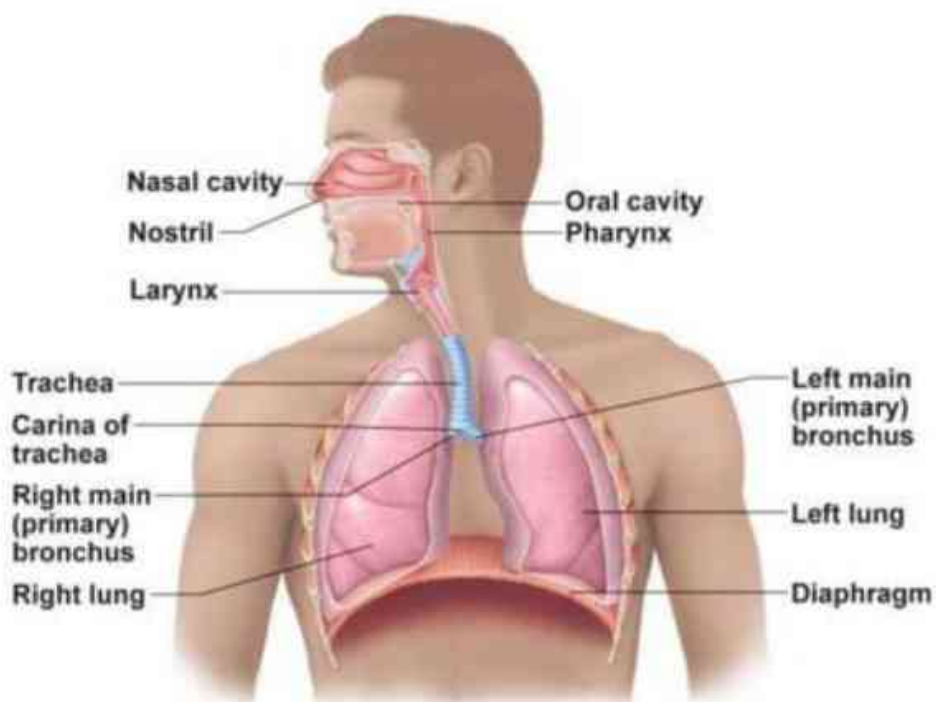


# Respiratory System

**Function:** supply  $O_2$  to the blood and remove  $CO_2$



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## THE HUMAN RESPIRATORY SYSTEM

- Respiratory system forms the path through which the air passes from the nose to the lungs
- Exchange of gases during internal and external respiration is the major function of respiratory system
- The system also filters, warms and humidifies the inhaled air
- The system includes vocal cord – produces sound
- Lungs controls body PH level
- Olfactory bulb helps in smelling

- The human cells need continuous supply of oxygen for its proper functioning
- Also it eliminates CO<sub>2</sub> (carbon dioxide) as metabolic waste product
- The exchange of gas between the atmosphere and human body takes place during the respiration

ANATOMY of *“Respiratory Tract”*  
can be divided into two groups  
**“STRUCTURALLY”**

**The Upper Respiratory Tract**

- \* Nose
- \* Nasal cavity
- \* Sinuses
- \* Pharynx

**The Lower Respiratory Tract**

- \* Larynx
- \* Trachea
- \* Bronchial Tree
- \* Lungs

The organs of the *“Respiratory Tract”*  
can be divided into two groups  
**“FUNCTIONALLY”**

### **The Conducting Portion**

- system of interconnecting  
cavities and tubes that  
conduct air into the lungs

- \* Nose
- \* Pharynx
- \* Larynx
- \* Trachea
- \* Bronchi

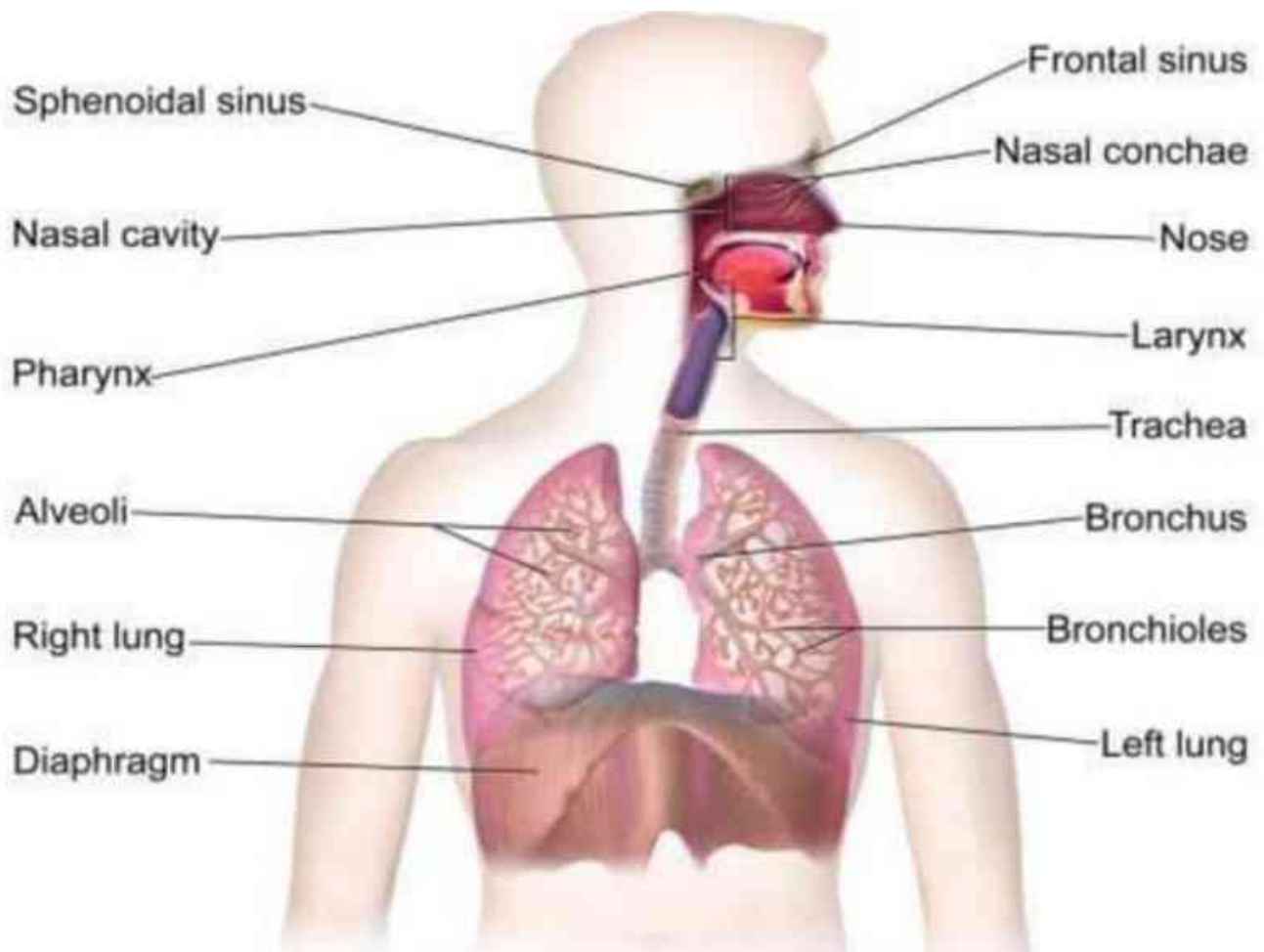
### **The Respiratory Portion**

- system where the exchange of  
respiratory gases occurs

- \* Bronchioles
- \* Alveolar Ducts
- \* Alveoli

# Anatomy

- ⊙ Nose/mouth: filtered, warmed, humidified
  - **Mucus** Traps bacteria & foreign debris
  - **Cilia** sweep mucus toward throat → digested by stomach
- ⊙ Pharynx: throat (passage for food/air)
  - **Tonsils**: clusters of lymphatic tissue
- ⊙ Larynx: contains vocal cords
  - **Epiglottis**: covers larynx when liquids/food swallowed
- ⊙ Trachea: windpipe; lined with cartilage (C-shaped)
- ⊙ Bronchi: branches to lungs
- ⊙ Bronchioles: smaller branches
- ⊙ **Lungs** → Alveoli: air sacs for gas exchange



**The Respiratory System**



## THE NOSE

- The nose is positioned between forehead and upper lip
- It is the **first organ of respiratory tract**
- It provides an **entrance for inhaled air**
- The nose performs the process of **warming, moistening and filtering of inhaled air**
- It has 2 portions :
  - The external nose (The nose)
  - The internal nose (nasal cavities)



- Nose is a **bony and cartilaginous structure**

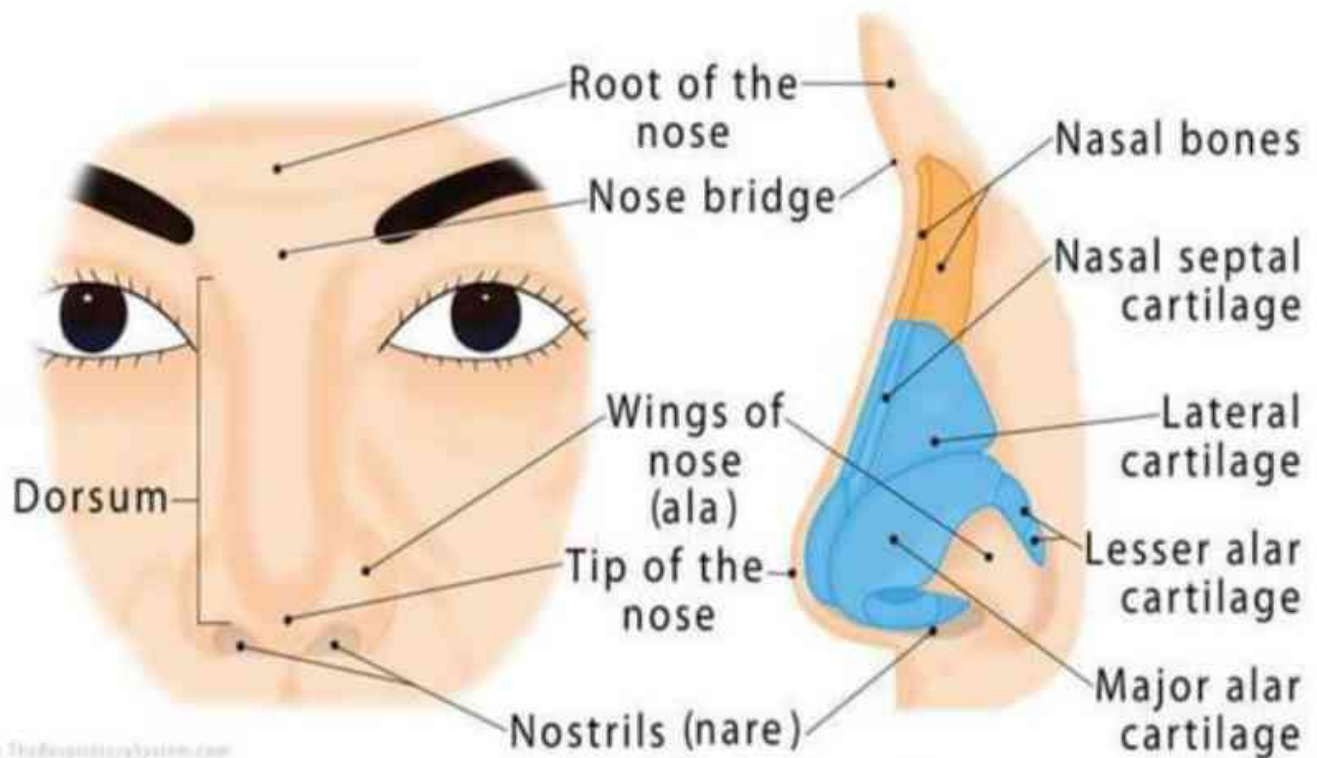
#### **Bony part:**

- It is made up of the frontal, nasal & Maxillae bones
- The cartilage part is made up of
  - septal cartilage,
  - lateral cartilages &
  - alar cartilages
- The internal portion is a large cavity in the skull, merging with the external nose anteriorly and communicating with the throat posteriorly.

#### **LINING OF THE NOSE:**

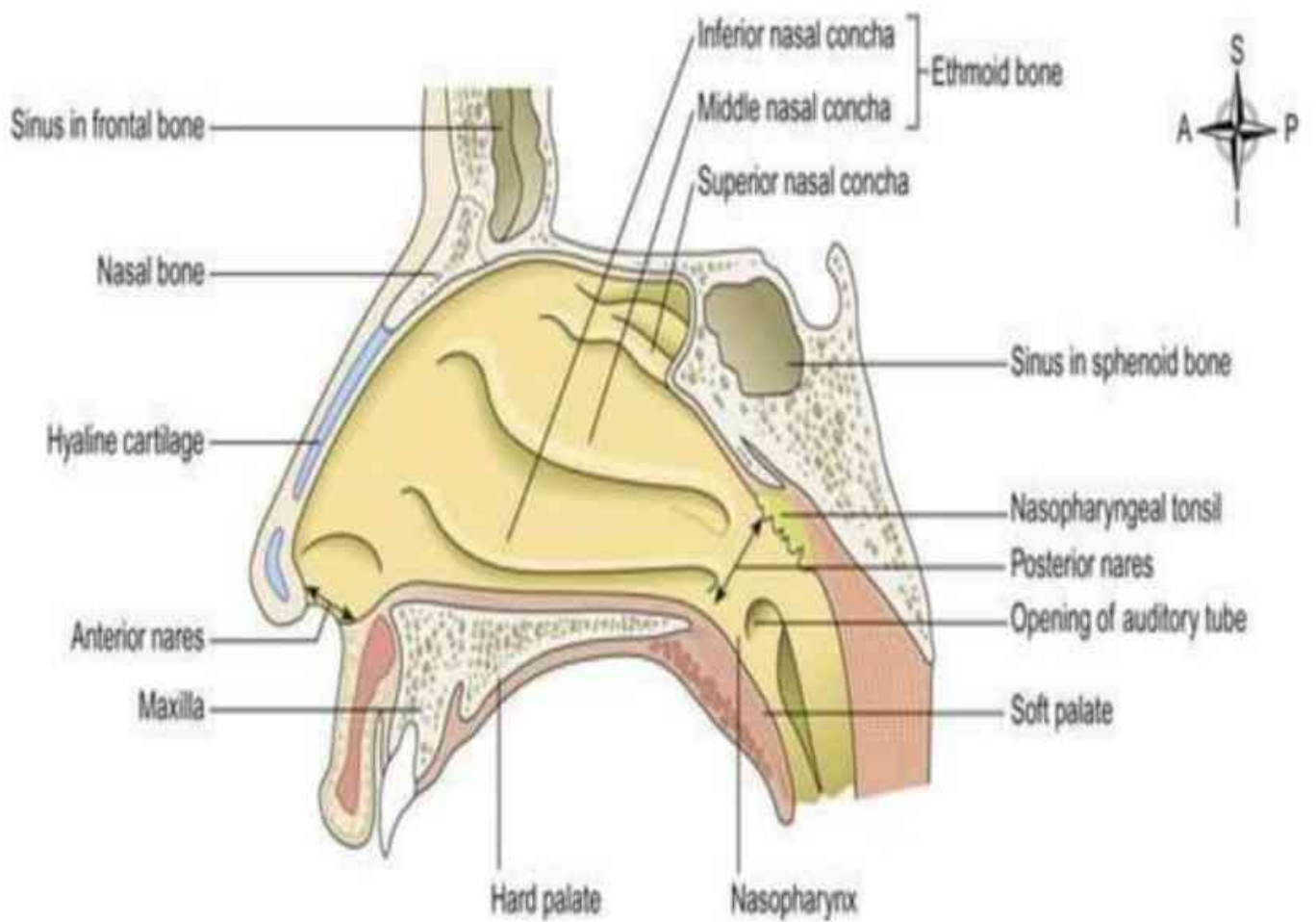
- The nose is lined with highly vascular ciliated columnar epithelium
- Contains mucus secreting goblet cells

# External Nose



## The Nasal Cavity

- At the base of the nose two openings separated by **nasal septum** – septum cartilage is present
- The openings are called as **nostrils** (anterior nares) through which the air enters to reach the nasal cavity
- The **anterior nares** are the openings of the nasal cavity – contains **small hairs** in it
- The posterior nares are the nasal cavity openings **in to the pharynx**



## Paranasal Sinuses

- Sinuses are air-filled spaces
- They present within the maxillary, frontal, ethmoid and sphenoid bones of the skull.
- These spaces open to the nasal cavity
- The space is lined with mucus membrane
- The sinuses reduce the weight of the skull

## Functions of Nasal cavity

### Respiration:

- Helps in the passage of air across the nasal cavity

### Air conditioning:

- Air with -5 degree C – 55degree C is converted in to 31-37 degree C at the nasopharynx
- Turbinate make the inhaled air water saturated so that the lungs receive 100% humid air
- Inhaled air is filtered, warmed, humidified n the nasal cavity



## Defense

- Mucociliary system hold back all the microorganism and foreign particles
- Antibodies and enzymes present in the mucus are active against bacteria
- The irritants are expelled from nose forcefully while sneezing
- Olfactory system recognize environment and food

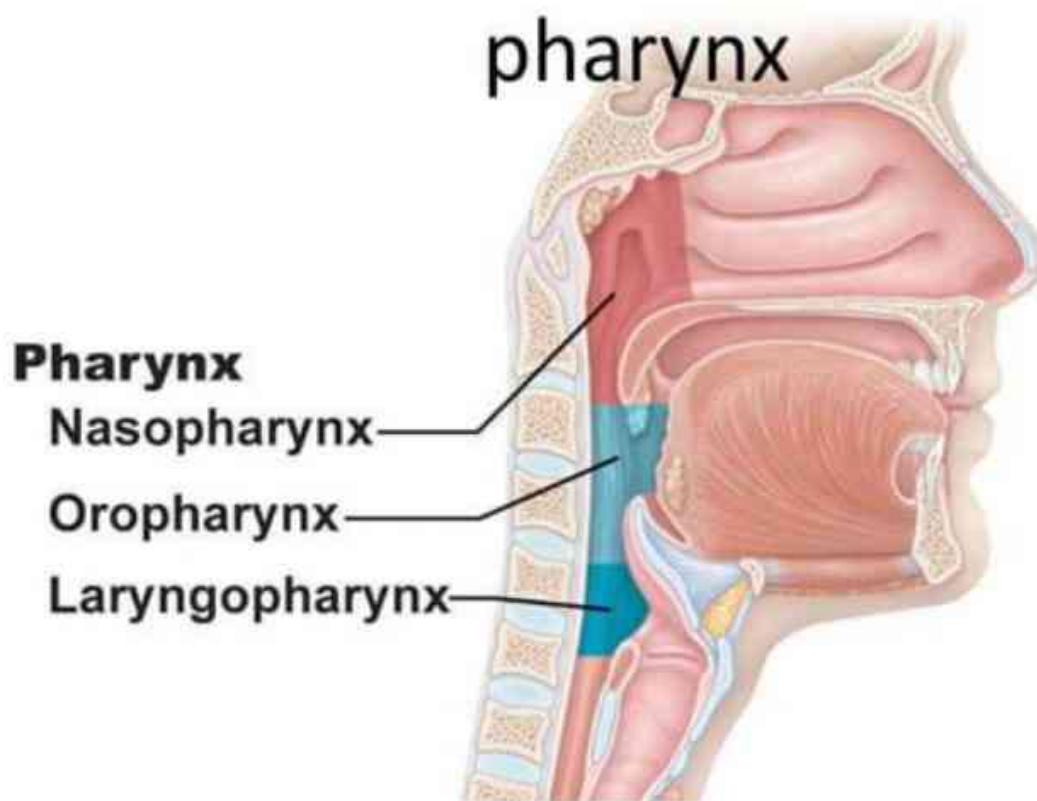
## Speech:

- Vocal cord help in the generation of voice



## THE PHARYNX

- The “throat” is a **funnel shaped tube** that lies posterior to the nasal cavity, oral cavity and larynx and anteriorly to the cervical vertebra.
- It is composed of:
  - Nasopharynx – uppermost portion
  - Oropharynx – middle portion
  - Laryngopharynx – lowermost portion
- It is a common passageway for air and food and it provides a **resonating chamber for speech sounds**



**(b) Regions of the pharynx**

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## The Epiglottis

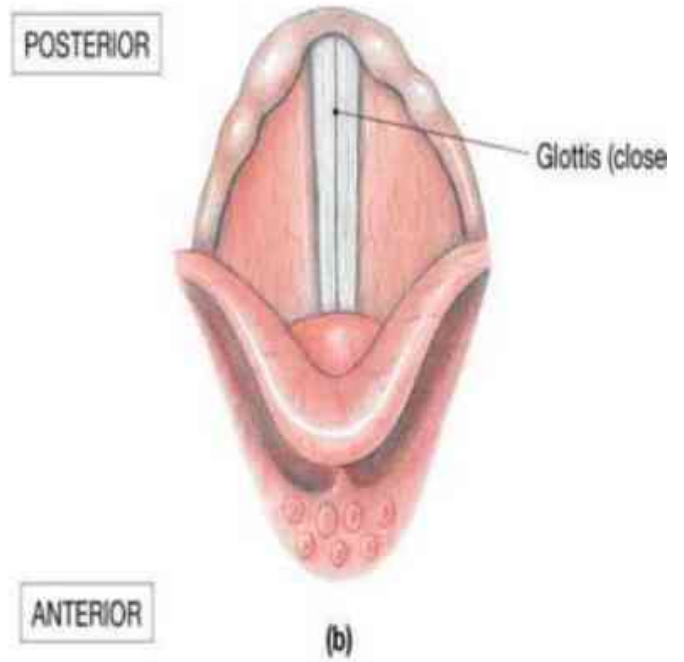
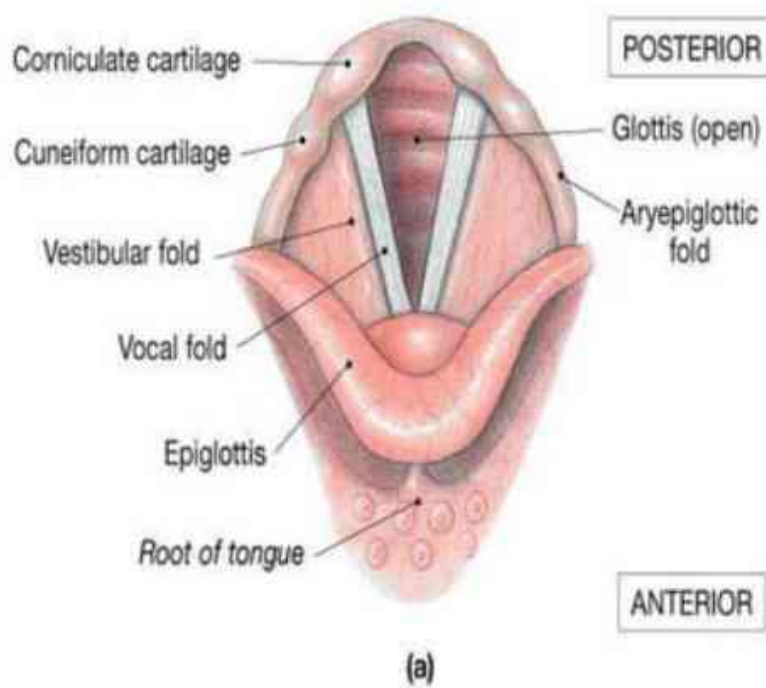
- It is a large leaf-shaped piece of cartilage.
- Found in the entrance of larynx
- Epiglottis close the tracheal opening during the swallowing of food
- that prevents food from entering the trachea (or windpipe).
- During swallowing, there is elevation of the larynx

## **Functions of Pharynx**

- **Passage way for food & air**
- **Taste**
- **Warming and humidifying**
- **Hearing**
- **Protection**
- **Speech**

## **THE LARYNX**

- It is the triangular chamber in the front upper part of the neck
  - A prominent elevation present just in front of the larynx – **adam's apple**
  - It joints pharynx with trachea
  - It is made up of cartilages – 3 single, 3 paired
- Single cartilages:
- Thyroid cartilage, cricoid cartilage, epiglottis
- Paired cartilages:
- Arytenoids, corniculates, cuneiforms



## The Vocal Cords

- Inside the larynx, 2 pairs of folds of muscle and connective tissues covered with mucous membrane make up the **vocal cords**.
- **Changing tension on the vocal cords controls pitch**, while increasing the loudness depends upon increasing the force of air vibrating the vocal cords.
- When vocal card is opened – **abducted**
- When vocal card is closed - **adducted**



# The Vocal Cords

## The larynx contains

- Vestibule – false vocal cord
- Ventricle
- Infraglottic cavity – from the vocal cords to the tracheal cavity

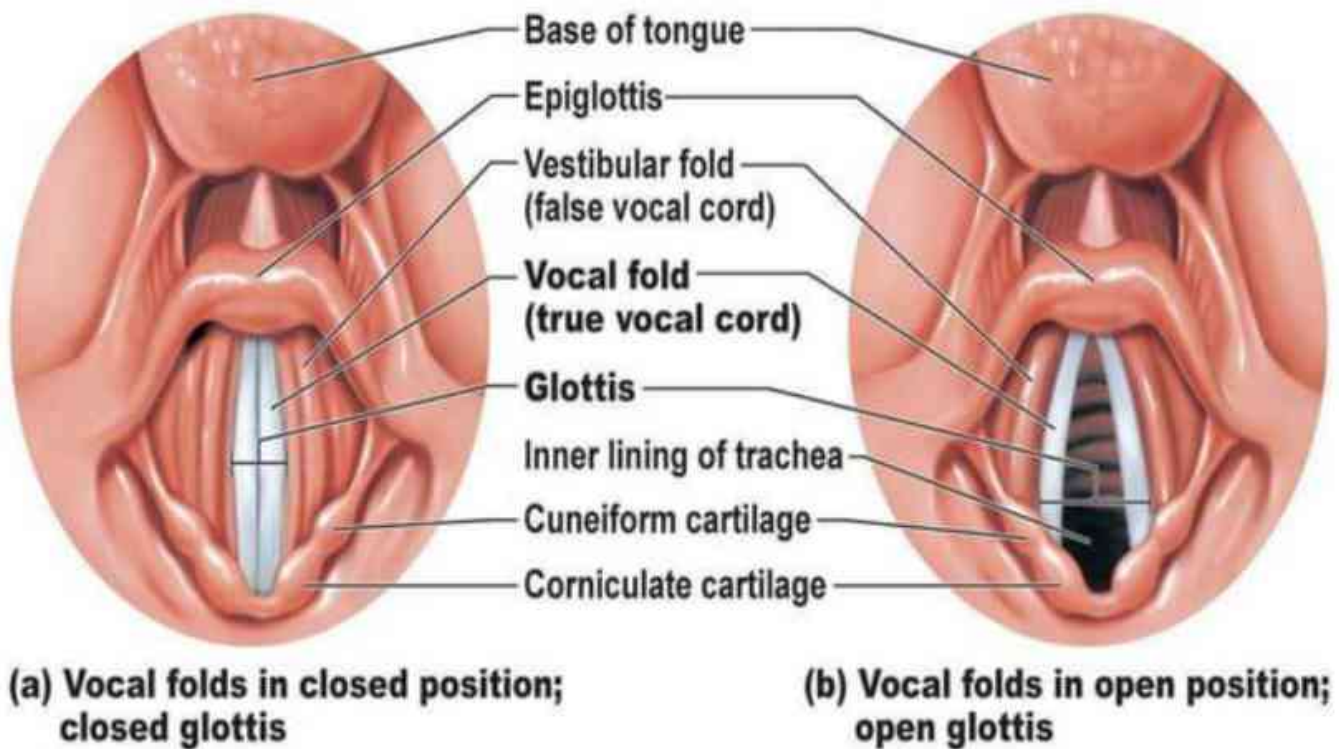
## During normal breathing,

The vocal cords are relaxed and the glottis is a triangular slit.

## During swallowing,

The False vocal cords and epiglottis close off the glottis.

# Vocal cords

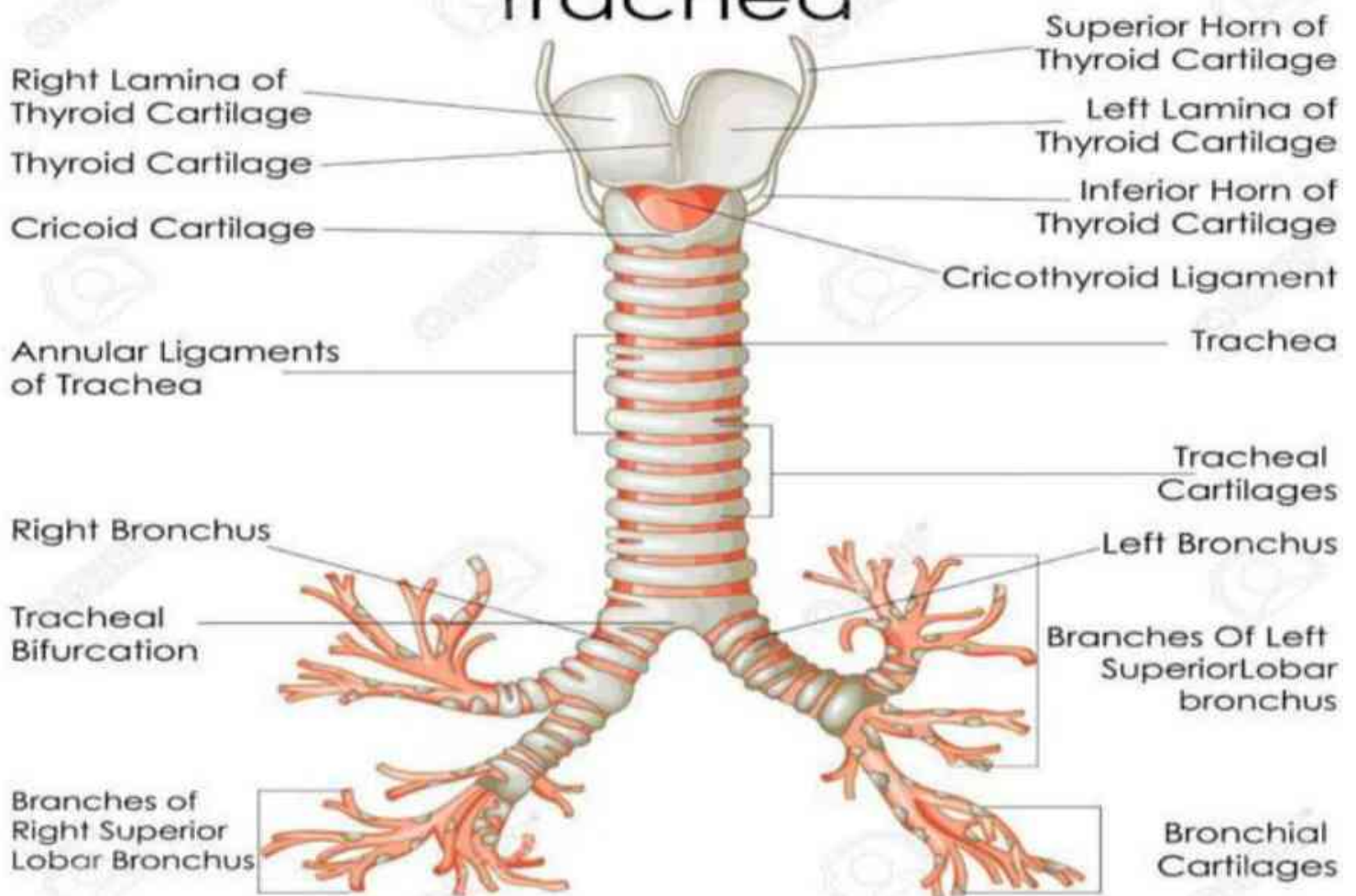


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## THE TRACHEA

- Trachea is a **wind pipe**
- It is measured around **10-11 cm**
- It extends downwards up to **5 th thoracic vertebra**
- At the end its divide in to **right and left bronchi**
- Which enters in to their respective lungs
- It is composed of **16-20 c shaped rings of hyaline cartilage**
- Connective tissues and involuntary muscles joins the cartilage and forms the posterior wall
- The trachea cartilages covered by **3 tissue layers**
- Outer layer, middle layer, inner layer
- It helps in the cough reflex

# Trachea



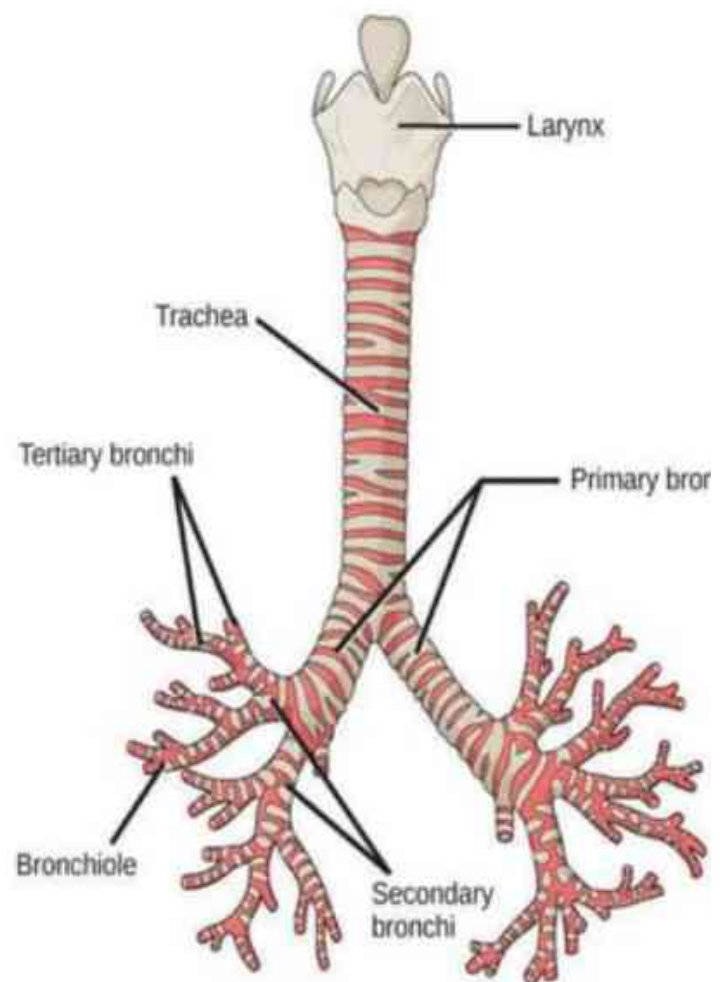
## **Bronchi**

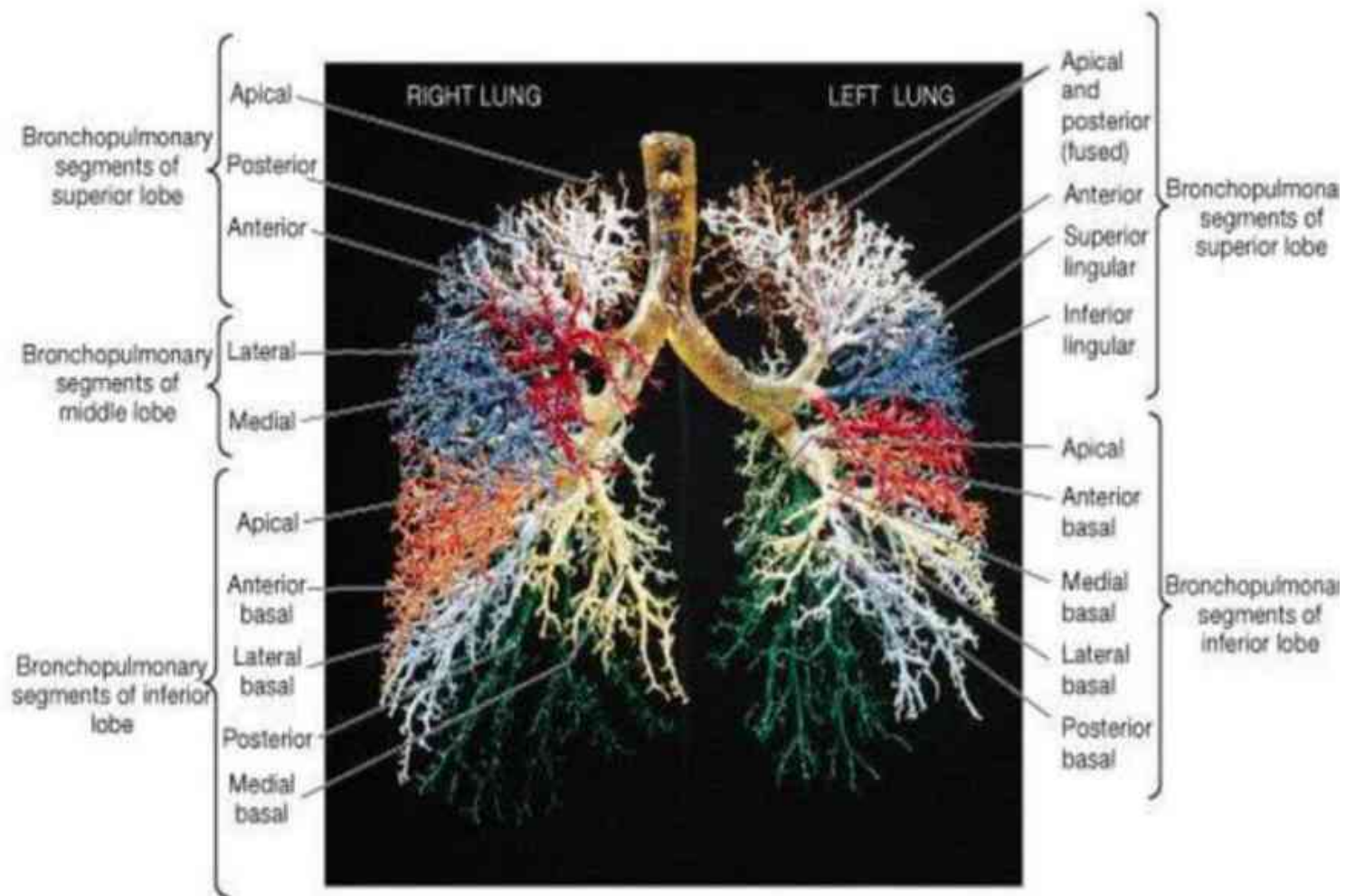
- It is the air way passage in to the respiratory tract
- They carry inhaled air in to lungs
- They are two types right bronchi and left bronchi
- The primary bronchi split in to three secondary bronchi
- They enter in to superior, middle & inferior lobes of the right lung
- Secondary bronchi further divide in to tertiary bronchi
- The tertiary bronchi then divide in to more smaller branches



## Bronchioles

- Bronchioles are the finest branches of bronchi
- Bronchiole converted in to terminal bronchioles
- Which further subdivided in to two or more respiratory bronchioles
- They terminate at alveolar sacs





(d) The bronchial tree



## ➤ LUNGS

- Lungs present in the thoracic cavity as two cone shaped lobes separated by heart and other structures
- Present from clavicle to diaphragm
- The paired soft, spongy, cone-shaped lungs, separated medially by the mediastinum and are enclosed by the diaphragm and thoracic cage.
- 2 layers of serous membrane, collectively known as **pleural membrane**, enclose and protect each lung.

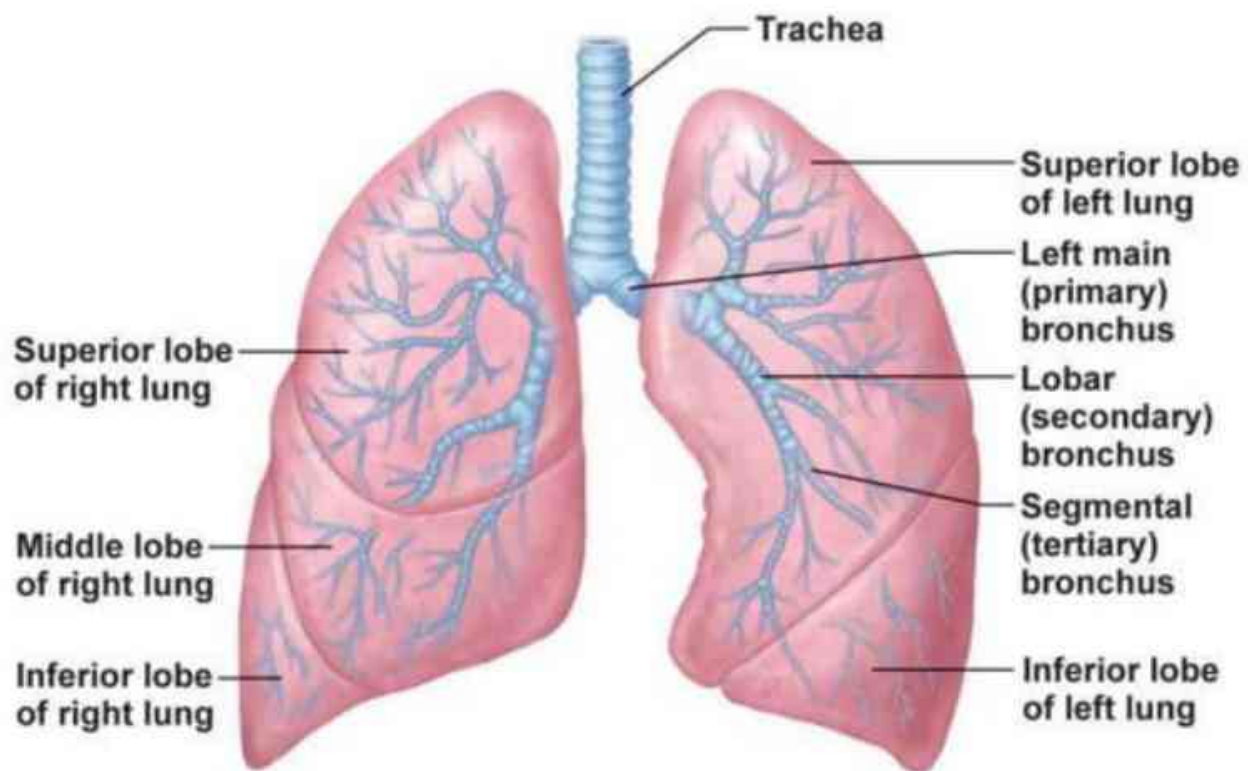
### *Parietal Pleura*

- outer layer attached to the thoracic cavity

### *Visceral Pleura*

- inner layer covering the lung itself
- Left lung is smaller than the right lung due to the space occupied by the heart in the thoracic cavity

# Lungs



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➤ The various parts of lungs are

➤ Apex, base, costal surface, medial surface

**APEX:**

➤ Lung has round apex

➤ Which extends up to the root of the neck

**BASE:**

➤ It has concave and semilunar base

➤ Which associated with the thoracic surface of diaphragm

**COSTAL SURFACE:**

➤ It has convex costal surface

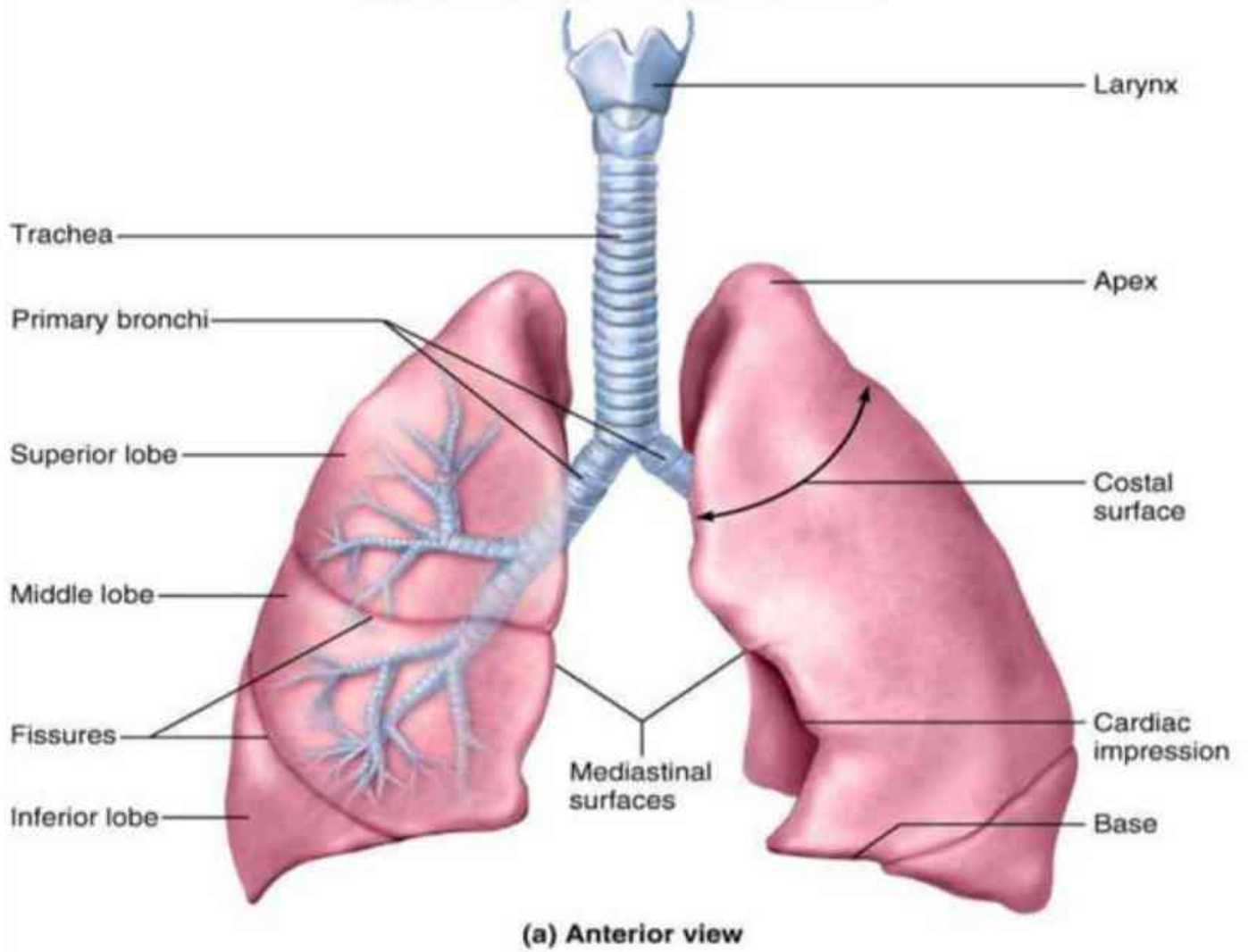
➤ Which is associated with the costal cartilages, ribs & intercostal muscles

**MEDIAL SURFACE:**

➤ It has concave medial surface

➤ Triangular shaped hilum present 5-7<sup>th</sup> thoracic vertebra

➤ All artery veins nerve supply pass through this surface



## **MEDIASTENUM:**

- It is an area between the lungs and is occupied by the heart, great vessels, trachea, right and left bronchi, oesophagus, lymph nodes, lymph vessels and nerves.

## **PLEURA & PLEURAL CAVITY:**

- Each lung is enclosed with in a pleural membrane – which is made up of double layered serous membrane
- **Parietal pleura** – outer layer lines thoracic cavity wall
- **Visceral pluera** – deep layer – lines the lungs
- **Pleural cavity:** it is the space between the two layers and contains **pleural fluid**
- pleural fluid lubricating fluid secreted by the membranes – prevents the friction between the layers

## **LOBES/FISSURES & LOBULES**

- Each lung is separated in lobes
- Left lung: divided in to two lobes
- Right lung: divided in to three lobes
- The lobes are further divided in to numerous lobules – contains alveoli.

## **FUNCTIONS:**

- Respiration
- Alter the blood pH filter out small blood clots formed in the vein
- Alter the concentration of drugs
- Convert angiotensin-I to angiotensin II
- Provides protection by Ig-A



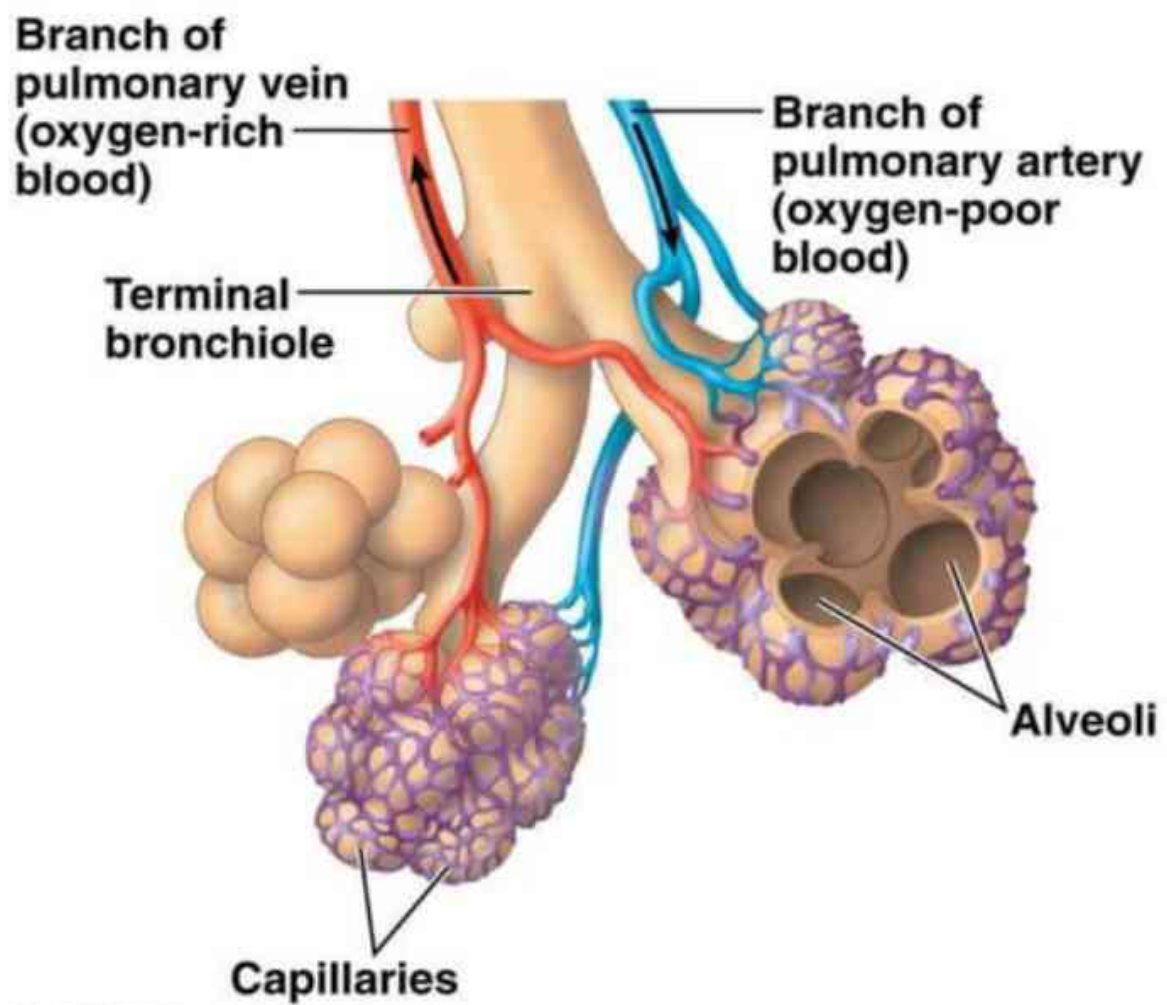
## **ALVEOLI**

- Hollow cavity found in the mammalian lungs
- Pulmonary alveoli is a spherical projections of the respiratory bronchioles
- The alveolar membranes are the major sites where exchange of gases occurs with the blood
- A human lung has around 300 million alveoli
- The alveoli are made up of an epithelial layer
- 70% of each alveoli is occupied with blood capillaries

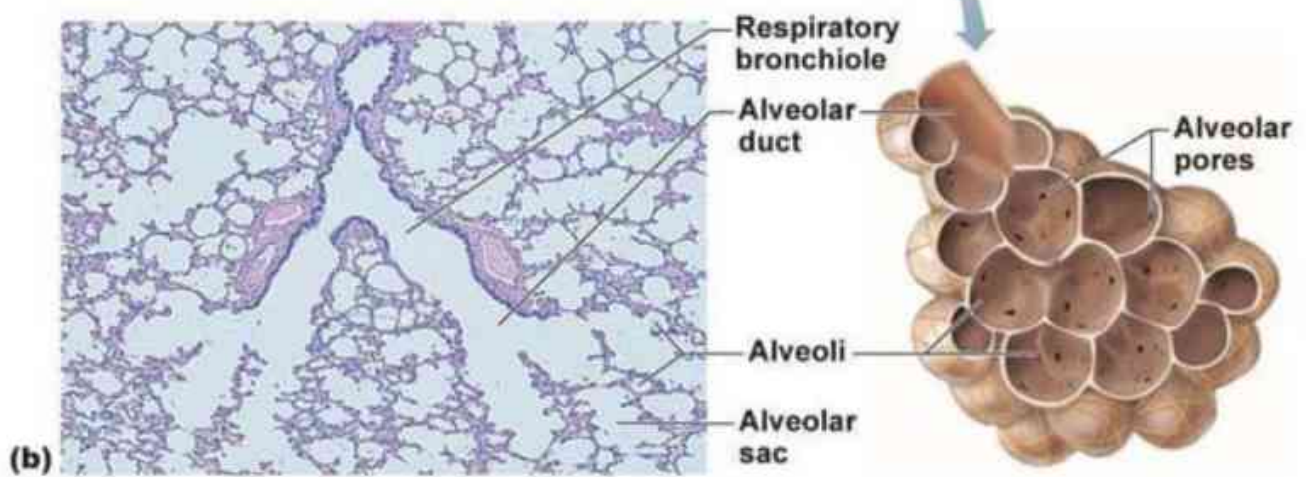
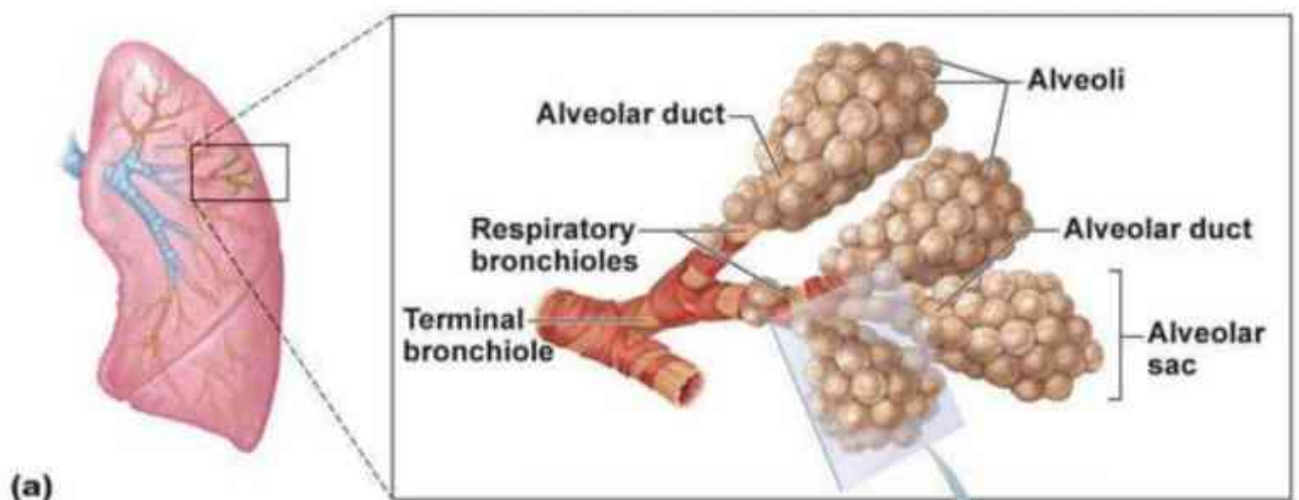
## **FUNCTIONS:**

- External respiration – gas exchange occurs between alveoli & blood by diffusion
- Protection against microbes





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## **MECHANISM OF RESPIRATION:**

- The process by which the respiration organs allow the air to move in and out of the lungs – Breathing
- Oxygen rich air is taken in from the atmosphere and in exchange carbon dioxide rich air is given out to the atmosphere
- The entire process of breathing is made up of two processes

INHALATION/ INSPIRATION: air flowing into lungs

EXHALATION/ EXPIRATION: air leaving lungs

- A Single breath comprises of one inhalation and one exhalation
- Breathing rate: number of times an individual breathes in a minute
- Breathing rate increases while walking fast, running or after heavy exercise / decreases when in a relaxed state
- Average breathing rate of an adult is 15-18 times per minute

## **INHALATION:**

It is also known as inspiration, the various steps involved in inspiration is followed by

**Contraction of diaphragm – become depressed down and become flat**



**Increase in the size and height of thoracic cavity**



**Contraction of external intercostal muscle**



**Lift the rib cage and pushes the sternum forward**



**Increases the anterior and posterior dimensions of the thoracic cavity**

**Increase in the size of the lungs**



**Increase in the intrapulmonary volume**



**Decrease in the gas pressure with in the lungs, the pressure become less than the atmospheric pressure**



**Air moves in to the lungs till the intrapulmonary and the atmospheric pressure attains equilibrium**

**EXHALATION:** also known expiration

- It is passive process

**relaxation of diaphragm – moves upward**



**Decrease in the size and height of thoracic cavity**



**relaxation of external intercostal muscle**



**Lift the rib cage and pulls the sternum backward**

**decreases the anterior and posterior dimensions of the thoracic cavity**



**decrease in the size of the lungs**



**decrease in the intrapulmonary volume**



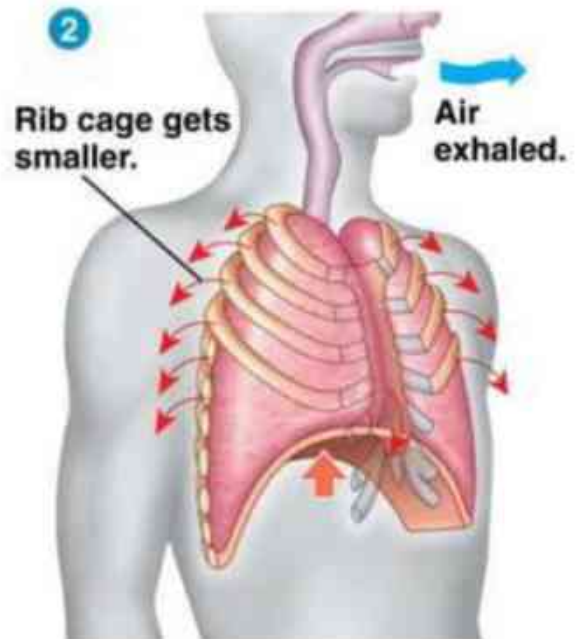
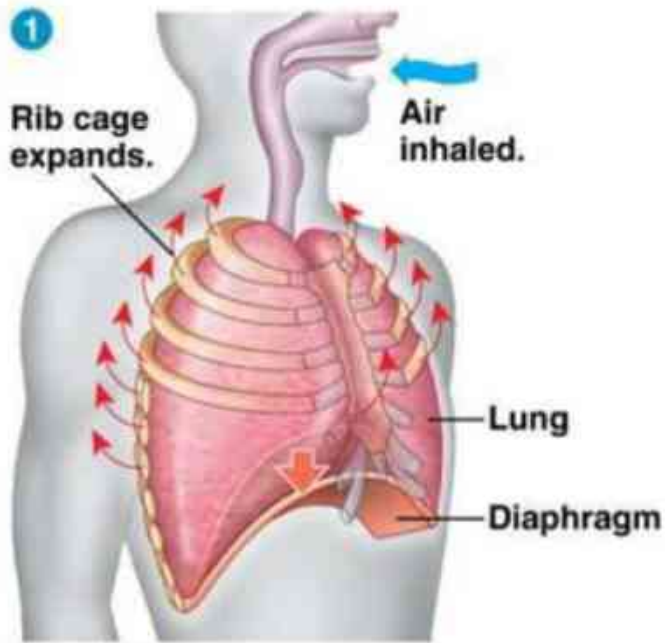
**increase in the gas pressure with in the lungs, the  
pressure become greater than the atmospheric  
pressure**



**Air moves out from the lungs till the intrapulmonary and  
the atmospheric pressure attains equilibrium**



# Inspiration vs. expiration



## Inspiration

- Diaphragm contracts & flattens
- External intercostals lifts rib cage
- Lungs stretched to larger size
- Air pressure inside lungs decrease
- Air sucked into lungs

## Expiration

- Inspiratory muscles relax
- Rib cage descends, lungs recoil
- Gases forced out

## **REGULATION OF RESPIRATION:**

- The average respiratory rate in adults is 15-18 times per minute
- Its more un case of children's
- The respiration is regulated by the following ways

**Nervous control**

**Chemical control**

## **NERVOUS CONTROL:**

- Respiration controlled by two mechanisms:

### **Voluntary control & Autonomic control**

#### **Voluntary control:**

- This control centre located in the cerebral cortex
- Sends the impulse to the respiratory motor neurons via cortico spinal tracts

#### **Autonomic control**

- This control center is located in the pons and medulla
- Also the pneumotaxic and apneustic centres are also responsible for controlling the respiration

## **CHEMICAL CONTROL:**

- **There are three chemical factors controlling the respiration**
  - **Carbon dioxide**
  - **Oxygen**
  - **pH**
- **When increase in the Co<sub>2</sub> and pH levels – increases the ventilation – excessive amount of Co<sub>2</sub> is washed out to normalize the level**
- **When decrease in Co<sub>2</sub> and pH levels – opposite effect – inhibit the activity of the respiratory centre – normalizes**
- **When decrease in O<sub>2</sub> concentration – increases the ventilation – excessive amount of O<sub>2</sub> enters in to the lungs to normalizes the level**

## **CYCLE OF BREATHING:**

**Average breathing rate is 12 – 15 per min**

**Each breath has 3 phases**

- **Inspiration – lasts about 2 seconds**
- **Expiration – lasts about 3 seconds**
- **pause**



## **LUNG VOLUMES /LUNG CAPACITY /RESPIRATORY CAPACITY**

### **LUNG VOLUMES**

- TIDAL VOLUMES
- INSPIRATORY RESERVE VOLUME
- EXPIRATORY RESERVE VOLUME
- RESIDUAL VOLUME

### **LUNG CAPACITY**

- INSPIRATORY CAPACITY
- EXPIRATORY CAPACITY
- FUNCTIONAL RESIDUAL CAPACITY
- VITAL CAPACITY
- TOTAL LUNG CAPACITY

### **Tidal Volume (TV):**

- It is the volume of air inspired or expired during a normal respiration
- An average value of tidal volume is ~500ml

### **Inspiratory Reserve Volume (IRV):**

- Additional volume of air a man can inspire after a forcible inspiration
- The average value is 2500-3000 ml

### **Expiratory Reserve Volume (ERV):**

- Additional volume of air a man can expire after a forcible inspiration
- The average value is 1000-1100 ml

### **Residual Volume (RV):**

- The volume of air remaining in the lungs even after a forcible expiration
- The average value is 1100-1200 ml

### **Inspiratory capacity (IC):**

- Total volume of air a person can inspire after a normal expiration
- It includes TV+IRV
- The average value is about 3500ml

### **Expiratory capacity(EC):**

- Total volume of air a person can expire after a normal inspiration
- It includes TV+ERV
- The average value is about 1600ml

### **Functional Residual Capacity (FRC):**

- It is the volume of air that will remain in the lungs after a normal expiration
- It includes ERV+ RV
- The average value is about 2300ml

### **Vital Capacity (VC):**

- It is the maximum amount of air a person can breathe out after a forced inspiration
- It includes ERV, TV & IRV
- The average value is about – 4600ml

### **Total Lung Capacity (TLC):**

- It is the total volume of air accommodated in the lungs at the end of a forced inspiration
- It includes RV, ERV, TV, & IRV/VC+RV
- The average value is about – 5800ml
- $TLC = VC$

## **TRANSPORT OF RESPIRATORY GASES:**

- Respiration involves inhalation of oxygen and exhalation of carbon di oxide
- During respiration O<sub>2</sub> and CO<sub>2</sub> gases are transported by the blood
- The oxygen enters the lungs to reach the alveoli.
- the alveoli and the capillaries lie in close to one another
- Both the alveoli and the capillaries are one cell thick
- The air and blood barrier is about one micrometer thick
- So the oxygen easily pass from alveoli to capillaries to reach the blood
- In the same manner carbon di oxide to be exhaled enters the alveoli from the blood
- The oxygenated blood travels to heart and distributed through out the body



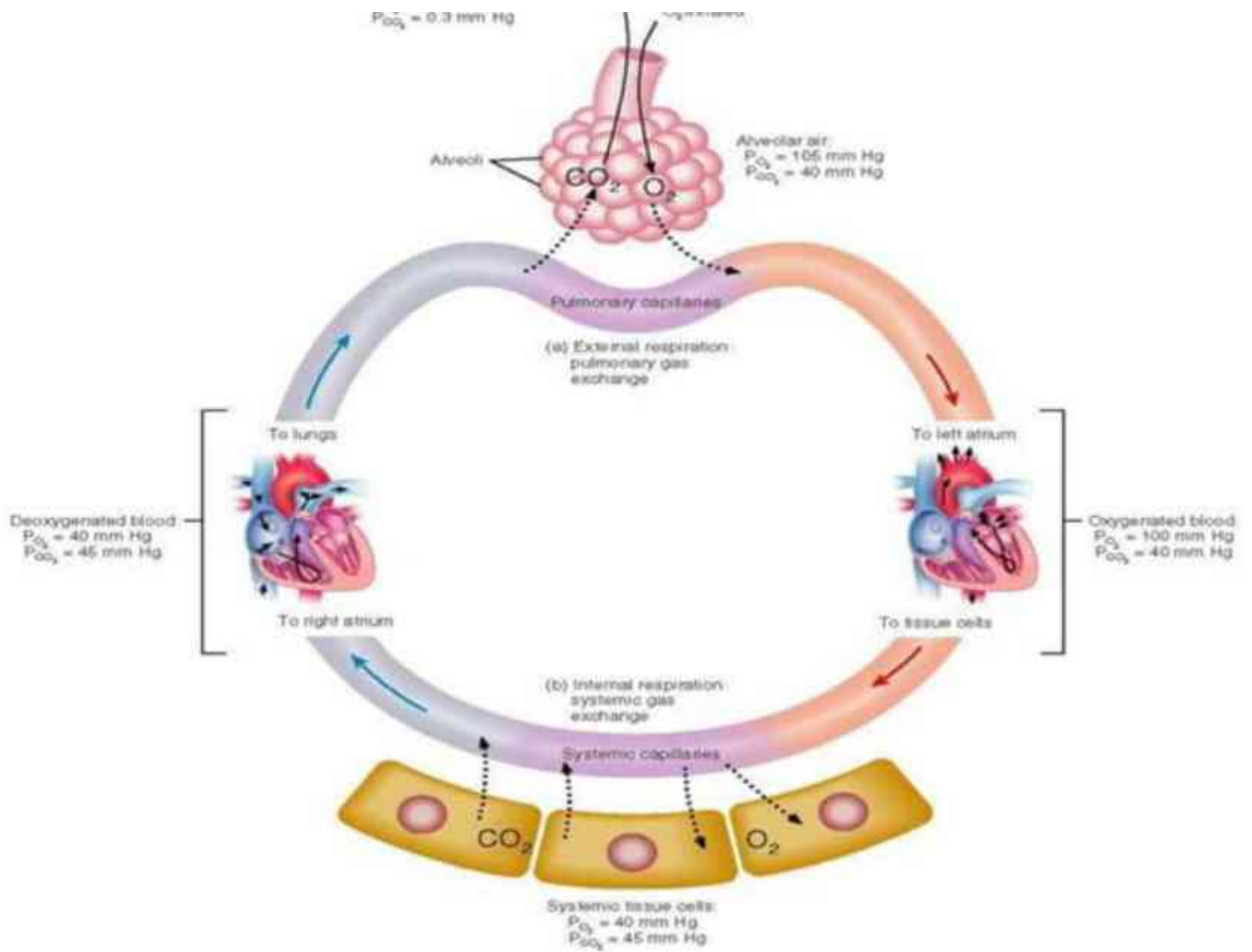
## **EXCHANGE OF GAS/ TRANSPORT OF RESPIRATORY GAS**

- Exchange of gas occurs when a difference in the partial pressure exist across a semipermeable membrane
- Gas moves by diffusion from the region of higher concentration to the lower concentration until the equilibrium attained
- Diffusion of oxygen and CO<sub>2</sub> depends on the pressure difference
- There are two kind of respiration based in the gas exchange they are
  - External respiration
  - Internal respiration



## **EXTERNAL RESPIRATION – PULMONARY RESPIRATION**

- Exchange of gases by diffusion between the alveoli and blood across the respiratory membrane
- Each alveolar sac is surrounded by network of capillaries (one cell thick)
- Pulmonary artery brings venous blood (Impure blood) – contains high level of CO<sub>2</sub> and low level of Oxygen
- based on concentration gradient (Partial Pressure) CO<sub>2</sub> diffuses to alveoli until equilibrium is attained
- By the same O<sub>2</sub> is diffused from alveoli to the blood until equilibrium is attained
- While passing through the alveoli blood flows slowly – so as to increase the time available for gas exchange
- When blood leaves from alveoli the CO<sub>2</sub> and O<sub>2</sub> levels are in equilibrium in both capillary and alveoli



## **INTERNAL RESPIRATION – TISSUE RESPIRATION**

- Exchange of gases by diffusion between the blood and tissue across the capillary membrane
- The blood present in the capillary tube is rich in Oxygen—lesser in CO<sub>2</sub> level
- based on concentration gradient O<sub>2</sub> diffuse to tissue until equilibrium attains
- By the same CO<sub>2</sub> is diffused from tissue to the blood until equilibrium attains
- While passing through the capillary- blood flows slowly – so as to increase the time available for gas exchange
- When blood leaves from tissue the CO<sub>2</sub> and O<sub>2</sub> levels are equilibrium in both capillary and tissue

## PARTIAL PRESSURE:

### Atmosphere:

- $P_{O_2}$  - 105mm Hg
- $P_{CO_2}$  - 40mm Hg

### Left Atrium:

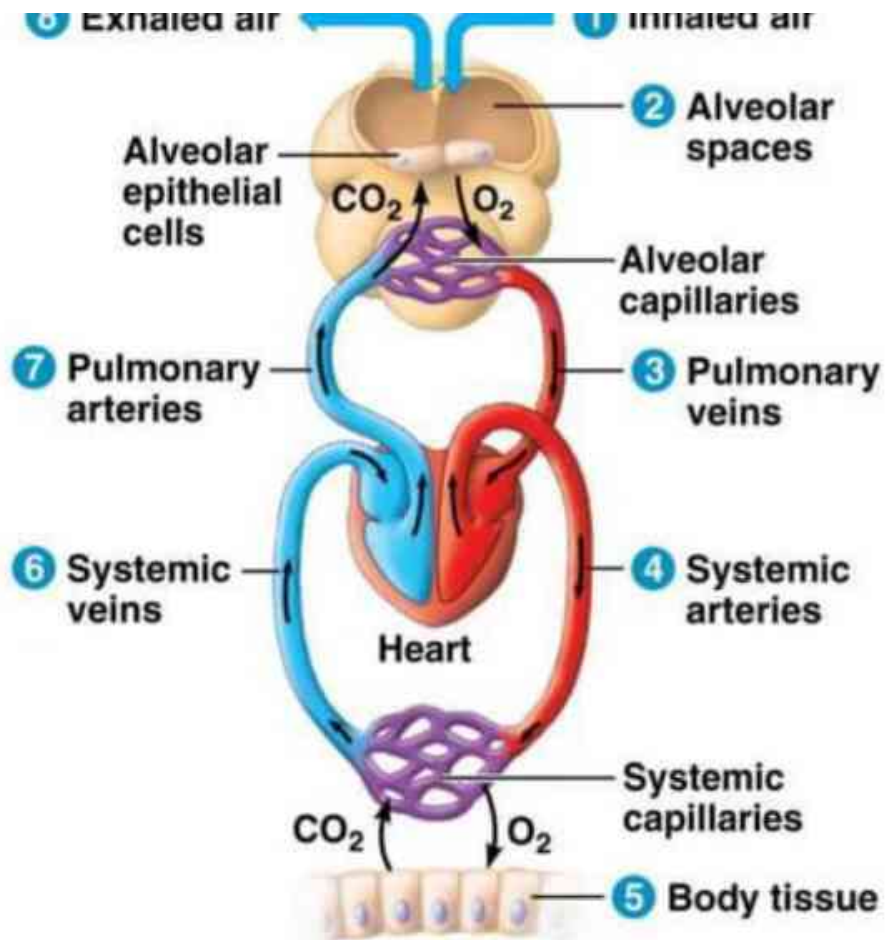
- $P_{O_2}$  - 100mm Hg
- $P_{CO_2}$  - 40mm Hg

### Right Atrium:

- $P_{O_2}$  - 40mm Hg
- $P_{CO_2}$  - 45mm Hg

### Tissue:

- $P_{O_2}$  - 40mm Hg
- $P_{CO_2}$  - 45mm Hg



(a) The path of respiratory gases in the circulatory system

## **ARTIFICIAL RESPIRATION:**

***“A method which allows the air to move in and out of the lungs in case of inadequate/ ceased natural breathing”***

***Different methods:***

- *Artificial lung***
- *Pulmotor***
- *Mechanical respirator***

***Or***

- *Mouth to mouth***
- *Mouth to nose method***



## **RESUSCITATION METHOD:**

### **Manual Methods:**

- Mouth to mouth respiration
- Prone pressure method (by Schafer)
- Arm Lift chest Pressure method
- Arm lift back pressure method (by Holger – Nielsen)
- Tilting/ Eve Rocking Method
- Instrumental Method

### **Drinkers method:**

- Bragg Paul's method
- Continuous insufflation method
- Tank respirator
- Resuscitator

**THANK YOU**