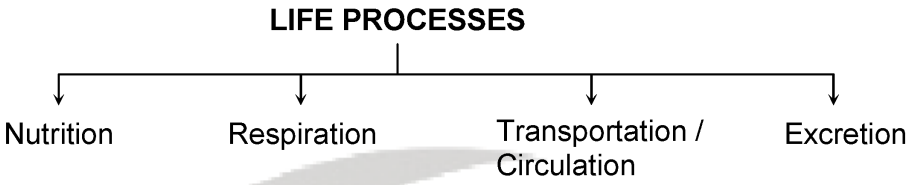
Life Processes

The various basic functions like nutrition, respiration, excretion etc performed by living organisms to survive and maintain their life on this earth are called life processes. The basic life processes common to all living organisms are as follows :

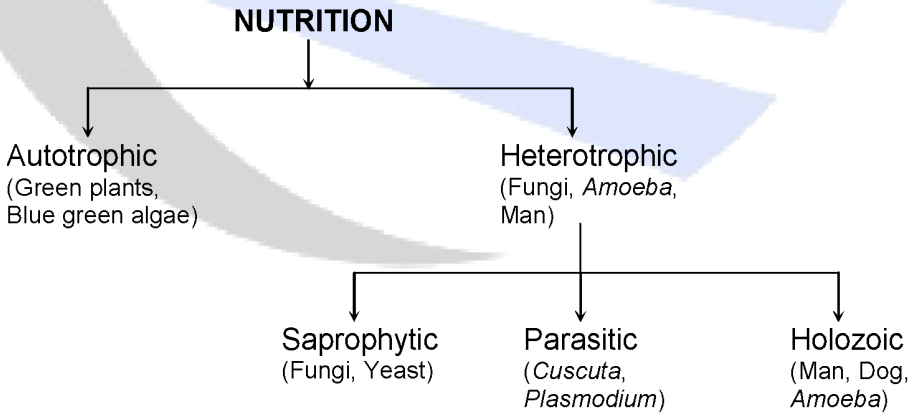


1. NUTRITION

- Nutrition is derived from the word **'nutrient'**. Nutrient is an organic or inorganic substance like proteins, carbohydrates, fats, vitamins and mineral salts, which provides energy for various metabolic processes.
- The process of obtaining food from the surroundings and using it for various metabolic activities by an organism is called **nutrition**.
- **Energy** is needed to maintain a **state of order** and balance in our body called **homeostasis**. We also need materials from outside to grow, develop, synthesize protein and other substances needed in the body. This source of energy and materials is the food we eat.
- Since, life on earth depends on carbon-based molecules most of these food sources are also carbon-based. Depending upon the complexity of these carbon-sources, different organisms can then use different kinds of nutritional processes.

1.1 MODE OF NUTRITION

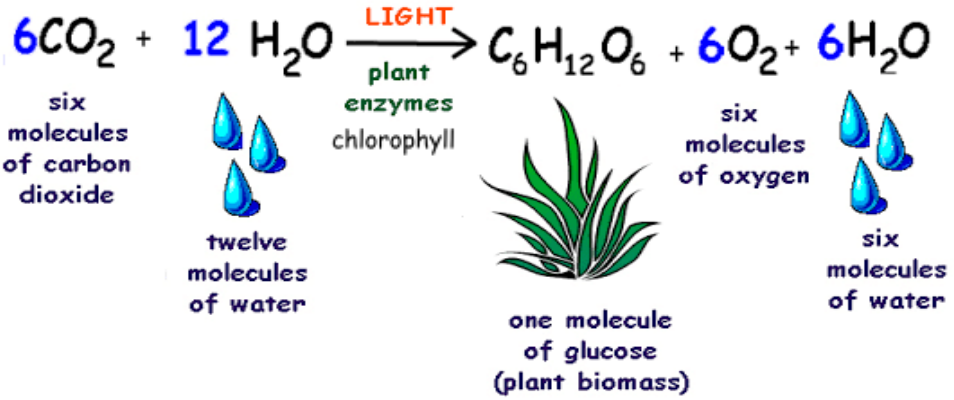
Nutrition is defined as the method or mode of obtaining food by an organism. These are of two types.

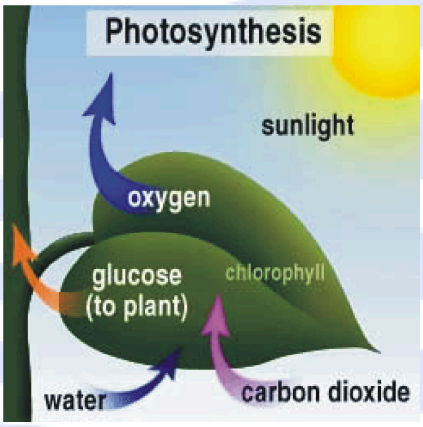


1.1.1 Autotrophic Nutrition

Green plants are capable of manufacturing their own food in presence of light by using water and carbon-dioxide, this process is called **photosynthesis**. Such mode of nutrition is termed as **autotrophic nutrition**.

(i) **Photosynthesis :** It is the process by which green parts of the plant synthesise organic food in the form of carbohydrates from CO_2 and water in the presence of sunlight.





Green plants make their own food by photosynthesis.

(a) **Steps of photosynthesis :** During the process of photosynthesis, the following events occur :

- **Absorption** of light energy **by chlorophyll**.
- **Conversion** of light energy to chemical energy and splitting of **water molecules** into **Hydrogen** and **oxygen**.

  $H_2O \rightarrow 2H^+ + 2e^- + 1/2\ O_2$

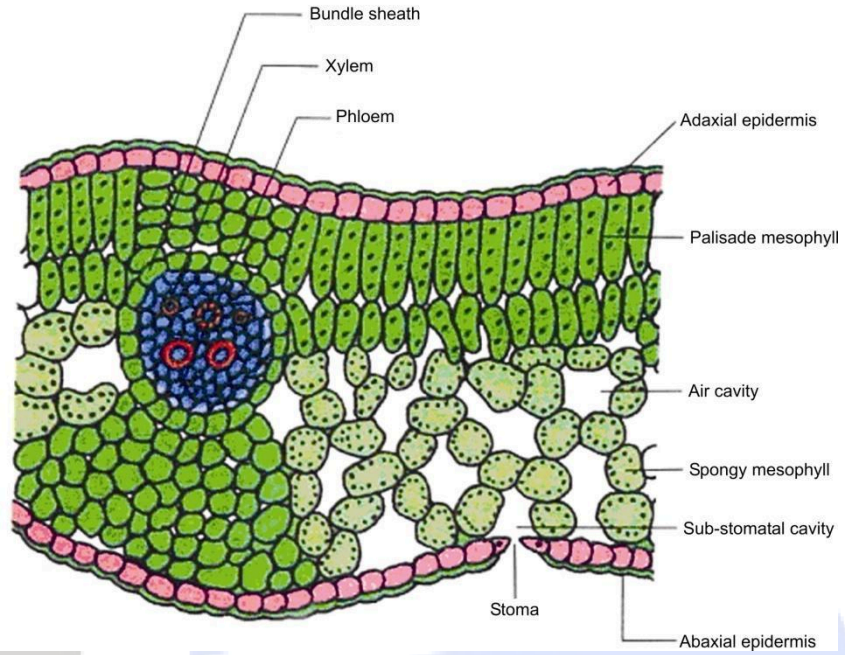
  The above processes are considered as **light reaction.**
- **Reduction** of **carbon-dioxide** to **carbohydrates**. This is also known as **dark reaction**.

(b) **Conditions necessary for photosynthesis.**

- Sunlight
- Chlorophyll
- Carbon-dioxide
- Water

These conditions are needed for **autotrophic mode of nutrition**.

(c) **Chloroplast :** Chlorophyll containing organelles (i.e. plastid) which are found in large numbers in plant and algal cells undergoing photosynthesis are called **chloroplast**.

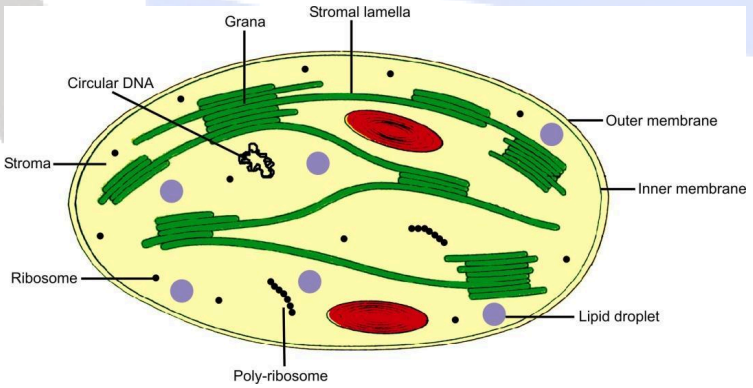


The structure of a leaf to show chloroplasts in it.

(The small circles in the above diagram are all chloroplasts).

- Leaf Adaptations to perform photosynthesis.
- Lamina – Leaf surface is large.
- Chlorophyll – Photosynthetic pigment in chloroplast.
- Water available through the xylem in vascular bundles of leaf.
- CO_2 obtained through *stomata* pores on the leaf epidermis.

The chloroplasts are, lens shaped and bounded by a double membrane. They are the main site of photosynthesis and occur in mesophyll cells of the leaf.



Internal Structure of Chloroplast

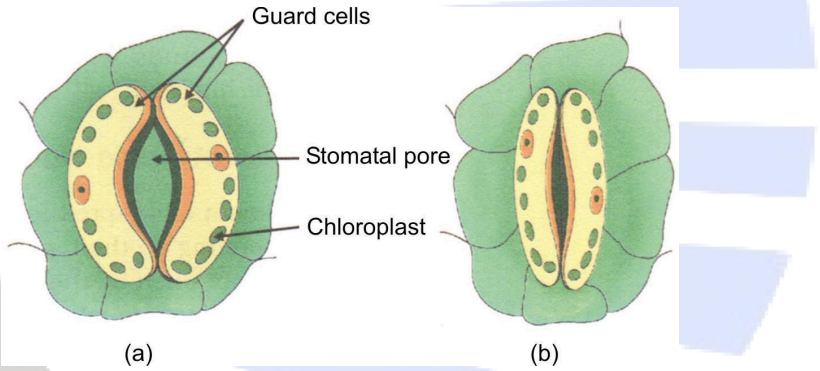
(d) Raw materials for photosynthesis

· **Carbon dioxide** : It is a gas, which is released into the atmosphere during respiration by all living organisms. This gas is utilized by autotrophic plants which enters the leaf through the stomata present on its surface during the process of photosynthesis.

- **Water :** It is another requirement for photosynthesis which is **transported** upward through **xylem tissues** to the leaves, from where it reaches the photo-synthetic cells. This water then splits in the presence of sunlight and chlorophyll.
- **Chlorophyll :** It is a green pigment in plants which act as a **catalyst.** It is responsible for absorption of sun's energy. The chlorophyll pigments are **photoreceptor molecules** which play a key role in the photosynthetic process. The different types of chlorophyll molecules are chlorophyll a, b, c, d and bacteriochlorophyll; of which **chlorophyll a** and **b** are most common.
- **Light :** It affects the rate of photosynthesis by its **intensity, quality** and **duration.** In green light, the rate of photosynthesis is minimum, while in red and blue lights the rate of photosynthesis is maximum. Rate of photosynthesis is higher in plants getting average light of 10-12 hrs a day.

(e) Structure of Stomata : They are tiny pores present on the surfaces of the leaves. Stomata function in **gas exchange** between the plant and the atmosphere. Each stoma is bordered by two **bean** / **dumbbell** shaped guard cells in **dicots** and **monocots** respectively.

Opening and Closing of Stomatal Pore : The opening and closing of the pore is the function of guard cells. The guard cells swell when water flows into them causing the stomatal pore to open. Similarly the pore closes if the guard cells shrink. As large amount of water is lost through stomata, the plant closes these pores.



(a) Open and (b) closed stomatal pore

Elements such as N, P, Fe and Mg are required by the plant to build their body is taken up from the soil by roots. **Nitrogen** is the most important constituent of amino acid and nitrogenous bases.

How do desert plants perform photosynthesis?

Since there is a lot of loss of water through transpiration during the day, they open their stomata at night and take in carbon dioxide. They convert the carbon dioxide to an intermediate. During the day, with the help of sunlight, the intermediate is converted to glucose.

1.1.2 Heterotrophic Nutrition

In multicellular organisms all the cells may not be in direct contact with the surrounding environment. Therefore, simple diffusion will not meet the requirement of all the cells.

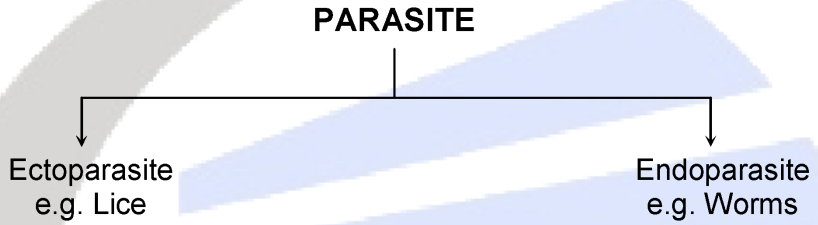
The type of nutrition in which organisms derive their food (nutrients) from other living organism is called **heterotrophic nutrition**. In heterotrophic nutrition the energy is derived from the

intake, digestion and oxidation of the organic substances, normally of plant or animal origin. Heterotrophic mode of nutrition is of different types :

(i) Saprotrophic Nutrition : It refers to the mode of nutrition in which organisms obtain nutrients from the **dead and decaying organic matter** e.g. fungi, yeast and bacteria. These organisms are called **saprophytes**.

(ii) Parasitic Nutrition : It refers to the mode of obtaining food synthesized by other animals and effecting them badly. The organism which obtains food is called the **parasite** and the organism from which the food is obtained is called **'host'**. This nutrition is observed in fungi, bacteria, few plants like *Cuscuta* and some animals like *Plasmodium* and roundworm, orchids, ticks, lick, leeches etc.

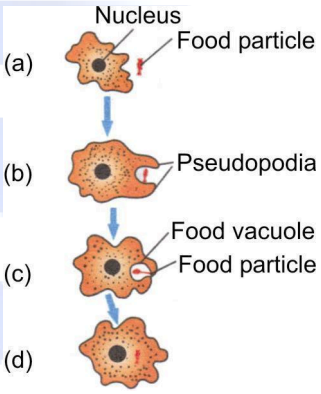
Parasite can be further classified as follows



(iii) Holozoic Nutrition : it refers to the mode of nutrition in which the complex organic matter in the form of solid food is **ingested, digested and then absorbed into** the cells and utilized e.g. *Amoeba*, frog, human being etc.

(a) Nutrition in *Amoeba*

- The mode of nutrition in ***Amoeba*** is **holozoic** and it is omnivorous.
- It feeds on **unicellular plants** or animals such as *Paramecium*, *Oscillatoria* etc.
- The various steps of nutrition are **ingestion, digestion, absorption, assimilation** and **egestion**.
- When *Amoeba* comes in contact with food particles, it sends out temporary finger-like extensions of the cell surface called **pseudopodia** which engulf the prey by forming a food cup. This process is **ingestion**.



Nutrition in Amoeba

- When the tips of encircling pseudopodia touch each other, the food is encaptured into a bag called **food vacuole**. This step is **digestion**.
- The **food vacuole** serves as a **temporary stomach** secreting digestive juice.
- The digested food gets absorbed and diffuses into the cytoplasm and then assimilated. This process is called **assimilation**.

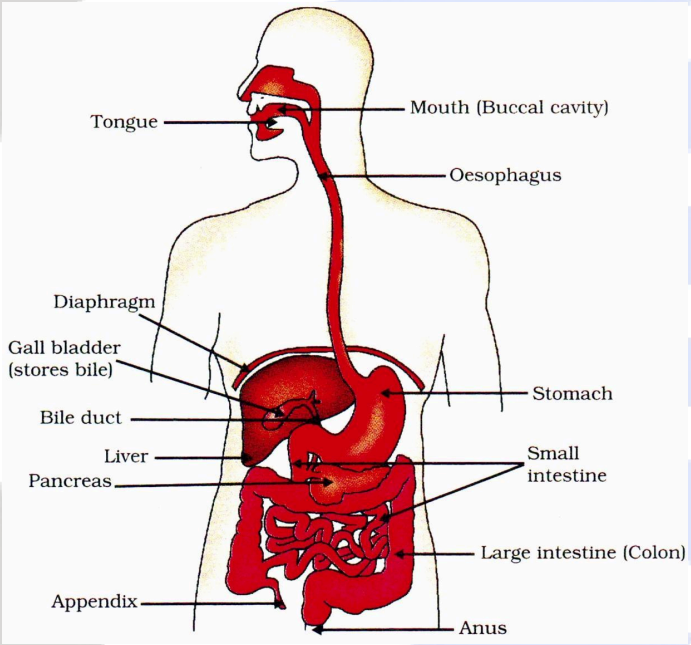
- The process of elimination of undigested food is called **egestion**. Egestion of undigested food takes place at any point on the surface of the body i.e. there is **no fixed anus.**

Nutrition in *Paramaecium:* Paramecium also shows holozoic nutrition. It is different from amoeba as it has a designated spot for taking in food and a designated spot for egestion.

(b) Nutrition in Human Beings : The organs which are responsible for ingestion, digestion absorption, assimilation and egestion constitute the digestive system. The digestive system comprises of alimentary canal and associated digestive glands.

Mouth → Buccal Cavity → Pharynx → Oesophagus → Stomach → Small Intestine → Large Intestine → Rectum → Anus

Process of nutrition : the digestive system consist of long alimentary canal extending from mouth to the anus.



The human digestive system.

PROCESS OF NUTRITION (HUMAN)

Ingestion → Digestion → Absorption → Assimilation → Egestion

Ingestion : Process of taking food inside the body.

Digestion : The food is crushed to smaller particles which are smaller and of same texture by teeth and mixed with saliva secreted by salivary glands.

- **Saliva** contains an enzyme called **salivary amylase** that breaks starch into sugar. Thus digestion of starch (carbohydrates) begins in mouth itself. Since the food remains in mouth only for a short time, so the digestion of food remains incomplete in mouth.

- The food is swallowed with the help of **tongue** and goes down the food pipe called **oesophagus** which carries it to the stomach by the rhythmic contraction of muscles produced by lining of alimentary canal. These movements are called **peristaltic movements**.
- **Stomach** is a large organ which expands when food enters it. The muscular walls of the stomach help in mincing the food thoroughly with more digestive juices.
- These digestive functions are taken care of by the gastric glands present in the wall of the stomach. These glands release hydrochloric acid, a protein digesting enzyme called pepsin and mucus.
- **HCl** (hydrochloric acid) **facilitates the action of enzyme pepsin** as this enzyme works in acidic medium. HCl also **prevents fermentation** of food and **kills harmful micro-organisms** present in food.
- Pepsin, the protein diagesting enzyme converts proteins into peptones and proteoses (digestive protein).
- Mucus protects the lining of stomach from the action of HCl.
- From stomach, the food enters the small intestine. The exit of food from the stomach is regulated by a **sphincter muscle** which releases it in small amounts into the small intestine.
- The length of the small intestine is different in various animals depending on the food they eat.
- Herbivores eating grass need a longer small intestine to allow cellulose to be digested. Meat is easier to digest, hence carnivores like tigers have a shorter small intestine.
- The small intestine is the site of complete digestion of carbohydrates, proteins and fats.
- The food coming from the stomach is acidic and has to be made alkaline for the pancreatic enzyme to act. Bile juice from the liver accomplishes this in addition to acting on fats.
- Fats are present in the form of large globules in small intestine which makes it difficult for enzymes to act on them.
- Bile salts break fats into smaller globules and thus increase the efficiency of enzyme action. This is called **emulsification of fat**.
- The pancreas secretes following enzymes :
  1. Trypsin which digest proteins.
  2. Lipase which digests fats.
  3. Amylase which digests carbohydrates.
- The walls of small intestine contain glands which secrete intestinal juice. The enzymes present in it, finally convert the proteins into amino acids, complex carbohydrates into glucose and fats into fatty acids and glycerol. Digestion is completed in the small intestine.

Absorption and Assimilation : The inner lining of the small intestine has numerous finger – like projections called **villi** which increase the surface area for the absorption of digested food. The villi are richly supplied with blood vessels which take the absorbed food to each and every cell of the body, where it is utilized for obtaining energy, building up new tissues and the repair of the old ones.

Egestion : The undigested food is sent into the large intestine where more villi absorb water from this material. The rest of the materials are removed from the body via anus. The exit of this waste material is regulated by anal sphincter. This is called **egestion**.

Summary of Digestive enzymes of various glands with their secretion and end products of Digestion in Man

Name of gland	Secretion	Site of action	Enzymes	Food acts upon	End product
1. Salivary gland	Saliva	Buccal cavity	Salivary amylase or Ptylin	Starch	Maltose
2. Gastic glands	Gastic Juice HCl	Stomach	Pepsin	Proteins	Peptones and proteoses
			Renin	Caesein of milk	Paracaesein
3. Liver	Bile	Duodenum	-	Fats	Emulsification of fats
4. Pancreas	Pancreatic juice	Duodenum	Amylase	Starch and Glycogen	Maltose and isomaltose
			Trypsin	Proteins	Peptones and peptides
			Lipase	Emulsified fats	Fatty acids and glycerol
5. Intestinal glands	Intestinal juice	Small intestine	Erepsin	Peptones and peptides	Amino acids
			Maltase	Maltose	Glucose
			Sucrase	Sucorose	Glucose and fructose
			Lactase	Lactose	Glucose and galactose
			Lipase	Triglycerides	Monoglycerides and fatty acids
	Mucous	Large intestine	-	Lubrication of faecal matter	-

2. RESPIRATION

2.1 RESPIRATION IN PLANTS

Plants need energy. This energy is obtained through the process of respiration :

- Plants exchange gases through stomata by the process of diffusion.
- **Exchange of gases CO_2 and O_2 in Plants :**

  At Night → No Photosynthesis only Respiration → CO_2 is given out

  At Daytime → Photosynthesis and Respiration → O_2 is given out

  ↓

  CO_2 is used up in photosynthesis.

Comparison between respiration in animals and plants

S.No.	Respiration in Animal	Respiration in Plants
1.	Animal performs respiration as a single unit.	All parts of plant (like root, stem, leaves) perform respiration individually.
2.	Respiratory gases are usually transported to long distances	There is little transport of respiratory gases from one part of the plant to other.
3.	Respiration occurs at faster rate.	It occurs at slower rate.
4.	Specialized organs for breathing.	No such specialized organs (only stomata and lenticels).

2.2 RESPIRATION IN ANIMALS

- The food material taken in during the process of nutrition is used in cells to provide energy for various life processes. Break-down of food in cells to release energy is called **cellular-respiration.**
- Some organisms use oxygen to break-down glucose (food) in cells completely into carbon dioxide and water (**aerobic respiration**).

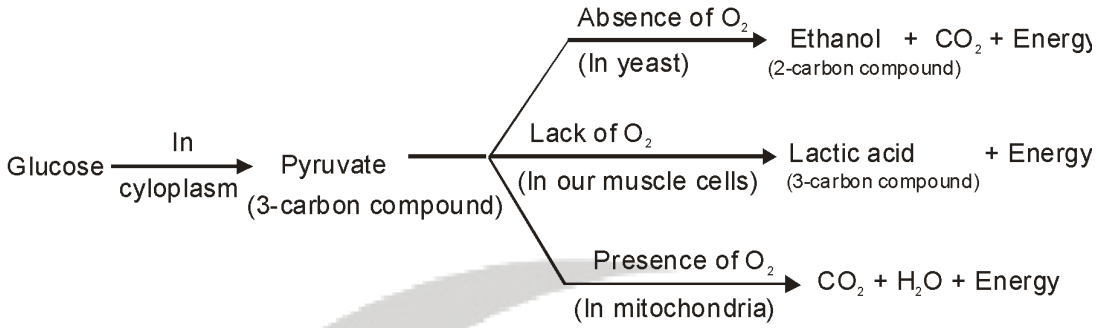
$$\text{Glucose} \xrightarrow[\text{(In Cytoplasm)}]{\text{Glycolysis}} \underset{\text{(3 Carbon Compound)}}{\text{Pyruvate}} \xrightarrow[\text{Mitochondria}]{\text{Oxygen}} 6CO_2 + 6H_2O + \underset{\text{Energy}}{38\ ATP}$$

- Organisms like yeast do not use oxygen and break-down of glucose is not complete resulting in break-down of glucose into ethanol, carbon-dioxide and release of energy (**anaerobic respiration**).

$$\text{Glucose} \xrightarrow[\text{(in Cytoplasm)}]{\text{Glycolysis}} \underset{\text{(3 Carbon Compound)}}{\text{Pyruvate}} \xrightarrow[\text{Yeast Fermentation}]{\text{Absence of Oxygen}} 2CO_2 + \underset{\text{ethanol}}{2C_2H_5OH} + \underset{\text{energy}}{2\ ATP}$$

- Similarly, during vigorous exercise in our body muscles, anaerobic respiration takes place resulting in formation of lactic acid and energy.

- Since glucose is not completely between down anaerobic respiration yields less energy.



- In all cases, the first step is the break down of glucose, a six-carbon molecule, into a three carbon compound called **Pyruvate**. Process is Anaerobic and is called glycolysis.
- This break-down takes place in cytoplasm.
- The break-down of pyruvate in presence of oxygen takes place in mitochondria resulting in release of energy. Hence, mitochondria are also known as **power-house of the cell**.

Difference between aerobic and anaerobic respiration :

S.No.	Aerobic Respiration	Anaerobic Respiration
1.	Takes place in presence of oxygen	Takes place in absence of oxygen
2.	Complete breakdown of food takes place	Partial breakdown of food takes place
3.	Food gets converted into CO_2 and water.	Food can be converted into either ethanol and CO_2 (as in yeast) or in lactic acid (as in animal muscles)
4.	38 molecules of ATP are produced	2 molecules of ATP are produced.

- **ATP :** It is a nitrogenous compound. The energy released during cellular respiration is used to synthesise, a molecule called ATP (Adenosine triphosphate) which is the energy currency of living organisms.

$$ADP + (P) \xrightarrow{Energy} ADP \sim (P) = ATP \quad P = Phosphate$$

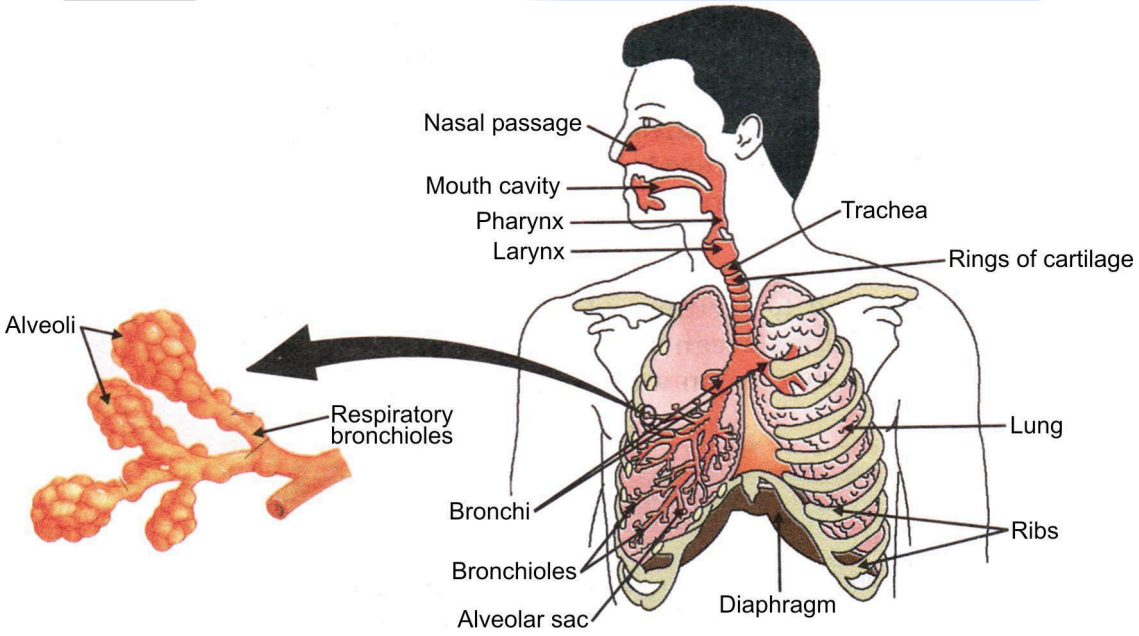
- It is commonly called **energy currency of the cell**.
- When the **terminal phosphate linkage** in ATP is broken using water, the energy equivalent to **30.5 KJ / mol** is released.
- ATP is used in body for muscle contraction, protein synthesis conduction of nerve impulses and all other activities.
- Aerobic organisms need to ensure that there is sufficient intake of oxygen.

- Animals have evolved different organs for the uptake of O_2 and release of CO_2.
- **Aquatic animals** use the O_2 dissolved in water. Since the amount of O_2 in water is fairly low as compared to the amount of O_2 in the air, the rate of breathing in aquatic organisms is much faster than that seen in terrestrial organisms.
- **Fishes**, take in water through their mouths and force it past the gills where the dissolved O_2 is taken up by blood.
- **Terrestial organisms** use the O_2 in the atmosphere for respiration. This O_2 is absorbed by different organs in different animals.
- Respiratory system of all organisms have following features.
  1. Large, fine and delicate surface area.
  2. Respiratory surface is well protected having a passage for air to reach it having good supply of blood.
  3. A mechanism for moving the air in and out of this area, where the oxygen is absorbed.

2.2.1 Respiration in Humans

- In human beings, the air is taken into the body by nostrils the air while passing through the nostrils is filtered by fine hairs that line the passage so that the air going into the body is free of dust and other impurities. The passage is also lined with mucus which helps in this process.
- From nostril, the air passes through the **throat** into the **lungs** via **trachea**, **rings of cartilage** are present in the trachea which ensures that the air-passage does not collapse.

  Nasal Passage → Pharynx → Larynx → Trachea → Bronchi → Bronchioles → Terminal Bronchioles → Alveoli → Alveolar sacs → Exchange of gases.



Human respiratory system

- The passage (trachea) divides into two bronchi and bronchioles in lungs which finally terminate in balloon-like structure called alveoli. The alveoli provide a surface where exchange of gases takes place. The wall of alveoli contains an extensive network of blood vessels.
- When we breathe in, our chest cavity becomes larger due to lifting of rib cage and flattening of diaphragm.
- When our chest cavity becomes larger.
- Just reverse happens when we breathe out (exhalation or expiration). Diaphragm relaxes size of chest cavity decreases, pressure increases and is pushed out.
- During breathing cycle, when the air is taken in and let out, the lungs always contain a residual volume of air so that there is sufficient time for O_2 to be absorbed and for the CO_2 to be released.
- In humans, respiratory pigment **haemoglobin** is present in the RBC which has very high affinity for O_2. Haemoglobin (red) and chlorophyll (green) are both pigments (similarity). Haemoglobin transports oxygen and chlorophyll absorbs sunlight during photosynthesis (difference).
- Solubility of CO_2 is more as compared to O_2 in water and hence is mostly transported in dissolved form in our blood.
- Carbon mono-oxide when binds with haemoglobin a stable compound carboxy-haemoglobin is formed which can cause death as no haemoglobin is left for transport of O_2.

(a) Mechanism of Breathing

Before inhalation : The diaphragm contracts and becomes straight, expanding the chest cavity. The **intercostal muscles** contract, ribs coming outwards. This further enlarges the chest cavity, lowering the pressure inside lungs. Therefore air rushes in.

Before exhalation : The diaphragm relaxes and coming in its normal arched position, compressing the lungs. Intercostal muscles relaxes and move inwards. This reduces the volume of chest cavity which is already full of air. This forces the air out.

Inhalation → Lifting of Ribs + Flat Diaphragm → Increase in Volume of Chest Cavity → Air is sucked inside the Nostrils → Alveoli and Vice Versa for Breathing out

(b) Exchange of Gases CO_2 and O_2 between blood and tissues

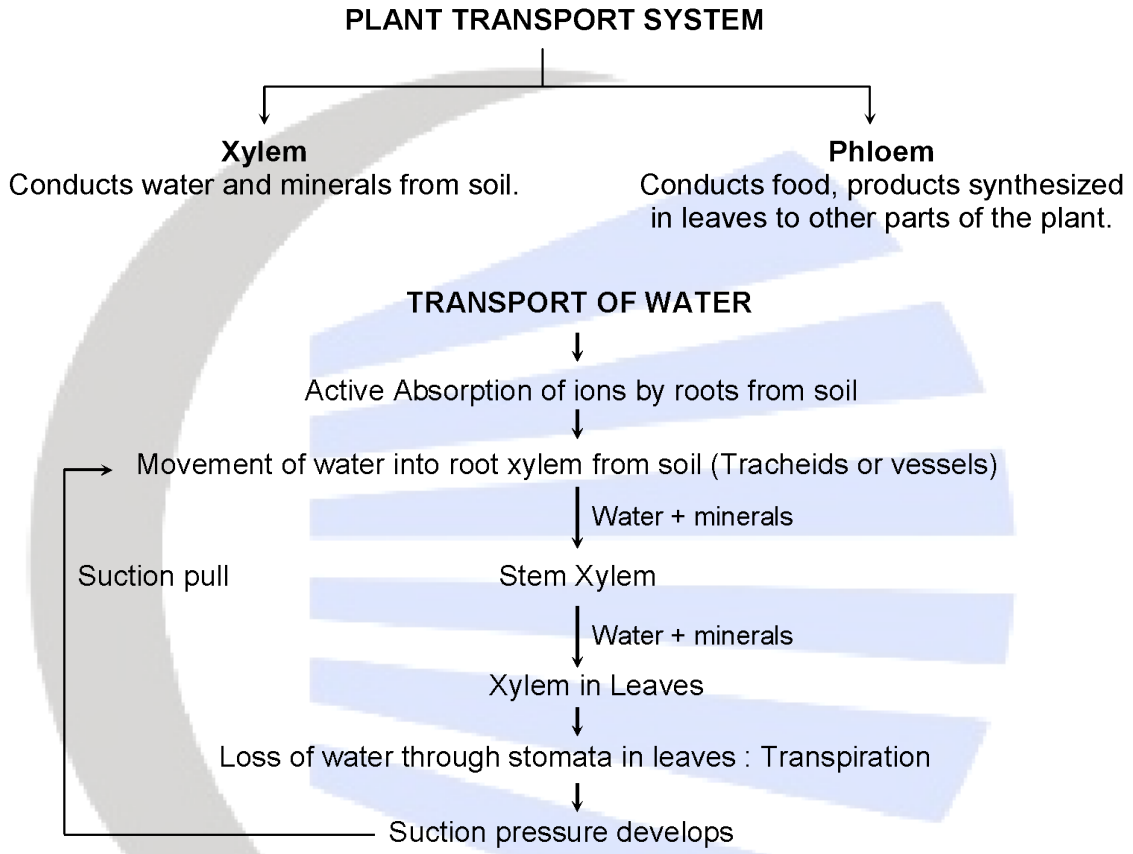
Air in Alveoli → Blood Vessels → Blood → RBC → Respiratory Pigment (Haemoglobin) → Oxygen Links with Hb (high pressure of O_2) → O_2 is released in tissues from Hb (Low O_2 Pressure in Tissues) $\xrightarrow[\text{Respiration}]{\text{Aerobic}}$ High CO_2 in Tissues → CO_2 Released into Blood $\xrightarrow{CO_2}$ Blood Vessels in Alveoli → CO_2 Released out Through Nostrils.

- Alveoli are specially adapted for exchange of gases as they
  (a) have a large surface area
  (b) are thin walled
  (c) have a such blood supply
  (d) are moist

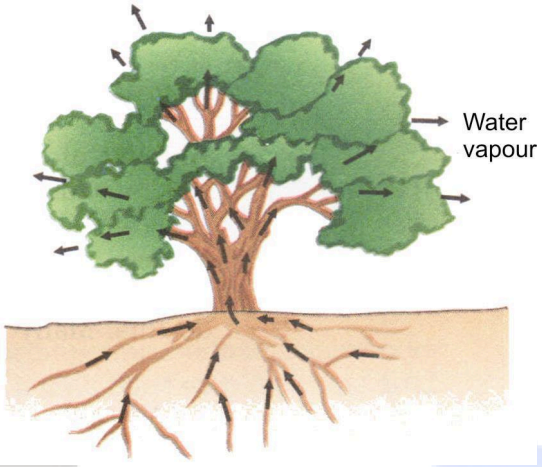
3. TRANSPORTATION

3.1 TRANSPORTATION IN PLANTS

- In plants, xylem transports minerals and water from roots to other parts of the plant while phloem transports food manufactured in leaves to other plant parts and storage organs.
- 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 plant parts.



Transpiration : It is defined as process by which plants lose water in the vapour form from the aerial parts of the plant.



Movement of water during transpiration in a tree

IMPORTANCE OF TRANSPIRATION

(a) Ascent of Sap: It is the upward movement of cell sap, i.e. water and minerals through the xylem and excess of water is then lost in the form of water vapours after preparation of food.

(b) Cooling effect : It helps to regulate the temperature of plant since evaporation reduces temperature.

(c) Removal of Excess of Water: Transpiration helps to remove excess of water.

(d) Absorption and Distribution of Salts : The continuous water current produced by transpiration helps to absorb and distribute the salts.

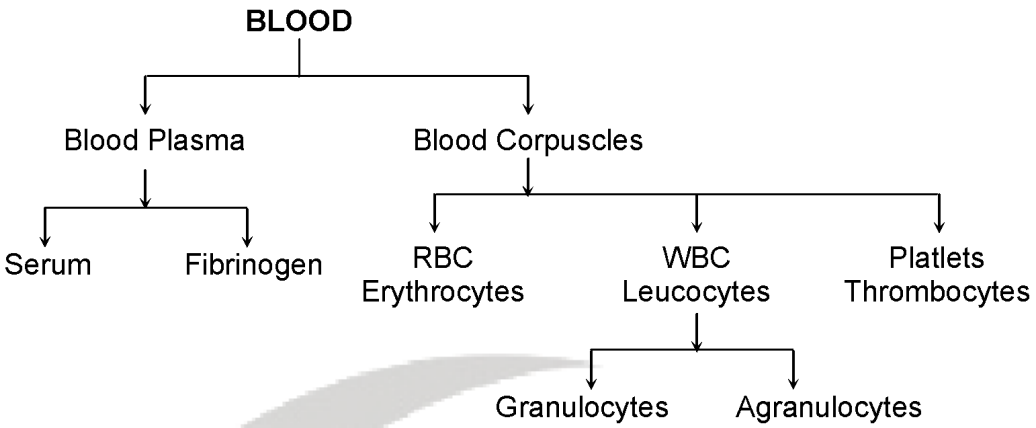
Translocation : The transport of soluble products of photosynthesis (sucrose), amino-acids and other substances through phloem is termed **translocation**. The translocation of food and other substances takes place in the sieve tubes with the help of adjacent companion cells both in upward and downward directions. The translocation in phloem is achieved by utilizing energy. Materials like sucrose is transferred into phloem tissue by using ATP.

3.2 TRANSPORTATION IN HUMAN

In humans transportation of O_2, nutrients, hormones, and other substances to the tissues, CO_2 to the lungs and waste products to the kidney is carried out by a well-defined **circulatory system**.

Circulatory System : It comprises of the heart, blood vessels, blood, lymphatic vessels and lymph which together serve to transport materials throughout the body.

(i) Blood : Blood has a liquid (or fluid matrix) called plasma with red blood cells, white blood cells and platelets floating in it. It is bright red-coloured fluid connective tissue that circulates in the entire body by the muscular pumping organ – the heart. The volume of blood is about 6 *L*. in adult human body.



(a) Plasma : The liquid part of blood excluding blood cells.

- Plasma consists of water, in which many substances are dissolved including plasma proteins (albumin, globulin, fibrinogen and anti-bodies) salts (sodium and potassium chlorides and bicarbonates) food substances (amino acids, glucose, fats) hormones, digested food and excretory waste products. Transports carbon dioxide.
- In the plasma, float RBC, WBC and blood platelets.
- Plasma without fibrinogen is called **serum**.

  Plasma = Serum + fibrinogen

(b) Blood corpuscles

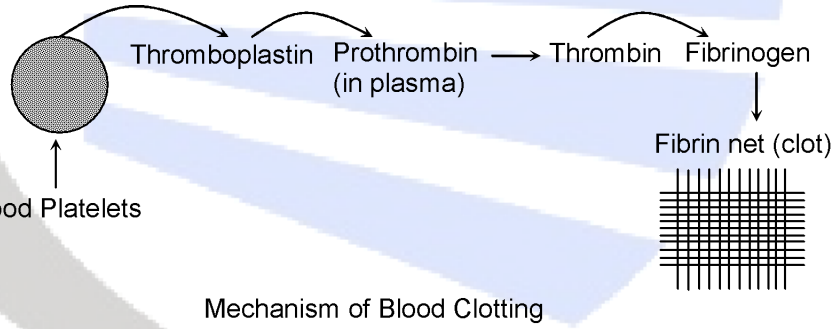
- **Red Blood Corpuscles (RBC) or Erythrocytes** : These are minute, circular biconcave discs having no nucleus. They are red due to the presence of red coloured pigment – haemoglobin. Transport oxygen.
- **White Blood Corpuscles (WBC) or Leucocytes** : These are large nucleated colourless cells, more numerous than RBC's. They are mainly of two types : Granulocytes and Agranulocytes. They defend our body against infections.
- **Blood Platelets or Thrombocytes** : Platelets are rounded, colourless, biconvex, non-nucleated blood cells, which help in the clotting of blood. They are called thrombocytes.
- **Blood clotting :** It is the mechanism that prevents the loss of blood during an injury. The blood has platelet cells which circulate around the body and plug these leaks by helping the blood to clot at these points of injury. The other name is 'blood coagulation'. The major events are :

Injured tissue + Blood platelets ⟶ Release thromboplastin

Prothrombin (inactive) $\xrightarrow[Ca^{++}]{\text{Thromoboplastin}}$ Thrombin (Active)

Fibrinogen (soluble) $\xrightarrow[Ca^{++}]{\text{Thrombin}}$ Fibrin (insoluble form)

Fibrin + Red blood corpuscles ⟶ Blood clot

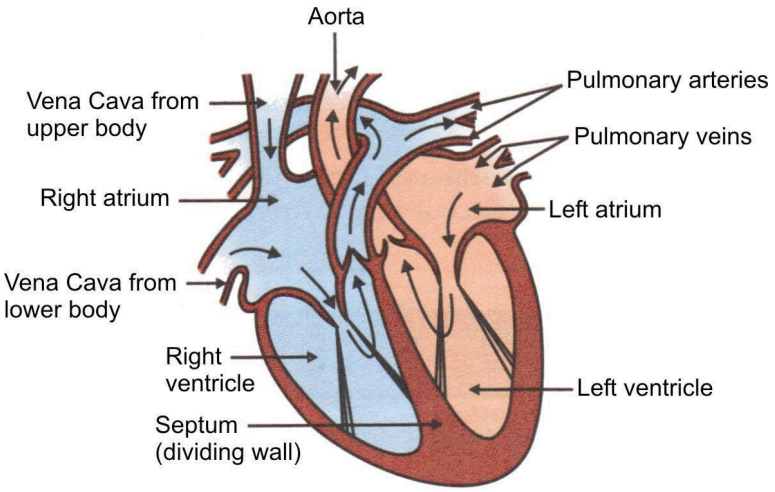


Mechanism of Blood Clotting

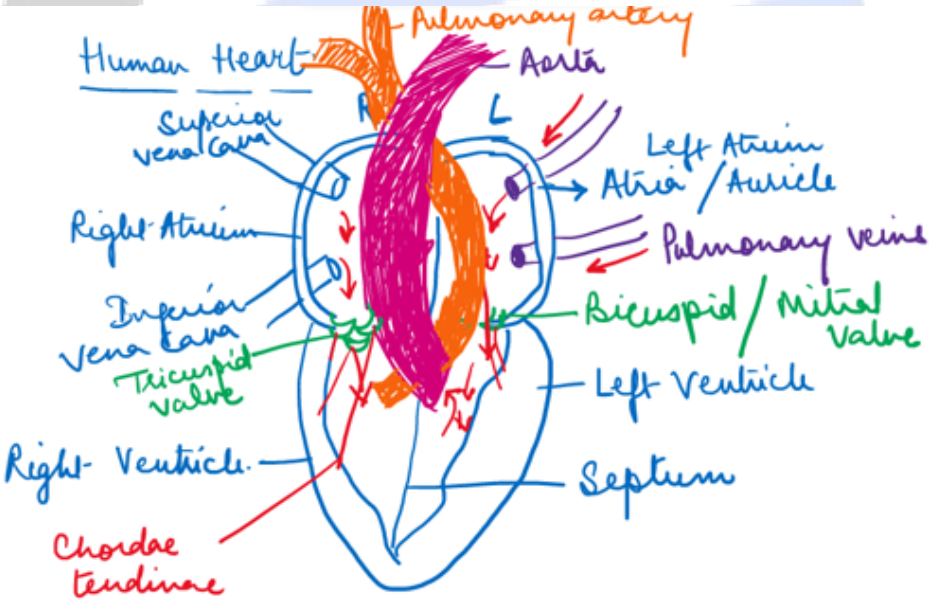
Advantages of Blood Clotting:

1. Plugs the leafs which lead to loss of pressure. Loss of pressure would decrease the efficiency of blood circulation.
2. Minimize the loss of blood.

(ii) Our Pump – The heart : The heart is a pumping muscular organ that receives blood from the veins and pumps it into the arteries. It is situated in the thoracic cavity which lies above the diaphragm between two lungs. It is enclosed in double – walled membranous sac the **pericardium**. Heart is as big as our fist. Out heart has four chambers two auricles (left and right) (upper chambers (receiving)) and two ventricles (left and right) (lower chambers (sending)).

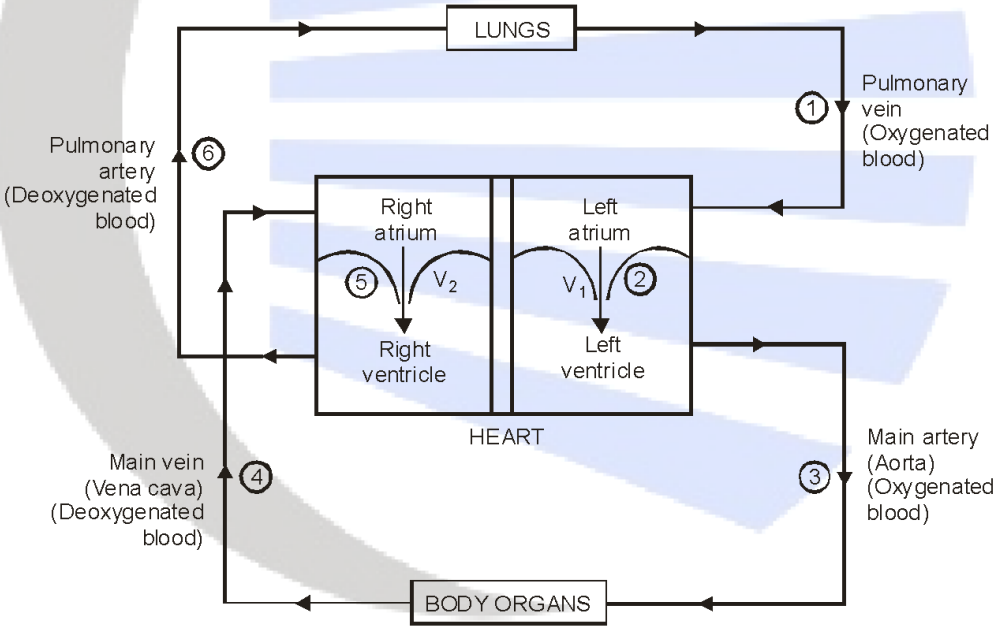


Sectional view of the human heart



- The oxygenated blood from lungs comes to thin walled left auricle through **pulmonary veins**.
- The de-oxygenated blood comes to thin walled right auricle through two large veins superior and inferior vena cava.
- When the left and the right atrium contracts, the oxygenated and deoxygenated blood reaches the respective ventricles.
- Contraction of ventricles results in transfer of blood from them into lungs and various body parts.

- Left ventricle on contraction sends oxygenated blood to body through the largest artery **aorta**. While the right ventricle pumps the blood into lungs for oxygenation through pulmonary artery.
- The walls of ventricle are thicker than auricle as they have to pump the blood to various body organs.
- Valves present in between auricle and ventricle as well as at the opening of major arteries in ventricles, check the back flow of blood and allow its unidirectional flow.
- In mammals and birds separation of the right side and left side of the heart is useful as it does not allow oxygenated and deoxygenated blood to mix. The separation is brought about by the **septum**. Hence the heart is four chambered in birds and mammals.
- Amphibians and reptiles have three-chambered heart two auricles and one ventricle.
- Fishes have two-chambered heart – one ventricle and one auricle.
- In fishes the blood is pumped into gills where it is oxygenated and supplied directly to body parts from gills. Thus blood goes only once through the heart. This is called single circulation.
- In other vertebrates, the blood passes twice through the heart. This is known as **double circulation**.



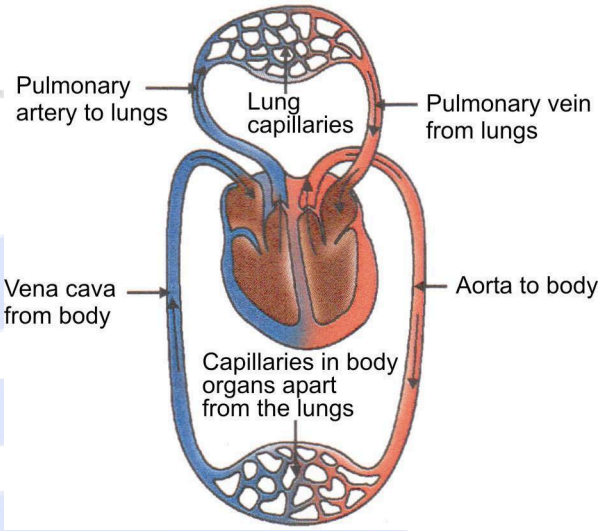
Blood circulation in human body

Mechanism of Double Circulation : As the blood passes twice through the heart in one complete cycle in man, it is called double circulation.

1. **Pulmonary circulation :**
   - It begins in the right ventricle which sends the blood into the pulmonary trunk (lungs) by pulmonary artery. Pulmonary artery is the only artery carrying deoxygenated blood.
   - The blood flowing to the lungs, becomes oxygenated and returns to the heart (left atrium) through pulmonary vein. Pulmonary vein is the only vein carrying oxygenated blood.

2. Systemic Circulation :

- Left ventricle pumps the blood through aorta into the body.
- The aorta divides into arteries, arterioles finally to capillaries and thereby supplies oxygenated blood to various parts of the body.
- From there deoxygenated blood is collected by veinules which join to form veins and finally vena cava and pour blood back into the heart.
- Arteries are the blood vessels which carry blood away from the heart to various organs of the body.
- Since the blood emerges from the heart under high pressure, the arteries have thick, elastic walls.
- Veins collect the blood from various organ and bring it back to the heart. They do not need thick walls, instead they have valves that ensure that the blood flows only in one direction i.e. from organs to heart.



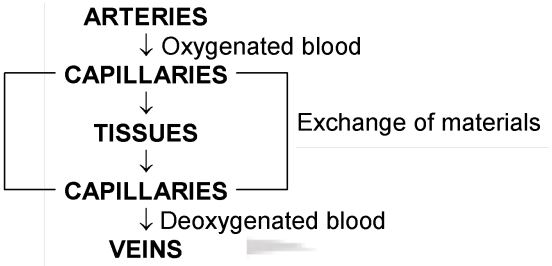
Schematic representation of transport and exchange of oxygen and carbon dioxide

- Usually arteries carry oxygenated blood away from the heart except **pulmonary artery** which carries deoxygenated blood from right ventricle to lungs for oxygenation.
- On the contrary, veins carry deoxygenated blood from body organs to heart except **pulmonary** vein which carries oxygenated blood from lungs to heart.
- On reaching organ or tissue, the artery divide into smaller and smaller vessels to bring the blood in contact with all the individual cells. The smallest vessels are known as capillaries.

BLOOD VESSELS

S.No.	Arteries	Veins
1.	Always carry blood away from the heart.	Always bring back blood to the heart.
2.	They carry oxygenated blood except pulmonary artery.	They carry deoxygenated blood except pulmonary vein.
3.	Blood flows under high pressure.	Blood flows at lower pressure.
4.	More thick and elastic.	Thin walled.

5.	Have no valves.	Have valves to ensure unidirectional flow of blood.



- Capillaries have walls which are one-cell thick to allow exchange of material between the blood and surrounding cells.
- The capillaries then join together to form veins that carry the blood away from the organs or tissue back to heart.

(iii) Lymph is another type of fluid which also helps in transportation. This is formed by passage of some fluid from blood capillaries into intercellular spaces in the tissue through the **pores** present in the walls of capillaries.

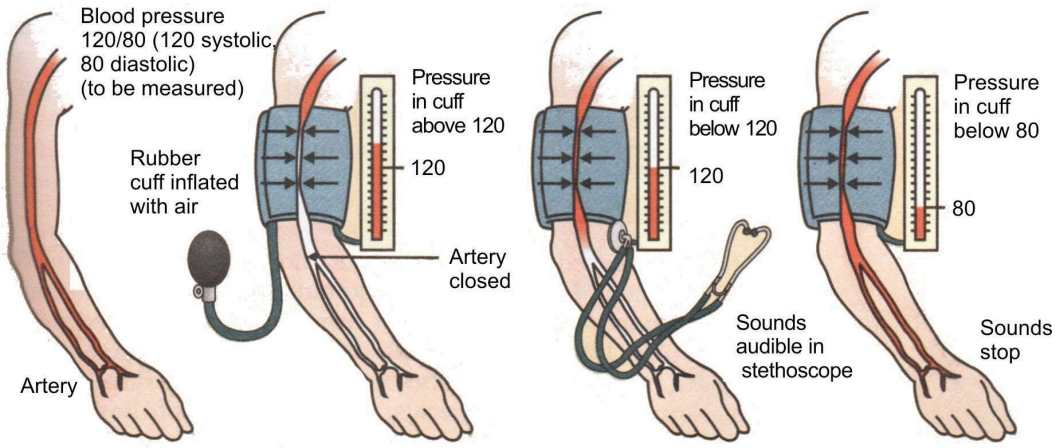
- It is similar to the plasma of blood but colourless and contains very less proteins.
- Does not contain RBC.
- Lymph drains into lymphatic capillaries from the intercellular spaces, these capillaries join to form large lymph vessels that finally open into larger veins.
- Lymph has lymphocytes – fights infection.

The major functions of lymph are:

1. It carries digested and absorbed fat from intestine into blood (lacteals).
2. Drains excess fluid from extra cellular space back into the blood.
3. Provides immunity to the body.

(iv) Blood pressure : It is the force that blood exerts against the wall of a vessel. This pressure is much greater in arteries than in veins.

- The pressure of blood inside artery during contraction or ventricular systole is called **systolic blood pressure**. Pressure in artery during relaxation or ventricular diastole is called **diastolic blood pressure**.
- The normal systolic blood pressure is about 120 mm of Hg and diastolic blood pressure is 80 mm of Hg.



Blood Pressure

- Blood pressure is measured using an instrument called **sphygmomanometer**.
- Abnormally high blood pressure is called **hypertension** and it can lead to rupture of an artery.

  People with high blood pressure are asked to have less salt .
- Increased salt intake causes our body to hold more water so as to maintain the osmotic balance.

4. EXCRETION

4.1 EXCRETION IN PLANTS

Plants get rid of excess water by transpiration. Plants give out oxygen as a waste generated by photosynthesis.

Many plant tissues have dead cells that can be used to dispose of the waste.

Many plant waste products are stored in cellular vacuoles.

Some waste products are removed along with falling leaves and other plant parts. Other waste products are stored as resins and gums in old Xylem tissue. Plants also excrete some waste substances into the soil around them.

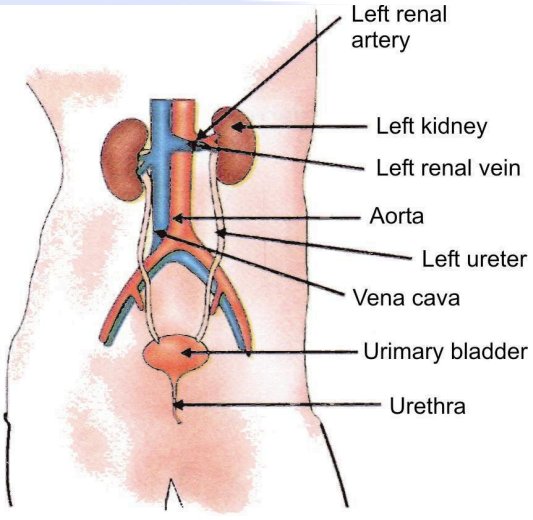
4.2 EXCRETION IN ANIMALS

It is the biological process of elimination of harmful metabolic waste products from the body of an organism. The mode of excretion is different in different organisms. Many unicellular organisms remove these wastes by simple diffusion from the body surface into the surrounding water, while complex multicellular organisms use specialized organs for excretion. The organs that are involved in this process constitute the excretory system.

(i) Human Excretory System : Human excretory system includes a pair of kidneys, a pair of ureters, a urinary bladder and a urethera. Urine produced in the kidneys passes through the ureters into the urinary bladder where it is stored until it is released through the urethra. On body produce urea in the liver for removal of Nitrogenous waste. Urea removal requires a moderate amount of water. Birds and amphibious excrete uric acid. Needs very less water for removal fish excrete. Ammonia which requires a lot of water for removal.

(a) Kidney and uric acid

- Kidneys (pair) are located in the abdomen.
- Urine produced by kidneys passes through ureters (pair) into urinary bladder. Urine is released from bladder through a single tube called urethra.
- The urine formed in each kidney enters a long tube the ureter which connects the kidney with the urinary bladder.
- Urine is stored in the urinary bladder until the pressure of the expanded bladder leads to pass out through the urethra.



Excretory system in human beings

- Each kidney has large numbers of filtering units called nephrons which are packed close to each other.

- Kidneys are vital organs of our body. They filter the poisonous waste from blood. Any damage, infections, injury and restricted blood flow leads to accumulation of poisonous wastes in the body which can even lead to death.
- Kidneys remove the poisonous substances such as urea, other waste salts and excess water from the blood and excrete them in the form of yellowish liquid called urine.
- It performs following functions :

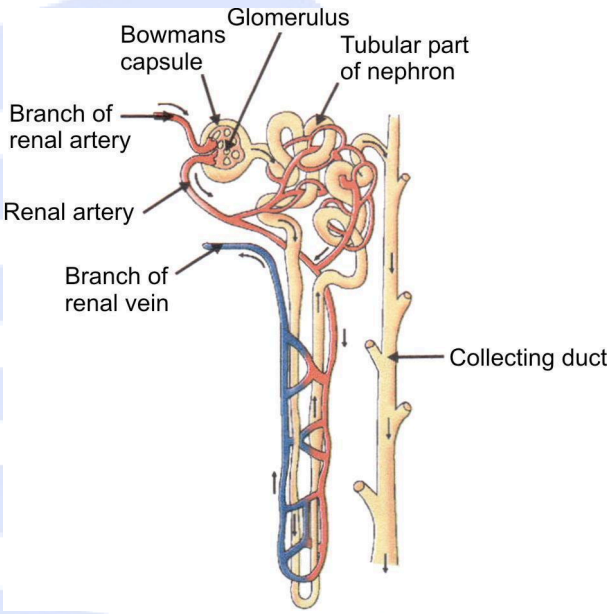
1. It regulates the osmotic pressure/water balance of the blood.
2. It regulates pH of the blood.

Basic filtration unit has a cluster of very thin – walled blood capillaries.

(Lungs have a similar cluster for exchange of gases)

Structure of Nephron

- Each kidney is made up of a large number of excretory filtration units called **nephrons** or **ureniferous tubules**.
- These are considered as **functional unit of kidney**.
- It consists of a long coiled tubule whose one end is connected to the double walled cup shaped structure of Bowman's capsule and its other end to a urine-collecting duct of a kidney.
- The Bowman's capsule contains a bundle of blood capillaries which is called **glomerulus**.



Structure of a nephron

- The function of glomerulus is to filter the blood passing through it.
- The function of tubular part of nephron is to allow the selective reabsoption of useful substances into the blood capillaries.

Blood having Metabolic Waste → Afferent Arteriole → Glomerulus → Bowman's Capsule → PCT (Proximal Convoluted Tubule) → Loop of Henle → DCT (Distal Convoluted Tubule) → Collecting Duct → Ureter → Urinary bladder → Urethra → Urine excreted out

(b) Formation of urine : The purpose of excretion is to filter out waste products from the blood.

(i) Filtration :

- The nitrogenous waste such as urea and uric acid are removed from blood in the kidneys, thus kidneys are the basic filtration unit.
- Each capillary cluster in the kidney is associated with the cup-shaped end of a tube that collects the filtered urine.
- Each kidney has large numbers of these filtration units called nephrons.
- Afferent arteriole brings the blood into bowman's capsule and efferent arteriole takes the pure blood. Filtrate having mainly urea / uric acid moves through the tubule.

(ii) Reabsorption :

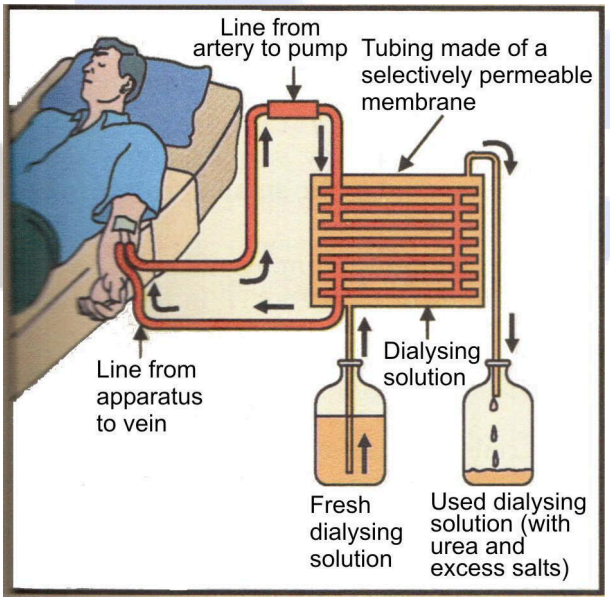
- Some substances in the initial filtrate such as glucose, aminoacids, salts and a major amount of water are selectively reabsorbed as the urine flows along the tube. This depends on how much excess water is there in the body and on how much of dissolved waste is there to be excreted. The remaining filterate goes to the collecting duct. Smaller ducts combine together to form a larger collecting duct.

(iii) Secretion :

- Secretion of water and salts from blood capillaries into the tubular parts of Nephron.

(c) Artificial kidney : It is a device to remove nitrogenous waste products from the blood through dialysis. In case of kidney failure an artificial kidney can be used (Haemodialysis).

Dialysis : It is the procedure used in artificial kidney to do the work of a non-functional or damaged kidney. In the process blood of the patient is allowed to pass through the long cellulose tubes dipped in a tank containing dialysing solution having same ionic concentration as plasma. The waste substance diffuse out of blood into the tank and the cleansed blood is returned back into the patient through a vein. This procedure is also known as haemodialysis.



Artificial kidney (Hemodialysis)

In a health adult 180 L of initial filtrate is produced every day. The volume of urine produced is 1 – 2 L per day. The remaining filtrate is reabsorbed in the kidney tubules (nephrons).