Breathing and Exchange of Gases

Cells continuously use oxygen (O_2) for the catabolic reactions that releases energy from molecules, e.g., breakdown of nutrient molecules like glucose. Thus, O_2 has to be provided to the cells constantly. Simultaneously, these reactions releases carbon dioxide (CO_2), which is harmful, so it must be removed quickly and efficiently.

Respiration is catabolic process in which oxidation of nutrients in the living cells to release energy for biological work.

1. Aerobic Respiration- Occur in presence of oxygen. Complete breakdown the food to release energy.

2. Anaerobic Respiration (fermentation)-Occurs in the absence of oxygen in the cytoplasm. Yields only about 5% of the food's energy. e.g., yeasts oxidise glucose to ethanol and CO_2.

- Anaerobic respiration appeared first in primitive atmosphere due to absence of oxygen.
- In frog 100% cutaneous respiration occurs during hibernation and in all marine snakes, 20% respiration is by skin.

Breathing is theprocess of exchange of O_2 from the atmosphere with CO_2 produced by the cell.

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Breathing	Respiration
a. It is simply an intake of fresh air and removal of foul air. **b.** It is a physical process. **c.** No energy is released. **d.** It is an extracellular process.	**a.** It is the oxidation of food to form carbon dioxide, water and energy. **b.** It is a biochemical process. **c.** Energy is released in form of ATP. **d.** It is an intracellular process.

Mode of gaseous exchange	Respiratory organs	Examples
Cutaneous respiration	Skin/ Through body surface	Poriferans, Coelenterates, Flatworms Moist cuticle- Earthworms Moist skin- Amphibians (frogs)
Tracheal	Spiracles	Arthropods (cockroaches)
Branchial respiration	Gills	Aquatic animals- arthropods, molluscs and fishes
Pulmonary respiration	Lungs	Terrestrial vertebrates including human

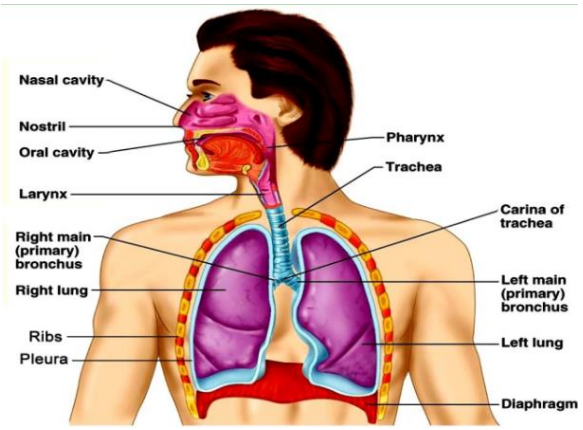
Human Respiratory System

Conducting part of the respiratory system:

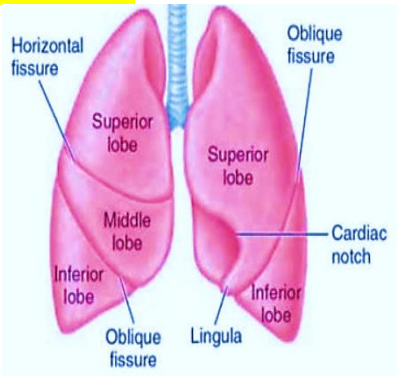
External nostrils → nasal passage → nasal chamber (nasal cavities) → nasopharynx → glottis → larynx → trachea → primary bronchi → sec. bronchi → tertiary bronchi → bronchioles → terminal bronchioles→ respiratory bronchiole → alveolar duct.

- **Nostrils**- (External Nares) - Hairs present prevent entry of Dust Particles.
- **Nasal Cavity**- Separated by Nasal Septum, secrets mucus -prevents entry of dust particles.
  Humidifies air and warmed up when it enters the nasal passage.
  Olfactory Cells present (Smell)

- **Internal Nares** (Opening into Nasopharynx)
- **Nasopharynx** -Pharynx (common passage for food & air)
- **Glottis** Slit like opening into Larynx guarded by **Epiglottis** (thin elastic cartilaginous flap like structure that prevents entry of food into wind pipe)
- **Larynx** - Sound box , made-up of 9 Hyaline cartilage. 2-pairs of vocal chords present -upper-false, lower true. At puberty larynx size grows larger in man, becomes prominent called Adam's Apple.
- **Trachea-** Thin-walled tube, about 11cm long and 2.5 cm wide extends up to mid-thoracic cavity.
    - Divides into right & left primary Bronchi at at **5th thoracic vertebra**.



- **Primary Bronchi** (Right and left)-
- **Secondary Bronchus** (Lobar)-
- **Tertiary Bronchi** -
- **Terminal Bronchioles** -No cartilaginous rings present
- **Alveolar Duct**
- **Alveoli** – Structural &Functional unit of Lungs, **300 millions** Alveoli present in both lungs (total surface area 80m^2 approx. Made-up of thin wall-squamous epithelium -single celled. Vascularised -richly supplied by blood vessels



- Wall of trachea, bronchi and bronchioles is composed of fibromuscular tissue & is lined by pseudo stratified ciliated columnar epithelium bearing glandular cell (mucus gland).
- **C-Shaped cartilaginous rings support the walls of the trachea and the bronchi** (primary, secondary & tertiary) to **prevent their collapsing.**
- Vocal cords in men are thick resulting in more slow vibrations, thus have lower pitch than women.
- Hyoid Bone (Horseshoe-shaped Bone supports the tongue) -lies just above the larynx. Embryologically considered a bone of skull.
- If the chest wall is pierced (e.g., by a stab wound), atmospheric air rushes into the pleural cavity, eliminating the pressure difference across lung walls causing the lungs to collapse. The condition is called pneumothorax.

Lungs: Bronchi, bronchioles & alveoli together constitute lung. They are soft, spongy, elastic organ, pinkish in colour.

- Lungs reside in air tight thoracic cavity, which is formed by the vertebral column (dorsal surface), sternum (ventral surface), ribs (present laterally) and diaphragm present at the lower side.
- Left lung is larger in size, consists of 3-lobes Superior, Middle , Inferior divided by horizontal fissure and oblique fissure. Left Lung have cardiac notch to accommodate Heart.
- Right lung consist of two lobes-Superior and Inferior lobes divided by oblique fissure.
- Each Lung is covered by double layered pleura (outer parietal & inner visceral)
- Pleural Fluid is filled between two pleural layer prevents friction and absorbs shock.

Respiratory Organs – Mechanism of breathing varies in different organism according to their body structure and habitat.

Alveoli and alveolar ducts together take part in the exchange of gases. No exchange of gases takes place till terminal bronchioles.

Steps of Respiration

1. (Pulmonary Ventilation) Breathing in which Oxygen rich atmospheric air is diffused in and CO_2 rich alveolar air is diffused out.
2. Diffusion of gases across lungs alveolar membrane & blood.
3. Transport of gases by blood.

4. Diffusion of O_2 and CO_2 between blood and tissues.
5. Cellular Respiration -Utilization of O_2 by cells (catabolism of food using O_2) to obtain energy and release of CO_2.

Breathing Mechanism

	Inspiration		Expiration
1	Contraction of radial muscles results in flattens of diaphragm (contract)- Vertical volume (antero-posterior axis) increases.	1	Relaxation of radial muscles -diaphragm returns to its original dome shape (relax)- Vertical volume (antero-posterior axis) decrease.
2	External intercostal Muscles Contracts & Internal Intercostal Muscles relax.	2	External intercostal Muscles relax & Internal Intercostal Muscles contract
3	Ribs & sternum lifts up result in increase of dorso-ventral volume	3	Ribs & sternum returns to its original position result in decrease of dorso-ventral volume
4	Thoracic/Pulmonary volume increase & pressure decrease – Lungs Expand	4	Thoracic/Pulmonary volume decrease & pressure increase – Lungs Expand
5	Air Moves from outside into lungs due to Lower intrapulmonary pressure	5	Alveolar air is expelled out due to high intrapulmonary pressure

- Inspiration is an active process, while expiration is a passive process
- Inspiration and expiration volume can be increased by the help of muscles in the abdomen.
- Normal breathing rate is 12-16 times/ minute.
- **Spirometer-** An apparatus for measuring the volume of inhaled and exhaled air.