

ANATOMY AND PHYSIOLOGY OF THE RESPIRATORY SYSTEM

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ZOOLOGY AND
BIOTECHNOLOGY**

WHAT IS RESPIRATORY SYSTEM?

- The **respiratory system** (also **respiratory apparatus, ventilatory system**) is a biological system, consisting of specific organs and structures used for gas exchange in human.
- Organs of Respiratory System:
- Nose and nasal cavity.
- Pharynx
- Larynx
- Trachea
- Two bronchi
- Bronchioles
- Two Lungs

NOSE AND NASAL CAVITY

- POSITION AND STRUCTURE

Main route of air entry.

Two cavities divided by a **SEPTUM**.

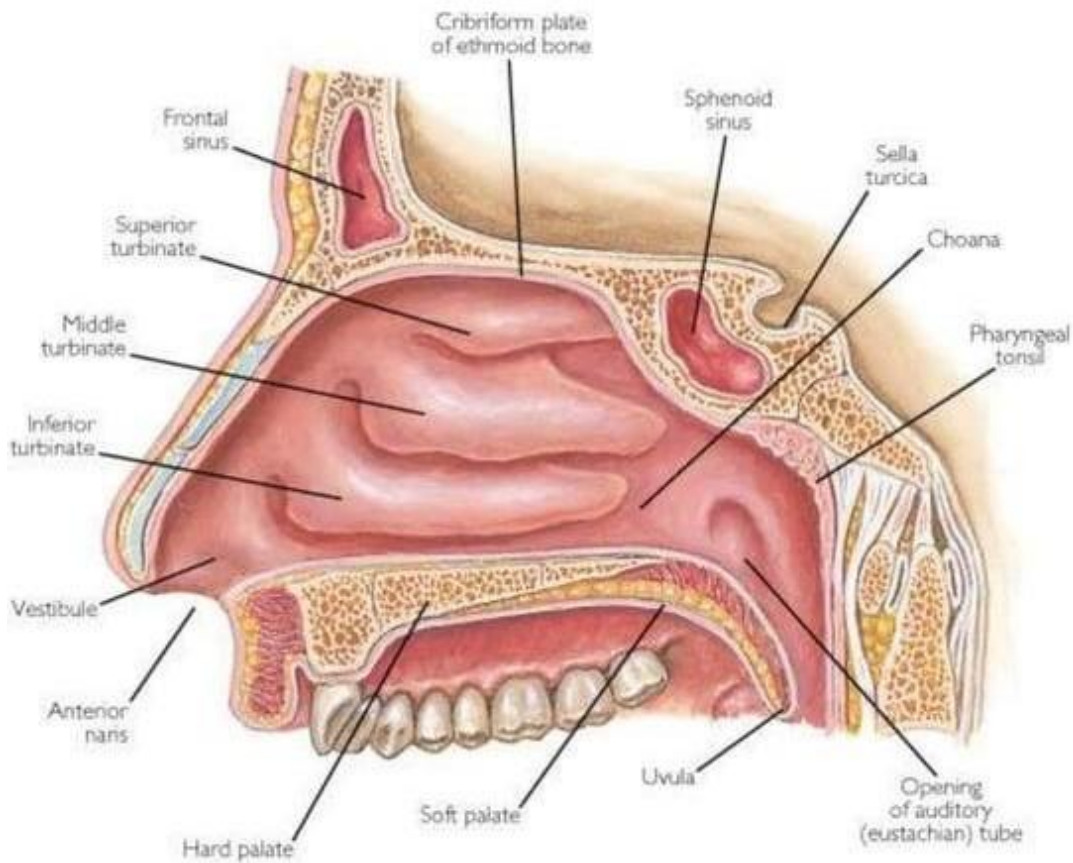
Anteriorly consist **hyaline cartilage**.

The **roof** is formed by **ethmoid bone**

The **floor** is formed by **roof of the mouth**.

The **medial wall** formed by the **septum**.

The **lateral wall** formed by the **maxilla**.



RESPIRATORY FUNCTIONS OF THE NOSE

- The first of the respiratory passages.
- **Warming-**
Due to the immense vascularity of the mucosa.
- **Filtering and cleaning-**
This occurs due to hairs which trap larger particles.
- **Humidification -**
As air travels over the moist mucosa, it becomes saturated with water vapour.

PHARYNX

- What is pharynx?

The **pharynx** is the part of the throat that is behind the mouth and nasal cavity and above the esophagus and the larynx.

Length- 12-14cm (extends from the base of the skull to the level of 6th cervical vertebra.)

Position

Superiorly-Base of the skull.

Inferiorly-Continuous with the oesophagus.

Anteriorly-Incomplete wall because of the nose, mouth and larynx opening.

Posteriorly-Areolar tissue & first 6 vertebra.

Nasal Cavity

Palate

Oral Cavity

Lips

Tongue

Pharynx

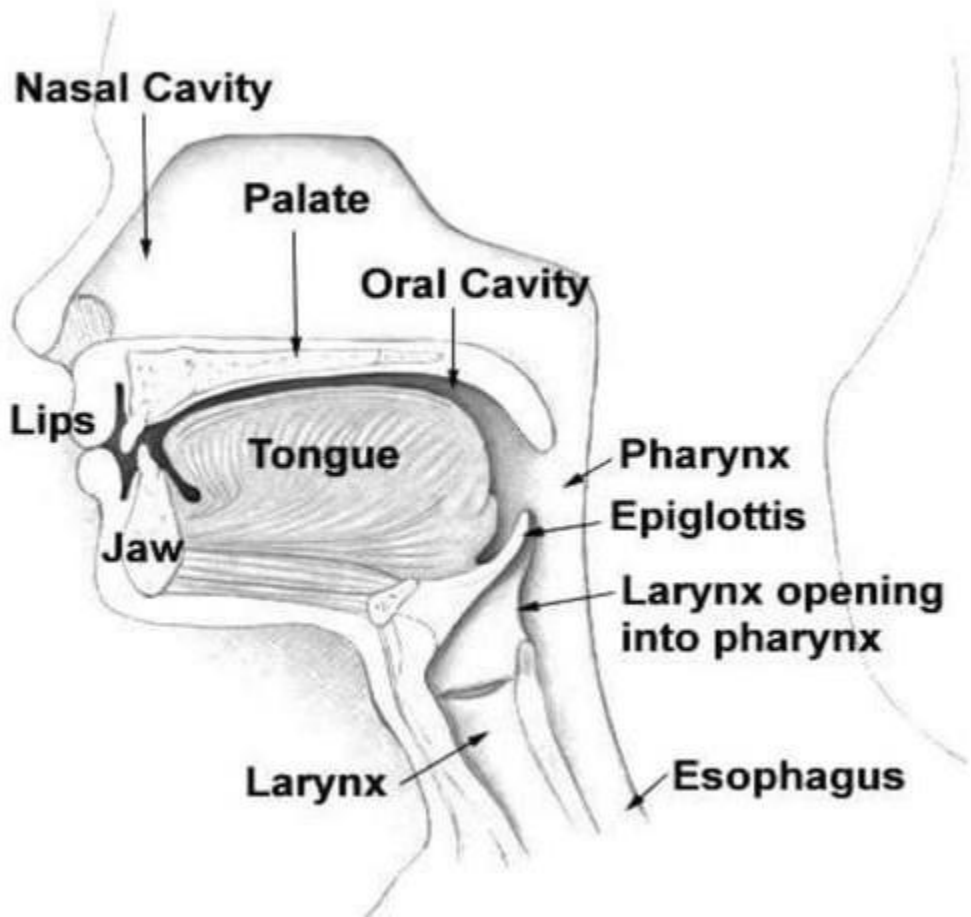
Jaw

Epiglottis

**Larynx opening
into pharynx**

Larynx

Esophagus



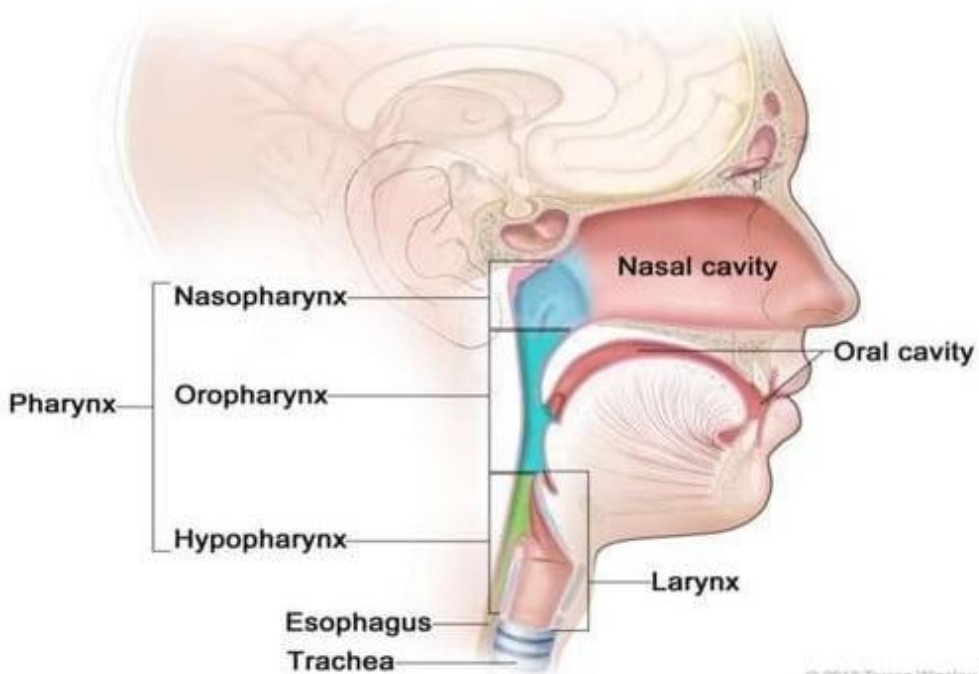
- For descriptive purposes the pharynx is divided into three parts:
 - (i) The nasopharynx
 - (ii) The oropharynx
 - (iii) The laryngopharynx
- **(i) The nasopharynx**

The nasal part of the pharynx lies behind the nose.
- **(ii) The oropharynx**

The oral part of the pharynx lies behind the mouth.
- **(iii) The laryngopharynx**

The laryngeal part of the pharynx extends from the oropharynx.

Anatomy of the Pharynx



- **STRUCTURE**

- The pharynx is composed of three layers:

 - Mucous membrane lining

 - Fibrous tissue

 - Smooth muscle

- **Blood supply**

 - Facial artery

 - Facial vein

 - Internal jugular veins

- **Nerve supply**

 - Vagus nerve

 - Glossopharyngeal nerve

Functions

- Passageway for air and food.
- Warming and humidifying.
- **Taste.**

There are olfactory nerve endings.

- **Hearing.**

The auditory tube, extending from the nasopharynx to each middle ear.

- **Protection.**

The lymphatic tissue of the pharyngeal tonsils produces antibodies.

- **Speech.**

Act as a resonating chamber for sound ascending from the larynx.

LARYNX

- **POSITION**

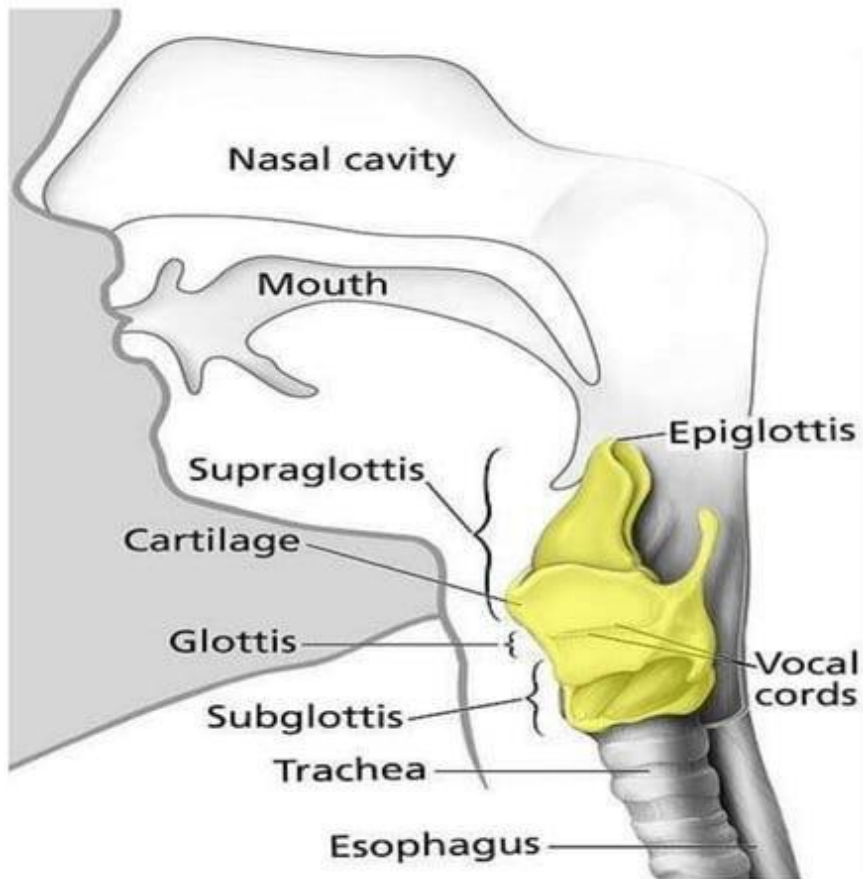
- The larynx or **voice box** extends from the root of the tongue.
- It lies in front of the laryngopharynx at the level of 3rd, 4th, 5th and 6th cervical vertebra.
- Until the puberty there is little **difference in the size** of the larynx between the sexes.
- It grows larger in the male.

Superiorly-The hyoid bone & roof of the tongue.

Inferiorly-Continuous with the trachea.

Anteriorly-The muscle of the neck.

Posteriorly-.The laryngopharynx and 3rd to 6th cervical vertebra.



STRUCTURE

- The larynx is composed of several irregularly shaped cartilages attached to each other by ligaments and membranes.
 - The main cartilages are:
 - 1 thyroid cartilage
 - 1 cricoid cartilage
 - 2 arytenoid cartilage
 - 1 epiglottis
- hyaline cartilage
- elastic fibrocartilage

The thyroid cartilage

This is the most prominent & consists of 2 flat pieces of hyaline cartilage & fused anteriorly forming the **Adam's apple**.

The cricoid cartilage

This lies below the thyroid cartilage & composed of hyaline cartilage.

- **The arytenoid cartilages**

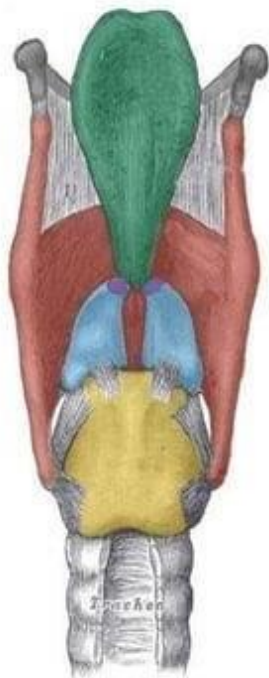
These are two roughly pyramid-shaped hyaline cartilages situated on top of the broad part of the cricoid cartilage.






- **The epiglottis**

This is a leaf-shaped fibroelastic cartilage attached to the inner surface of the anterior wall of the thyroid cartilage.

Blood and nerve supply

- Superior and inferior laryngeal arteries.
- Thyroid veins.
- Superior laryngeal nerves.



-  Epiglottis
-  Thyroid cartilage
-  Arytenoid cartilages
-  Cricoid cartilage
-  Corniculate cartilages

FUNCTIONS

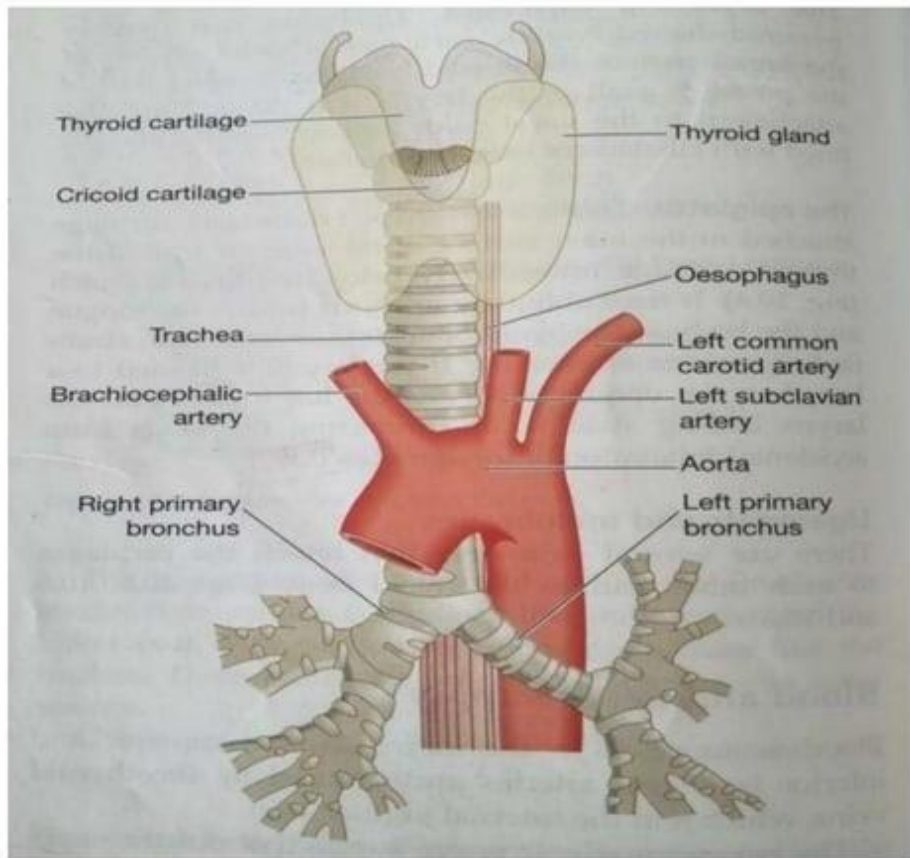
- Production of sound
- Speech
- Protection of the lower respiratory tract

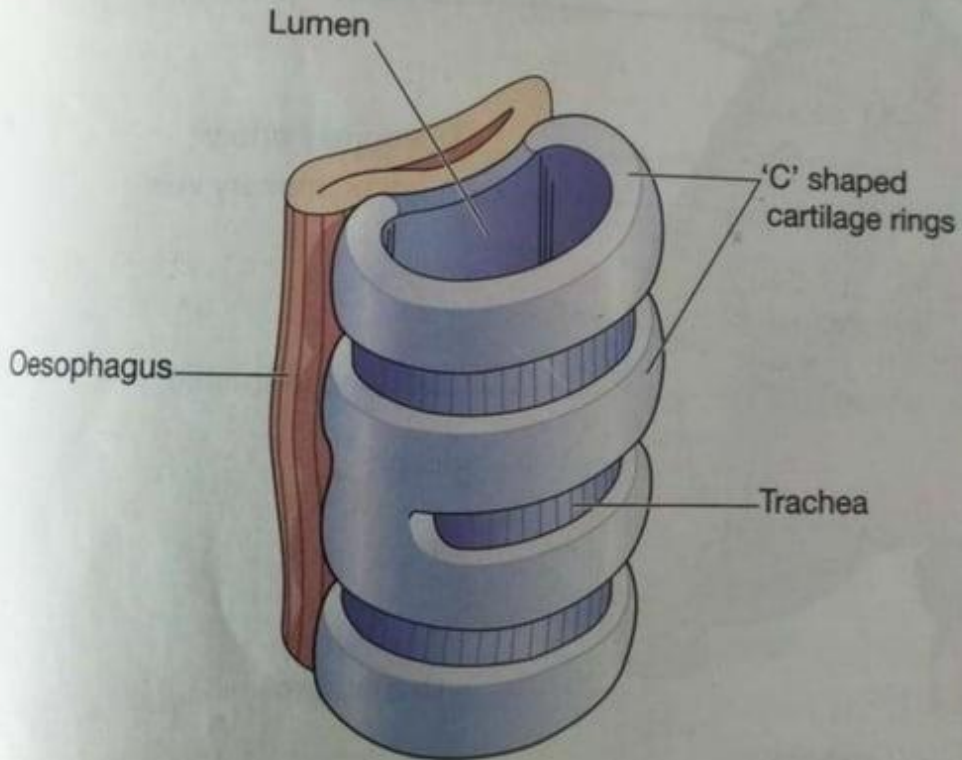
During swallowing the larynx moves upwards and hinged epiglottis closes over the larynx.

- Passageway for air
- Humidifying
- Filtering
- Warming

TRACHEA

- **Position**
- The trachea or **windpipe** is a continuation of the larynx & extends downwards to about the level of **T-5** where it divides into right & left primary bronchi.
- **Length**-10-11cm
- **Relation**
 - Superiorly**-the larynx
 - Inferiorly**-the right & left bronchi
 - Anteriorly**-upper part-the thyroid gland.
lower part-the arch of aorta & the sternum.
 - Posteriorly**-.the oesophagus
 - Laterally**- the lungs





STRUCTURE

- Composed of 3 layers of tissue.
- (i) fibrous & elastic tissue
- (ii) smooth muscle
- (iii) ciliated columnar epithelium
- Held open by between 16-20 incomplete cartilage rings (C-shaped)

Blood supply

Inferior thyroid artery

Bronchial artery

Venous drainage

Inferior thyroid veins

Nerve supply

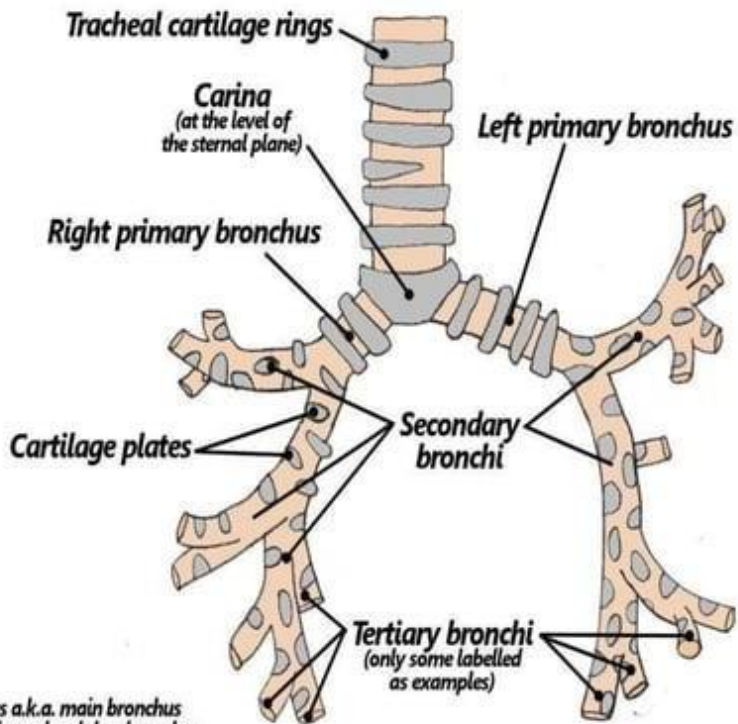
Laryngeal nerve

FUNCTIONS

- Support and patency
- Mucociliary escalator
- Cough reflex
- Warming
- Humidifying
- Filtering

BRONCHI & BRONCHIOLES

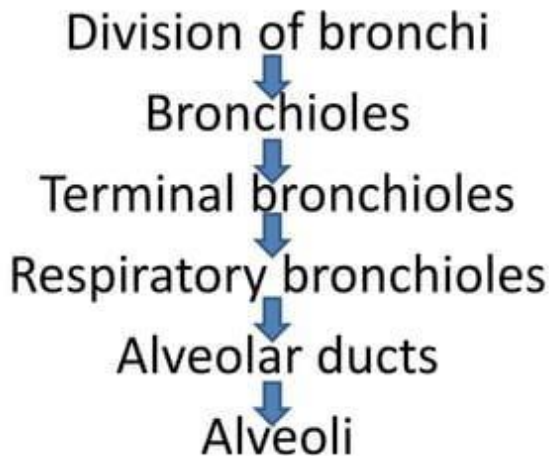
- The two primary bronchi when the trachea divides about the level of T-5.
- **The right bronchus**
- This is wider, shorter and more vertical than the left bronchus.
- Length-2.5cm
- After entering the right lung, it divides into 3 branches, one to each lobe.
- **The left bronchus**
- This is **narrower** than the **right**
- Length-5cm
- After entering the left lung, it divides into 2 branches, one to each lobe.



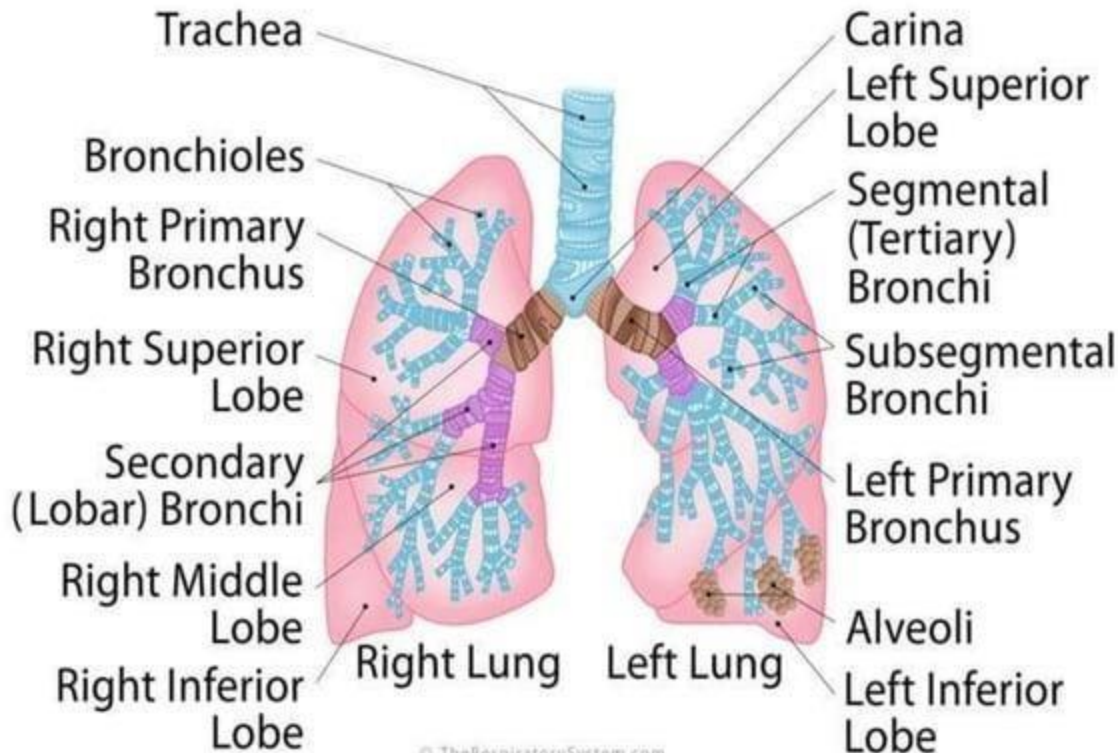
Note:
Primary bronchus a.k.a. main bronchus
Secondary bronchus a.k.a. lobar bronchus
Tertiary bronchus a.k.a. segmental bronchus

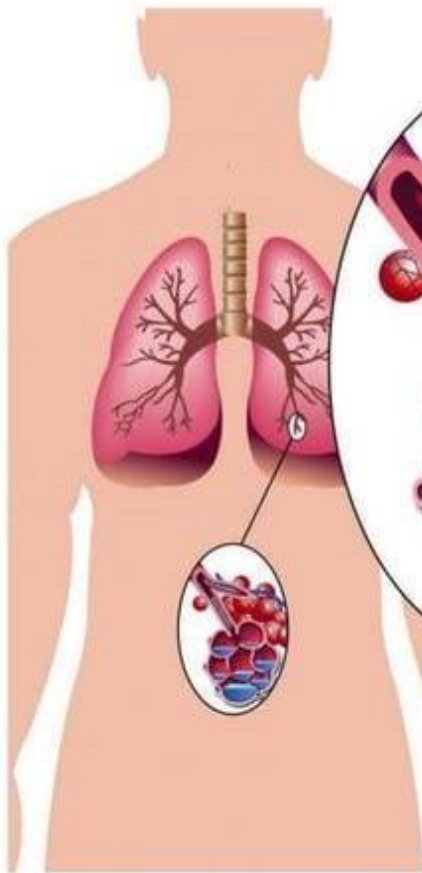
STRUCTURE

- The bronchi are composed of the same issues as the trachea.
- Are lined with **ciliated columnar epithelium**.

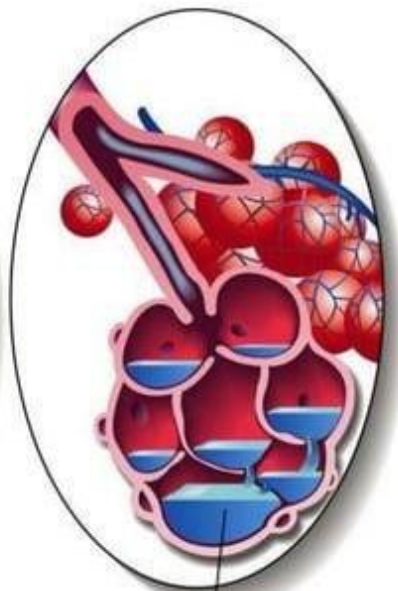


Bronchi





Normal bronchiole
and alveoli



Pneumonia causes
an accumulation
of fluid in the alveoli

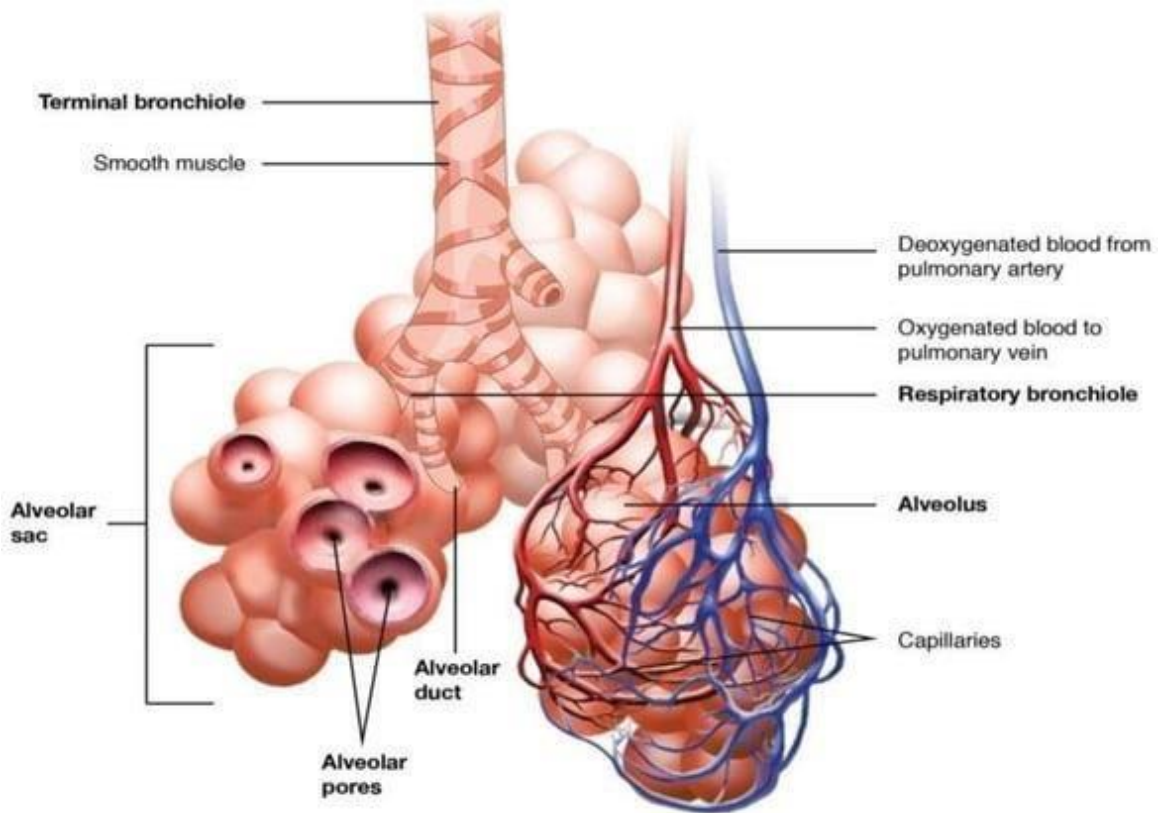
- Ciliated columnar mucous membrane changes gradually to non-ciliated cuboidal-shaped cells in the distal bronchioles.
- The wider passages are called **conducting airways**
- Conducting airways, bring air into the lungs & their walls are too thick to permit gas exchange.
- **Blood supply**
- Bronchial arteries
- **Venous drainage**
- Bronchial veins
- **Nerve supply**
- Vagus nerve
- **Lymph drainage**
- The Thoracic duct

FUNCTIONS

- Control of air entry
- Warming & humidifying
- Support & patency
- Removal of particulate matter
- Cough reflex

- **RESPIRATORY BRONCHIOLES & ALVEOLI**

- Each lobule is supplied with air by a terminal bronchiole
- Which further subdivides into respiratory bronchioles, **alveolar ducts** and large numbers of **alveoli (air sacs)**
- About **150 million** alveoli in the adult lung
- In these structures that the process of gas exchange occurs.
- As airways progressively divide & become smaller & smaller, their walls gradually become thinner.
- These distal respiratory passages are supported by a loose network of elastic connective tissue.
- Exchange of gases in the lungs takes place in alveoli



- **Nerve supply**

- Vagus nerve

- **FUNCTIONS**

- **External respiration**

This is exchange of gases by diffusion between the alveoli and the blood.

- **Defence against microbes**

Protective cells present within the lung tissue, include lymphocytes & plasma cells, which produce antibodies.

- **Exchange of gases**

LUNGS

- There are **two lungs**, one lying on each side.
- **Shape**-cone
- **Weight**-600-700gms
- **Length**-20-24cm
- **Colour**-pinkish
- **Lobes**- **three** lobes in the **right** lung
two lobes in the **left** lung
- Lobes are **separate** by **the fissures**
- The area between the lungs is the **mediastinum**.

- **Surfaces**

Apex

A base

Costal surface

Medial surface

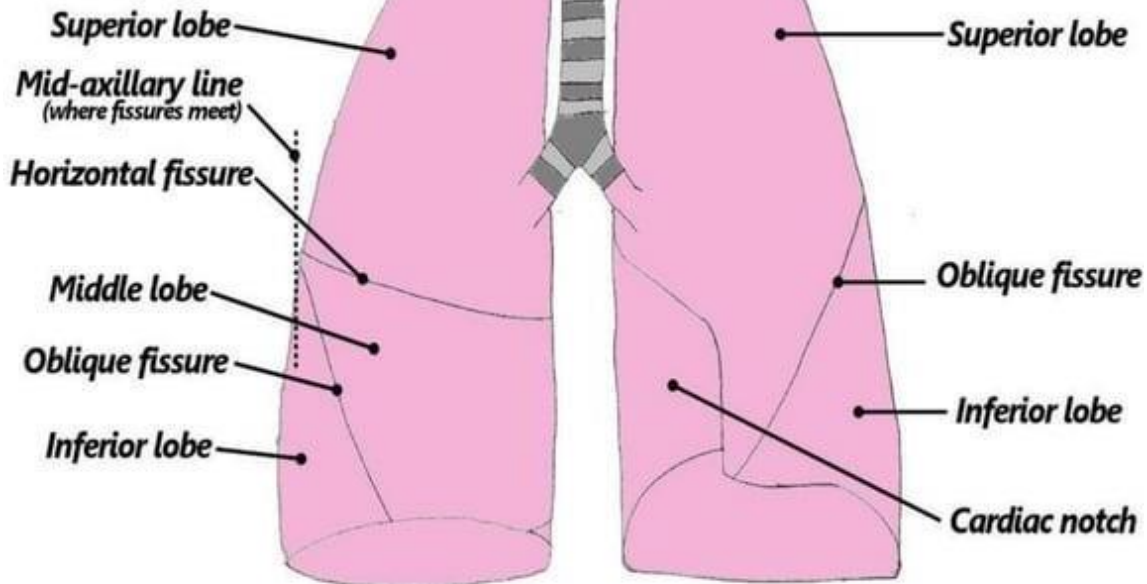
- **Apex** – rounded and rises into the root of the neck.
- **A base**-this is concave & semilunar in shape, lies on the thoracic surface of the diaphragm.
- **Costal surface**-this surface is convex & lies against the costal cartilages.
- **Medial surface**-this surface is concave & has a roughly triangular-shaped area, called the hilum. The pulmonary artery supplying the lung & two pulmonary veins draining it.

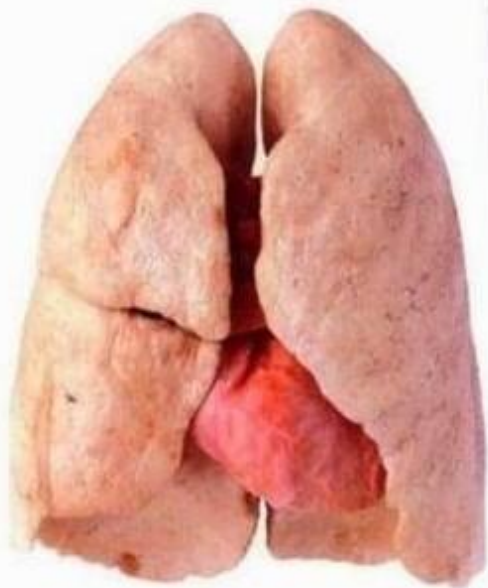


Right Lung

Left Lung

Lobes of the lung





**Non Smokers
Lungs**



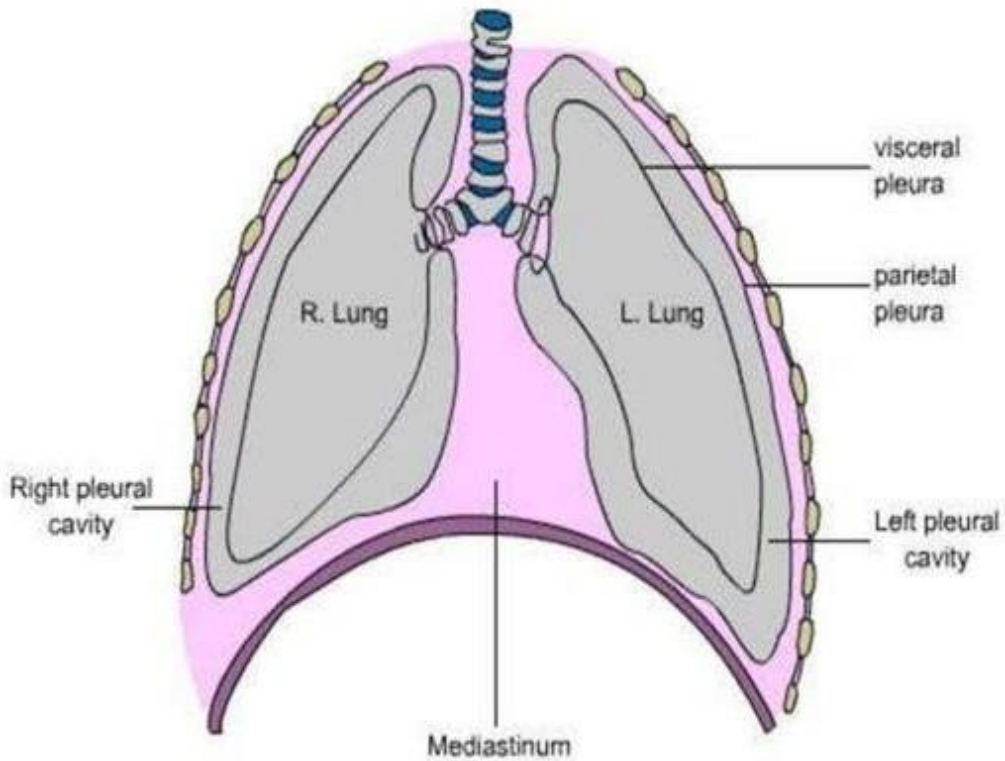
**Rollup Cigarette
Smokers Lungs**

Pleura

- The **pleura** consists of a closed **sac** of serous membrane, one for each lung which contains a small amount of **serous fluid**.
- The lung is invaginated or pushed into this sac.
- It forms **two layers**:
 - (i) The **visceral** pleura
 - (ii) The **parietal** pleura
- (i) The **visceral** pleura
 - This is **adherent to the lung**, covering each lobe & passing into the fissures that separate them.
- (ii) The **parietal** pleura
 - This is **adherent to** the inside of the **chest wall & the thoracic surface** of the diaphragm.

The pleural cavity

- The two layers of pleura are separated by a thin film of serous fluid which allows them to glide over each other.
- **Preventing friction** between them during breathing.
- The **serous fluid** is secreted by the epithelial cells of **the membrane**.



RIGHT LUNG

- The right lung has more lobes and segments than the left.
- It is divided into **three lobes**:
 - **(i) Upper or superior lobe**
 - **(ii) Middle lobe**
 - **(iii) Lower or inferior lobe**
- They separate by **two fissures**
 - **(i) One oblique fissure** which separates **middle & lower lobe**
 - **(ii) One horizontal fissure** which separates **middle & upper lobe**

LEFT LUNG

- The left lung is divided into two lobes
- (i) **upper** lobe
- (ii) **lower** lobe
- They separate by the **oblique fissure**
- Left lung does not have a **middle** lobe
- The mediastinal surface of the left lung has a large **cardiac impression** or **cardiac notch** where the heart sits.

BLOOD SUPPLY

- Bronchial arteries
- Pulmonary capillaries, where there is exchange of oxygen & carbon dioxide take place between blood & tissues.

• **VENOUS DRAINAGE**

- Bronchial vein

• **NERVE SUPPLY**

- Vagus nerve

FUNCTION

- Control of air entry
- Warming & humidifying
- Support & patency
- Removal of particulate matter
- Cough reflex

RESPIRATION

- The term **respiration** means the exchange of gases between body cells and the environment.
- **Breathing** or **pulmonary ventilation**
- This is movement of air into and out of the lungs.
- **Exchange of gases:**
- This takes place:
- In the lungs:external respiration.
- In the tissues:internal respiration.

BREATHING

- Breathing supplies oxygen to the alveoli, and eliminates carbon dioxide.
- MUSCLES OF BREATHING
- Expansion of the chest during inspiration occurs as a result of muscular activity, partly voluntary and partly involuntary.
- The main muscles used in normal quiet breathing are the **INTERCOSTAL MUSCLES** and the **DIAPHRAGM**.
- During difficult or deep breathing they are assisted by muscles of the neck, shoulders and abdomen.

INTERCOSTAL MUSCLES

- There are **11 pairs** of intercostal muscles that occupy the spaces between the 12 pairs of ribs.
- They are arranged in two layers, the **external** and **internal** intercostal muscles
- The first rib is fixed.
- Therefore, when the intercostal muscles contract they pull all the other ribs towards the first rib. Because of the shape and sizes of the ribs they move outwards when pulled upwards, enlarging the thoracic cavity.

Innermost
intercostal

External
intercostal

Clavicle

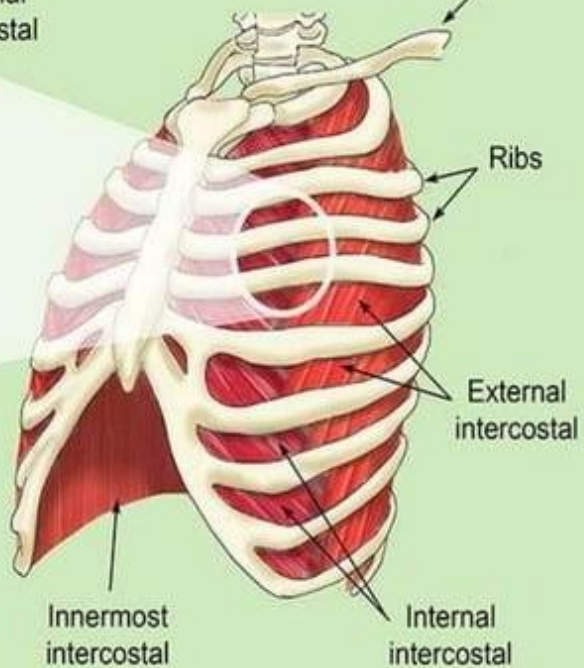
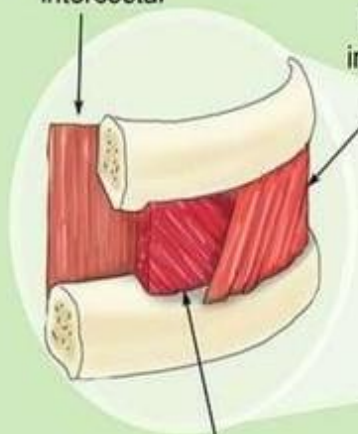
Ribs

Internal
intercostal

External
intercostal

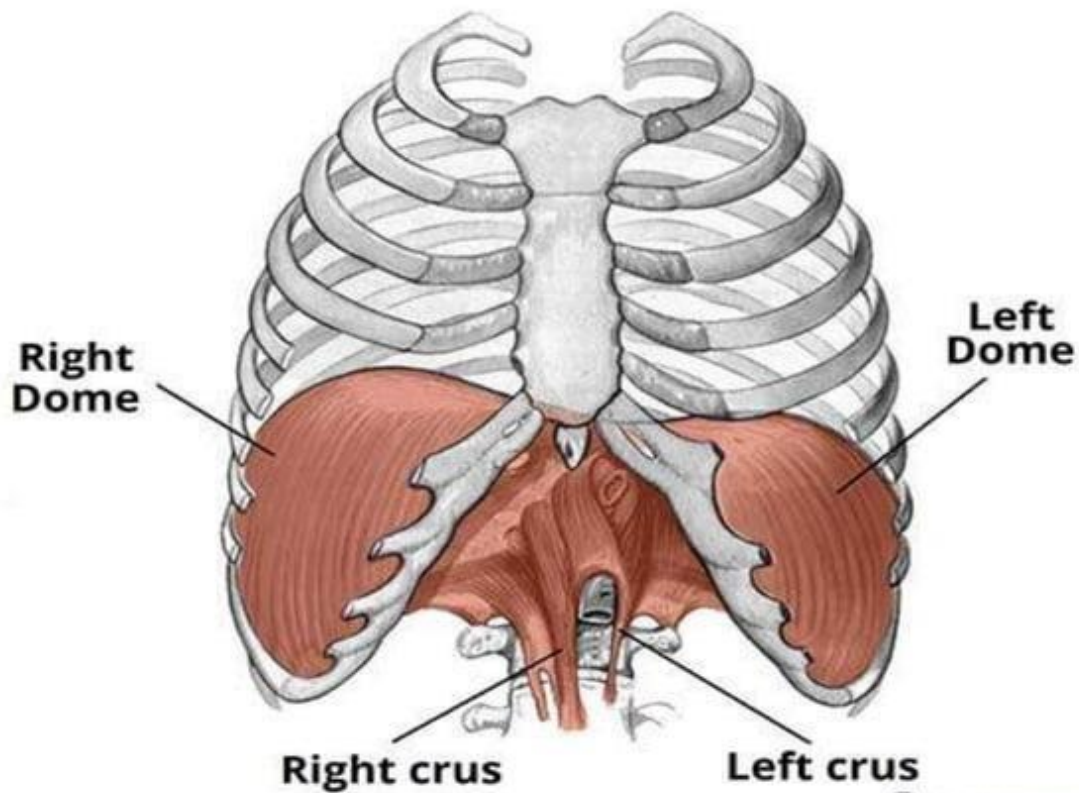
Innermost
intercostal

Internal
intercostal



DIAPHRAGM

- The diaphragm is a dome-shaped muscular structure separating the thoracic and abdominal cavities.
- It forms the floor of the thoracic cavity and the roof of the abdominal cavity and consists of a central tendon from which muscle fibres radiate to be attached to the lower ribs and sternum and to the vertebral column by two crura.
- When the muscle of the diaphragm is relaxed ,the central tendon is pulled downwards to the level of the T-9,enlarging the thoracic cavity in length.
- This decreases pressure in the thoracic cavity and increases it in the abdominal and pelvic cavities.



- The intercostal muscles and the diaphragm contract simultaneously, enlarging the thoracic cavity in all directions.

- **CYCLE OF BREATHING**

- The average respiratory rate is **12 to 15 breaths/minute.**
- Each breath consists of **three phases:**
 - (i) Inspiration
 - (ii) Expiration
 - (iii) Pause.

- **(i)Inspiration**

- When the capacity of the thoracic cavity is increased by simultaneous contraction of the intercostal muscles and the diaphragm.
- The parietal pleura moves with the walls of the thorax & the diaphragm.
- This reduces the pressure in the pleural cavity to a level considerably lower than atmospheric pressure.
- The visceral pleura follows the parietal pleura ,pulling the lungs with it.
- This expands the lungs and the pressure within the alveoli and in the air passages,drawing air into the lungs in attempt to equalise the atmospheric and alveolar air pressure.

- The process of inspiration is **ACTIVE**, as it needs energy for muscle contraction.
- Inspiration lasts about **2 seconds**.
 - **(ii) Expiration**
- Relaxation of the intercostal muscles and the diaphragm results in downward and inward movement of the rib cage and elastic recoil of the lungs.
- As this occurs, pressure inside the lungs exceeds that in the atmosphere and so air is expelled from respiratory tract.
- The still contain some air, are prevented from collapse by the intact pleura.
- This process is **PASSIVE** as it does not require the expenditure of energy.

LUNG VOLUMES AND CAPACITIES

- **Respiratory cycles**-15/minute
- **Tidal volume (TV)**- this is the amount of air passing into and out of the lungs during each cycle of breathing.
- About **500ml** is tidal volume.

- **EXCHANGE OF GASES**

- Inhaled oxygen enters the lungs and reaches the alveoli. The layers of cells lining the alveoli and the surrounding capillaries are each only one cell thick and are in very close contact with each other.
- Oxygen passes quickly through air-blood barrier into the blood in the capillaries.
- Similarly, carbon dioxide passes from the blood into the alveoli and is then exhaled.

- Diffusion of oxygen & carbon dioxide depends on pressure differences.
- **DIFFUSION OF GASES**
- **External respiration**
- External respiration refers to gas exchange across the respiratory membrane in the lungs.
- Each alveolar wall is one cell thick and surrounded by a network of tiny capillaries.
- Carbon dioxide diffuses from venous blood down its concentration gradient into the alveoli.
- By the same process, oxygen diffuses from the alveoli into the blood.

Internal respiration

- **Internal respiration** refers to gas exchange across the respiratory membrane in the metabolizing tissues, like your skeletal muscles, for example.
- Blood arriving at the tissues has been cleansed of its CO_2 & saturated with O_2 during its passage through the lungs, therefore has a higher O_2 & lower CO_2 than the tissues.
- This concentration gradients between capillary blood and the tissues lead gase exchange.
- O_2 diffuses from the bloodstream through the capillary wall into the tissues.
- CO_2 diffuses from the cells into the extracellular fluid, then into the bloodstream towards the venous end of capillary.

TRANSPORT OF GASES IN THE BLOODSTREAM

- Transport of blood oxygen & carbon dioxide is essential for internal respiration to occur.
- **OXYGEN**
- Oxygen is carried in the blood in as combination with haemoglobin as **oxyhaemoglobin.**
- **CARBON DIOXIDE**
- It is excreted by the lungs & transported by combined with haemoglobin as **carbaminohaemoglobin.**
- **CONTROL OF RESPIRATION**
- **The respiratory centre:** Medulla oblongata

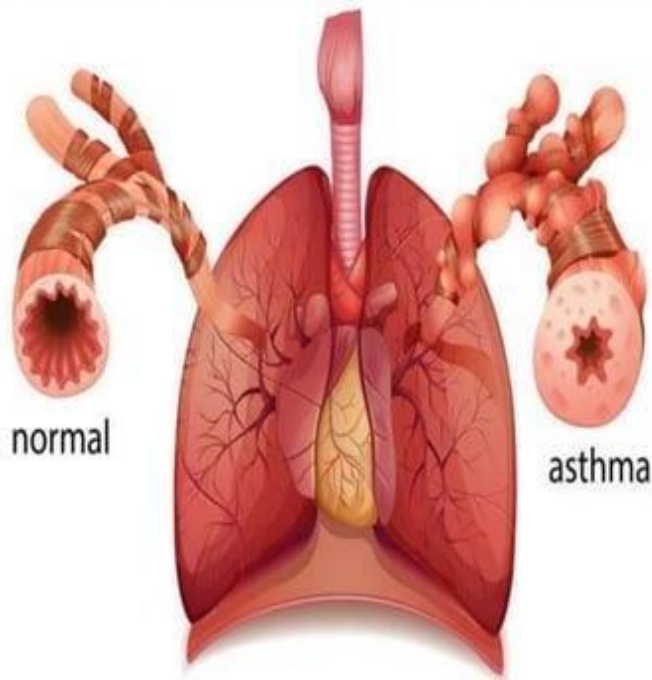
DISORDERS OF RESPIRATORY TRACT

ASTHMA

it is a common longterm inflammatory disease of the airways of the lungs.

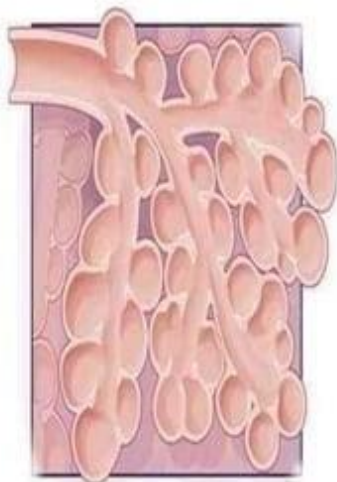
The mucous membrane & muscle layers of the bronchi become thickened.

Asthma - Inflamed Bronchial Tube

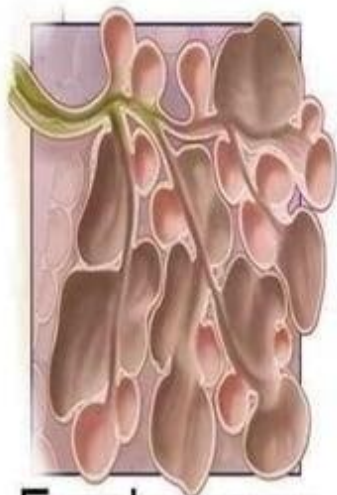


EMPHYSEMA

Emphysema is a lung condition that causes shortness of breath. In people with **emphysema**, the air sacs in the lungs (alveoli) are damaged.



Healthy

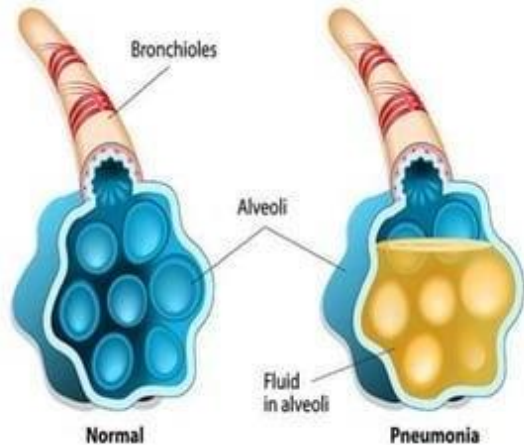


Emphysema

PNEUMONIA

Pneumonia is an inflammatory condition of the lung affecting primarily the small air sacs known as alveoli.

PNEUMONIA



LUNG ABSCESS

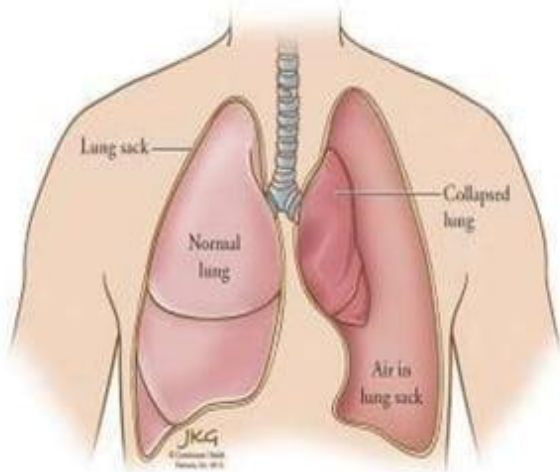
Lung abscess is a type of liquefactive necrosis of the **lung** tissue and formation of cavities (more than 2 cm) containing necrotic debris or fluid caused by microbial infection.



LUNG COLLAPSE

A **collapsed lung** occurs when air escapes from the **lung**.

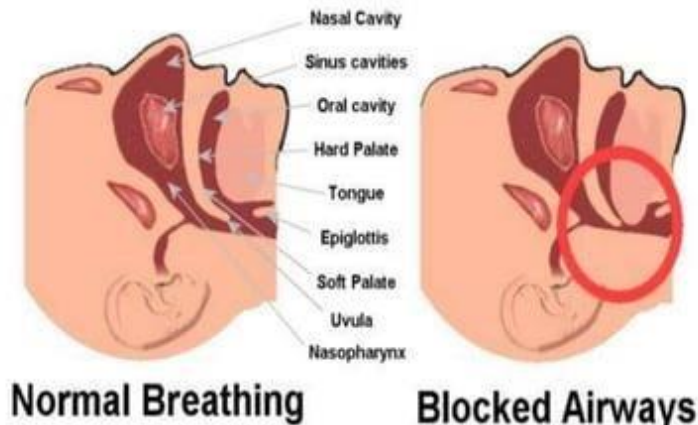
The air then fills the space outside of the **lung**, between the **lung** and chest wall.



APNEA

Apnea or apnoea is suspension of breathing. During **apnea**, there is no movement of the muscles of inhalation, and the volume of the lungs initially remains unchanged.

Sleep Apnea



LUNG TUMOURS

Lung cancer, also known as **lung carcinoma**, is a malignant lung tumor characterized by uncontrolled cell growth in tissues of the lung.

