The Respiratory System

Respiration is the chemical process of releasing energy by breaking down glucose for carrying out life processes.

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + Energy$$

Body cells need energy for a vast variety of activities in them. The activities are as follows:

1) Synthesis of proteins from amino acids.
2) Production of enzymes.
3) Contraction of muscles for movement.
4) Conduction of electrical impulse in a nerve cell.
5) Production of new cells by cell division.

Animals need more energy:

- The need for production of energy is greater in animals than in plants because animals consume more energy in doing physical work.
- Birds and mammals need still more energy because they have to produce a lot of heat for keeping the body warm. This heat comes through respiration in the cells. The amount of heat to keep the body warm is quite large.
- Shivering and clattering of teeth is an emergency activity of the muscle cells to produce

extra heat to keep body warm.

- Glucose has no alternative for respiration. If the simple carbohydrate is not available directly, the cells may break down the proteins or fats to produce glucose for respiratory needs.
- The main constituent of diet of totally flesh-eaters is protein with very little carbohydrates.

Kinds of Respiration

Aerobic	Anaerobic
Respiration takes place in the presence of oxygen	Respiration takes place in the absence of oxygen
Ex- Human beings, several bacteria and fungi	Ex- Yeast, some bacteria

Chemical steps in respiration

- Aerobic respiration in animals → The chemical changes taking place are the same in both plants and animals.

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + 686 \text{ k Cal/mole}$$

OR

$$C_6H_{12}O_6 + 6O_2 \xrightarrow{\text{Enzymes}} 6CO_2 + 6H_2O + 38ATP + 420 kCal$$

- Anaerobic respiration in animals → In animal cells, particularly in the skeletal muscle cells, anaerobic respiration may occur when they have to work very fast with insufficient oxygen.

$C_6H_{12}O_6 \longrightarrow$ Lactic acid + 2ATP + Heat energy

Special points for above chemical reaction are as follows:

1) It is a slow process.
2) The reaction cannot continue for long time. The product lactic acid has a toxic effect on cells, which causes muscle fatigue and ache.
3) No CO_2 is produced.
4) Total energy released per mole of glucose is much less compared to aerobic respiration.

Parts of respiration:

Four major parts of respiration are:

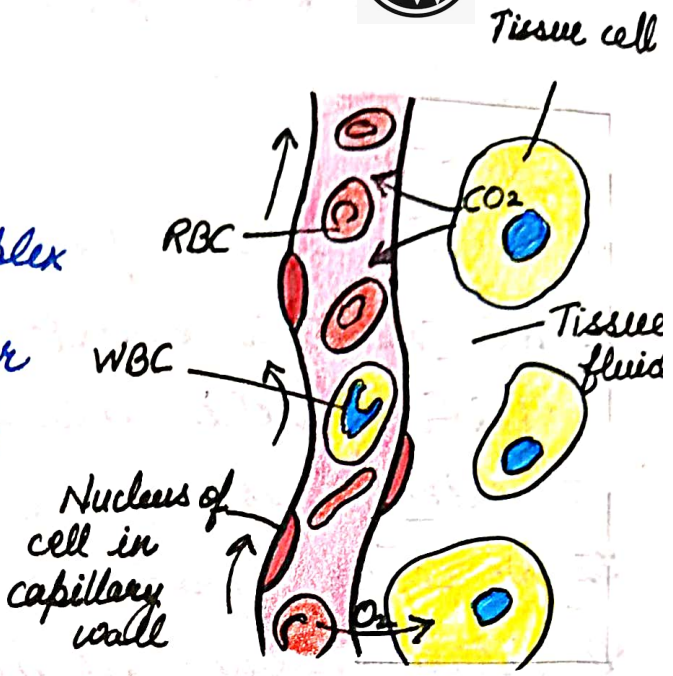
1. **Breathing** — This is a physical process in which the atmospheric air is taken in and forced out of the oxygen absorbing organs, the lungs.

2. **Gaseous transport** — The oxygen absorbed by the blood in the lungs is carried by RBCs as oxy-haemoglobin throughout the body by means of arteries.

3. **Tissue respiration** — The terminal blood vessels, i.e the capillaries deliver the oxygen to the body cells

or tissues where oxygen diffuses through their thin walls.

4. **Cellular respiration** – The complex chemical changes which occur inside the cell to release energy from glucose.



Tissue respiration

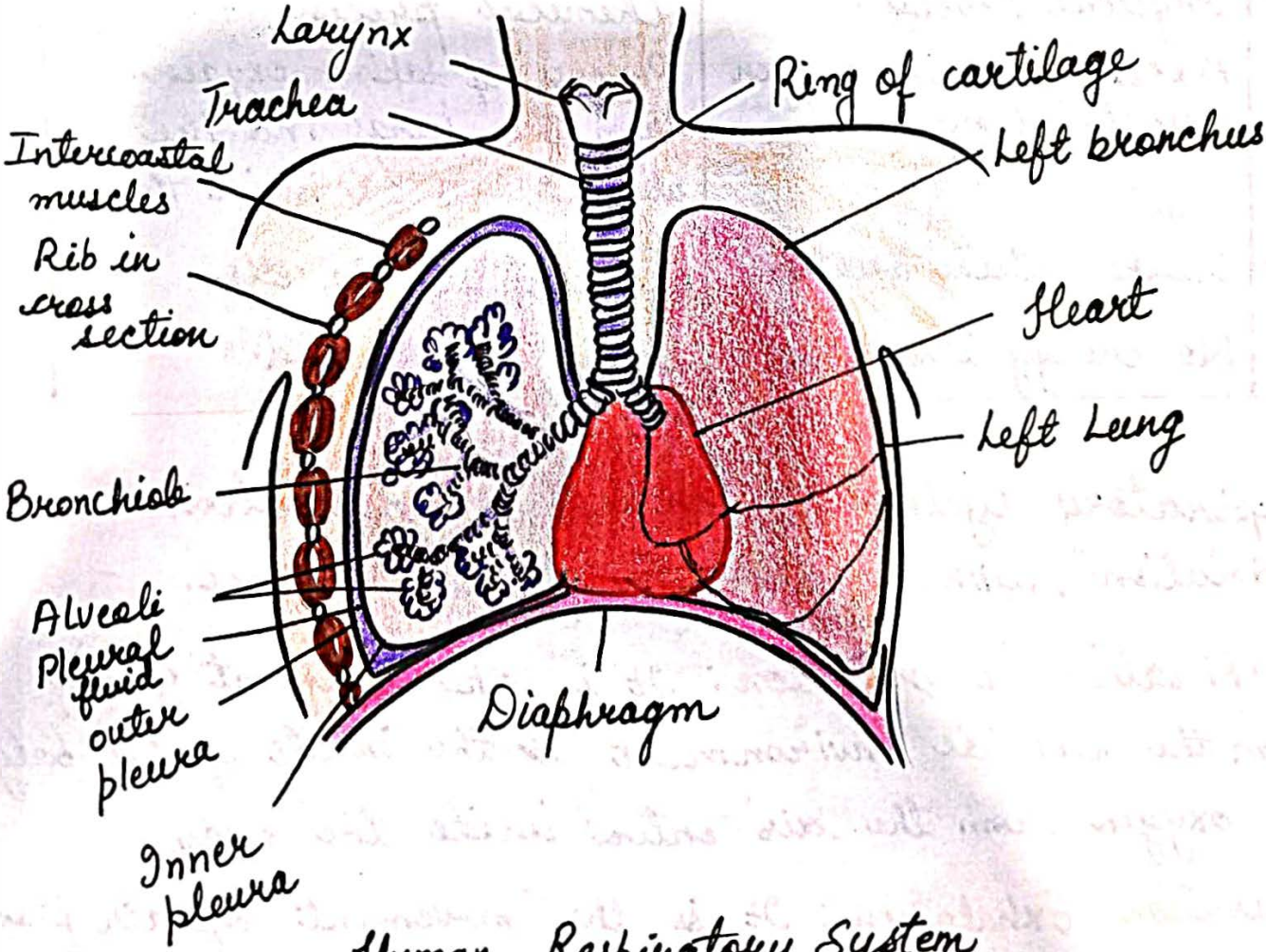
Respiratory organs :

1. **The nose** – The external part of the nose bears two nostrils seperated by a cartilaginous septum. The hairs present in the nostrils prevent large particles from entering the system.
2. **The pharynx** – The nasal chambers open at the back into a wide cavity, the pharynx situated at the back of the mouth. It is a common passage for air and food.
3. **The Larynx** – It is also called voice box. It is a hollow cartilaginous structure located at the start of the wind pipe.
4. **The trachea** – The trachea is also called windpipe. It emerges from the larynx down below in the neck where it is partly covered by the thyroid gland

5. The Bronchi - The trachea divides into two tubes called bronchi, which enter the respective lungs.

6. Protective inner lining of respiratory passage - The entire inner lining of larynx, trachea, bronchi and bronchioles is formed of ciliated epithelium.

7. The Lungs - These are a pair of spongy and elastic organs formed by the air sacs, their connecting bronchioles, blood vessels etc. Each lung is covered by two membranes, the inner pleura and outer pleura with a watery fluid (pleural fluid) in the pleural cavity found between two membranes.



Human Respiratory System

Blood supply to the lungs -

The right auricle pumps all the deoxygenated blood received in it from the body into the right ventricle, which in turn, pumps it into the lungs through the main pulmonary artery. The pulmonary artery, soon after its emergence, divides into two branches entering their respective lungs. Inside the lungs, they divide and redivide several times to ultimately form capillaries around the air sacs.

	BREATHING	RESPIRATION
1)	Physical process	Chemical process
2)	Process of taking oxygen into the lungs.	Process of taking oxygen from the lungs into the blood stream or inside the cells.
3)	Occurs outside the cells.	Occurs inside the cells.
4)	No energy is released.	Energy is released.

Respiratory Cycle: It consists of inspiration and expiration, with a short respiratory phase.

1. **Inspiration / Inhalation:** It is the movement of air from the outside environment to the inside of the body. The oxygen from the air enters inside the body.
2. **Expiration / Exhalation:** It is the movement of air from the inside of the body to the outside environment.

The carbon dioxide from the body is released into the outside environment.

PART OF THE RESPIRATORY SYSTEM	INSPIRATION	EXPIRATION
• Diaphragm	Contracts and flattens downwards.	Relaxes and moves upwards to form a dome shape.
• External intercoastal muscles	Muscles contract	Muscles relax
• Internal intercoastal muscles	Relaxed / Stretched	Contracted for forced expiration
• Ribcage and sternum	Moves upwards and outwards	Moves downwards and inwards
• Thoracic cavity	Increases	Decreases
• Air pressure	Decreases inside the thorax and lungs	Increases inside the thorax and lungs
• Air movement	External air pressure drives air into the lungs at low pressure	Air is forced out of the lungs by thoracic compression and elastic recoil of the lungs

Control of breathing movements

The breathing movements are largely controlled by a respiratory centre located in the medulla oblongata of the brain. This centre is stimulated by the carbon dioxide content of the blood.

Capacities of the Lungs:

Respiratory volumes in a normal human adult are approximately as follows:

1) **Tidal volume** - Air breathed in and out in a normal quiet breathing = 500 mL

   Dead air space: Some tidal air is left in respiratory passages such as trachea and bronchi where no diffusion of gases can occur = 150 mL

2) **Inspiratory Reserve Volume** - Air that can be drawn in forcibly over and above the tidal air = 3000 mL

3) **Inspiratory capacity** - Total volume of air a person can breathe in after a normal expiration = 3500 mL

4) **Expiratory Reserve Volume** - Air that can be forcibly expelled out after normal expiration = 1000 mL

5) **Vital capacity** - The volume of air that can be taken in and expelled out by maximum inspiration and expiration = 4500 mL

6) **Residual volume** - Some air is always left in the lungs even after forcibly breathing out. = 1500 mL.

7) **Total lung capacity** - Maximum air which can at any time be held in the two lungs = 6000 mL

The expired air differs from inspired air in the following respects:

1) It contains less oxygen.

- Degenerative - Arthritis, Cataract
- Physical and chemical causes - Injury, Heat, Cold, Poisoning etc
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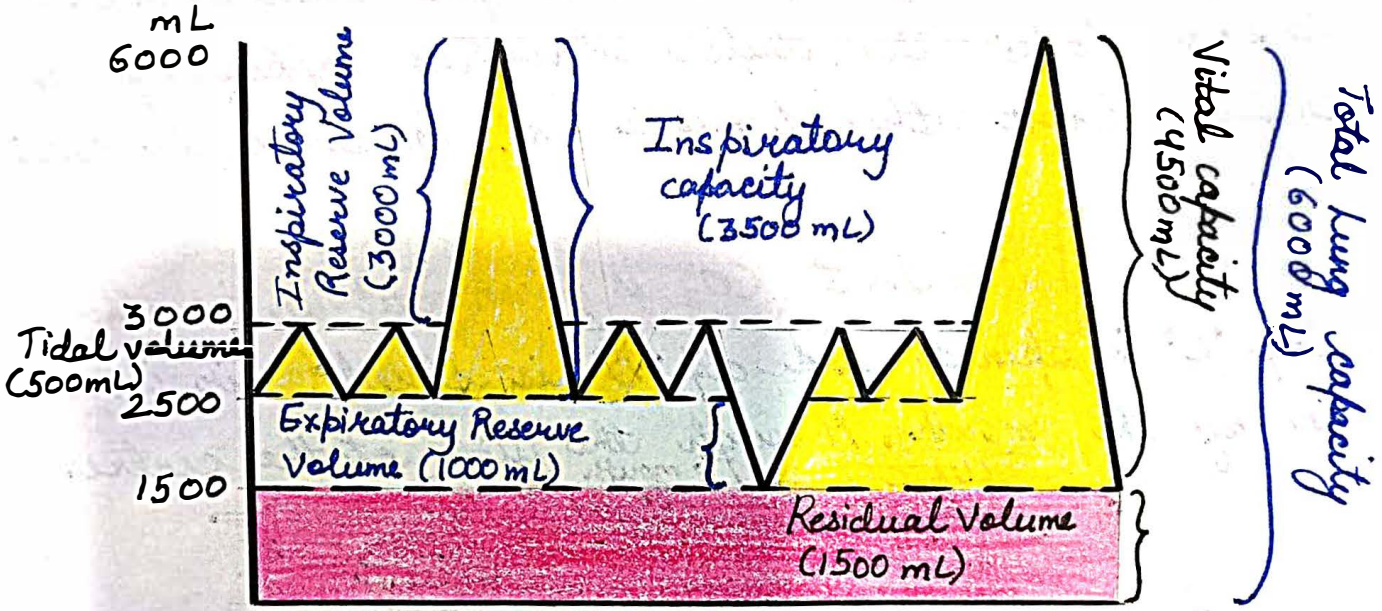
2) It contains more carbon dioxide.

3) It contains more water vapour.

4) It is warmer.

5) It may contain some bacteria.



Volumes of air exchanged in the lungs

Effect of altitude on breathing : As we go higher up, the air we breathe in decreases in pressure accompanied by a gradual decrease in oxygen content.

1) Hypoxia - It is the deficiency of oxygen reaching the tissues. It may result due to sitting for long hours in a crowded room with poor ventilation.

2) Asphyxiation - It is a condition in which the blood becomes more venous by accumulation of more

carbondioxide and the oxygen supply is diminished.

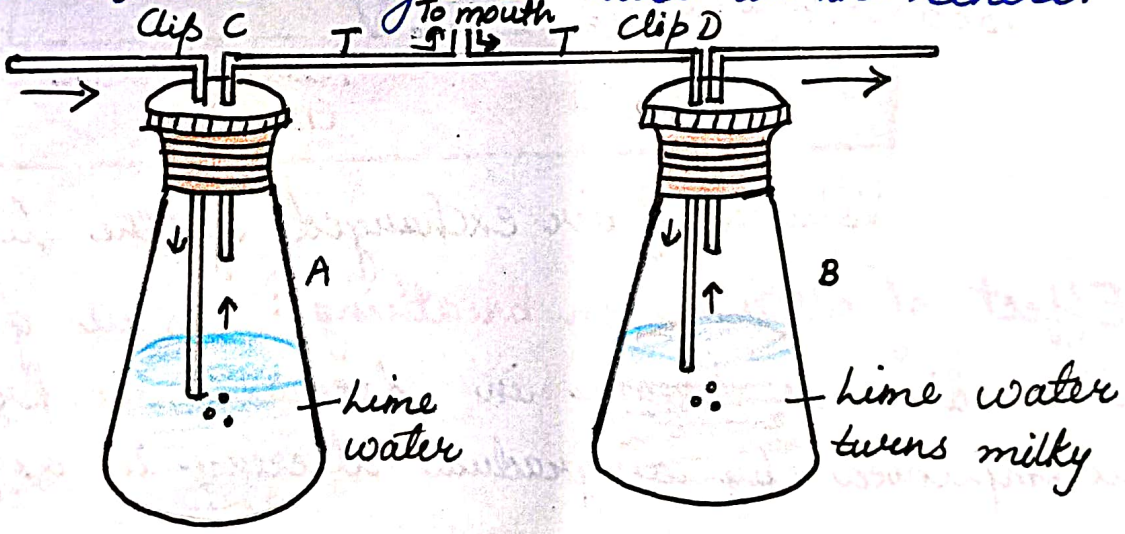
Experiments on Breathing and Respiration

1) **To demonstrate that water is lost during breathing**

Gently breathe upon a cold surface such as a piece of glass or slate; the water droplets appearing on the surface prove the presence of moisture in expired air.

2) **To demonstrate that CO_2 is given out in breathing :**

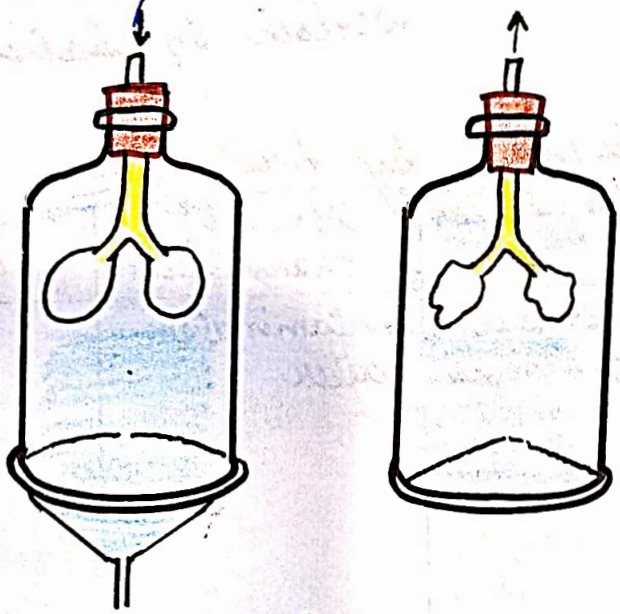
Clip 'C' is opened and clip 'D' is closed. Air is sucked in by the mouth, through the tube at the centre.



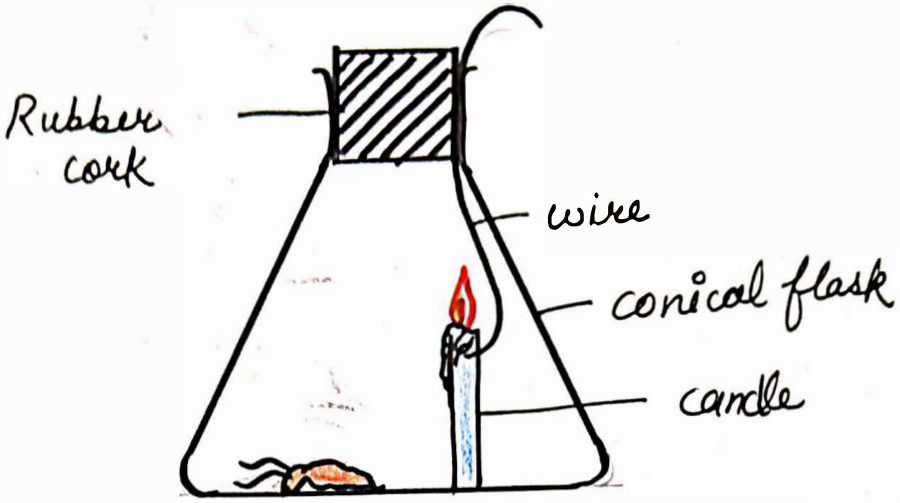
Atmospheric air rushes in flask 'A' bubbling through the lime water. Clip 'C' is closed and clip 'D' is opened and the exhaling air is blown through the same central tube. This time the air is forced into flask

'B' bubbling through its lime water. The process is repeated about ten times. The lime water in flask 'B' turns milky much faster than in flask '1'.

3) To demonstrate the action of the diaphragm during breathing: The rubber sheet tied around the bottom edge of the bell jar represents the diaphragm. When the sheet is pulled downward, volume is increased, pressure inside the bell jar lowered and the rubber balloons are expanded by the air rushing in through the tube at the top.



4) To show that oxygen is taken in by animals during respiration: Take two conical flasks 'A' and 'B'. Place a live cockroach in one flask 'A' and a dead cockroach that has been soaked in formalin to prevent decay in the other flask 'B'. This flask with the dead cockroach acts as a control.



5) To measure the volume of expired air :

Fill your chest with air to the maximum, and then blow out through the short tube expelling as much air as you can. The water expelled from the other tube when measured gives the volume of the air exhaled.