

THE RESPIRATORY SYSTEM

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Course contents

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- Mechanism of respiration
- Muscles of respiration
- Volumes of lung
- Capacities of lung

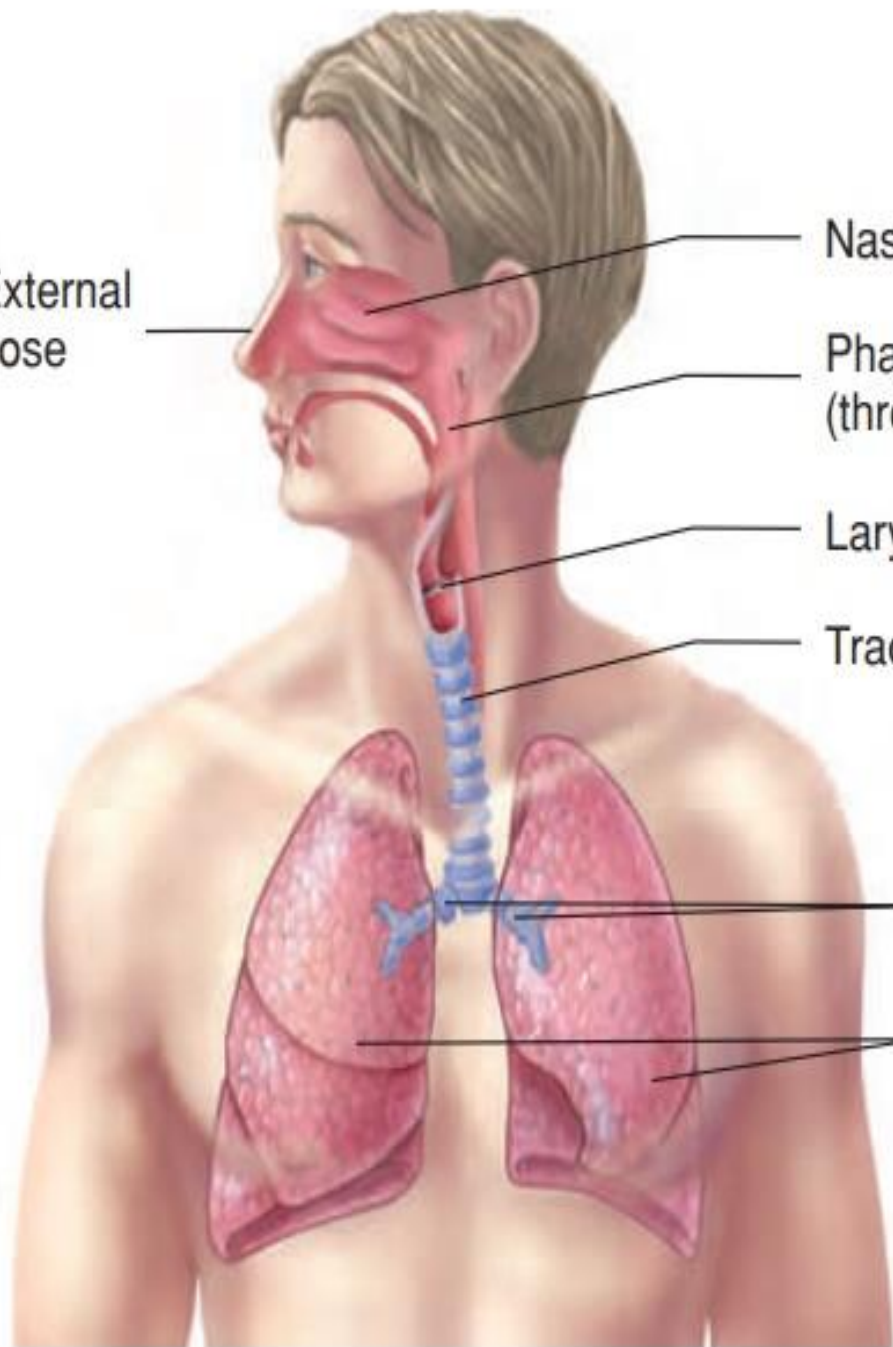
Respiratory system?

- The **respiratory 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

External
nose



Nasal cavity

Pharynx
(throat)

Larynx

Trachea

Bronchi

Lungs

**Upper
respiratory
tract**

**Lower
respiratory
tract**

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

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

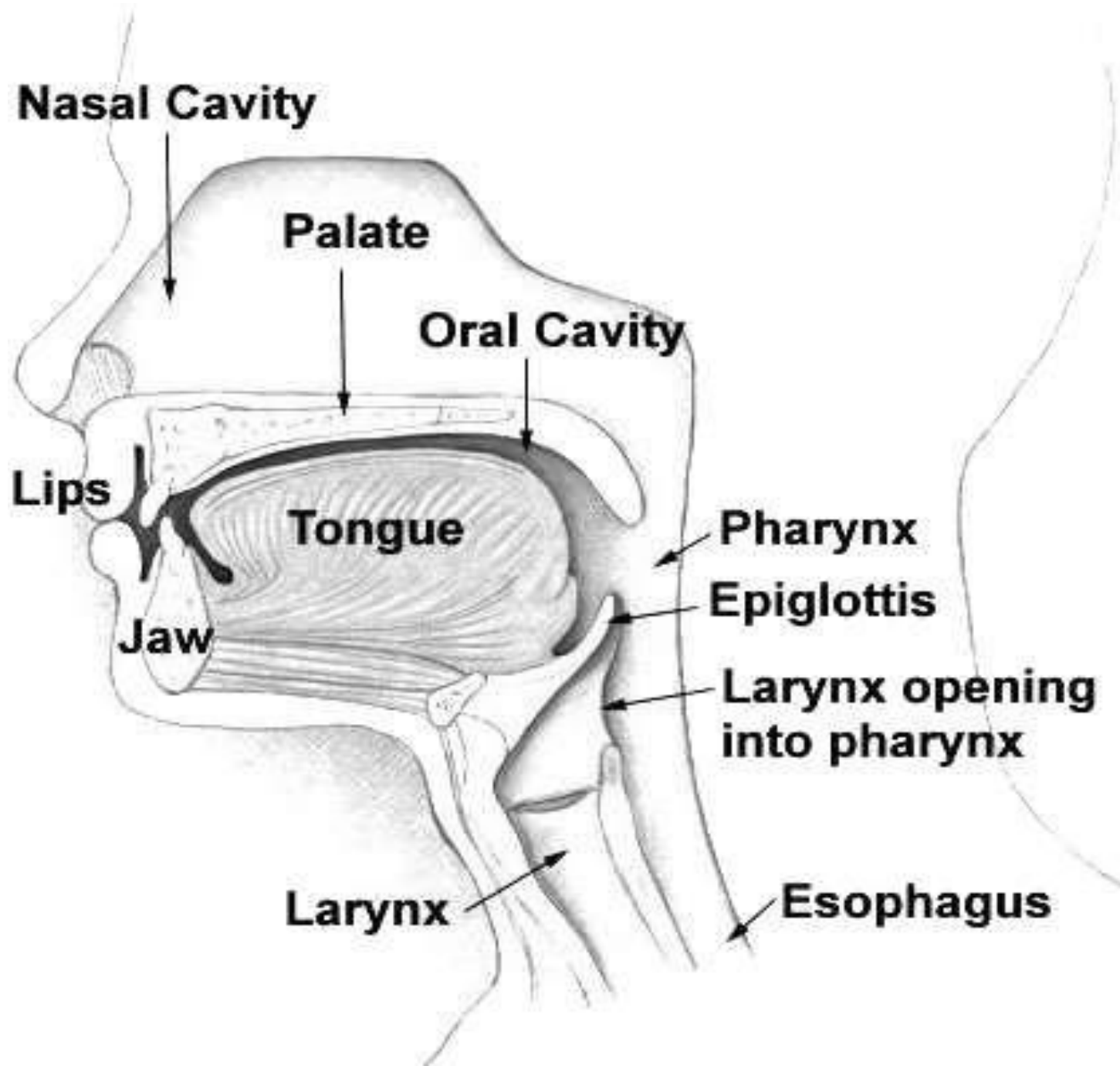
Jaw

Epiglottis

**Larynx opening
into pharynx**

Larynx

Esophagus

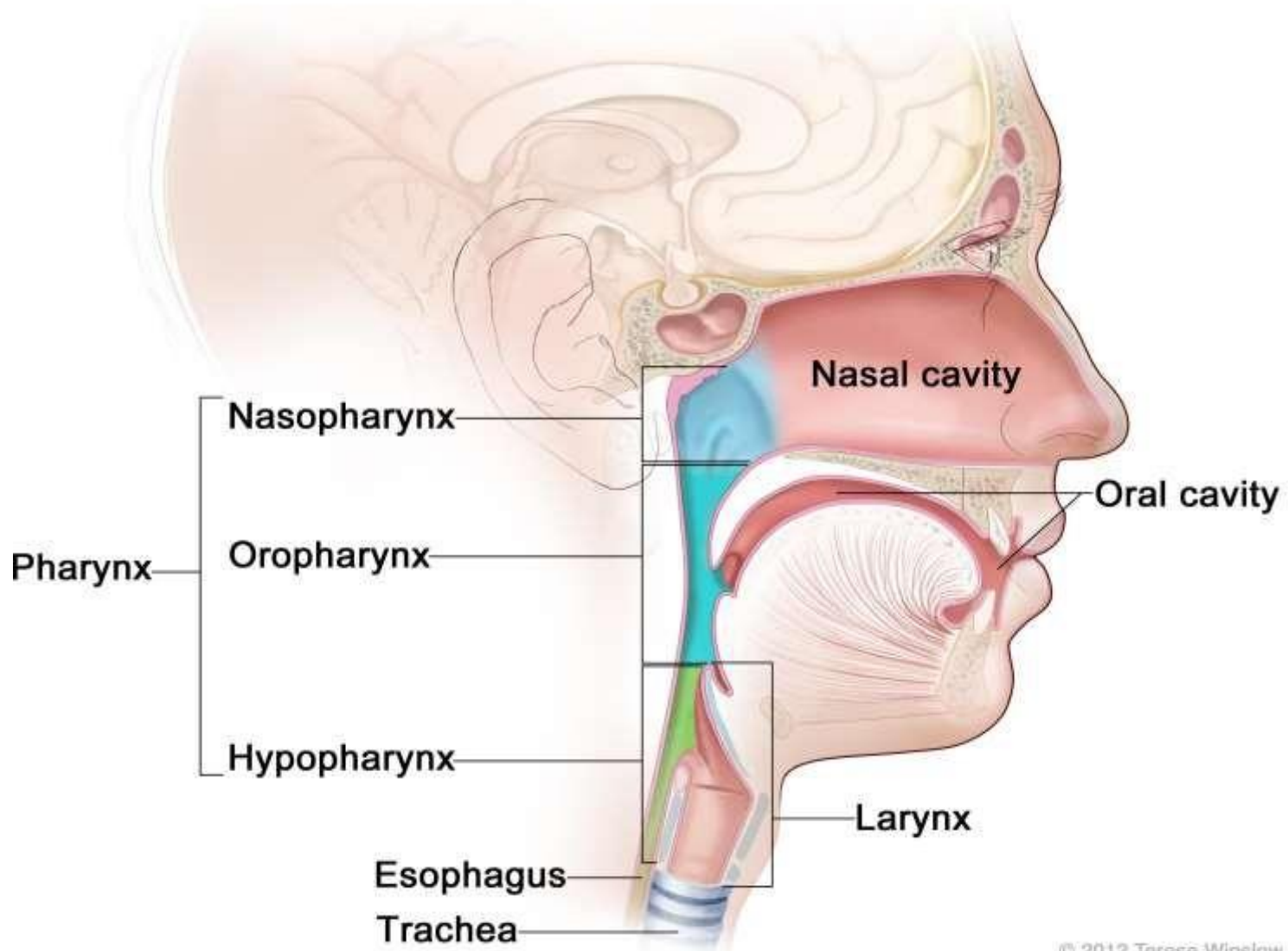


The pharynx is divided into three parts:

- The nasopharynx
- The oropharynx
- The laryngopharynx

- **The nasopharynx** :The nasal part of the pharynx lies behind the nose.
- **The oropharynx**:The oral part of the pharynx lies behind the mouth.
- **The laryngopharynx**:The laryngeal part of the pharynx extends from the oropharynx.

Anatomy of the Pharynx



Blood supply

Facial artery

Facial vein

Internal jugular veins

Nerve supply

Vagus nerve

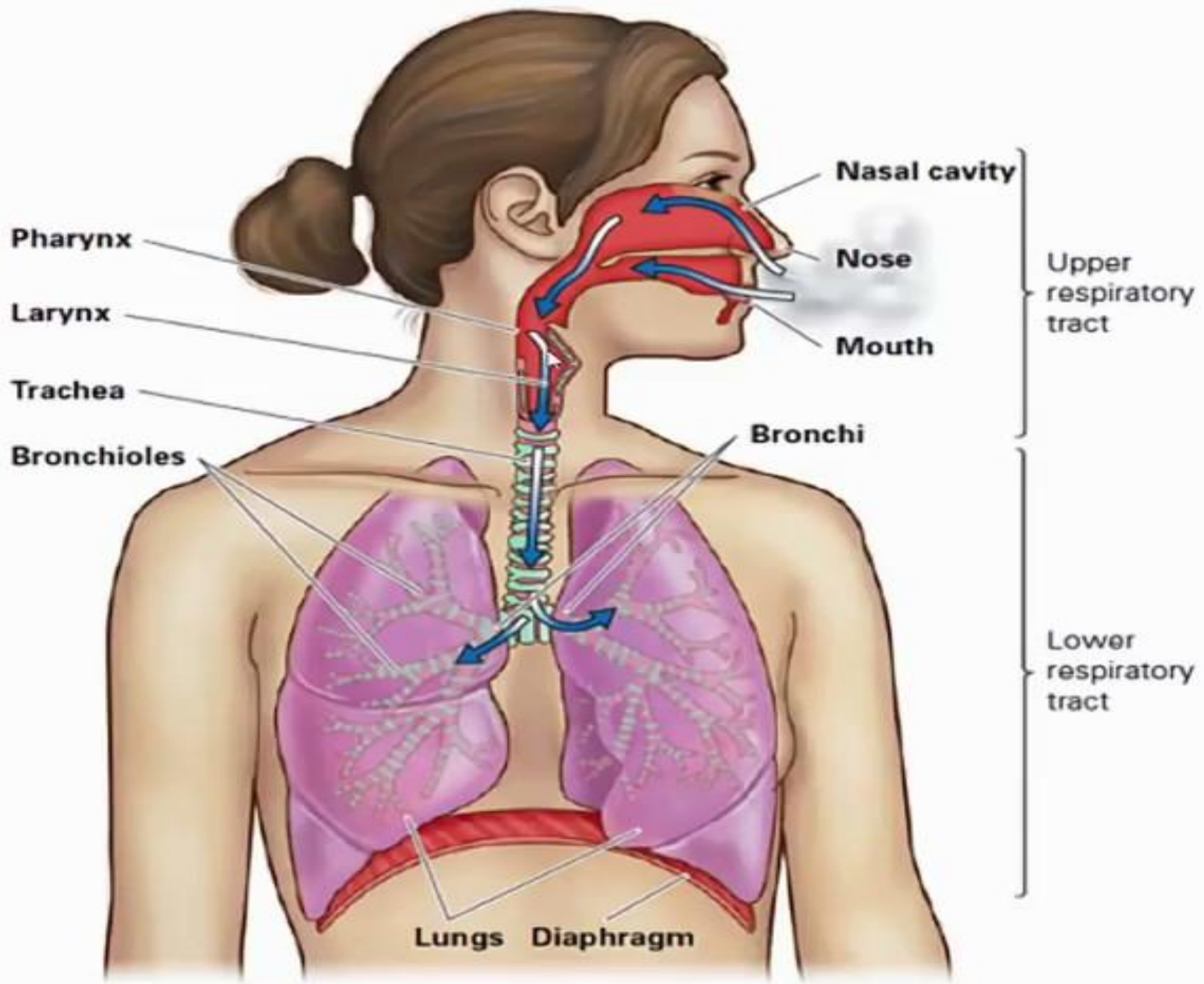
Glossopharyngeal nerve

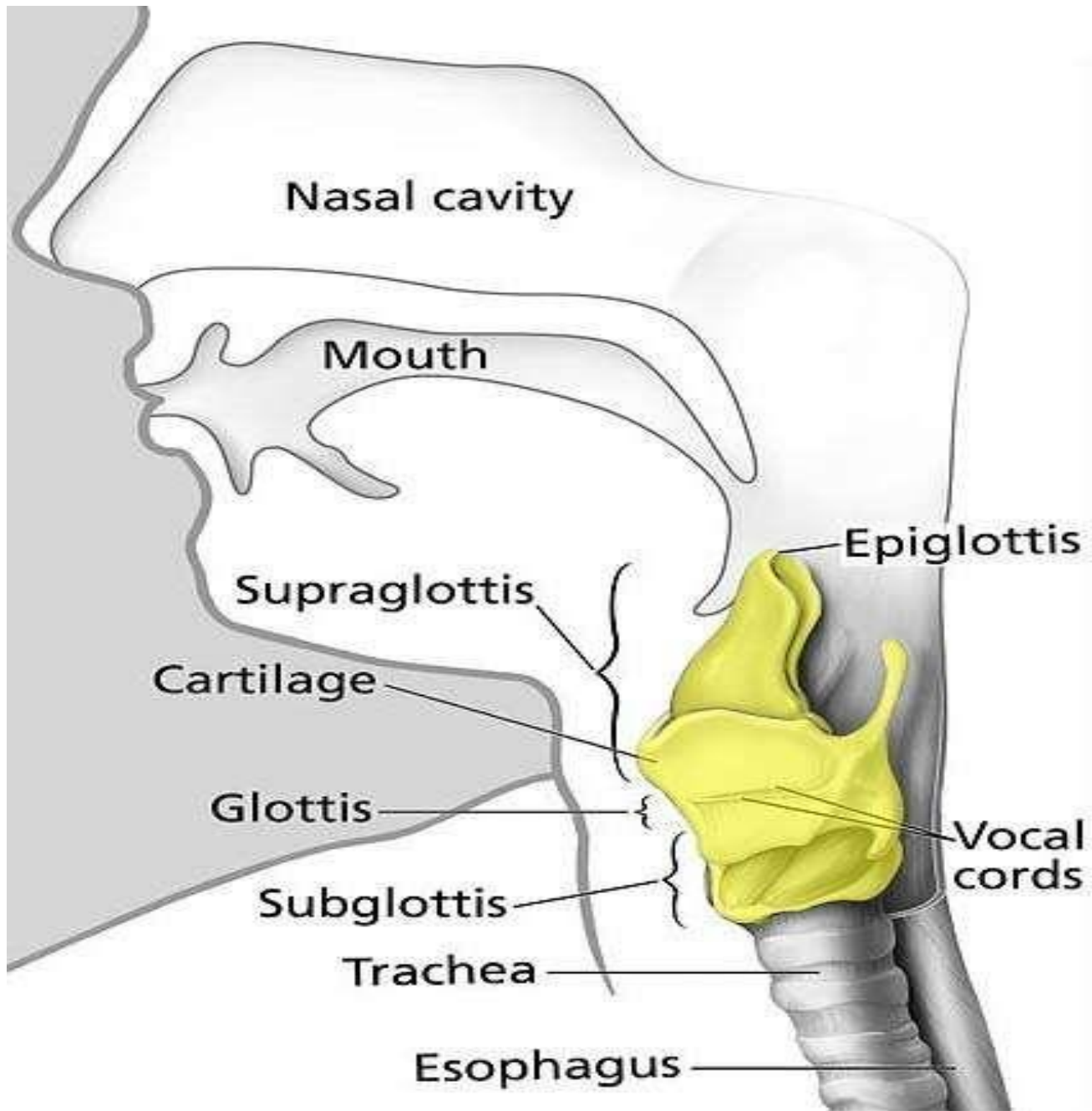
Functions

- 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

- 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.





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

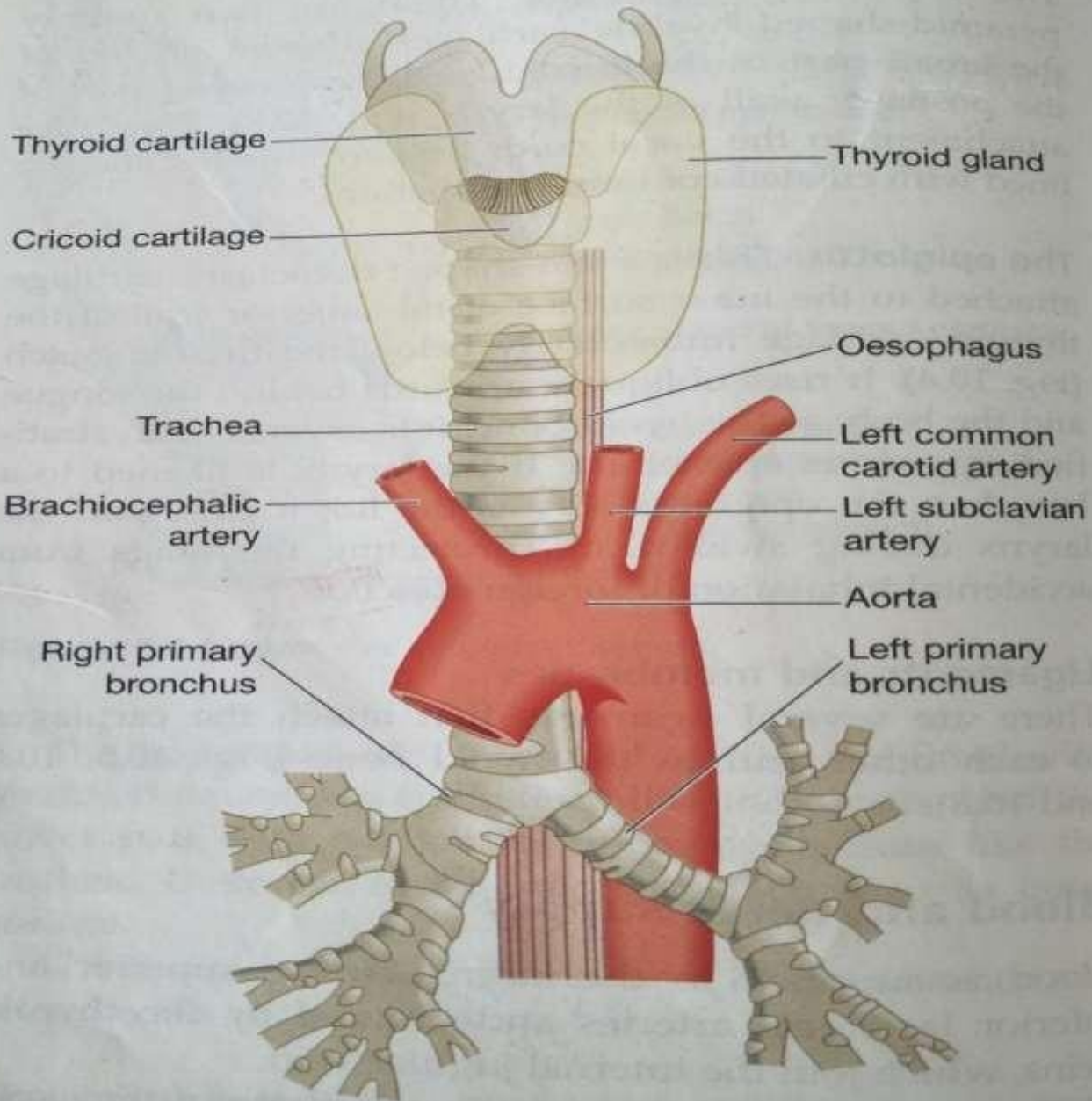
TRACHEA

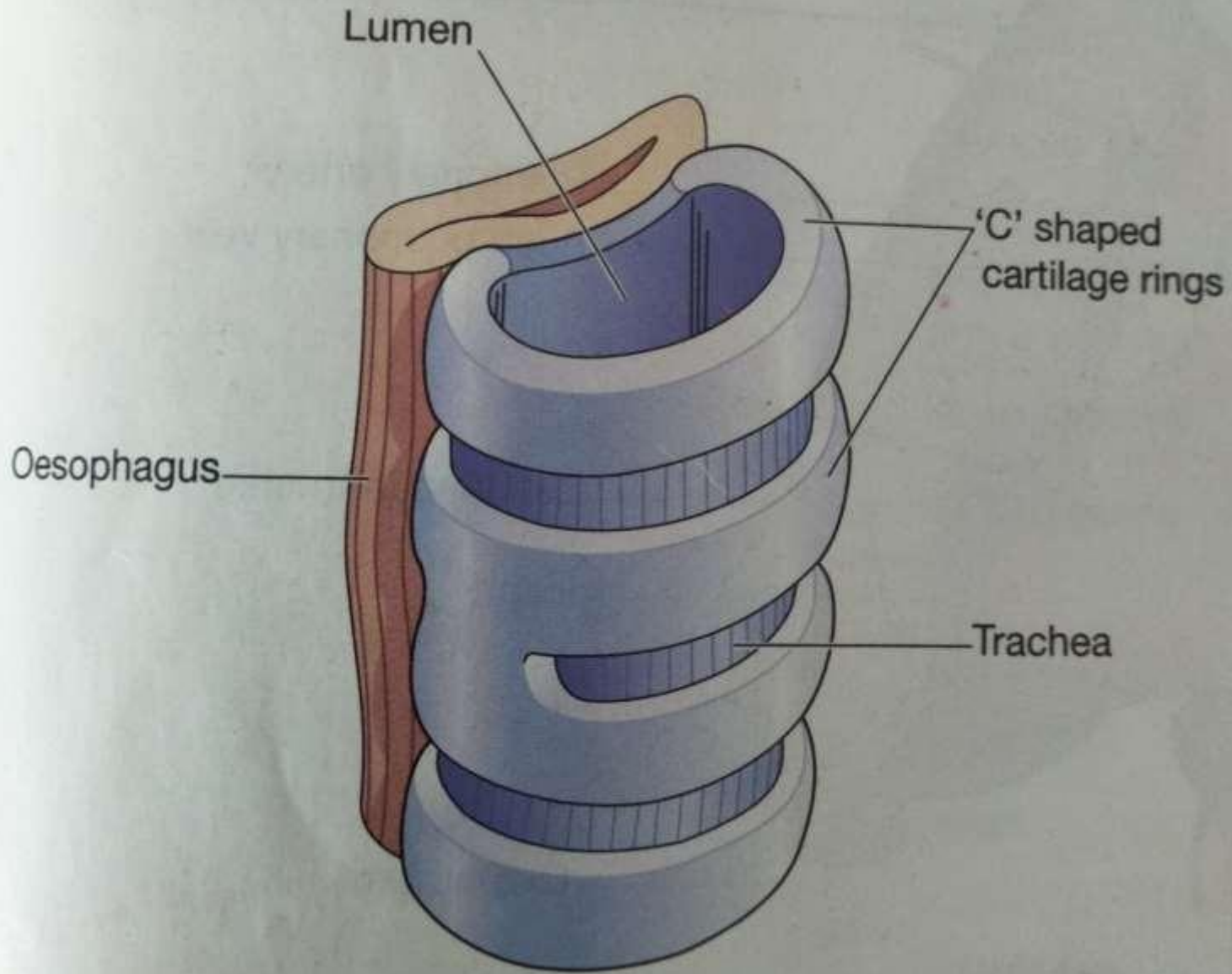
- The trachea or **windpipe** is a continuation of the larynx & extends downwards to about the level of **T-5** where it divides into right & left primary bronchi.
- **Length**-about 12 cm

STRUCTURE

Composed of 3 layers of tissue.

- fibrous & elastic tissue
- smooth muscle
- ciliated columnar epithelium
- 16-20 cartilage rings (C-shaped)





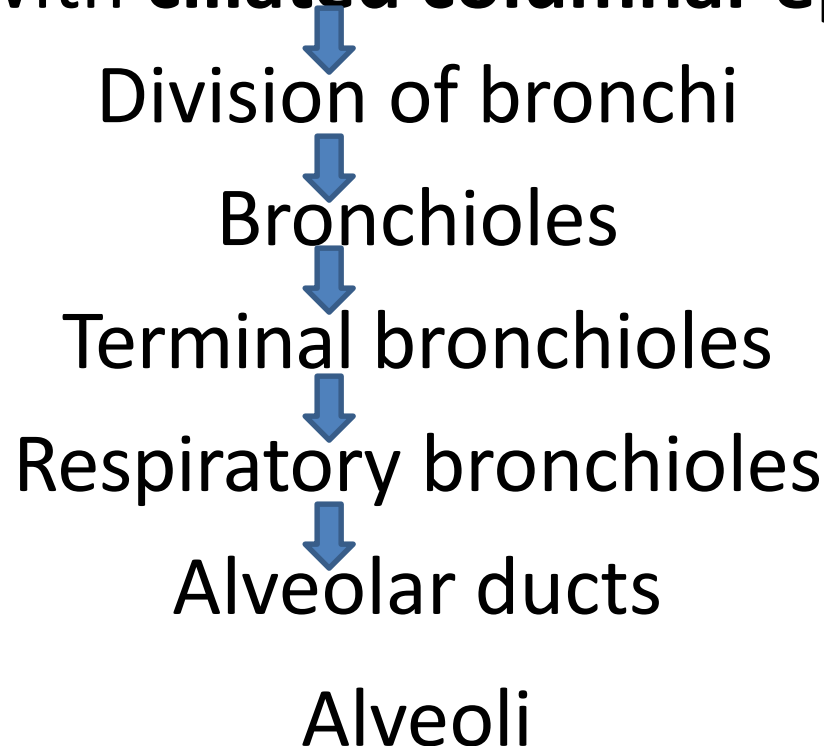
FUNCTIONS

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

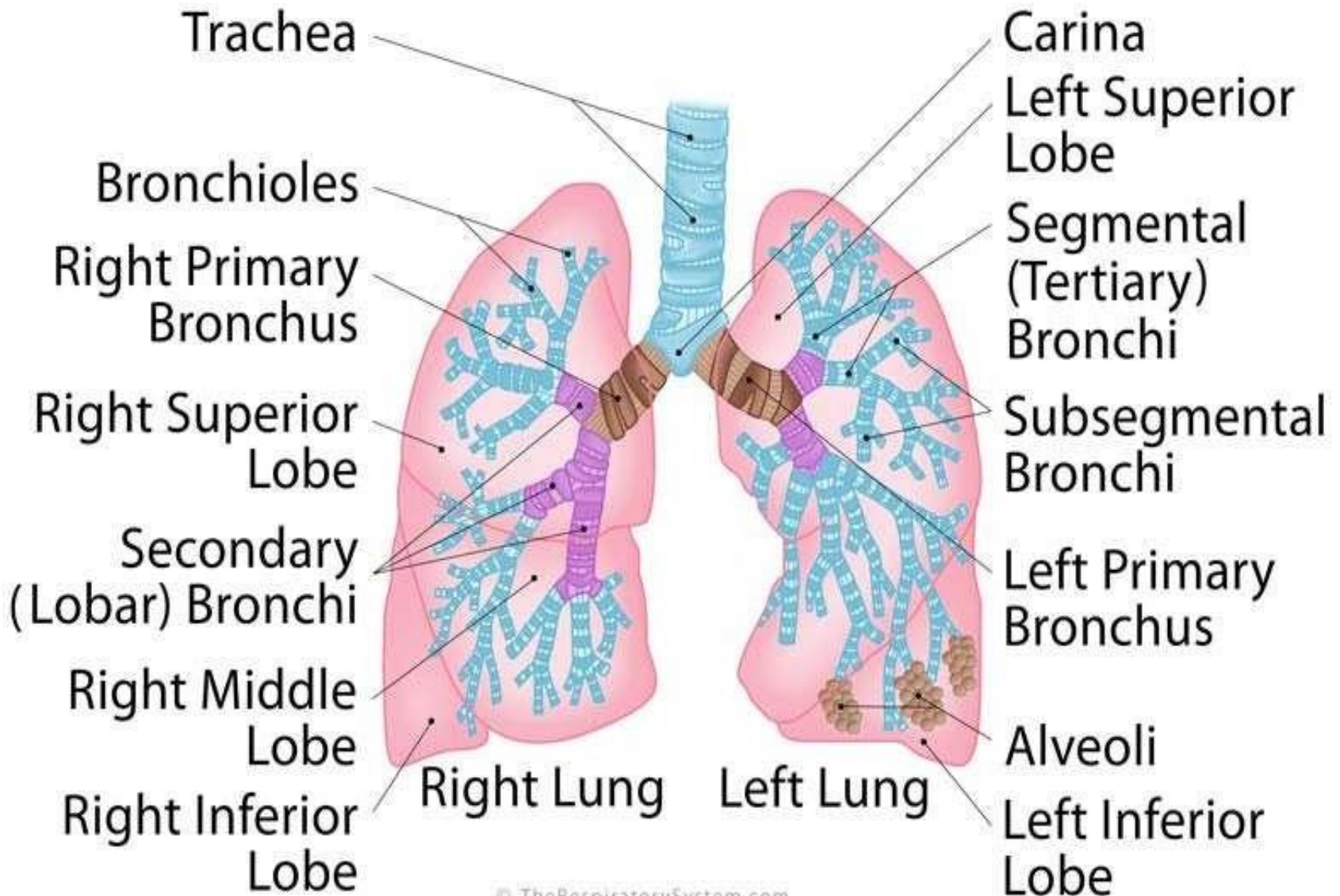
BRONCHI & BRONCHIOLES

STRUCTURE

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



Bronchi

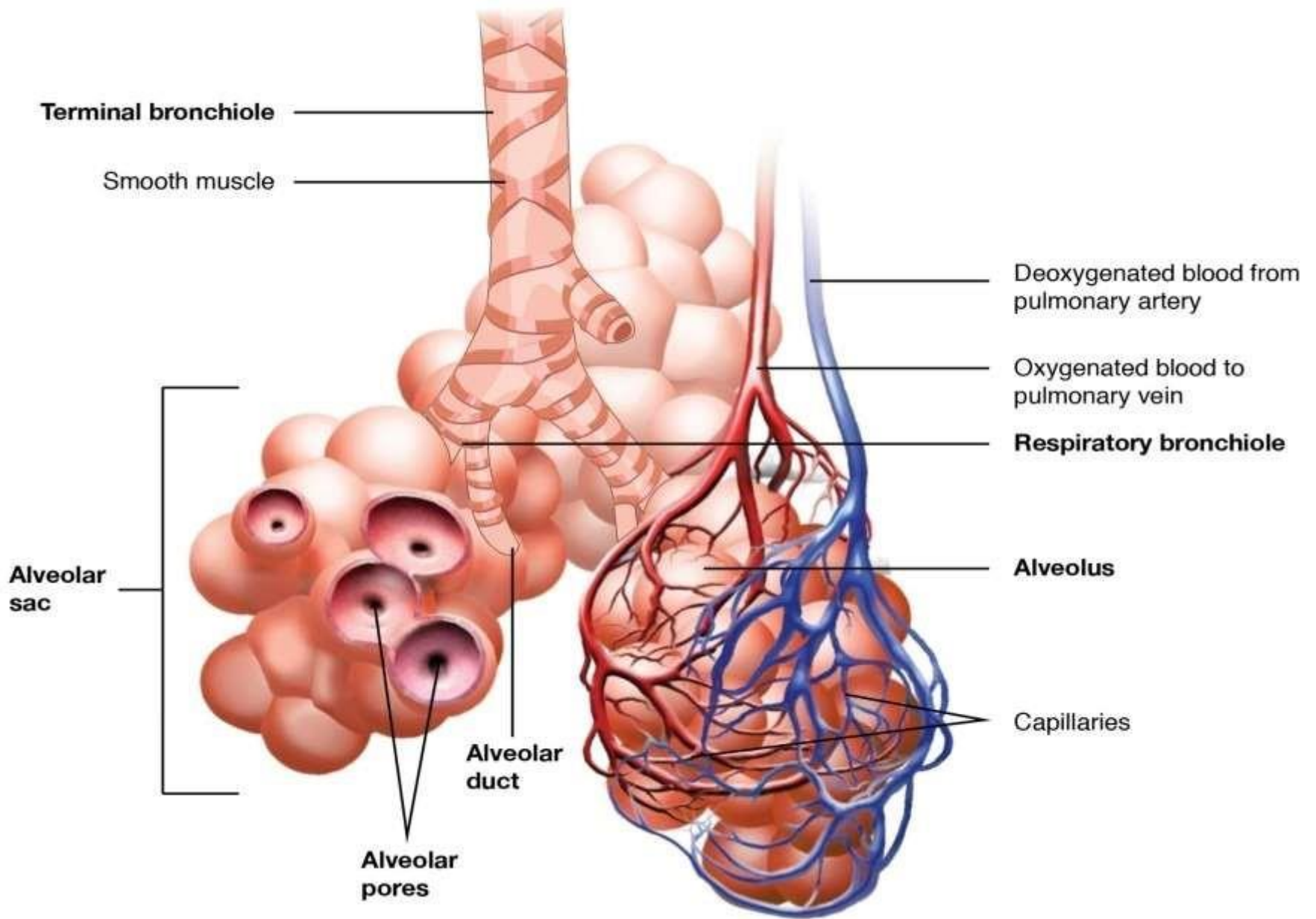


FUNCTIONS

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

- 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

- **ALVEOLI**
- Each lobule is supplied with air by a terminal bronchiole
- Bronchi 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



- **FUNCTIONS**
- **External respiration** :This is exchange of gases by diffusion between the alveoli and the blood.
- **Exchange of gases**

LUNGS

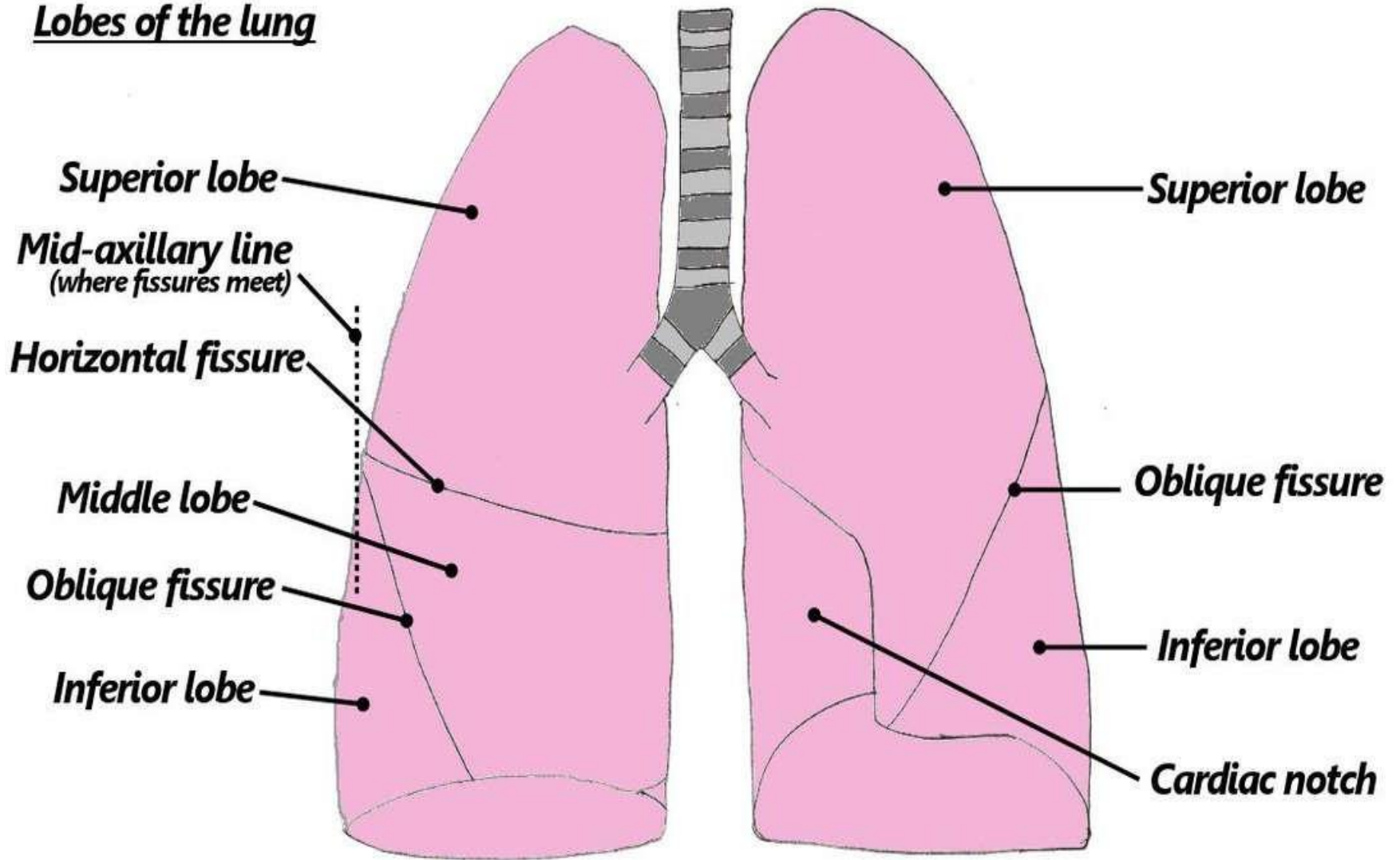
- There are **two lungs**, one lying on each side.
- **Shape**-cone
- **Weight**-600-700gms
- **Length**-20-24cm
- **Colour**-pinkish
- **Lobes**- **three** lobes in the **right** lung
two lobes in the **left** lung
- Lobes are **separate** by **the fissures**
- The area between the lungs is the **mediastinum**.

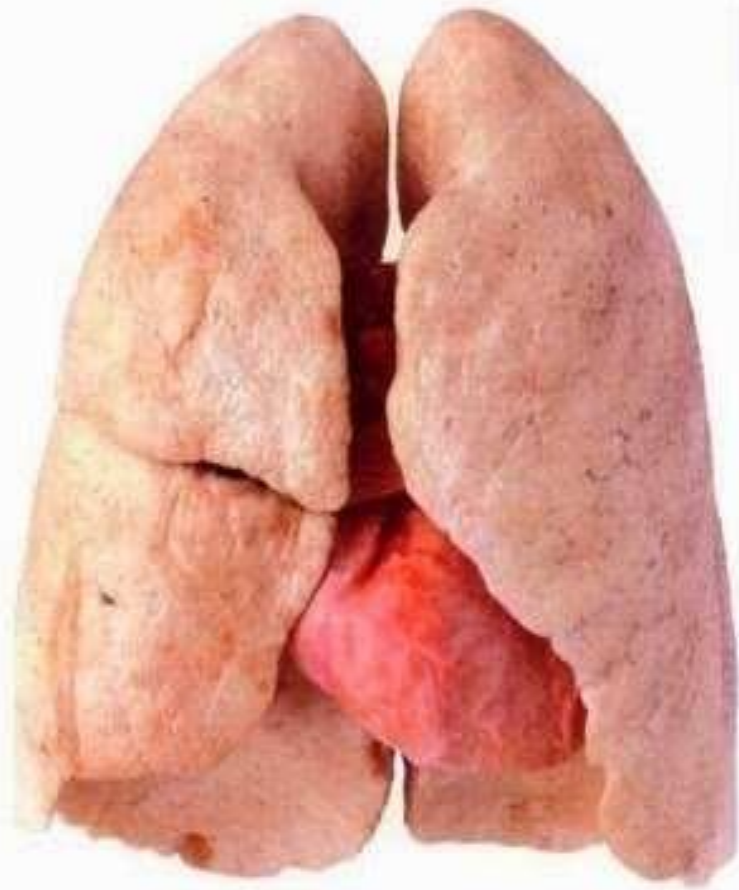


Right Lung

Left Lung

Lobes of the lung





**Non Smokers
Lungs**



**Rollup Cigarette
Smokers Lungs**

Pleura

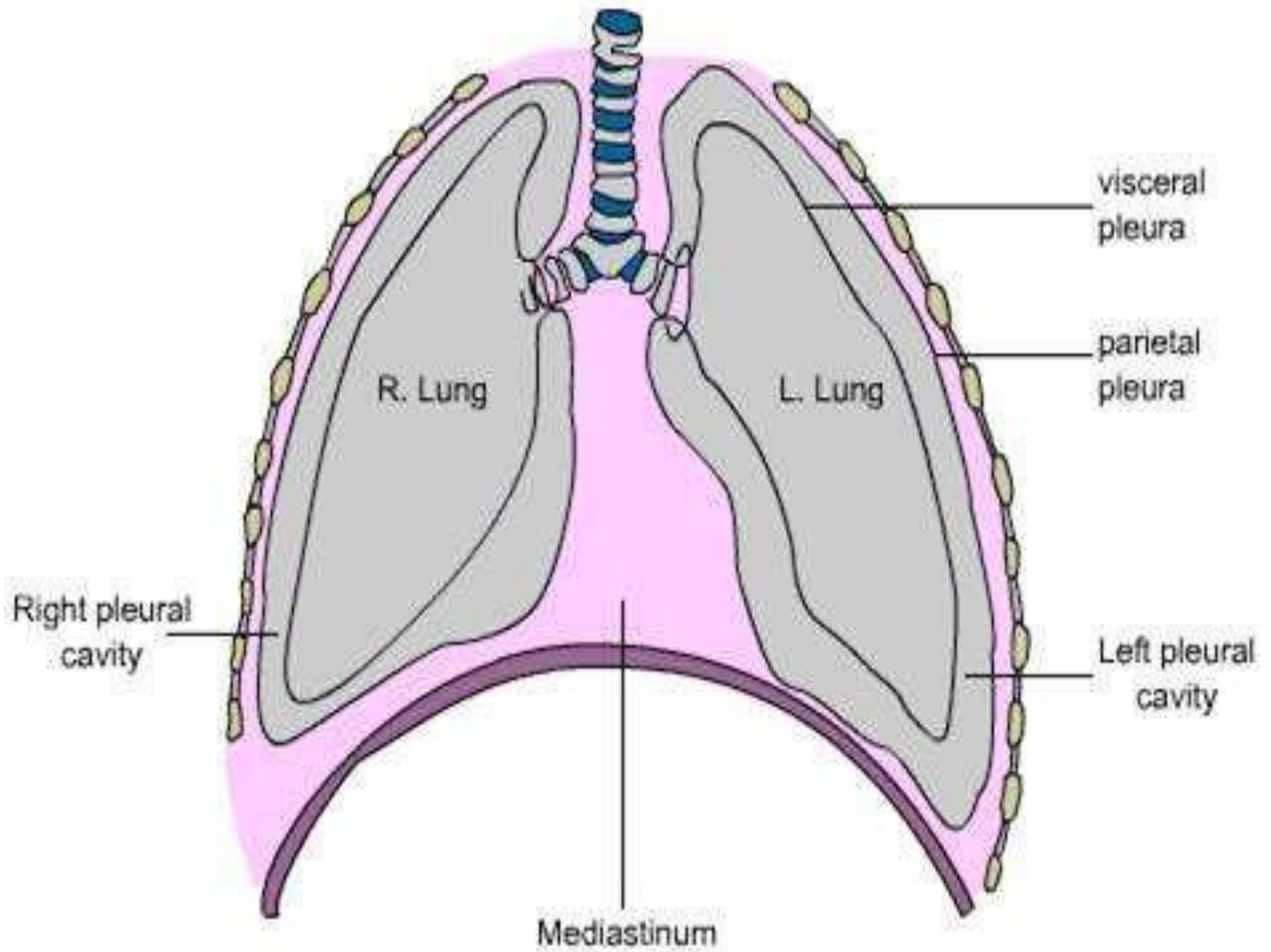
- The **pleura** consists of a closed **sac** of serous membrane, one for each lung which contains a small amount of **serous fluid**.
- It forms **two layers**:
 - (i) The **visceral** layer
 - (ii) The **parietal** layer
- (i) The **visceral** pleura

Visceral layer adherent to the lung, covering each lobe.

The parietal pleura : This is **adherent to** the inside of the chest wall

The pleural cavity

- The two layers of pleura are separated by a thin film of serous fluid.
- **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.
- **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**
- 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.
- 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

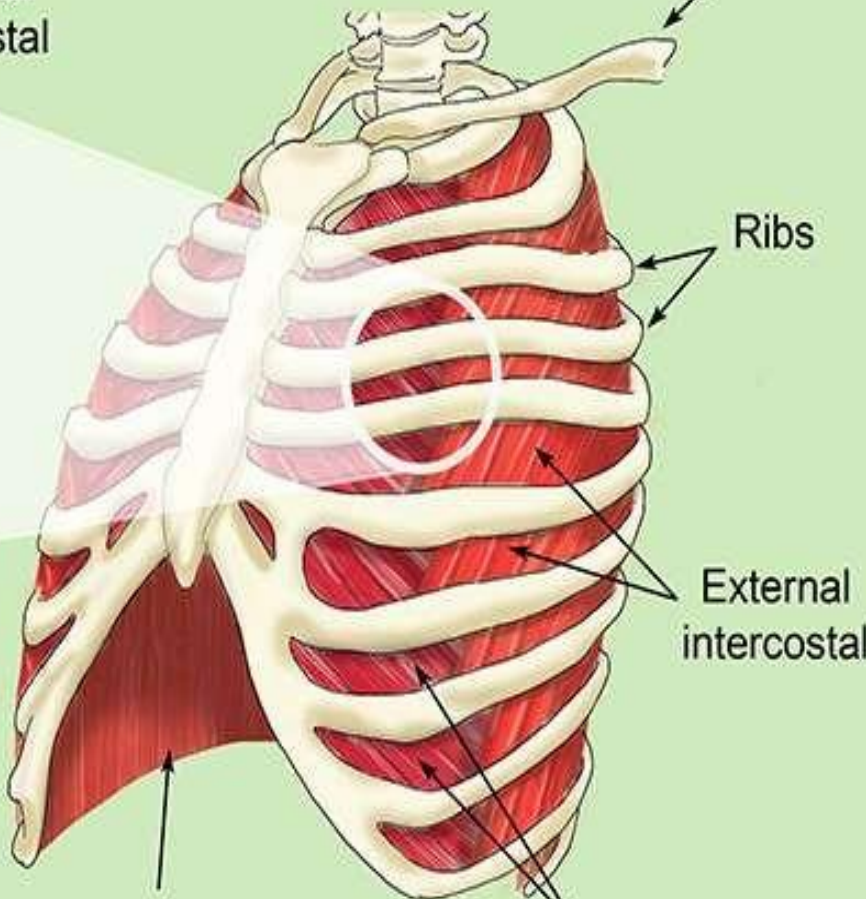
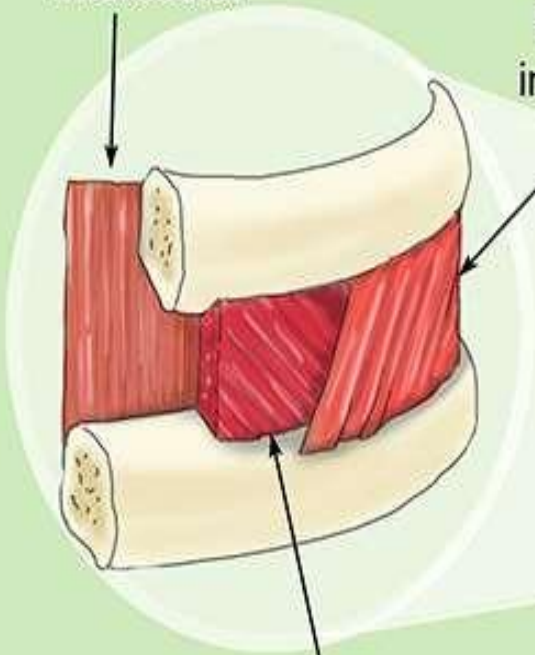
Ribs

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 diaphragm is pulled downwards ,enlarging the thoracic cavity in length.
- This decreases pressure in the thoracic cavity and increases it in the abdominal 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 **two phases:**
 - Inspiration
 - Expiration

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.

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.

Exchange 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.

LUNG VOLUMES AND CAPACITIES

Lung volumes

1. Tidal volume (TV)- this is the amount of air passing into and out of the lungs during each cycle of breathing.

Normal- **500ml**

2. Inspiratory reserve volume (IRV) : the extra volume of air a person inspire forcefully after a normal quite breath

Normal- **3000ml**

Lung volume

3. Expiratory reserve volume(ERV): The extra volume of air that a person can expire after a normal tidal volume

Normal- 1100ml

4.Residual volume (RV): the volume of air remain in the lung after more forcefull expiration

Normal:1200ml

Lung capacities : consists of two or more volume

1. Inspiratory capacity (TV+IRV): maximum volume air a person can inspire forcefully
Normal- $500\text{ml} + 3000\text{ml} = 3500\text{ ml}$
2. Functional residual capacity (ERV+RV) volume of air remaining in the lung after a normal passive expiration
Normal- $1100\text{ml} + 1200\text{ ml} = 2300\text{ml}$

3. Vital capacity : maximum amount of air a person can expire from lungs after a maximum inspiration.

Normal- $(TV+IRV+ERV)$ $500\text{ml} + 3000\text{ml} + 1100\text{ml} = 4600\text{ml}$

4. Total lung capacity : total amount of air after forceful inspiration.

Normal- $(TV+IRV+ERV+RV)$

$500\text{ml} + 3000\text{ml} + 1100\text{ml} + 1200\text{ml} = 5800\text{ ml}$

- **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 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 gas exchange.
- O₂ diffuses from the bloodstream through the capillary wall into the tissues.
- CO₂ diffuses from the cells into the extracellular fluid, then into the bloodstream towards the venous end of capillary.