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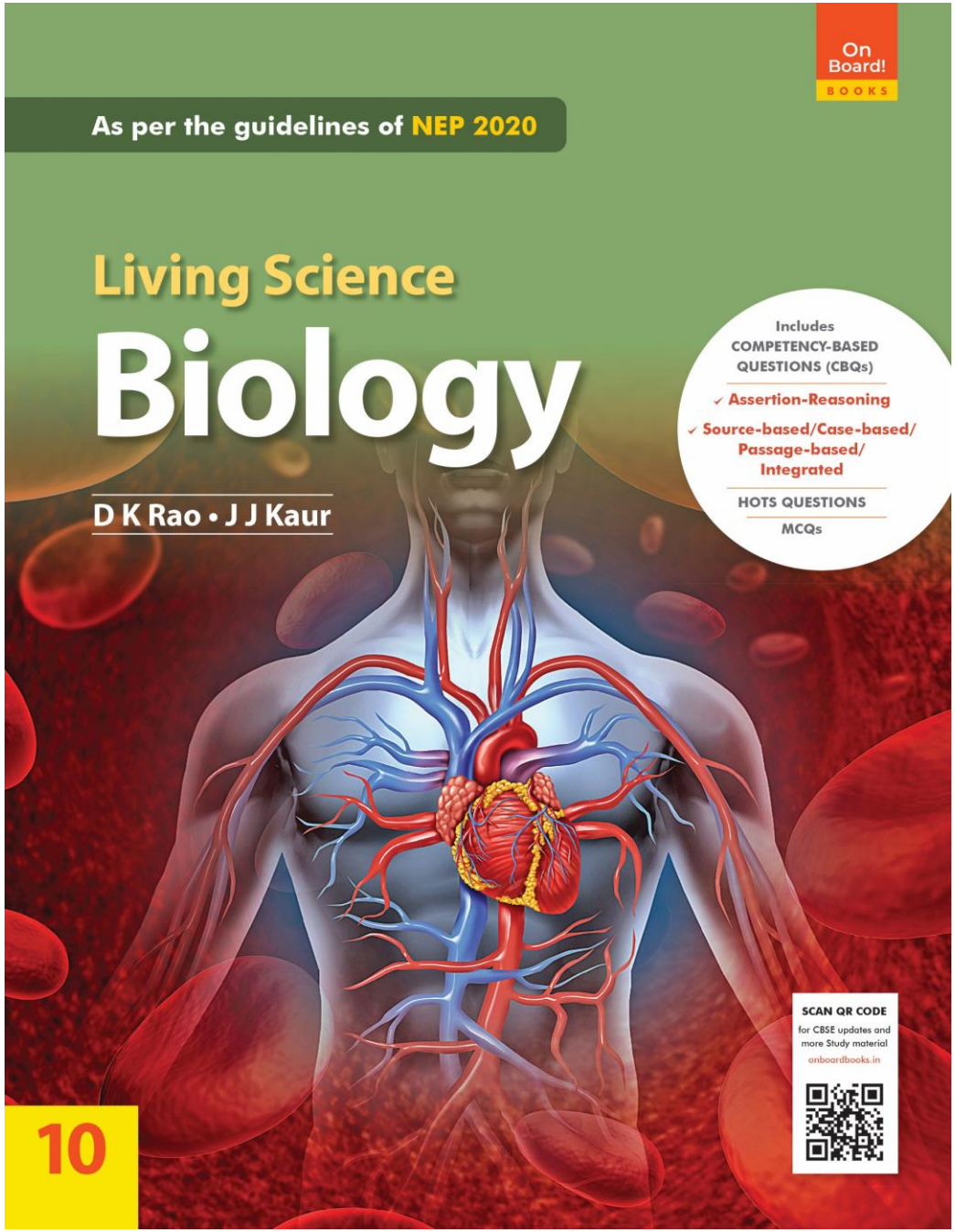
Board!
BOOKS


On Board! BOOKS
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Living Science
Biology
D K Rao • J J Kaur
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CBSE
Living Science
Biology

Class 10

Chapter 1 Life Processes
Unit 2: Respiration

LEARNING OBJECTIVES

Types of Respiration

- Aerobic and anaerobic respiration

Respiration in Plants

Gaseous Exchange in Animals

- Gaseous exchange in lower organisms
- Gaseous exchange in higher organisms

Respiration in Humans

- Breathing and respiration

Respiratory System in Human Beings

- Nostrils and nasal cavity
- Pharynx
- Trachea
- Bronchi and bronchioles
- Lungs

The Breathing Mechanism

- Inhalation (Breathing in)
- Exhalation (Breathing out)

Exchange of Gases in Lungs and Tissues

- Exchange of gases in lungs
- Exchange of gases in tissues

What is Respiration?

Respiration can be defined as the process of the release of energy in the form of ATP (adenosine triphosphate) from glucose molecules that are broken down to carbon dioxide and water molecules. It is initiated in the cytoplasm and completed in the mitochondria (in case of aerobic respiration).

Types of Respiration

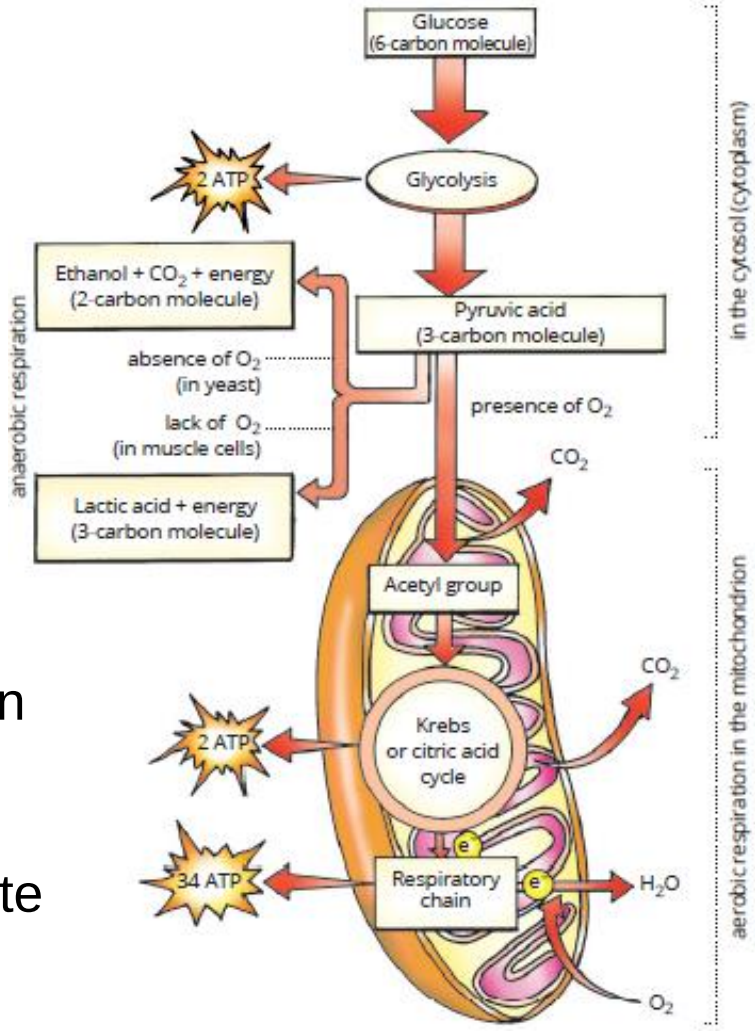
Depending upon the availability of oxygen for breaking down of glucose, two types of respiration are found – **aerobic respiration** and **anaerobic respiration**.

In the first step, each glucose molecule (6 carbon molecule) is broken down into two molecules of pyruvate (3 carbon molecule) by the process of glycolysis. The process occurs in the cytoplasm of the cell (not in the mitochondria) and does not require the presence of oxygen..

Aerobic Respiration

Respiration that occurs in the presence of oxygen is called aerobic respiration. It takes place inside the mitochondria**.** During aerobic respiration, if sufficient oxygen is available, each of the pyruvate molecule enters mitochondria where it is completely oxidized to produce CO_2 and H_2O

Fate of a glucose molecule in aerobic and anaerobic respiration pathways



Anaerobic respiration

Respiration that occurs in the absence of oxygen is called anaerobic respiration. There are two main types of anaerobic respiration i.e. lactic acid fermentation and alcoholic fermentation. In case of complete absence of oxygen, pyruvate does not enter mitochondria but is converted into ethyl alcohol (ethanol) (Reaction 3).

In both the above cases, a small amount of energy is released as a by-product (2 molecules of ATP per molecule of glucose). Thus, **the energy released in aerobic respiration is much greater than the anaerobic respiration**.

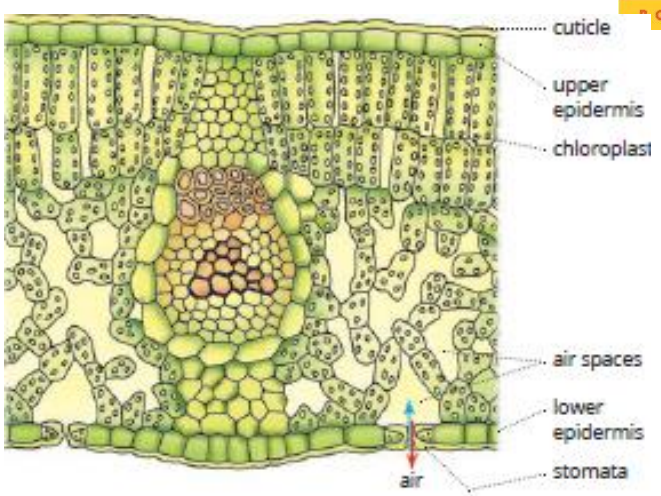
Note: Refer to Table 1.2 for the Differences between aerobic and anaerobic respiration

How is energy released during respiration used?

The energy released during respiration is immediately stored in the form of ATP (adenosine triphosphate) in the cells of the body. This ATP molecule is used to fuel all other activities in the cell. ATP is the energy currency for cellular processes. The energy equivalent of 30.5 kJ/mol is released by break down of one ATP molecule. This energy from ATP is used for body functions like protein synthesis, contraction of muscles, conduction of nerve impulse

Respiration in Plants

Plants respire by taking in oxygen and giving out carbon dioxide. All the parts of plant like root, stem and leaf respire day and night in order to survive. Further, the rate of respiration is high in the actively growing regions of plants while it is low in mature regions of plant body. The transport of gases in plants is much lower than in animals. In plants, the gases move entirely by the process of diffusion.

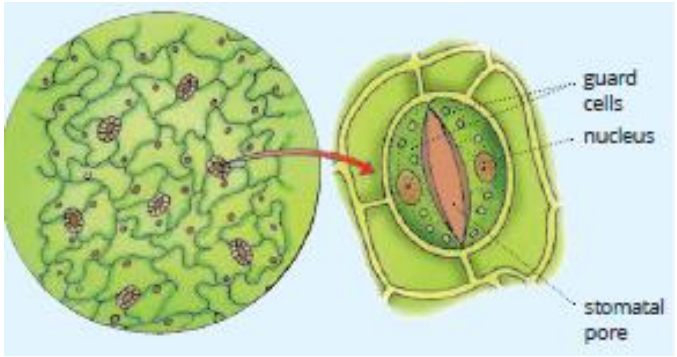


A cross section of leaf showing numerous intercellular spaces

Thus, tissues have intercellular spaces through which these gases diffuse freely. The arrangement of cells in a leaf is such that there are many air spaces in it that provide greater surface area for gaseous exchange.

Opening and closing of stomata

The opening and closing of stomata depends upon changes in turgor pressure of guard cells. When water gets inside the guard cells, their turgor pressure increases and they expand. As a result, the stomatal pore opens.



When guard cells lose water, the turgor pressure inside guard cells decreases. This results in closing of the stomatal pore.

Gaseous Exchange in Animals

Different organisms have different types of gaseous exchange structures which are designed to suit their habitats.

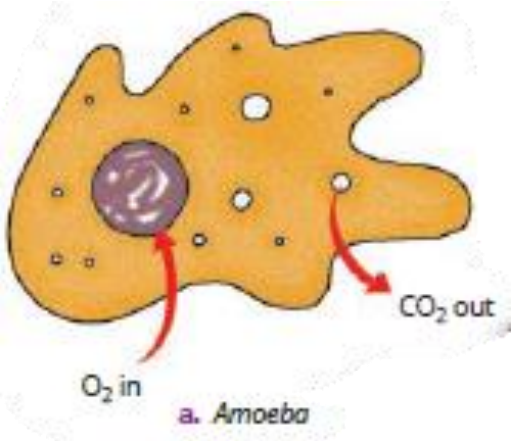
Gaseous exchange in lower organisms

The four main types of respiratory organs found among animals are **body surface** or **skin**, **air tubes** or **tracheae**, **gills** and **lungs**.

In lower organisms like *Amoeba*, sponges, *Hydra* and earthworm, there are no specialised organs for respiration. **In these organisms, gaseous exchange occurs by means of diffusion through the body surface via the cell membrane.**

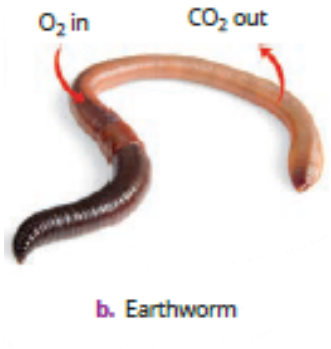
Respiration in unicellular organisms

The gaseous exchange in *Amoeba* takes place by means of diffusion via the cell membrane. The oxygen dissolved in water diffuses into the body and is utilized for the release of energy during respiration. The carbon dioxide produced is expelled out through the cell membrane.



Respiration in earthworm

Earthworm lives in the soil and respires through the skin. The skin is thin, moist, highly permeable and is richly supplied with blood capillaries that are present immediately below the cuticle. The oxygen absorbed by the skin is transported to all the cells of the body. The carbon dioxide produced is carried back by the blood capillaries and is expelled through the skin

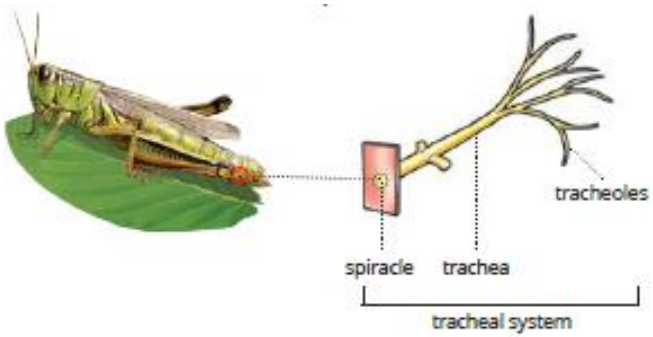


Gaseous exchange in higher organisms

To cope with the increased need of oxygen, certain specialised structures are present in the bodies of higher organisms that act as **respiratory organs**.

Respiration in insects

In insects, gaseous exchange occurs through a system of tubes called the **tracheal system**. The tracheal system consists of tiny holes called spiracles and the air tubes called tracheae that further bifurcate into tracheoles.

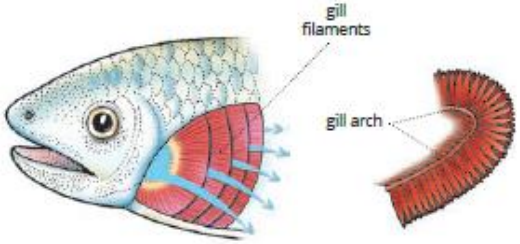


Tracheal system in grasshopper

Unlike the method of gaseous exchange through body surface, the tracheal system allows the oxygen in the inhaled air to diffuse directly to the tissues.

Respiration in aquatic organisms

Gills are the respiratory organs in aquatic organisms like prawns, mussels, fish and tadpoles. Gills are thin and moist membranous structures that are richly supplied with blood capillaries. During breathing, the fish takes in water through its mouth and sends it over the gills.



Fish breathes through gills .

Gaseous exchange occurs across the gill surface where the dissolved oxygen is absorbed by the blood and is transported to all the cells of the body. The carbon dioxide produced during respiration is carried back by the blood capillaries and is expelled in the surrounding water.

Respiration in terrestrial organisms

Lungs are internal conical-shaped structures that serve as respiratory organs in organisms with terrestrial mode of life such as frogs, lizards, birds and human beings. In frogs, exchange of gases occurs through both lungs and skin.

Respiration in Humans

In humans, respiration involves two steps – breathing and cellular respiration. **Breathing** or **external respiration** involves taking in of air containing oxygen and giving out of air containing carbon dioxide produced during oxidation of food.

Internal or **cellular respiration** involves release of energy by oxidation of food (glucose), and conversion of the energy released into biologically usable form, such as ATP (adenosine triphosphate) inside cell.

Respiratory System in Human Beings

The respiratory system in human beings includes **nostrils, nasal cavity, pharynx, larynx, trachea, bronchi, bronchioles, alveolar sacs or alveoli and lungs**

Nostrils and nasal cavity

The nasal passages are paired, tube-like structures that open outside through two nostrils separated by a **cartilaginous septum**. The inner surface of the nasal passage is lined by fine hairy ciliated epithelium and mucus secreting cells. Both cilia and mucus check the entry of microbes and dust particles in the respiratory passage.

Pharynx

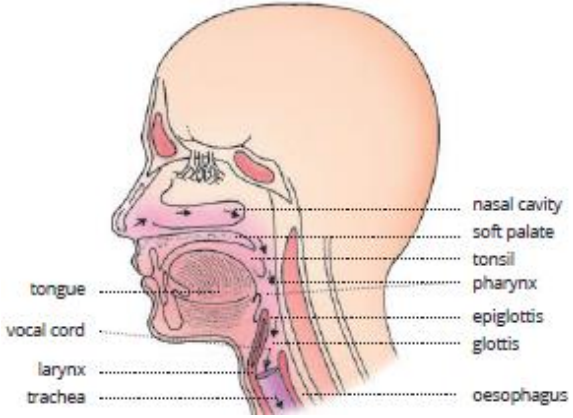
The pharynx is situated at the back of the mouth. From the nasal cavities, the air moves into the pharynx which is a common area to both digestive and respiratory tracts.

Note: Refer to Table 1.3 for Comparison between breathing and respiration

The pharynx opens into the **larynx** or **voice box** which leads to the trachea. It is also connected to the oesophagus or food pipe, which leads further into the digestive system. A cartilaginous flap called **epiglottis** guards the entrance to trachea.

Trachea

The trachea or windpipe is a tube, that extends into the thoracic cavity. It lies on the ventral side of the oesophagus. Its wall is provided with incomplete C-shaped **cartilaginous rings**.



These keep the trachea in dilated position and prevent it from collapsing. The ciliated epithelial lining and the mucus secreting cells extend from the nasal cavities up to the trachea. They help in preventing any dust particle or microbe from entering the lungs.

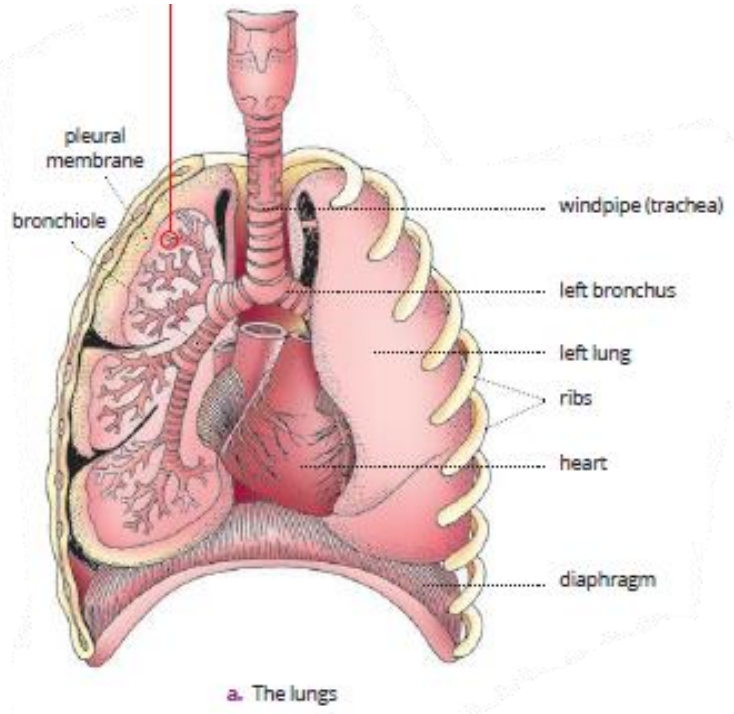
Bronchi and bronchioles

At its lower end, the trachea splits into two primary **bronchi** (sing. bronchus). The right bronchus is divided into three bronchi which extend separately into three lobes of the right lung. Similarly, the left bronchus is divided into two bronchi penetrating into the two lobes of the left lung.

Each bronchiole terminates in a sac called alveolus or alveolar sac. Alveoli are the actual sites of respiratory exchange. Hence, these are called functional units of lungs.

Lungs

The lungs are a pair of highly elastic, hollow, membranous bag-like structures situated in the thoracic cavity. Rib cage protects the lungs along with the heart. The broad lower surface of the lungs rests on a sheet of muscles called the **diaphragm** which forms the floor of the thoracic cavity and separates it from the abdominal cavity. **The right lung is larger than the left one.** The right lung is divided into three lobes whereas the left lung has two lobes. The lungs are covered by two membranes called **pleural membranes**.



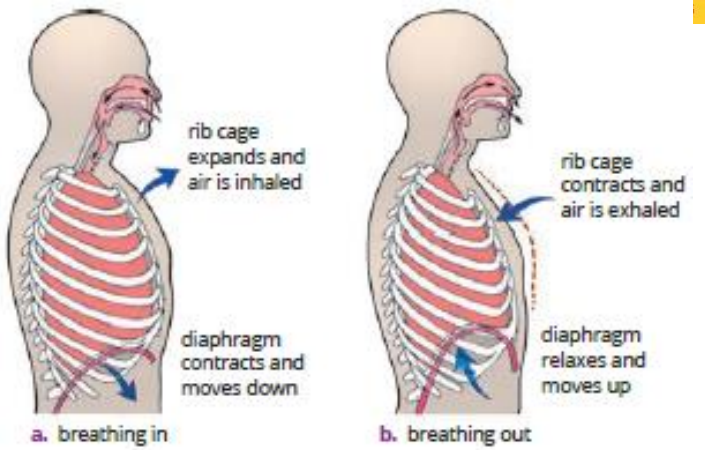
The Breathing Mechanism

Breathing, which ventilates the lungs, has a cyclic pattern. Air flows in and out of the lungs by alternate expansion and contraction of the thoracic cavity. **Breathing involves the movements of the rib cage and diaphragm** which alternately change the volume of the thoracic cavity.

Breathing involves two steps – 1.Inhalation or inspiration 2. Exhalation or expiration

Inhalation (Breathing in)

Inhalation or breathing in is always an active, energy-requiring process. It is brought about by simultaneous contraction of the intercostal and diaphragm muscles.



Mechanism of breathing

This produces a **forward** (upward) and **outward** movement of the rib cage. This action straightens and contracts the diaphragm.

Exhalation (Breathing out)

Exhalation or breathing out, is a passive process. It is brought about by relaxation of the intercostal and diaphragm muscles. This produces a **downward** and **inward** movement of the rib cage. The diaphragm and makes it dome-shaped (due to its upward movement). This results in a decrease in the volume of thoracic (chest) cavity and is followed by return of the lungs to their original size.

Note: Refer to Table 1.4 for Functions of different structures in the human respiratory system

Exchange of Gases in Lungs and Tissues

The process involves exchange of oxygen and carbon dioxide between the lungs and blood and between blood and body cells.

Exchange of gases in lungs

1. During breathing in, the air containing oxygen fills up alveoli of lungs. The alveoli are surrounded by very thin blood capillaries carrying rich supply of blood.

2. The concentration of oxygen in alveoli is higher than that in the deoxygenated blood in capillaries.

3. This difference causes oxygen to diffuse from the alveoli into the lung capillaries. This diffusion continues as long as the concerned molecules are unequally distributed.

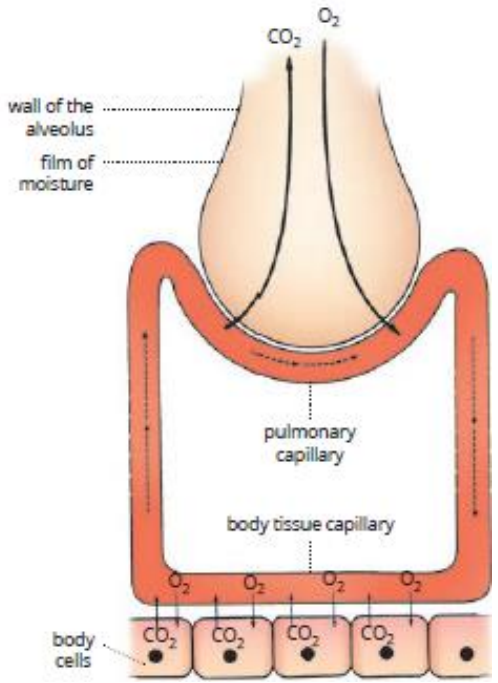
4. The blood present in the capillaries has high concentration of carbon dioxide which it has absorbed from body tissues. Therefore, carbon dioxide diffuses out from blood capillaries into the alveoli.

5. The oxygen is carried by a red pigment in our blood called **haemoglobin**. The haemoglobin binds the oxygen and takes it to all parts of the body. Deficiency of haemoglobin lowers the oxygen-carrying capacity of blood leading to breathing problems, lack of energy and tiredness.

Exchange of gases in tissues

In tissues, oxygen is used up in various metabolic activities and carbon dioxide is produced. Hence, in tissues the concentration of oxygen becomes lower than that in the capillaries, whereas carbon dioxide is present in a greater concentration in tissues than in capillaries.

Therefore, **oxygen is diffused from blood in capillaries to tissues (body cells) due to its higher concentration in blood than tissues and carbon dioxide is diffused from body cells to capillaries due to its higher concentration in body cells and tissues**. During each breathing cycle (breathing in asnd breathing out), the lungs always contain some air so that there is sufficient time for the oxygen to be absorbed and for the carbon dioxide to be released. This is called **residual volume**.



SUMMARY...

- Respiration is a biochemical process which involves the release of energy by break down of glucose molecules into carbon dioxide and water.
- Respiration which occurs in the presence of oxygen is called aerobic respiration. If it occurs in the absence of oxygen, it is called anaerobic respiration.
- Mitochondria are the sub-cellular compartments that contain the enzymes required to control biochemical processes involved in cellular respiration.
- There is little transport of gases in plants unlike animals. In plants, gases move entirely by diffusion through intercellular spaces, stomata and lenticels.
- In animals, breathing is simply an exchange of respiratory gases, whereas respiration includes exchange of gases along with the release of energy in cells.
- In arthropods, such as insects, gaseous exchange occurs via a system of tubes called the tracheal system.
- Gills are the respiratory organs in aquatic organisms like prawns, molluscs, fish and tadpoles.

- Lungs are the respiratory organs in terrestrial organisms, such as amphibians, reptiles, birds and mammals.
- The respiratory system in human beings includes – nostrils, nasal cavity, pharynx, larynx, trachea, bronchi, bronchioles, alveolar sacs or alveoli and lungs.
- Breathing in human beings is brought about by movements of the intercostal and diaphragm muscles which change the volume of thoracic cavity during inhalation and exhalation.
- Gaseous exchange is the primary function of the respiratory system. The process involves exchange of oxygen and carbon dioxide between the lungs and blood and between blood and body cells.

THANK YOU