14. BREATHING AND EXCHANGE OF GASES

- **Breathing** :- Process involves inhalation and exhalation.
- Involves exchange of gases (O_2, CO_2) (from air)

RESPIRATION

Aerobic — O_2 is required

Anaerobic — O_2 is not required

Oxidation of glucose in the presence or absence of oxygen.

ATP is produced (Adenosine triphosphate)

Respiratory Organs

- **Gills-** Pisces, Aquatic arthropods, Molluscs.
- **Skin-** Earthworm.
- **Moist skin and lungs-** Amphibians
- **Entire body surface-** sponges, coelenterate and flatworm.
- **Tracheal System-** Insects
- **Lungs-** Mammals

Respiratory System

Conducting part

- Transport air (O_2) to alveoli
- Prevents the entry of foreign particle, humidifies and brings the air to body temperature.

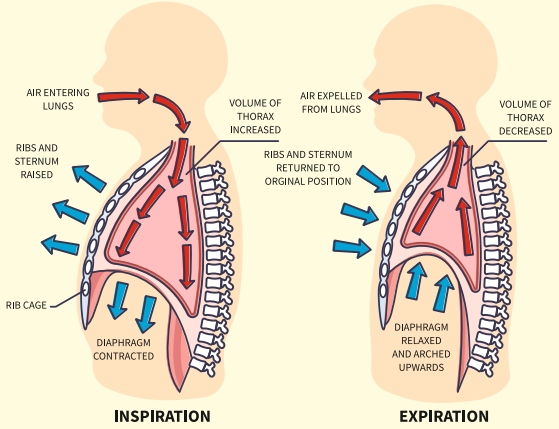
Respiratory or exchange part

- Site of diffusion of gases (O_2 & CO_2).
- Consists alveoli and blood vessels.

Epiglottis

- Cartilaginous flap
- Prevents the entry of food during swallowing.

Mechanism of Breathing



Inspiration

- Air is drawn in, an active process.
- Occurs due to negative pressure.

Diaphragm and external intercoastal muscles contracts

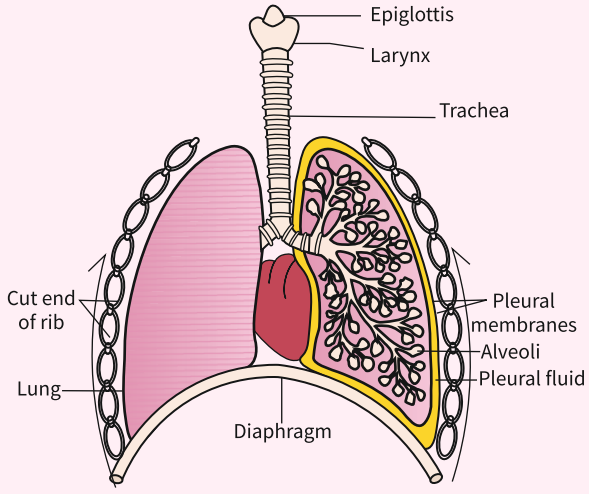
- Volume of thoracic chamber increases.
- Pulmonary pressure decreases.
- Air moves from high pressure zone to low pressure zone (PL < PA).
- Air moves inside the lungs ($p \propto \frac{1}{v}$)

Expiration

- Alveolar air is expelled out, passive process
- Occurs due to positive pressure

Diaphragm and external intercoastal muscles relax

- Pulmonary pressure increases.
- Air moves outside the lungs (PA < PL).
- Volume of thoracic chamber decreases.



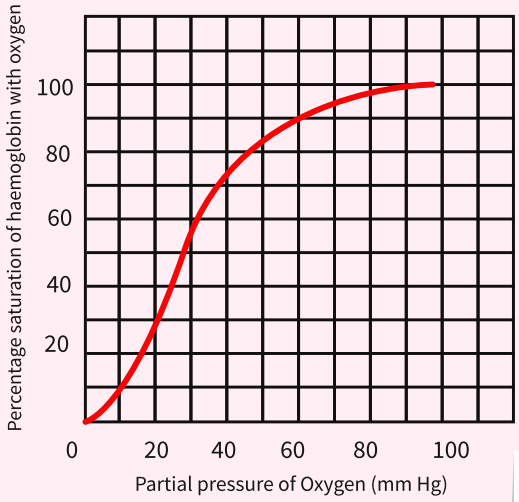
HUMAN RESPIRATORY SYSTEM

- **External nostrils**
- **Nasal cavities**
- **Pharynx**
- **Larynx** - Voice box.
- **Trachea** - protected by 'c' shaped cartilaginous rings.
  - prevent collapsing.
- **Bronchi** - secrete mucous.
- **Bronchioles** - Give rise to numerous Alveoli.

Respiratory Volumes

Tidal volume (Tv) (500ml : 6000-8000ml/min)	Volume of air inspired or expired per breath.
Inspiratory Reserve Volume (IRV) (2500-3000 ml)	Volume of air one inhales by forced inspiration.
Expiatory Reserve volume (ERV) (1000-1100 ml)	Extra volume of air one inhales by forced expiration.
Residual volume (RV) (1100-1200 ml)	Volume of air remaining in lungs after forced exhalation.
Dead air volume	Not involved in gaseous exchange but present in the lungs (150 ml).

Oxygen dissociation curve



Factors affecting the binding of O_2 with Hb

Conditions favorable for association

- High pO_2 , low pCO_2
- Low H+ Concentration
- Low Temperature

Conditions favorable for dissociation

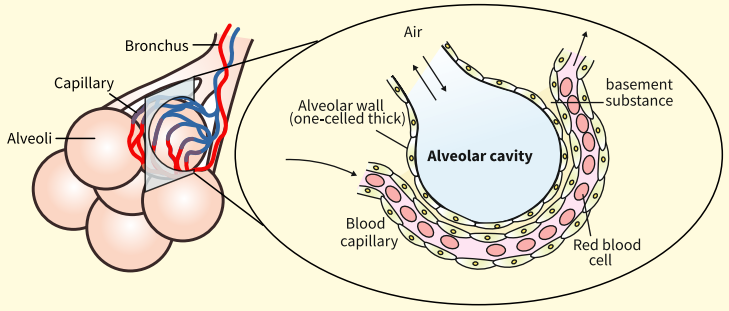
- Low pO_2 , high pCO_2
- High H+ Concentration
- High Temperature

Exchange of gases

- occurs by diffusion

Rate of diffusion influenced:-

- Pressure/Concentration gradient of gases.
- Solubility of gas & thickness of membrane.



Respiratory Capacities

Inspiratory Capacity	Volume of air one inhales after normal exhalation [IC = TV+ IRV] 3000 – 3500 ml
Expiratory Capacity	Volume of air one exhales after normal inhalation (EC = TV + ERV) 1500 – 1600 ml
Functional Residual Capacity (FRC)	volume of air remaining in lungs after normal exhalation [FRC = ERV + RV] 2100 – 2300 ml
Vital capacity (Vc)	volume of air exhales or inhales after forced inhalation or exhalation (VC = ERV + TV + IRV 3500 – 4500 ml)

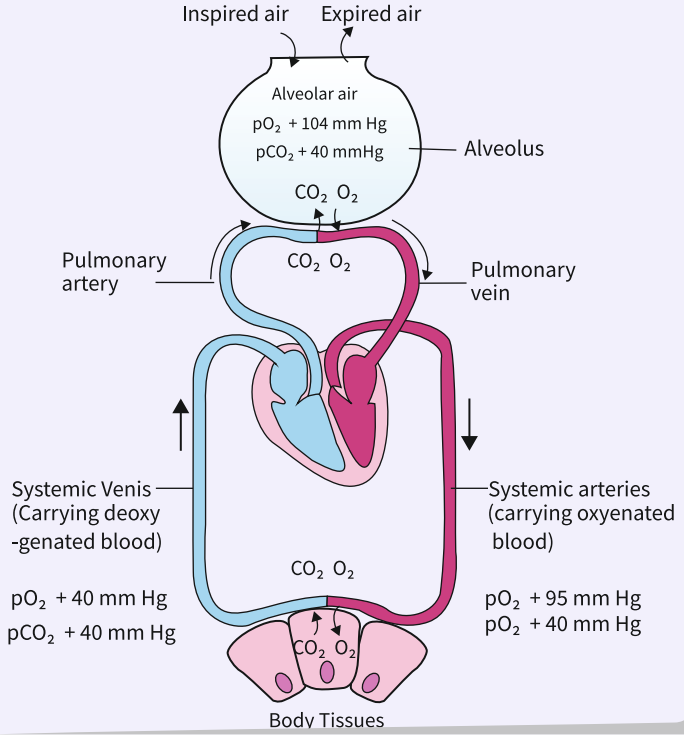
Transport of Gases

O_2

- 97% through Hb (oxyhemoglobin)
- 3% through plasma

CO_2

- 70% through HCO_3^-
- 7% through plasma.
- 20-25% through RBCs



Factors affecting the blinding of CO_2

For association

- Low pO_2
- High pCO_2
- High H temp

$HCO_3^- + H^+ \longrightarrow H_2CO_3$

carbonic anhydrase

For dissociation

- High pO_2
- Low pCO_2
- Low H temp.

$H_2CO_2 \longrightarrow CO_2 + H_2O$

carbonic anhydrase

Regulation of Respiration

- **Pneumotaxic center** → pons of brain
- **Respiratory rhythm center** → Medulla oblangata

Disorders

Asthma

Inflammation of bronchi & bronchioles, difficulty in breathing.

Silicosis

- Example of occupational respiratory disorder.
- Caused by inhalation of silica dust for long time.

Emphysema

- Decreased respiratory surface.
- Caused by smoking.
- Damaged alveolar wall.