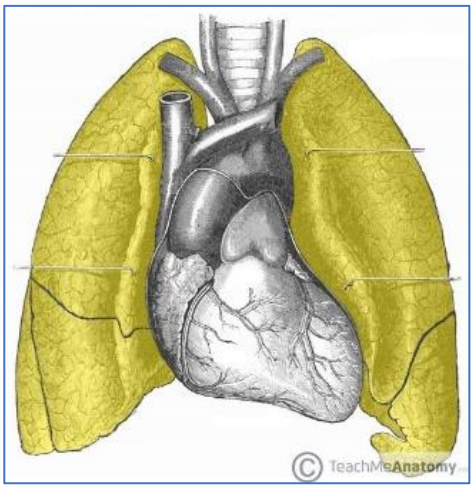
  - Segmented into 3 lobes:
    - Superior.
    - Middle.
    - Inferior.

  - Lobes are separated by 2 fissures:
    - **Horizontal (transverse) fissure:** between superior and middle lobes.
    - **Oblique fissure:** between middle and inferior lobes.

- Left lung:

  - Segmented into 2 lobes:
    - Superior.
    - Inferior.

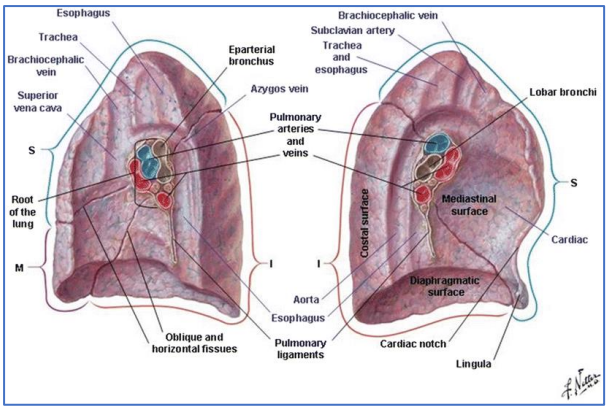
  - Lobes are separated by 1 fissure:
    - **Oblique fissure**: between superior and inferior lobes.



    - ✓ **Cardiac notch:** it is an impression of left ventricle of the heart on lower border of left lung.

    - ✓ **Lingula** is a part of <u>superior</u> lobe located anterior to the heart between chest wall and heart.

❖ Pulmonary Hilum



- [for you]: Hilum (of an organ): a depression or fissure where a bundle of cables enter and exit that organ. (cables=blood vessels, nerves, lymphatic vessels, bronchi -for lungs-, ureters -for kidneys-, bile duct -for liver-, etc).

- **Pulmonary hilum (hilum of the lung)**: the place where things go in and out of the lung (arteries, veins, main bronchus).
- The blue structure is the **pulmonary artery** getting into the lung carrying deoxygenated blood.
- The red structure is the **pulmonary vein** which brings oxygenated blood to the heart.
- **Point of entry of the main bronchi.**
- in the left lung, posterior to the hilum there is an impression of descending thoracic aorta.

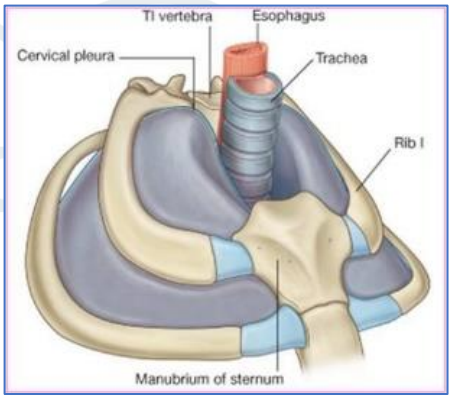
> The pulmonary artery is the most anterior, the pulmonary veins most inferiorly and point of entry of bronchi is most posteriorly (as doctor said).

❖ Thoracic inlet

- This is the **thoracic inlet** (opening) that is made by:

a. The vertebral column.
b. The first ribs as they come anteriorly and meet the manubrium.

- Notice that the apex of the lung is at the neck, superior to first rib.



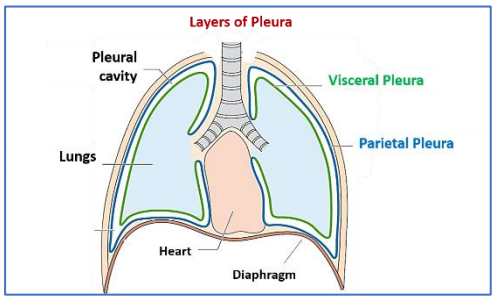
❖ Pleura

- The lung moves during inspiration and expiration, like the heart they need cavity lined with serous membrane.

The pleura:

- Is a serous membrane.
- Extends above the level of the 1st rib into the root of the neck, because the apex of the lung extends above the first rib.

➢ Pleura is made of 2 layers:



1. **Visceral pleura**: the pleura that covers the lung itself.
2. **Parietal pleura**: that covers parts of the chest wall and whatever makes a wall or any part of the pleural cavity on the sides of the mediastinum.
   Parietal pleura divides into:

1) costal parietal pleura: lining the inside of the chest wall.
2) diaphragmatic parietal pleura: covers the diaphragm as it makes the lower end of the thoracic cavity.
3) mediastinal parietal pleura: covering the mediastinum on its sides.

This is the anterior view of surface markings of the lungs and the pleural cavity.

- Right lung markings:

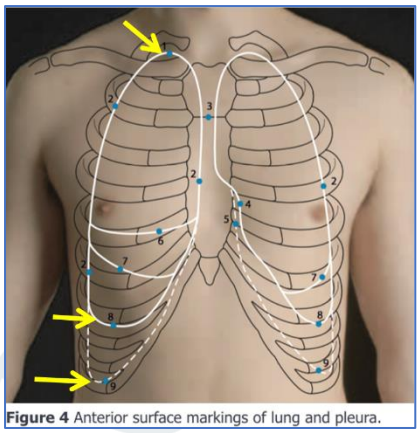


Figure 4 Anterior surface markings of lung and pleura.

- Anteriorly, horizontal fissure is along 6th rib.
- oblique fissure extending along the line from 6th intercostal space to 7th rib.
- Anteriorly, The lung ends at lower border of 8th rib while the pleural cavity ends at the level of the 10th rib.

- The left lung is the same except the presence of only oblique fissure.

- The upper arrow indicates the apex above the clavicle, so the lunge's apex and the pleura extend above the clavicle.

- The middle arrow indicates the lower end of the lung.

- The lower arrow indicates the lower end of the pleural cavity. The pleural cavity is a bit larger than the lungs because the lungs need to expand so they need space.

- This is a posterior view of surface markings of the lower end of the lung and the lower end of pleural cavity. The pleural cavity is larger than the lungs.

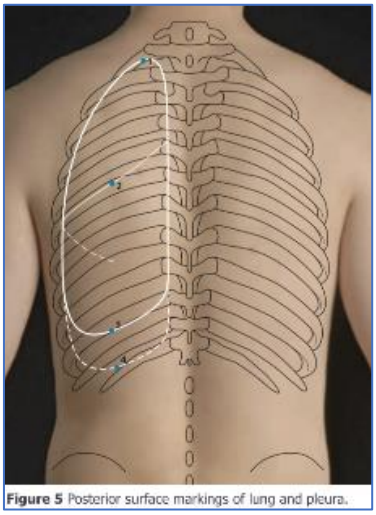
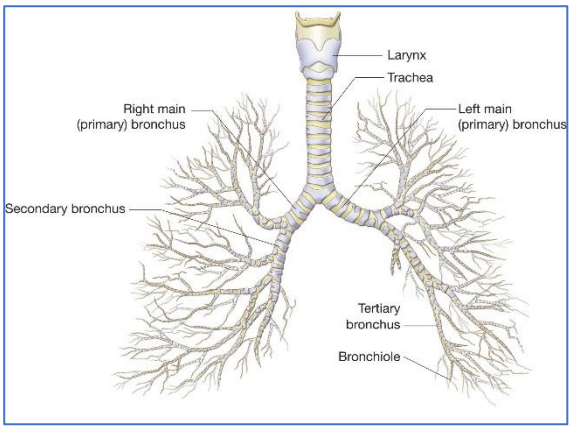


Figure 5 Posterior surface markings of lung and pleura.

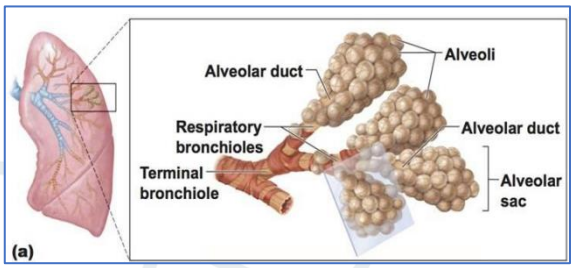
❖ Branching

Trachea (look at the image) divides -at carina- into 2 **primary bronchi** (singular: bronchus), in which each divides into 2 **secondary bronchi**, of which each divides into 2 **tertiary bronchi**, that branches into a network of **bronchioles**, of which the end of each one (called **terminal bronchiole** (Terminal: because it is the end of so many divisions)) divides into **respiratory bronchioles** (first place to find alveoli), that ends up in an **alveolar ducts**, which opens into **alveolar sacs**, each of which contains thousands of **alveoli** (singular: alveolus), which are the final target of the whole mentioned airway.



- Summary: **Trachea→primary Bronchus→secondary Bronchus→tertiary Bronchus→Bronchiole→Terminal Bronchiole→Respiratory Bronchiole→Alveolar Duct→Alveolar Sac→Alveolus.**

- There are **22** branching points of the airway between trachea and an alveolar sac.
- Each secondary bronchus enters a lobe, so that:
  - left primary bronchus will give two secondary bronchi (left lung = 2 lobes).
  - right will give three secondary bronchi. (right lung = three lobes).



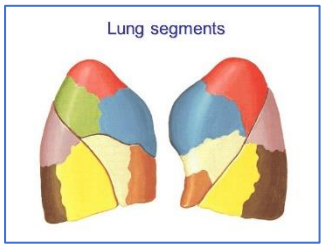
- The terminal bronchioles are the end of the <u>conducting</u> pathway.

- Bronchi branch into bronchioles, which are:

- Lined with <u>simple columnar or cuboidal epithelium</u>.
- No cartilage in walls (no rings).
- Smooth muscle around walls (replace the rings) causes bronchoconstriction when they contract (there are drugs that dilate these respiratory passages).

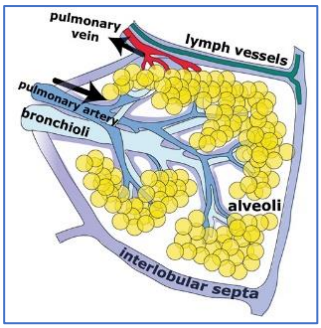
- secondary bronchus will divide into tertiary bronchi, each one will inter a **pulmonary segment.**

❖ Segments



- pulmonary segment is also called pulmonary lobule.
- Functional unit of the lung.
- There are 10 segments in each lung.
- This pulmonary segment (pulmonary lobule) is surrounded by connective tissue **the septa**. (so, segments are separating from each other by septa).

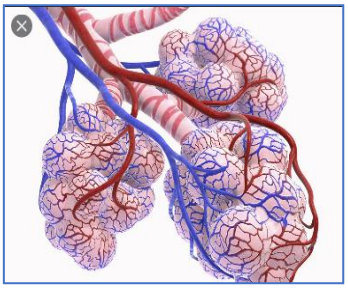
- segments are supplied by arteries, veins, and lymphatic vessels.



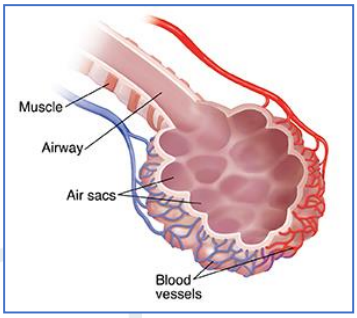
- This is a pulmonary segment. A bronchiole (or tertiary bronchus) getting in and is dividing into more smaller bronchioles until the starting of presence of alveoli.

❖ Pulmonary circulation

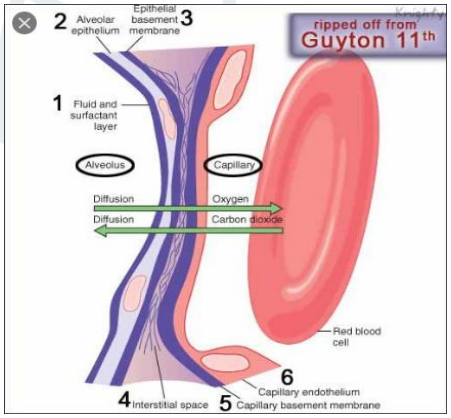
The next step after filling alveoli with fresh air, is to undergo gas exchange process, that occurs between fresh air and blood contaminated in the Pulmonary Capillaries.



- The story of the pulmonary circulation:
  Right ventricle pumps deoxygenated blood into pulmonary trunk (which is the pulmonary artery) going to the lungs, branching there and still branching until encirculating the alveoli (as shown in the image) → Gas exchange; unloading CO_2 and loading O_2 → taking the freshly oxygenated blood in a little picnic in a Luxury car of *Pulmonary Vein*™ brand, to park in a green plain at the heart land called Left atrium, transferring it to the left ventricle, distributing it throughout the body.

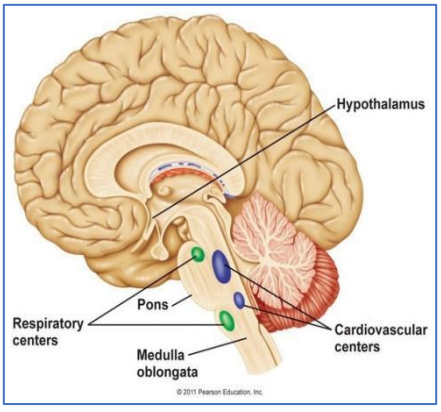


- This figure represents **Blood-Air Barrier.**
  - blood-air barrier separates the air in alveolus from RBCs in capillaries.
  - Blood-Air Barrier consists of:
    1- The alveolus lined internally with cells called **Pneumocytes** (simple squamous epithelium)**.**
    2- The endothelial cells of the capillaries.
    3- Two basement membranes between the two cells (one for endothelial cells -capillary- and other for pneumocytes).
    4- Very small interstitial space between the two basement membranes (to allow gases to pass easily).



❖ Nervous control

- **respiratory centers**
  - ✓ located in Pons and medulla oblongata.
  - ✓ they initiate respiration and go throw the cycle of inspiration and expiration.
  - ✓ Also its important for illegal heart drugs, by depressing these centers. whenever they have an over dose that will start breathing in less frequent times and their blood is not oxygenated and they go in coma and die.



The End