LIFE PROCESSES

- Usually we differentiate living organisms from non-living by observing the movements in them. These movements can be:
    - Locomotion movements – In animals, e.g. running, chewing cud, etc.
    - Growth related movements – In plans, e.g. shoot growth, root growth, etc.
- These visible movements cannot be considered as defining characters of life, because so many of organisms don't show any visible movements but still they are alive. Like plants and many sleeping animals.

MOLECULAR MOVEMENTS

- There is one movement which is very important and necessary for life but invisible to naked eyes, this is **molecular movement** or movement of molecules.
- Viruses are considered as 'not alive' in free form only because they don't show any molecular movement when they are outside of host. But inside host they are alive and show molecular movements as well.

WHY MOLECULAR MOVEMENTS NEEDED FOR LIFE?

- Living organisms are well organized structures, they have tissues, tissues have cells, and cells have cell organelles in them. Because of the environmental effect the components of this organization is very likely to keep breaking down over time and the organism will no longer be alive. So living organisms must keep repairing and maintaining their structures. Since all these structures are made up of molecules, they must move molecules around all the time for repair and maintenance.

LIFE PROCESSES

- The basic functions performed by living organisms to maintain their life on earth are called **life processes**.

- The maintenance process requires energy to carry on their work so they need:
    - Energy source (food) by the process of **Nutrition**.
    - Food must be broken down to extract energy by process of **Respiration.**
    - Energy, O_2 and other materials must be provided to every cell by **Transportation**.
    - Toxic by-products must be expelled out of the body by process of **Excretion**.

- In unicellular organisms like amoeba, no specific organs for various life processes are needed because the entire surface of the organism is in contact with the environment. Here diffusion plays key role in exchange of materials.

- In multi-cellular organisms, all the cells may not be in direct contact with the surrounding environment. Thus simple diffusion will not meet the requirement of all the cells. That is why they require specialised tissue or organs for each life processes.

NUTRITION

- **Nutrition:** The process of transfer of a source of energy (or food) from outside the body of the organism to the inside is celled nutrition.
- **Nutrients:** Nutrients are energy rich chemical substances present in food which an organism obtains from the surroundings.

MODES OF NUTRITION

- All the organisms do not obtain their food in the same way. Different organisms have different methods of procuring food or obtaining food. There are two major groups:
  1. Autotrophs
  2. Heterotrophs

- **Autotrophs:** These are the organisms which make their own food by converting simple inorganic matter into complex organic matter. **All green plants** are autotrophs.

- **Heterotrophs:** These are the organism which depends on others for their food. They utilize complex substances and break them into simpler ones before they can be used.
- Heterotrophs depend directly or indirectly on autotrophs. It includes **animals** and **fungi.**

AUTOTROPHIC NUTRITION (PHOTOSYNTHESIS)

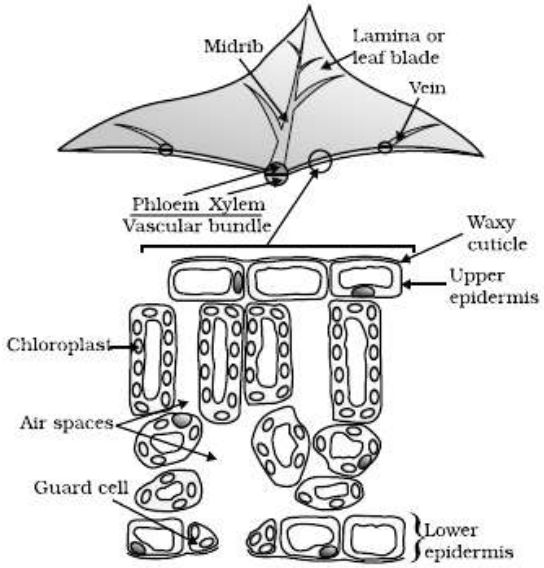
- Carbon and energy requirements of the autotrophic organisms are fulfilled by photosynthesis.

- **Photosynthesis** is a process by which green plants take carbon dioxide and water from the environment and transform into carbohydrate (glucose) and oxygen with the help of sunlight and chlorophyll.
- Carbohydrate is utilized for providing energy to the plant. The carbohydrates which are not used immediately are stored in the form of **starch as reserve food.**

$$6CO_2 + 6H_2O \xrightarrow[\text{Sunlight}]{\text{Chlorophyll}} C_6H_{12}O6 + 6O_2$$

SITE OF PHOTOSYNTHESIS

- **Chloroplasts** are the main site of photosynthesis; they occur mainly in the **mesophyll cells** of green leaves.
- All green parts of the plants contain chloroplasts in which **chlorophyll pigments** are contained.



Cross-section of a leaf

REQUIREMENTS OF PHOTOSYNTHESIS

- **CO_2:** It is obtained from atmosphere and enters the leaf through stomata present on its surface.
- **Water:** It is an essential raw material. Plants absorb water from the soil with the help of root system. It is then transported upwards to the leaves through xylem tissues.
- **Chlorophyll:** They are green coloured photosynthetic pigments present in chloroplast. They trap the light energy and utilize it during photosynthetic process.
- **Sunlight:** Energy of sunlight or solar energy is required to carry the photosynthetic process.

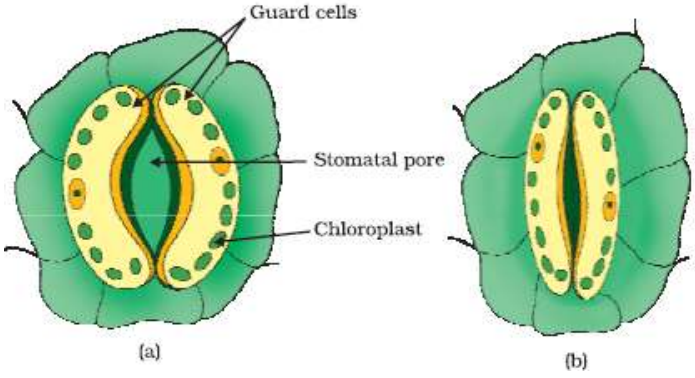
EVENTS OCCURRING IN PHOTOSYNTHESIS

1. Absorption of light energy by chlorophyll.
2. Conversion of light energy to chemical energy and splitting of water molecules into hydrogen and oxygen.
3. Reduction of carbon dioxide to carbohydrate.

- These steps need not take place one after the other immediately. For example, desert plants take up carbon dioxide at night and convert them in to an intermediate compound, during day, in the presence of sunlight this compound is converted into carbohydrate by energy absorbed by the chlorophyll.

STOMATA

- They are the tiny pores present on the surface of the leaves. The plant obtains CO_2 through these pores. Massive amount of gaseous exchange takes place between the plants and the atmosphere through these pores for the purpose of



photosynthesis. Sometimes exchange of gases also occurs across the surface of stems and root as well.

- Opening of stomata is guarded by **guard cells**. Guard cells regulate the opening and closing of stomata. When water flows in to them the guard cells swell causing the stomata pore to open and when guard cell shrink the pore closes. Guard cells are only epidermal cell which contain chloroplast.
- When CO2 is not required the opening of stomata are closed as large amount of water is also lost through this pores.
- Other materials like **nitrogen**, **phosphorus**, **iron** and **magnesium** are taken up from the soil. Nitrogen is an essential element used in the synthesis of protein and other compounds. This is taken up in the form of inorganic nitrates and nitrites. \

HETEROTROPHIC NUTRITION

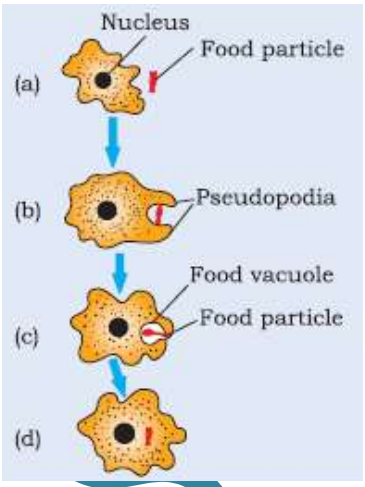
- This is characteristic of all animals and fungi, many bacteria and some non-green plants (e.g., Insectivorous plants) and man. These organisms do not possess the ability to synthesize their own food. Therefore, they depends upon autotrophs for their food supply directly or in directly.

- The living organism showing heterotrophic mode of nutrition, are called **Heterotrops**.
- Types of heterotrophic nutrition:-
  1. **Holozoic Nutrition:** In this type of nutrition, the animals take in the solid food through a definite path. e.g., Mammals, Amoeba, Hydra, etc.
     It involves a number of processes like.
     a. Ingestion: taking in complex organic food through mouth.
     b. Digestion: change of complex food into simple components.
     c. Absorption: passing simple nutrient into the blood and lymph.
     d. Assimilation: utilization of absorbed food; and
     e. Egestion: expelling the undigested food.

  2. **Saprophytic Nutrition:** In this mode of nutrition, the organisms feed on dead and decaying materials. The organisms release some enzymes to digest the dead organic food outside and then the nutrients are absorbed through the body surface. e.g., **fungi** like bread moulds, **yeast** and **mushrooms**.

3. **Parasitic Nutrition:** In this mode, the organisms derive nutrition from plants or animals without killing them. The parasites live on or inside the body of their hosts. e.g., **cuscuta** (amar-bel), **orchids**, **ticks**, **lice**, **leeches** and **tape-worm.**

How do Organisms obtain their Nutrition?



- Since the food and the way it is obtained differ, the digestive system is different in various organisms.

Nutrition in Amoeba

- Amoeba follow holozoic mode of nutrition, it possess no mouth, and therefore, intake of food may occur at any part of the body by the help of pseudopodia.
- Food inside body is contained within a food vacuole, where digestion process starts with the help of Lysosomes.
- The digested materials then diffuse into the cytoplasm. The remaining undigested material is moved to the surface of the cell and thrown out.

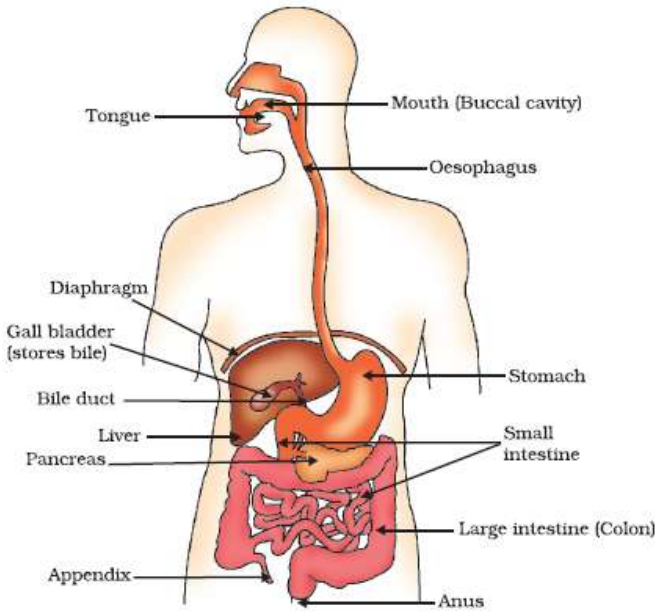
Nutrition in Paramoecium

- It is also a unicellular organism like amoeba but it has fixed body shape and entire body is covered by cilia.
- The food is taken in at a specific spot called mouth, cilia helps in ingestion of food. Rest processes are similar like that of Amoeba.

Nutrition in Human Beings

- Human digestive system is responsible for nutrition in human beings. It is comprises of the alimentary canal and associated digestive glands.
- The alimentary canal is basically a long, coil tube within the human body running mouth to anus. This tube has different parts, which are specialized for different functions.

Alimentary Canal



1. Mouth: It is site of ingestion which leads to buccal cavity.
2. Pharynx: It is a short region just after buccal cavity. It is junction of so many canals.
3. Oesophagus: It is long narrow muscular tube which leads to the stomach.
4. Stomach: It lies below the diaphragm on the left side of abdominal cavity. The food is stored and partly digested in the stomach. Its further opening is regulated by sphincter muscles.
5. Small intestine: It is the longest part of

the alimentary canal, which is very much coiled. It is longer in herbivores like deer and shorter in carnivores like tiger. Because herbivore need longer small intestine which is needed for digestion of cellulose, meat is easier to digest, hence carnivores have shorter alimentary canal. It has two main regions:

a. Duodenum
b. Ileum.

6. Large intestine: This is much shorter and wider than small intestine. It is differentiated into three regions:
   a. Caecum
   b. Colon
   c. Rectum

DIGESTIVE GLANDS

1. Salivary glands: These glands are open in mouth cavity and secrete saliva which contains an enzyme called salivary amylase that breaks down starch into sugar.
2. Gastric glands: These glands are present in the wall of stomach. These secrete a protein digesting enzyme known as pepsin, HCl and mucus.
3. Intestinal glands: Few glands are present along the wall of intestine. It also helps in digestion by secreting various enzymes.
4. Liver: It is the largest gland in man and lies just below the diaphragm in the right upper part of abdomen. The liver cells secrete bile juice which is stored in gall bladder and drained to small intestine in the presence of food.
5. Pancreas: It is soft lobule gland present near liver. It is second largest gland in human body. It secretes pancreatic juice which contains enzymes like trypsin, lipase and amylase.

PROCESS OF NUTRITION

1. Ingestion:

- It is the process of taking food inside the mouth. Food is crushed down by the help of teeth and tongue.

2. Digestion:

- The process of digestion involves breaking down of complex food molecules in to simple ones.
  - Digestion in mouth: In mouth food gets mixed up with saliva, secreted by salivary glands. The mucus and water of saliva make the food moist and salivary amylase (ptyalin) break starch into maltose (sugar).
  - Oesophagus: No digestion takes place in the oesophagus. Food passes through oesophagus to stomach by a characteristic muscular movement known as **peristaltic movement**.

- These rhythmic peristaltic movements which keep pushing food forward, occurs all along the gut.
- Digestion in stomach: In stomach gastric glands secrete gastric juice on the food. The muscular wall of the stomach helps in mixing the food with enzymes.
- Gastric juice contains HCl, Pepsin and Mucus. HCl serves functions like:
    - Kills the bacteria present in food
    - Provide acidic medium for action of pepsin.
- Pepsin works on proteins and converts them in to peptones.
- Mucus protects the lining of stomach from the action of HCl and enzymes.
- Digestion in small intestine: Small intestine receives the secretions of the liver and pancreas. The liver secretes bile juice which helps in **emulsification of fats.** In this process big fat droplets are broken down into smaller globules, which increase the efficiency of enzyme action. Liver dose not play any direct role in digestion process.
- Pancreas secretes pancreatic juice which contains enzymes like trypsin, lipase and pancreatic amylase working on proteins, fats and starch respectively.
- The medium in small intestine in changed to alkaline by bile salts for the pancreatic enzyme to act.
- The walls of the small intestine contain intestinal gland which secrete intestinal juice. The enzyme present in it finally converts the proteins to amino acids, carbohydrates (starch) to glucose and fat to fatty acids and glycerol. The digestion process completes in small intestine.
- Large intestine: No digestion takes place here. Large intestine absorbs water from the undigested materials and these undigested materials are stored temporarily.

3. **Absorption:**
    - The digested food is taken up by the wall of the intestine. The inner lining of the small intestine has numerous, finger like projections called **villi** which increase the surface area for absorption.
4. **Assimilation:**
    - It is the utilization of absorbed food for various body functions. The villi are richly supplied with blood vessels which take the absorbed food to each and every cell of the body, where it is used for obtaining energy, building up new tissue and the repair of old tissue.
5. **Egestion:**
    - The undigested waste materials are removed from the body via anus. The exit of this waste is regulated by the anal sphincter.
    - **Glygogen** is the reserve food material in animals which is stored in liver and muscles.

RESPIRATION

- Generally respiration is defined as "intake of oxygen and release of carbon dioxide" which is in fact a kind of gaseous exchange.
- The scientific meaning of respiration is a complex process involving:
    1. **Gaseous exchange** *i.e.* intake of oxygen from the atmosphere and release of carbon dioxide, and
    2. **Break down of simple food** in order to release energy inside the cells.
- Thus, respiratory process can be divided into two separate terms:
    1. Breathing
    2. Cellular respiration
- **Breathing:** It is gaseous exchange in which the organisms take oxygen from the environment and release carbon dioxide.
- **Cellular respiration:** It is a complex process that occurs inside the living cells. It is the oxidation of respiratory substrate (glucose) in the cell resulting in release of carbon dioxide and energy in the form of ATP.

Breathing	Respiration
It is the mechanism of exchange of gases, oxygen and carbon dioxide.	It is biochemical process involving oxidation of food.
It does not release any energy.	It releases energy that is stored in ATP.
It does not involve enzyme action.	It involves number of enzymes in oxidation.
It is confined to certain organ only	It occurs in all cells of the body.

TYPES OF CELLULAR RESPIRATION

- Cellular respiration can be divided into two categories depending upon the availability of atmospheric oxygen:
    1. Aerobic respiration
    2. Anaerobic respiration

AEROBIC RESPIRATION

- It is a type of respiration which occurs in the presence of oxygen. During this process, food or respiratory substrate (glucose) is completely broken down into CO_2 and H_2O by the oxidation process. This result in the production of ATP, which is the source of energy.

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{Energy (38 ATP)}$$

- Entire aerobic respiration can be divided into two sub-parts:
    1. Glycolysis, and
    2. Krebs cycle.

- The first part of aerobic respiration (**Glycolysis**) occurs **in cytoplasm**, where glucose molecule is broken down to **pyruvic acid** (a three carbon compound).
- In the second part (**Krebs cycle**), the pyruvic acid enters **into mitochondria** in the presence of oxygen where it is completely broken. This oxidative breakdown results in the production of energy rich compound ATP.
- One molecule of glucose gives 38 ATP in aerobic respiration.
- The organisms showing aerobic respiration are called **aerobes.** It includes majority of animals and plants.

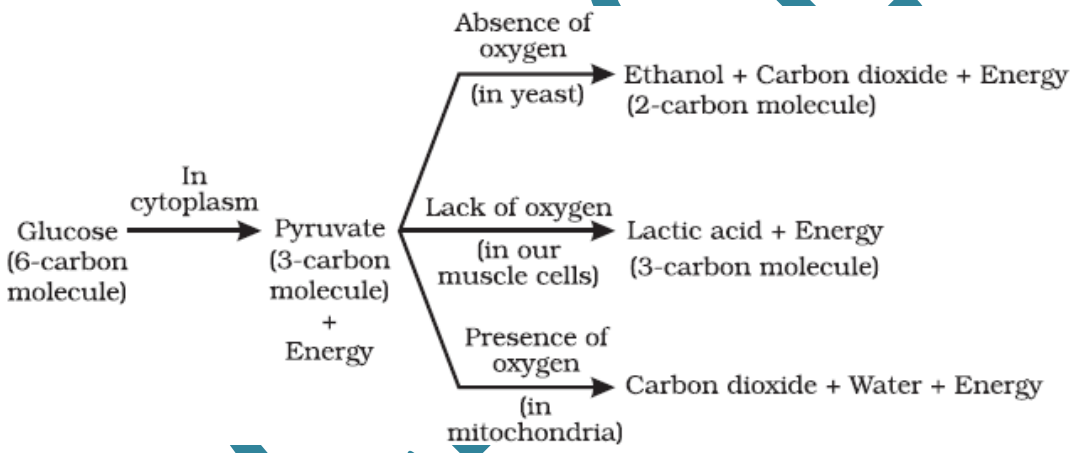


FIGURE: BREAKDOWN OF GLUCOSE BY VARIOUS PATHWAYS

ANAEROBIC RESPIRATION

- It is type of respiration which occurs in the absence of oxygen. It involves incomplete breakdown of food (glucose) in which the end products, such as ethanol & CO_2 or lactic acid are formed. During this process, respiration may or may not produce carbon dioxide but does not utilize molecular oxygen.
- The first step of anaerobic respiration is same as aerobic respiration, in which the initial breakdown of glucose to pyruvic acid occurs in cytoplasm, known as glycolysis. **Glycolysis is common step in both aerobic and anaerobic respiration.**
- Further breakdown of pyruvic acid in the absence of oxygen results in the production of ethanol & CO_2 or lactic acid. This breakdown takes place in cytoplasm only; there is no role of mitochondria in anaerobic respiration.
- One molecule of glucose gives 2 ATP in anaerobic respiration.

- Anaerobic respiration is also called **fermentation**. It is found in microorganisms like yeast, anaerobic bacteria, etc. It results in the production of ethanol & CO_2.

$$C_6H_{12}O_6 \rightarrow C_2H_5OH + CO_2 + \text{Energy (2 ATP)}$$

- The organisms which depend on anaerobic respiration are called **anaerobes**. It includes microorganisms like yeast, anaerobic bacteria, etc.

- Anaerobic respiration also occurs inside the **muscles during vigorous activities**. It usually occurs when oxygen get used up faster than it is available to the muscles cells. In this condition glucose breakdown into pyruvic acid and due to absence of oxygen pyruvic acid is converted into lactic acid which is also a three- carbon molecule. This build up of lactic acid in our muscles during sudden activity causes **cramps.**

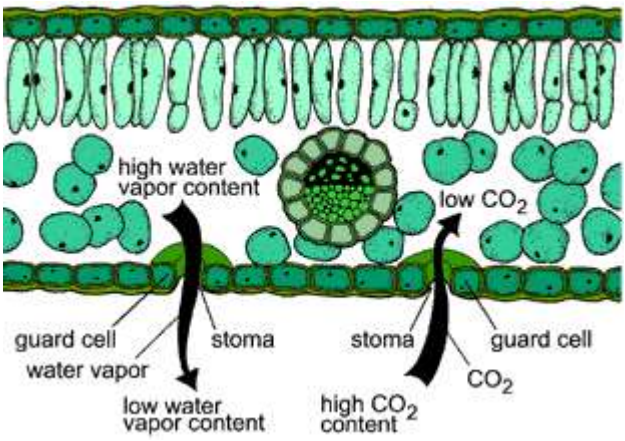
Aerobic Resp.	Anaerobic Resp.
It occurs in the presence of oxygen where oxygen is utilized.	It occurs in the absence of oxygen.
Glucose is completely broken down into CO_2 and H_2O.	Glucose is incompletely broken down into ethanol or lactic acid.
Energy released in larger amount.	Energy released in lesser amount.
It takes place in cytoplasm and mitochondria.	It takes place only in cytoplasm; mitochondria not involved.

GASEOUS EXCHANGE OR BREATHING

- Since the aerobic respiration pathway depends on oxygen, aerobes need to ensure that there is sufficient intake of oxygen.

GASEOUS EXCHANGE IN PLANTS

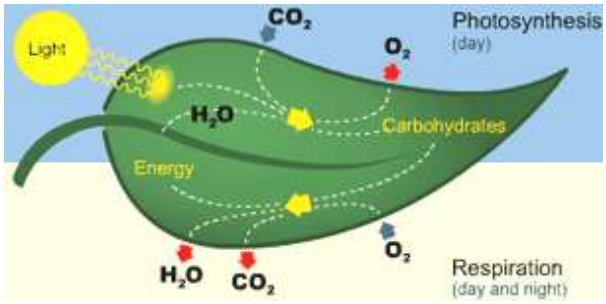
- Respiration in plant is simpler than the respiration in animals. Gaseous exchange takes place in all parts of a plant like root, stem and leaves. It occurs through:
    - Stomata in leaves
    - Lenticels in stems
    - General surface of the roots.



RESPIRATION THROUGH STOMATA

- Stomata are small apertures found on the surface of leaf through which plants exchange gases. The large inter-cellular spaces ensure that all cells are in

contact with air. CO_2 and O_2 are exchanged by diffusion here.



- The direction of diffusion depends upon the environmental conditions and the requirement of the plant.
- **At night,** when there is no photosynthesis occurring, **Oxygen enters stomata** by the process of diffusion and then into other cells of the leaf. This oxygen is utilized in the breakdown of glucose to CO_2 & H_2O. When concentration of CO_2 increases inside the cells, it diffuses out through stomata.
- **During the day**, CO_2 generated during respiration is used up in photosynthesis; hence there is no CO_2 release. Instead, **O_2 release and CO_2 intake** are the major event at this time.

GASEOUS EXCHANGE IN ANIMALS

- In animals respiration takes place with the help of some specific respiratory organs, which differs in different animal groups.
    - **Aquatic animals** like fish, prawns and mussels have **gills** for respiration.
    - **Land animals** like lizard, bird, and human have **lungs** as respiratory organ.
    - **Frog** breath both by **skin and lungs**. (Tadpole breathes by gills.)
    - **Insects** like grasshopper, housefly or cockroach have **air tubes or trachea** as their respiratory organ.
- Terrestrial or land animals can breathe the oxygen in the atmosphere, but animals that live in water (aquatic) need to use the oxygen dissolved in water.
- Since the amount of oxygen is fairly low compared to the amount of oxygen in the air, the rate of breathing is much faster in aquatic organisms than terrestrial organisms.

RESPIRATION IN TERRESTRIAL ANIMALS

- Terrestrial organisms use the atmospheric oxygen for respiration. This oxygen is absorbed by different organs in different animals. But all these organs must have some common specialization in order to perform respiration or gaseous exchange:
    - All these organs have a structure that **increases the surface area** which is in contact with the oxygen rich atmosphere.
    - For the easy diffusion of gases this surface must be very **fine and delicate**. They must be **supplied with rich capillary network**.
    - In order to protect, it is usually placed within the body, so there have to be passages for the movement of gases to this area.

RESPIRATORY SYSTEM IN HUMAN BEINGS

- In human beings, the lungs are the respiratory organs and are located in the thoracic cavity.
- The human respiratory system consists of nostril, nasal cavity, pharynx, trachea, bronchi, bronchioles leading to alveoli inside the lungs.
- In human beings air is taken into the body through the **nostrils**. The air passing through the nostrils is filtered by fine hairs and mucus.
- The air passes through the throat or **pharynx** into **trachea** or windpipe. Rings or cartilage are present in the throat to ensure that the air-passage or trachea.
- The trachea runs down the neck and enters the thorax and divides into **right and left bronchi.**
- The bronchi within lungs branch into smaller tubes called **bronchioles** and each bronchiole finally terminate in balloon like structure called **alveoli**.
- The alveoli provide a surface where the exchange of gases can take place. For that the wall of alveoli contains an extensive network of blood capillaries.

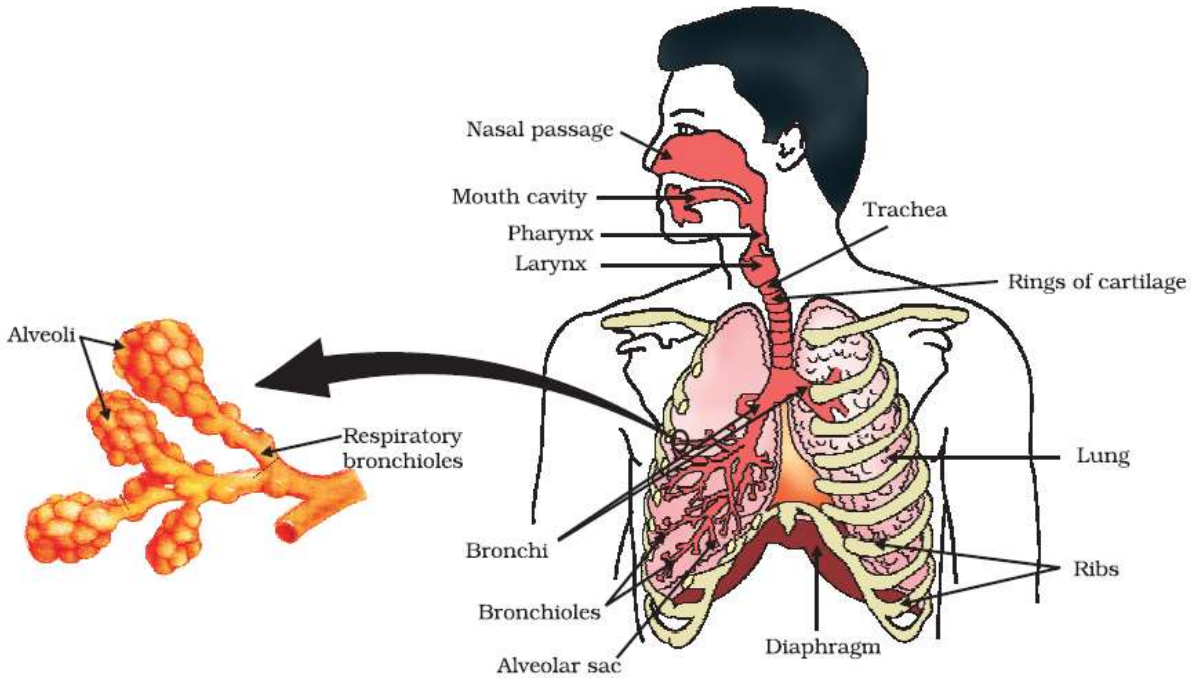


FIGURE : HUMAN RESPIRATORY SYSTEM

BREATHING MECHANISM IN HUMAN BEINGS

- The mechanism by which organisms obtain oxygen from the environment and release carbon dioxide into environment is called breathing.

- Breathing has two events:
  - Inhalation
  - Exhalation

INHALATION OR INSPIRATION:

- It is taking up of atmospheric air or oxygen into the thoracic cavity. This occurs when the thoracic cavity expands.

- The diaphragm and muscles attached to ribs contracts, which lift our ribs and flatten our diaphragm. This makes the thorax move upward and outward thereby increasing the volume inside thoracic cavity.

- Thus air pressure decreases and air from outside rushes into lungs through nostrils trachea and bronchi.

EXHALATION OR EXPIRATION:

- It is concerned with the expelling of carbon dioxide from lungs.

- This happens when the thoracic cavity come back to original size as diaphragm and rib muscles relaxed.

- **Diaphragm** is a muscular partition separating the thorax from the abdomen in mammals.

- During the breathing cycle, when air is taken in and let out, the lungs always contain a **residual volume** of air so that there is sufficient time for oxygen to be absorbed and for the carbon dioxide to be released.

- In small and microscopic animals diffusion pressure is alone sufficient to deliver oxygen to all part of the body. But in case of large bodied animals this is not possible.

- So large bodied animals must have some transport mechanism to carry oxygen from lungs to the tissue and bring CO_2 from tissue to lungs.

- In human beings, **heamoglobin** is a respiratory pigment which has very high affinity for oxygen. It is present in RBC and play major role in transport of oxygen from lungs to tissue.

- CO_2 from tissue is mainly transported in the dissolved form in our blood; because it is much more soluble in water hence no special pigment is required.

TRANSPORTATION

- The body of every plant and animal is made of cell. For the survival and maintenance of this cells oxygen water and food or other substance are required. This must be picked up at one end of the body of an organism and transported to other parts.
- **Transportation** is a life process in which a substance absorbed or synthesized in one part is move to other part of body.
- The transportation methods are different in plants and animals. In plants this is mainly done by conducting tissue *e.i.,* xylem and phloem and in animals transportation of material is mainly done by circulatory system.

TRANSPORTATION IN HUMAN BEINGS

- In higher organism various such as oxygen carbon dioxide, digested food, hormones, excretory products, etc are transported by specialize long distance transport system. The materials are generally transported from one point to another as a result of pressure difference between the two points.
- In human beings there are two circulatory system through which the materials are transported to relevant organs and tissue they are:
  1. Blood vascular system
  2. Lymphatic system

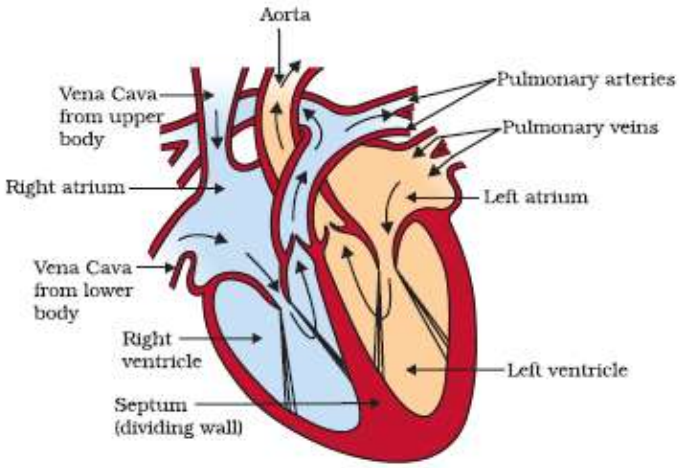
BLOOD VASCULAR SYSTEM

- It is consists of three components:
  1. Blood
  2. Heart
  3. Blood vessels

BLOOD – THE FLUID CONNECTIVE TISSUE

- It is a red coloured, opaque, sticky fluid that flows in blood vessels. Blood is formed of two parts (1) Plasma and (2) Corpuscles or Cells.
- **Plasma** is liquid matrix of the blood. About 90 per cent of plasma is water. Plasma contains inorganic salts, proteins, glucose, urea, dissolved gasses, hormones, vitamins, enzyme, etc, for transportation.
- **Corpuscles** or blood cells bathe in the plasma. It is of three types:
  - Erythrocytes or RBC: It has iron containing pigment known as heamoglobin which helps in Oxygen transport.
  - Leucocytes or WBC: These cells fight against pathogens and play major role in immune system.
  - Blood Platelets: It helps in the clotting of blood.

THE HEART – OUR PUMP

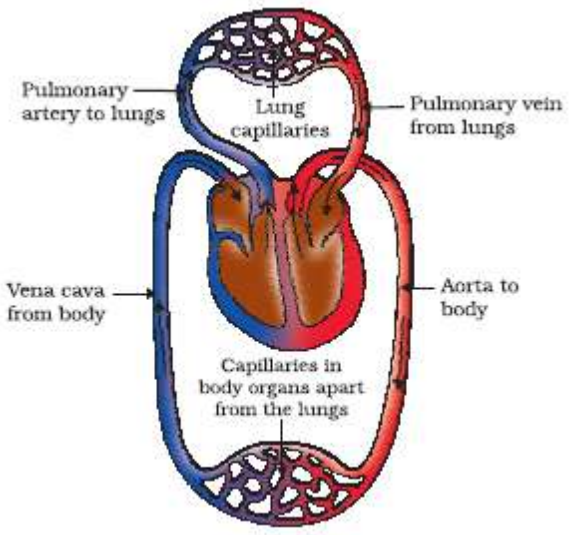


- The heart is a hollow, muscular organ which lies obliquely in the thorax between the lungs, just above the diaphragm. It is as big as out fist.
- The heart is partitioned into right and left parts; each consists of two parts, an upper thin walled atrium and a lower thick walled ventricle.
- Four chambers of the heart are:
    1. Left atrium
    2. Left ventricle
    3. Right atrium
    4. Right ventricle
- Ventricles are separated from each other by a septum or dividing wall.

BLOOD FLOW THROUGH THE HEART

- The carbon-dioxide rich blood has to reach the lungs for the carbon-dioxide to be removed, and oxygenated blood from the lungs has to be brought back to the heart. This oxygen rich blood is then pumped to the rest of the body.

- The flow of blood through heart takes place step by step-
    1. Oxygenated blood from the lungs comes to the left chamber of the heart, the atrium via the pulmonary veins.
    2. When the left atrium contracts, the ventricle expands and the blood is transferred to it.
    3. On contraction of the left ventricle, the blood is pumped out from heart through aorta.
    4. The aorta branches into vessels which transports blood to the heart and all body parts.
    5. De-oxygenated blood comes from the body to the upper chamber of the heart, the right atrium through large veins called vena-cava.
    6. When right atrium is full of blood, it contracts and the blood into the right ventricle.



7. When the right ventricle contracts, the blood is pumped into pulmonary artery.
8. The pulmonary artery carries the de-oxygenated blood to the lungs for oxygenation.

- The atrium act as receiving chambers and the ventricles as pumping chambers. Wall of the ventricle is thicker because they have to pump the blood.

VALVES OF THE HEART:

- Valves are muscular flaps generally present in veins to prevent the backflow of blood.
- There are two types of valves present in heart too:
    1. Valve between atria and ventricle on both left and right side.
    2. Valves located in pulmonary artery and aorta.

- In humans, the separation of the right side and left side of the heart is useful to keep oxygenated and de-oxygenated blood from mixing such separation allows a highly efficient supply of oxygen to the body. This is useful in animals that have high energy needs, such as birds and mammals, which constantly use energy to maintain their body temperature (warm blooded animals).

HEART OF DIFFERENT VERTEBRATES:

- In Birds and Mammals
- In warm blooded animals like birds and mammals the heart is four chambered and completely divided into two parts left and right, to prevent the mixing of oxygenated and deoxygenated blood.

- In Amphibian and Reptile
- They are cold blooded animals and their body temperature is equal to the environment, such animals can tolerate the mixing of oxygenated and de-oxygenated blood up to some extent. Because the energy needs is less as compare to the worm blooded animals. That's why they have three chambered heart.

- In Fishes
- Fishes (a cold blooded animal) have only two chambered heart, and the blood goes only once through the heart in the fish during one cardiac cycle. This is known as single circulation of blood.

- **Double circulation of blood**
- In all other vertebrates except fishes, e.g., mammals, birds, reptiles and amphibians, the blood enters twice in the heart during one cardiac cycle. One circulation involves the entry of de-oxygenated blood from all body parts into heart and goes to lungs for oxygenation. The second circulation involves entry of oxygenated blood from lungs into heart and then its distribution to all parts of body.

BLOOD VESSELS – THE TUBES

- There are three types of blood vessel of different sizes involved in blood circulation viz, arteries, veins, capillaries.

- **Arteries:** Arteries are the vessels which carry blood away from the heart to various organs of the body.
- Blood pressure is high in arteries because blood of artery emerges from the heart, so they have thick, elastic walls with narrow lumen.
- They generally carry oxygenated blood except pulmonary artery, which carry de-oxygenated blood.

- **Veins:** Veins are the vessels which collect the blood from different organs and bring it back to the heart.

- The blood pressure is low in vein because the blood emerges from body tissue, so they have thin walled and have valve to prevent the backflow.
- They generally carry de-oxygenated blood except pulmonary veins which carry oxygenated blood.

- **Capillaries:** The artery divides into smaller and smaller vessels to bring the blood in contact with all the individual cells. The smallest vessels have walls which are one cell thick and are called capillaries.
- Their walls are permeable, so that water and dissolved substances pass in and out exchanging oxygen, carbon dioxide, dissolve nutrients and excretory products with the tissue.
- The capillaries than join together to form veins that convey the blood away from the organ and tissue.

MAINTENANCE BY PLATELETS – BLOOD CLOTTING

- The blood has platelets cells which circulate around the body which help in the clotting of blood to prevent it from excessive bleeding.
- The mechanism that prevents the loss of blood at the site of an injury or wound by forming a blood clot is called blood clotting.

LYMPHATIC SYSTEM

- It is a system consisting of:
  1. Lymph,
  2. Lymph vessels and capillaries
  3. Lymph nodes or lymph glands.

- It transports the liquid lymph from the body tissue to the blood circulatory system. The flow is unidirectional.

- **Lymph:** It is a light yellow fluid containing lymphocytes cell, which fight against infection. Lymph flow only in one direction that is from tissue to heart. Lymph is also called extra-cellular fluid.

- **Lymphatic capillaries:** They are thin walled capillaries forming a network in every tissue except nervous system.
- **Lymphatic vessels:** The lymphatic capillaries unite to form lymphatic vessels which are very similar to veins in structure. They are the pathway for fluid returning from tissue to the heart.

- **Lymph nodes and lymph glands:** They are in the course of the lymph vessels and generically rich in lymphocytes thus acts as filter for the microorganism.

- **Functions of lymph:**
  1. Lymph carries digested and absorbed fat from intestine and drains excess fluid from extra cellular space. Back in to the blood.
  2. It also protects the body by killing the germs with the help of lymphocytes.
  3. It helps in exchange of materials between blood and tissue.

TRANSPORTATION IN PLANTS

- The major materials which are needed by plant cells are gases like oxygen and carbon dioxide, water and minerals like nitrogen, phosphorus, etc., they get from the soil by the process of absorption by roots. These raw materials need to be transported to each and every part of the plant, mainly to leaves.
- The other substances needed by all living cells are organic food and hormones which are synthesized by the plant cells and distributed by the transport system.
- If the distance between roots and leaves is small, then these raw materials can reach till leaves easily by the process of diffusion.
- In case distance between roots and leaves is more, then proper system of transportation is required.
- Transport system is less elaborate in plants as compare to animals. It is because the plants bodies have a large proportion of dead cells and comparatively less active thus require less supply of energy.
- In plants the transport of water and minerals form the roots to all other parts of the plant take place through **xylem.** There is continuous absorption of water and

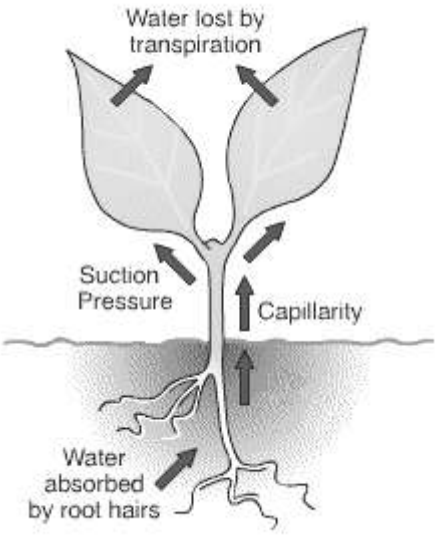
minerals from the soil by the root cells. This produces a force to that pushes water in the upward direction. Transpiration of water from the surface of leaf also produces a pulling force which causes the water to move.

- The food prepared by the leaves is transported to various parts of the plant for the purpose of storage or consumptions through **phloem.**

- In plants, transport system mainly consists of tube like structures xylem and phloem, organizing in different ways in different plants. These constitute the **vascular system** of plants.

TRANSPORT OF WATER

- In xylem tissue, **vessels and tracheids** of the roots, stems and leaves are interconnected to form a continuous system of water-conducting channels reaching all parts of the plant.
- Water and minerals enters roots from the soil through root hairs. Root hairs are directly in contact with the water in between the soil particle.
- The cells of roots, actively take up ions which creates a difference in the concentration of the ions between the root and soil.
- To eliminate this difference, there is a steady movement of water into root xylem, creating a column of water that is steadily pushed upwards called **root pressure.**
- The pressure creating this column of water by itself is unlikely to be enough to move water over the heights. Plant uses another strategy to move water in the xylem upwards to the highest points of the plant body, which is known as **transpiration pull mechanism.**
- As the plant has adequate supply of water, water is mainly lost through the stomata. The lost water is replaced from the xylem vessels in the leaf.
- The evaporation of water molecules from the leaf cells creates a suction which pulls the water from xylem cells of the roots.
- This loss of water is transpiration, which helps in the absorption and upward movement of water and minerals dissolved in it from roots to leaves.



- Thus, transpiration pull becomes the major driving force in the movement of water in the xylem when the stomata are open during the day. At night, the effect of root pressure on transport of water is more important.
- Transpiration also helps in temperature regulation by keeping the surface of the leaves cool due to constant evaporation.

TRANSPORT OF FOOD AND OTHER SUBSTANCES

- The food prepared by the leaves, amino acids, hormones and other substances are transported to various parts of the plant in the solution form through a process called translocation.
- Translocation is facilitated by phloem. Movement of material through phloem occurs due to action of living cells called **sieve tubes** with the help of adjacent **companion cells** both in upward and downward direction.
- Unlike xylem, the transport in phloem is energy consuming process, where energy is utilized in the form of ATP.
- The osmotic pressure of the tissue increases causing water to move into it. This pressure moves the materials in the phloem to other tissues.

EXCRETION

- The cells of the body work all the time for the sustenance of life in organisms. The work mainly takes place in the form of biochemical reactions. During these reactions toxic wastes may be generated and there may be excess of water content in the body.
- These waste products are harmful if they are allowed to accumulate in the body. These need to be removed and this is mainly done by the process of excretion.
- *The biological process involved in the removal of the excess or metabolic toxic wastes from the body is celled execration.*
- For execration, different organism uses various strategies to do this. Many unicellular organisms remove wastes by simple diffusion. And other complex multicellular organisms use specialized organ to perform the function of excretion.

EXCRETION IN HUMAN BEING

- The excretory system of human beings includes:
  - A pair of kidneys

- A pair of ureters
- A urinary bladder
- A urethra.

- **Kidneys:** Each kidney is bean shaped reddish in colour and is located in the abdomen, one on other side of the backbone. The left kidney is placed a little higher than the right kidney.

- **Ureters:** Urine produced in the kidneys passes through the two excretory tubes or ureters, one from each kidney in to urinary bladder.

- **Urinary bladder:** The urine collected in the urinary bladder, which is a bag like temporary storage organ.

- **Urethra:** from urinary bladder, urine is passes in to a muscular tube called urethra, from which it is thrown out through the urinary opening.

NEPHRON

- Each kidney up of excretory units called nephron.
- They are considered as functional unit of the kidney.
- Each nephron has a cup shaped structure called **Bowman 's capsule**.
- This Bowman's capsule contain bundle of blood capillaries which is called **glomerulus**.
- Blood is flitered from blood capillaries in to Bowman's capsule.
- Useful products such as glucose, amino acids, present in the blood are reabsorbed by the blood capillaries surrounding the nephrons.
- The nephrons drain the waste into a space inside kidney leading to the ureter.

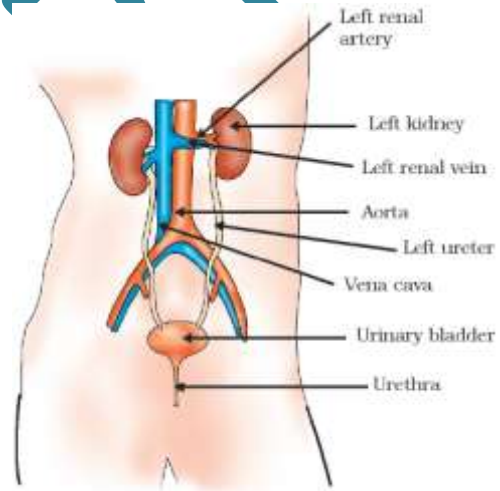


Figure 6.13
Excretory system in human beings

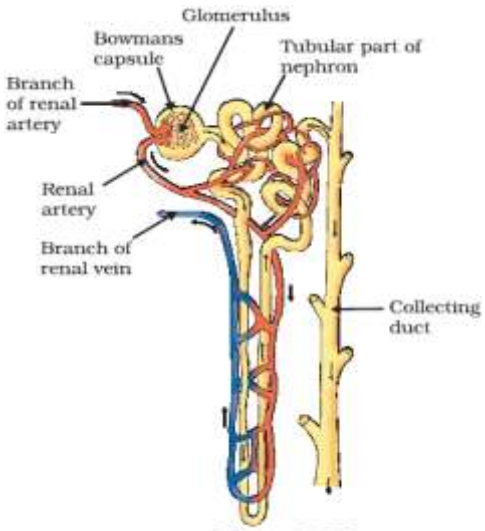


Figure 6.14
Structure of a nephron

FORMATION OF URINE

- The purpose of making urine is to filter out the waste products from the blood.
- All nitrogenous waste such as urea and uric acid are removed from blood in the kidneys, thus the basic filtration unit is the kidneys.
- Each capillary cluster in the kidney is associated with the cup shaped end of a tube that collects the filtrated urine.
- Each kidney has large numbers of filtration units called nephrons packed close together.
- In the initial filtrate, some substances such as glucose, amino acids, salts and major amount of water are selectively reabsorbed as the urine flows along the tube.
- The amount of re-absorption of water depends on how much excess water is there in the body and on how much of dissolved waste is there to be excreted.
- The urine formed in each kidney eventually enters the ureters which connect kidneys with the urinary bladder.
- Urine is stored in the urinary bladder, until the pressure of the expended bladder leads to the urge to pass it out through the urethra.

EXCRETION IN PLANTS

- Plants also produce certain excretory materials which have to be expelled out. Plant use completely different strategy for excretion than those of animals.
- The main waste products produced by plant are CO_2, water vapour and O_2.
- They get rid of excess water by the process of transpiration. Photosynthetic and respiratory waste like O2, CO2 and Water are expelled out through the stomata of leaves and lenticels of the stems.
- Dead leaves, bark or any other part of a plant which fall of or got rid of by the plants are also the products of excretion.
- Many plant waste products are stored in cellular vacuoles; waste products may be stored in the leaves that fall off.
- Other waste products are stored as resins and gums especially in old xylem.
- Plants also excrete some waste substances into the soil around them.