

BREATHING AND EXCHANGE OF GASES

Human Respiratory System,

- Human respiratory system consists of a pair of nostrils, pharynx, larynx, bronchi and bronchioles that finally terminates into alveoli.
- Nasal chamber open into pharynx that leads to larynx. Larynx contains voice box (sound box) that helps in sound production.
- The trachea, primary, secondary and tertiary bronchi and initial bronchioles are supported by incomplete cartilaginous rings to prevent collapsing in absence of air.
- Each bronchiole terminates into a irregular walled, vascularized bag like structure called alveolus.
- Two lungs are covered with double layered pleura having pleural fluid between them to reduce the friction on lung surface.

Steps of Respiration

- Breathing in which Oxygen rich atmospheric air is diffused in and CO₂ rich alveolar air is diffused out.
- Diffusion of gases across alveolar membrane.
- Transport of gases by blood.
- Diffusion of O₂ and CO₂ between blood and tissues.
- Utilization of O₂ by cells to obtain energy and release of CO₂ (cellular respiration).

Mechanism of Breathing

Breathing involves inspiration and expiration.

- Movement of air in and out takes place due to difference in pressure gradient. The diaphragm and external and internal intercostal muscles between the ribs help in developing pressure gradient due to change in volume.
 - The contraction of intercostal muscles lifts the ribs and sternum causing an increase in volume of thoracic cavity that results in the decrease in pressure than the atmospheric pressure to cause inspiration.
- Relaxation of the diaphragm and intercostal muscles reduce the thoracic volume and increase the pressure to cause expiration.
- The volume of air involved in breathing movements is estimated by using spirometer for clinical assessment of pulmonary functions.

Respiratory Volumes and Capacities

Tidal Volume (TV) - volume of air inspired or expired during a normal respiration. It is about 500 mL in healthy man.

Inspiratory Reserve Volume (IRV) - additional volume of air a person can inspire by forceful inspiration. It is about 2500 mL or 3130 mL.

Expiratory Reserve Volume (ERV) - additional volume of air a person can expire by forceful expiration. It is about 1200 mL to 1100 mL.

Residual Volume (RV) - volume of air remains in lungs even after a forcible expiration, it is about 1100 mL to 1200 mL.

Inspiratory Capacity (IC) = TV + IRV

Expiratory Capacity (EC) = TV + ERV

Functional Residual Capacity (FRC) = TV + RV

Vital Capacity (VC) - maximum volume of air a person can breathe in after a forcible expiration. VC = RV + TV + IRV

Total Lung Capacity (TLC) - total volume of air accommodated in lung at the end of forced inspiration. TLC = RV + ERV + TV + IRV

Vital capacity = VC = TV + IRV + RV

Exchange of Gases

- Exchange of gases takes place at two sites

- Alveoli to blood
- Between blood and tissues.

Partial pressure contributed by individual gas in a mixture of gas is called partial pressure represented by p_i and p_0 .

Transport of Oxygen

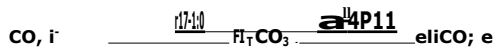
- Haemoglobin in RBC combines with O₂ to form Oxyhaemoglobin. Each haemoglobin molecule combines with four oxygen molecules.

In the alveoli, pO_2 is more and pCO_2 is less

Transport of Carbon dioxide

Carbon dioxide is transported by haemoglobin as carbamino-haemoglobin. In tissues, pCO_2 is high and pO_2 is less that favour the binding of carbon dioxide with haemoglobin. Opposite condition help in dissociation of carbamino-haemoglobin in alveoli.

Enzyme carbonic anhydrase help in formation of bicarbonate ions to transport carbon dioxide.



Regulation of Respiration

* Respiratory rhythm centre is located in medulla region of hind brain. Pneumotaxic centre inhibits moderate the function of respiratory rhythm centre.

Mountain Sickness is the condition characterised by the ill effect of hypoxia (shortage of oxygen) in the tissues at high altitude commonly to person going to high altitude for the first time.

Disorder of Respiratory System

- Asthma.** It is due to allergic reaction to foreign particles that affect the respiratory tract. The symptoms include coughing, wheezing and difficulty in breathing. This is due to excess of mucus in wall of respiratory tract.
- Emphysema-** is the inflation or abnormal distension of the bronchioles or alveolar sacs of lungs. This occurs due to destroying of septa between alveoli because of smoking and in use of other smokes.
- Occupational Respiratory Disorders-** occurs due to occupation of individual. This is caused by inhalation of gas, fumes or dust present in surrounding of work place. This includes Silicosis, Asbestos due to exposure of silica and asbestos. The symptom includes proliferation of fibrous connective tissue of upper part of lung causing inflammation.
- Pneumonia.** It is acute infection or inflammation of the alveoli of the lungs due to bacterium *Streptococcus pneumoniae*. Alveoli become acutely inflamed and most of air spaces of the lungs are filled with pus and dead white blood corpuscles limiting gaseous exchange.