The Respiratory System

Need for energy

a. Synthesis of proteins from amino acids
b. Production of enzymes
c. Contraction of muscles for movement

- The need for energy production is greater in animals as compared to plants because animals have to move from one place to another, either to obtain food or to escape from their enemies.

- **Respiration** is the catabolic process of releasing energy from simple sugar, glucose, for carrying out various life processes.

$$\underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Oxygen}}{6O_2} \longrightarrow \underset{\text{Carbon dioxide}}{6CO_2} + \underset{\text{Water}}{6H_2O} + \underset{\text{Energy}}{ATP}$$

Characteristics of Respiration

a. The breakdown of glucose to carbon dioxide and water does not occur in a single step. It involves a series of chemical reactions—glycolysis, Krebs cycle and electron transport.
b. Each breakdown step is carried out by a specific enzyme.
c. A small amount of energy liberated in the breakdown of the glucose molecule is released as heat energy. But a major part of it is converted into chemical energy in the form of Adenosine Triphosphate (ATP).

Kinds of Respiration

- **Aerobic Respiration:** The breakdown of glucose in the presence of oxygen is called aerobic respiration. Most of the animals such as human beings, several bacteria and fungi are aerobic in nature.

$$\text{Glucose} \xrightarrow{\text{Presence of oxygen}} \text{Carbon dioxide + Water + Energy (38 ATP)}$$

- **Anaerobic Respiration:** The breakdown of glucose in the absence of oxygen is called anaerobic respiration. The unicellular organisms such as yeast and some bacteria are examples of anaerobes.

$$\text{Glucose} \xrightarrow{\text{Absence of oxygen}} \text{Alcohol + Carbon dioxide + Energy (2 ATP)}$$

- **Fermentation:** The breakdown of pyruvic acid to ethanol and carbon dioxide in the absence of oxygen is called fermentation. Certain microorganisms or their enzymes carry out fermentation.

- **Differences between Aerobic and Anaerobic Respiration in Plants**

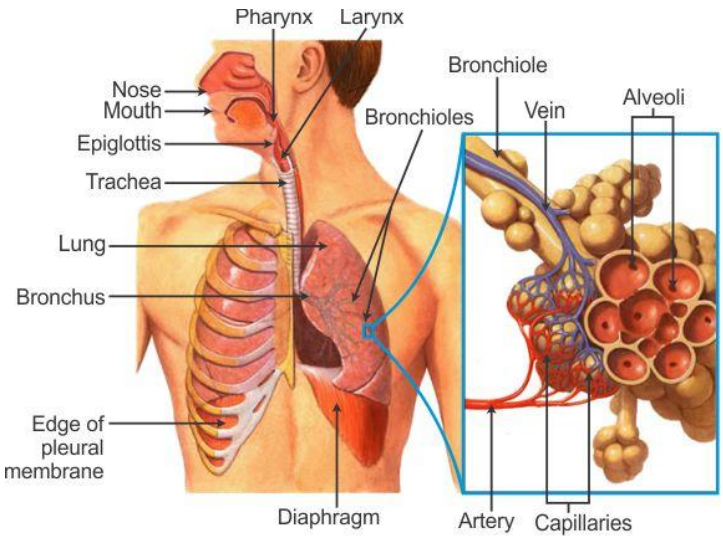
AEROBIC RESPIRATION	ANAEROBIC RESPIRATION
1. Also called oxybiotic respiration.	1. Also called anoxybiotic respiration.
2. Proceeds in the presence of oxygen.	2. Proceeds in the absence of oxygen.
3. Occurs in mitochondria.	3. Occurs in cytoplasm.
4. Complete breakdown of glucose.	4. Incomplete breakdown of glucose.
5. End products are carbon dioxide and water.	5. End products are ethyl alcohol and carbon dioxide.
6. Large quantity of energy is liberated (38 ATP) from one mole of glucose.	6. Small quantity of energy is liberated (2 ATP) from one mole of glucose.
7. Normally occurs throughout life.	7. Occurs temporarily for short periods.

Parts of Respiration

a. **Breathing:** It is a physical process in which the atmospheric air is taken in and forced out of the oxygen-absorbing organs, the lungs.
b. **Gaseous transport:** Oxygen absorbed by the blood in the lungs is transported by the red blood cells (RBCs) as oxyhaemoglobin throughout the body by the means of arteries. Carbon dioxide from the tissues is transported to the lungs by the blood via veins in two ways.
    - As bicarbonates dissolved in plasma.
    - In combination with haemoglobin of RBCs as carbamino-haemoglobin.
c. **Tissue respiration:** The terminal blood vessels or the capillaries transport the oxygen to the body cells or tissues, where the oxygen diffuses through their thin walls. Likewise, the capillaries pick up the carbon dioxide released by them.
d. **Cellular respiration:** The complex chemical changes which occurs inside the cells to release the energy from glucose.

- Cellular respiration consists of three main stages: glycolysis, Krebs cycle and electron transport.

- The respiratory system in human beings consists of the nose, pharynx, larynx, trachea, bronchi and lungs.



Human respiratory system

COMPONENT OF THE RESPIRATORY SYSTEM	DESCRIPTION
Nose	Consists of nostrils which open into the nasal cavity. Nasal hair prevents the entry of large particles inside the nose.
Pharynx	Muscular chamber is connected to the larynx through glottis. Air from the pharynx enters the larynx when the food enters the oesophagus.
Larynx	Hollow, cartilaginous structure that connects the pharynx to the trachea. Contains vocal cords. Air is expelled forcibly through the vocal cords vibrates them to produce sound.
Trachea	Begins from the larynx, situated below the neck, and enters the thoracic cavity. Walls of the trachea are strengthened by several C-shaped rings of cartilage that provide flexibility. Moves the air into the lungs through the bronchi.
Bronchi	Branches of trachea. Bronchi→Secondary bronchi→Tertiary bronchi→Bronchioles→Alveoli Helps in gaseous exchange.
Lungs	Pair of spongy and elastic respiratory organs. Enable rapid exchange of gases between air and blood. Separate the CO_2 from the blood and also excrete water vapour.
Diaphragm	Curved, musculo-fibrous sheath. Plays a major role during respiration.

Blood supply to the Lungs

- The deoxygenated blood is brought from the heart into the lungs through the pulmonary artery. The pulmonary artery divides into fine capillaries, which surround the alveoli.

- The concentration of oxygen in the alveolar air is more than the concentration of oxygen in the blood capillaries surrounding the alveoli. Hence, oxygen from the alveolar air moves into the blood capillaries by the process of diffusion.

- The exchange of gases between the air and the blood is called external respiration.

- The blood contains RBCs which contain the pigment haemoglobin. Haemoglobin has an affinity for oxygen and hence acts as an oxygen carrier. The oxygen combines with the haemoglobin to form oxyhaemoglobin.

- Whenever oxyhaemoglobin is exposed to an environment deficient of oxygen, it dissociates and releases oxygen. In tissues, the concentration of oxygen is low. Hence, oxyhaemoglobin dissociates and releases oxygen. The oxygen diffuses inside the tissues. The haemoglobin is re-formed in the process. In this way, the oxygen is supplied to all the tissues of the body which are deficient in oxygen.

- Exchange of gases between the cells and blood is called internal respiration.

- A large fraction of carbon dioxide produced inside the tissue is converted into bicarbonate, which gets dissolved in the blood plasma. A small fraction of carbon dioxide diffuses into the RBCs and combines with the haemoglobin, forming carbamino-haemoglobin.

- The blood rich in carbon dioxide is then transported back to the heart through the veins. From the heart, the blood is supplied to the lungs through fine branches of the pulmonary artery.

- The concentration of carbon dioxide is more in the blood capillaries surrounding the alveoli as compared to the alveolar air. Hence, the carbon dioxide from the blood moves into the alveolar air by the process of diffusion. The carbon dioxide is released from the body by the process of expiration.

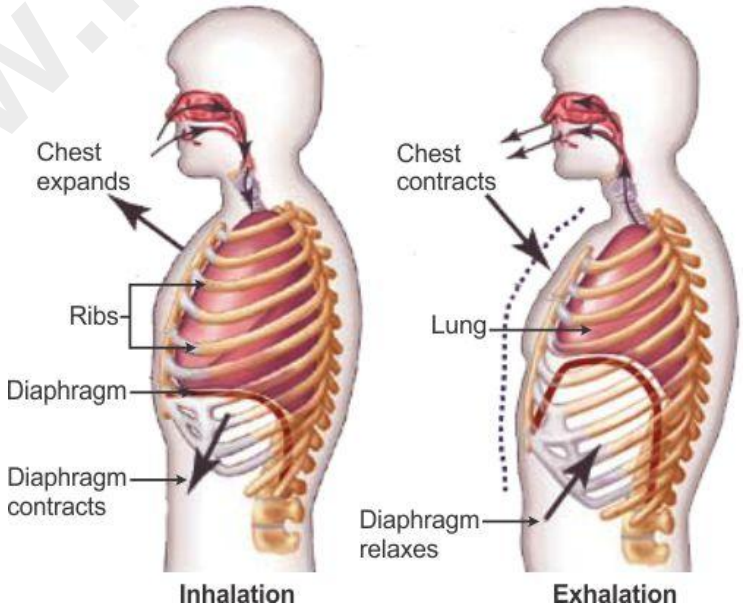
- **Differences between Breathing and Respiration**

BREATHING	RESPIRATION
• Physical process.	• Chemical process.
• Process of taking oxygen into the lungs.	• Process of taking oxygen from the lungs into the bloodstream or inside the cells.
• Occurs outside the cells.	• Occurs inside the cells.
• No energy is released.	• Energy is released.

- The respiratory cycle consists of inspiration and expiration, with a short respiratory pause.

- The inspiration or inhalation is the movement of air from the outside environment to the inside of the body. The oxygen from the air enters inside the body.

- The expiration or exhalation 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.



- A breath consists of one inhalation and one exhalation.

- The number of times a person breathes in a minute is called the breathing rate or respiratory rate.

- **Differences between Inspiration and Expiration**

PART OF THE RESPIRATORY SYSTEM	INSPIRATION	EXPIRATION
• Diaphragm	• Contracts and flattens downwards.	• Relaxes and moves upwards to form a dome shape.
• External intercostal muscles	• Muscles contract.	• Muscles relax.
• Internal intercostal muscles	• Relaxed/stretched.	• Contracted for forced expiration.
• Rib cage 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.

- Breathing movements are largely controlled by a respiratory centre located in the medulla oblongata of the brain.

- They are normally not under the control of our will. They are involuntary. However, one can consciously increase or decrease the rate of breathing.

- Air at higher altitudes contains a lesser amount of oxygen. Therefore, one may suffer from air sickness due to a lack of oxygen. Air sickness results in dizziness, unsteady vision, loss of hearing, lack of muscular coordination and even complete blackouts at times.

- Hypoxia is a condition in which the tissue is deprived of adequate supply of oxygen. It may occur due to sitting for long hours in a crowded room with poor ventilation. It may also occur at higher altitudes, where the oxygen concentration is low.

- Asphyxiation is a condition of severely deficient supply of oxygen to the body. It may occur due to several causes such as strangulation, drowning, choking or any other obstruction in the respiratory tract.

- **Comparison of Respiration in Plants and Animals**

SIMILARITIES	
• The process of cellular respiration releases energy. This energy released in the form of ATP is stored in the mitochondria.	
• The end products of aerobic respiration are carbon dioxide and water.	
DIFFERENCES	
RESPIRATION IN PLANTS	**RESPIRATION IN ANIMALS**
• Do not exhibit external ventilation or breathing movements.	• Higher animals such as human show external ventilation or breathing movements.
• No gaseous transport involved during respiration. The respiratory gases simply diffuse in and out of the cell.	• The tissue fluid—blood—is responsible for the transport of gases.
• Oxygen released during the process of photosynthesis acts as an additional source of oxygen.	• Air is the only source of oxygen.
• End product of anaerobic respiration is ethanol.	• End product of anaerobic respiration is lactic acid.
• Produces a small amount of heat.	• Produces a large amount of heat.
• Rate of respiration is comparatively lower.	• Rate of respiration is comparatively higher.