CH-1 Life Processes

What criteria do we use to decide whether something is alive?

- The most important criterion to decide whether something is alive (or not) is the movement.
- All the living things (which are alive) move by themselves without any external help.
- In some cases, the movements of the living things are quite fast which can be easily observed by us but in other cases the movements are very slow and hence observed with difficulty.
- The movements in most of the animals are fast and can be observed easily but the movements in plants are usually slow and observed with difficulty.
- Animals can move from one place to another or they can move their body parts.
- The plants can only move parts of their body such as leaves, flowers, shoots, and roots. The plant parts move towards a stimulus such as sunlight, gravity or water, etc.
- Non – living things (which are not alive) cannot move by themselves.
- The characteristics of living things are as follows:

i. Living things can move by themselves.
ii. Living things need food, air and water.
iii. Living things can grow.
iv. Living things can respond to changes around them. They are sensitive.
v. Living things respire (release energy from food).
vi. Living things excrete (get rid of waste materials from their body).
vii. Living things can reproduce. They can have young ones.

What are life processes?

- The basic functions performed by living organisms to maintain their life on this earth are called life processes.
- Nutrition and Respiration; Transport and Excretion; Control and Coordination (Response and Stimuli); Growth; Movement and Reproduction.
- The process of nutrition involves the taking of food inside the body and converting it into smaller molecules which can be absorbed by the body.
- Respiration is the process which releases energy from the food absorbed by the body.
- Transport is the process in which a substance absorbed or made in one part of the body is moved to other parts of the body.
- Excretion is the process in which the waste materials produced in the cells of the body are removed from the body.
- Control and coordination (or response to stimuli) is a process which helps the living organisms to survive in the changing environment around them.

Energy is needed for the life processes:

- Food is a kind of fuel which provides energy to all the living organisms.
- The living organisms use the chemical energy for carrying out various life processes. They get this chemical energy from food through chemical reactions.
- Actually, living organisms continuously need energy for their various life processes and other activities which they perform.
- This is because when we are asleep, a number of biological processes keep on occurring in the body which requires energy. Our heart beats non – stop even when we are asleep to pump blood throughout the body and this beating of heart requires energy.

Nutrition

- Food is an organic substance. The simplest food is glucose. It is also called simple sugar.
- A more complex food is starch. Starch is made from glucose. The general name of substances like glucose (sugar) and starch is carbohydrates.

- A nutrient can be defined as a substance which an organism obtains from its surroundings and uses it as a source of energy or for the biosynthesis of its body constituents (like tissues and organs). For example, carbohydrates and fats are the nutrients.
- Nutrition is a process of intake of nutrients (like carbohydrates, fats, proteins, minerals, vitamins and water) by an organism as well as the utilization of these nutrients by the organism.

Modes of nutrition

➢ A mode of nutrition means methods of procuring food or obtaining food by an organism.

There are mainly two modes of nutrition:

1. **Autotrophic, and**
2. **Heterotrophic**

1. Autotrophic Mode of Nutrition

- Autotrophicnutrition is that mode of nutrition in which an organism makes (or synthesizes) its own food from the simple inorganic materials like carbon dioxide and water present in surroundings (with the help of sunlight energy).
- The green plants have an autotrophic mode of nutrition. The autotrophic bacteria also obtain their food by the autotrophic mode of nutrition.
- Those organisms which can make their own food from carbon dioxide and water are called autotrophs.
- All the green plants are autotrophs.
- The autotrophic organisms (or autotrophs) contain the green pigment called chlorophyll which is capable of trapping sunlight energy.

2. Heterotrophic Mode of Nutrition

- Heterotrophic nutrition is that mode of nutrition in which an organism cannot make (or synthesizes) its own food from the simple inorganic materials like carbon dioxide and water, and depends pn the other organisms for its food.
- All the animals have a heterotrophic mode of nutrition. Most bacteria and fungi also have heterotrophic mode of nutrition.
- Those organisms which cannot make their own food from inorganic substances like carbon dioxide and water, and depend on other organisms for their food are called heterotrophs. All the animals are heterotrophs.
- The non – green plants (like yeast) are also heterotrophs.

Types of Heterotrophic Nutrition

A heterotrophic organism (or heterotroph) can obtain its food from other organisms in three ways. So, the heterotrophic mode of nutrition is of three types:

1. **Saprotrophic Nutrition**
2. **Parasitic Nutrition**
3. **Holozoic Nutrition**

1. Saprotrophic Nutrition (or saprophytic Nutrition)

- Saprotrophic Nutrition is that Nutrition in which an organism obtains its food from decaying organic matter of dead plants, dead animals and rotten bread, etc.
- Saprophytes are the organisms which obtain their food from dead plants (like rotten leaves), dead and decaying animal bodies, and other decaying organic matter (like rotten bread).Fungi (like bread moulds, mushrooms, yeast).
- The saprophytes break down the complex organic molecules present in dead and decaying matter and convert them into simpler substances outside their body. These simpler substances are then absorbed by saprophytes as their food.

2. Parasitic Nutrition

- The parasitic nutrition is that nutrition in which an organism derives its food from the body of another living organism (called its host) without killing it.
- A parasite is an organism (plant or animal) which feeds on another living organism called its host.
- Parasitic mode of nutrition is observed in several fungi, bacteria, a few plants like cuscuta (amarbel) and some animals like Plasmodium and roundworms.

3. Holozoic Nutrition

- The holozoic nutrition is that nutrition in which an organism takes the complex organic food materials into its body by the process of ingestion; the ingested food is digested and then absorbed into the body cells of the organism.
- In other words, man, cat, dog, cattle, deer, tiger, lion, etc have the holozoic mode of nutrition.

NUTRITION IN PLANTS

- Chlorophyll is present in the green coloured bodies called 'chloroplasts' inside the plant cells.
- The process, by which green plants make their own food (like glucose) from carbon dioxide and water by using sunlight energy in the presence of chlorophyll, is called photosynthesis.
- The process of photosynthesis takes place in the green leaves of a plant.

$$\underset{\text{Carbon dioxide (From air)}}{6CO_2} + \underset{\text{Water (From soil)}}{6H_2O} + \underset{\text{(From sun)}}{\text{Light energy}} \xrightarrow[\text{(Photosynthesis)}]{\text{Chlorophyll}} \underset{\text{Glucose (A food)}}{C_6H_{12}O_6} + \underset{\text{Oxygen}}{6O_2}$$

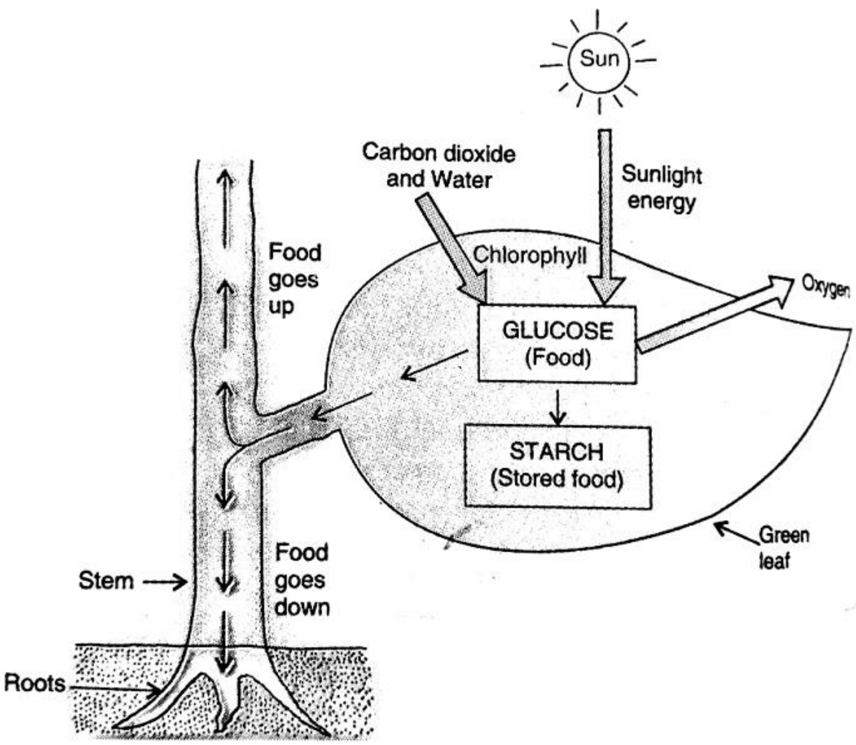


Figure Green plants make their own food by photosynthesis.

Mechanism of Photosynthesis

- The carbon dioxide gas required for making food is taken by the plant leaves from the air.
- This carbon dioxide enters the leaves through tiny pores in them called stomata. Water required for making food is taken from the soil.
- This water is transported to the leaves from the soil through the roots and stem. The sunlight provides energy required to carry out the chemical reactions involved in the preparation of food.
- The green pigment called chlorophyll present in green leaves helps in absorbing energy from sunlight.
- Oxygen gas is produced as a by – product during the preparation of food by photosynthesis.
- This glucose food made in the leaves is then sent to the different parts of the plant.
- The extra glucose is changed into another food called starch. This starch is stored in the leaves of the plant.
- Glucose and starch belong to a category of foods called carbohydrates. The food like carbohydrates prepared by photosynthesis contain chemical energy stored in them. Thus, the green plants convert sunlight energy into chemical energy by making carbohydrates (food).

Thus, photosynthesis takes place in following **steps:**

i. Absorption of sunlight by chlorophyll.
ii. Conversion of light energy into chemical energy and splitting of water into hydrogen and oxygen by light energy.
iii. Reduction of carbon dioxide by hydrogen to form glucose by using chemical energy.

Condition Necessary for Photosynthesis

The conditions necessary for photosynthesis to take place are:

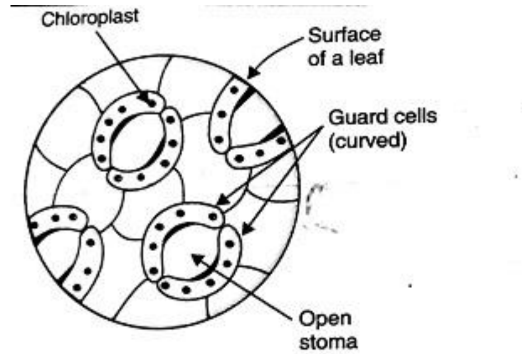
1. **Sunlight,**
2. **Chlorophyll,**
3. **Carbon dioxide, and**
4. **Water**

Raw Materials for Photosynthesis

Theraw materials for photosynthesis are:

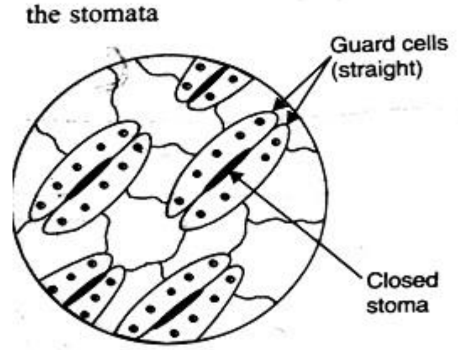
i. **Carbon dioxide, and**
ii. **Water**

How the Plants Obtain Carbon Dioxide?



(*a*) Open stomata

Figure . The plants take carbon dioxide required for photosynthesis from air through the stomata



(*b*) Closed stomata

- The green plants take carbon dioxide from air for photosynthesis.
- The carbon dioxide gas enters the leaves of the plant through the stomata present on their surface.
- Each stomatal pore (or stoma) is surrounded by a pair of guard cells.
- The opening and closing of stomatal pores are controlled by the guard cells.
- When water flows into the guard cells, they swell, become curved and cause the pore to open. on the other hand, when the guard cells lose water, they shrink, become straight and close the stomatal pore.
- The oxygen gas produced during photosynthesis also goes out through the stomatal pores of the leaves.
- The stomata are also present in the green stems (or shoots) of a plant.
- So, the green stems (or shoots) of a plant also carry out photosynthesis.
- In other words, the gaseous exchange in plants takes place through the stomata in leaves.

How the Plants Obtain Water for Photosynthesis

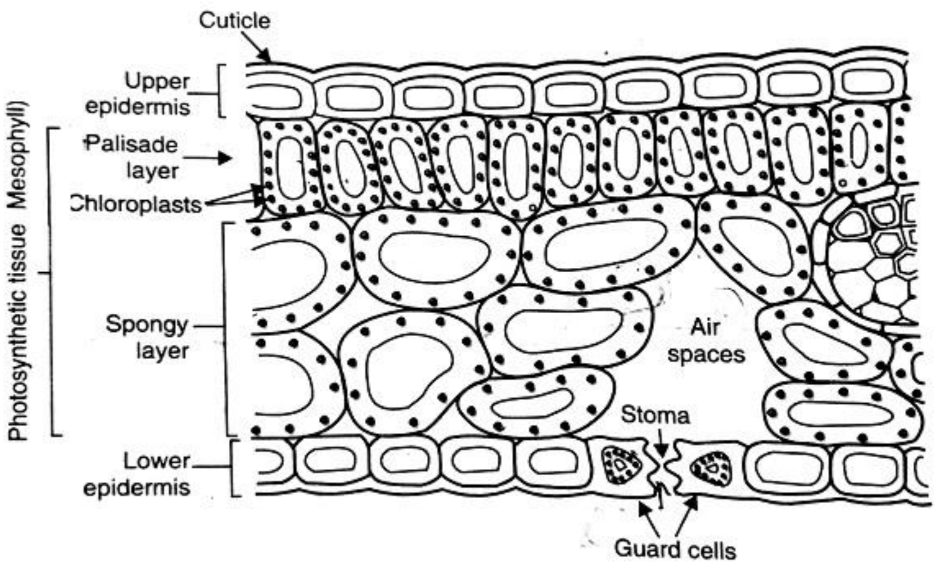
- The water required by the plants for photosynthesis is absorbed by the roots of the plants from the soil through the process of osmosis. The water absorbed by the roots of the plants is transported upward through the xylem vessels to the leaves where it reaches the photosynthesis cells and utilized in photosynthesis.
- The plants take materials like nitrogen, phosphorus, iron, and magnesium, etc., from the soil.

Site of photosynthesis: Chloroplasts

- Photosynthesis occurs in the organelles called chloroplasts present in the photosynthetic cells (or mesophyll cells) of green plants. In other words, the site of photosynthesis in a cell of the leaf are chloroplasts.
- Chloroplasts can be seen as numerous disc - like organelles in the photosynthetic cells (or mesophyll cells) of the palisade tissue just below the upper epidermis.
- The middle layers in the leaf (palisade layer and spongy layer) contain photosynthetic cells called mesophyll cells.
- A typical photosynthetic cell (or mesophyll cell) of a green leaf may contain 100 or more tiny chloroplasts in it, and a whole leaf may contain many thousands of photosynthetic cells.

• Carbon dioxide needed for photosynthesis enters from air into the leaf through the stomata in its surface and then diffuses into the mesophyll cells and reaches the chloroplasts. Water is carried to the leaf by xylem vessels and passes into the mesophyll cells by diffusion and reaches the chloroplasts.

• There is a thin, waxy protective layer called cuticle above and below a leaf which helps to reduce the loss of water from the leaf.



The structure of a leaf to show chloroplasts in it (The small green circles in the above diagram are all chloroplasts).

Animals Obtain their Food from Plants or Other Animals

All the animals can be divided into three groups on the basis of their food habits (or eating habits). These are:

i. **Herbivores,**
ii. **Carnivores, and**
iii. **Omnivores.**

1. Herbivores

- Those animals which eat only plants are called herbivores.
- Herbivores are: goat, cow, buffalo, sheep etc.

2. Carnivores

- Those animals which eat only other animals as food are called carnivores.
- Carnivores are: lion, tiger, frog, vulture etc.

3. Omnivores

- Those animals which eat both, plants and animals, are called omnivores.
- Omnivores are: man (human beings), dog, crow, sparrow, bear, etc.
- Omnivores are plants eaters as well as meat eaters.

Different Steps in the Process of Nutrition in Animals

1. Ingestion

➢ The process of taking food into the body is called ingestion.

2. Digestion

➢ The process in which the food containing large, insoluble molecules is broken down into small, water soluble molecules (which can be absorbed by the body) is called digestion.

3. Absorption

➢ The process in which the digested food passes through the intestinal wall into blood stream is called absorption.

4. Assimilation

➢ The process in which the absorbed food is taken in by body cells and used for energy, growth and repair, is called assimilation.

5. Egestion

➢ The process in which the undigested food is removed from the body is called egestion.

Nutrition in Simple Animals

➢In unicellular animals, all the processes of the nutrition are performed by the single cell.

NUTRITION IN AMOEBA

➢Amoeba is a unicellular animal. Amoeba eats tiny (microscopic) plants and animals as food which float in water in which it lives. The mode of nutrition in amoeba is holozoic.

➢The process of obtaining food by amoeba is called phagocytosis.

1. Ingestion

- Amoeba ingests food by using its pseudopodia.
- When a food particle comes near amoeba, then amoeba ingests this food particle by forming temporary finger- like projections called pseudopodia around it. The food is engulfed with a little surrounding water to form a food vacuole inside the amoeba. This food vacuole can be considered to be a 'temporary stomach' of amoeba.

2. Digestion

- In amoeba, food is digested in the food vacuole by digestive enzymes. The enzymes from surroundings cytoplasm enter into the food vacuole and break down the food into small and soluble molecules by chemical reactions.

3. Absorption

- The digested food present in the food vacuole of amoeba is absorbed directly into the cytoplasm of amoeba cell by diffusion. since amoeba consists of only one small cell, it does not require blood system to carry the digested food. The digested food just spreads out from the food vacuole into the whole of amoeba cell.
- After absorption of food, the food vacuole disappears.

4. Assimilation

- A part of the food absorbed in amoeba cell is used to obtain energy through respiration. The remaining part of absorbed food is used to make the parts of amoeba cell which lead to the growth of amoeba.
- Amoeba grows in size. And then amoeba can reproduce by dividing into two daughter cells.

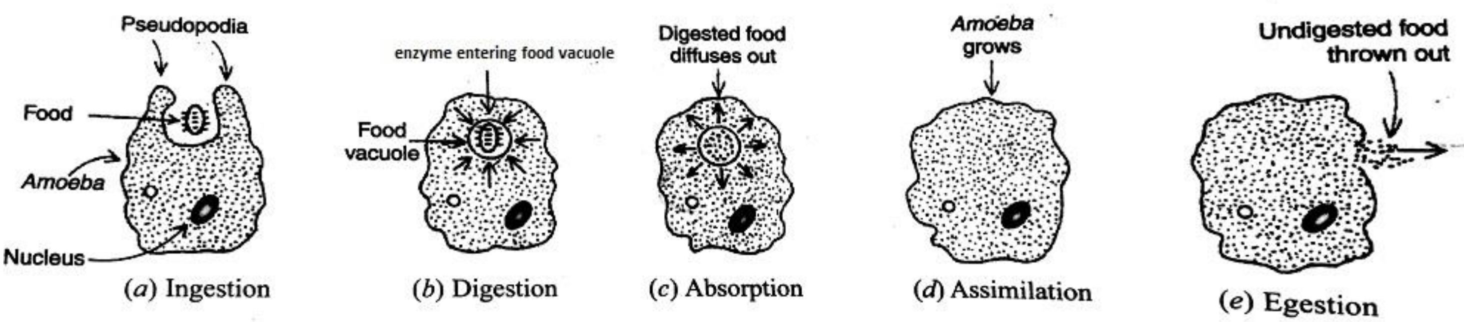
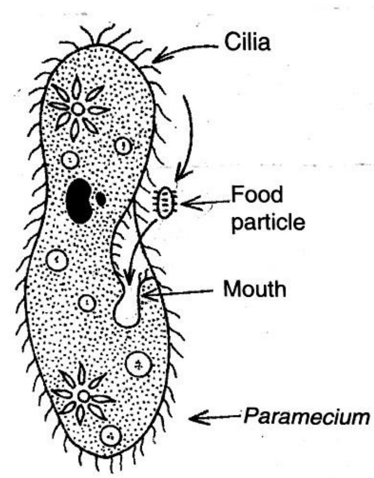


Figure Different stages in the nutrition (feeding) of *Amoeba*.

5. Egestion

- Amoeba has no fixed place (like anus) for removing the undigested part of food. When a considerable amount of undigested food collects inside amoeba, then its cell membrane suddenly ruptures at any place and the undigested food is thrown out of the body of amoeba.



Nutrition in Paramecium

- Paramecium is also a tiny unicellular animal which lives in water.
- Paramecium uses its hair like structures called cilia to sweep the food particles from water and put them into its mouth.
- When the cilia present around the mouth region of paramecium move back and forth, they sweep the food particles present in water into the mouth of paramecium.
- This is the first step in the nutrition of paramecium which is called ingestion. Ingestion is followed by other steps such as digestion, absorption, assimilation and egestion.

Nutrition in Complex Multicellular Animals

- In the complex multicellular animals like man (human), grasshopper, fish and frog, etc., all the processes involved in nutrition are performed by a combination of digestive organs.
- A long tube running from mouth to anus of a human being (or other animals) in which digestion and absorption of food takes place is called alimentary canal.

NUTRITION IN HUMAN BEINGS

(Human Digestive System)

The various organs of the human digestive system in sequence are: mouth, oesophagus (or food pipe), stomach, small intestine and large intestine. The glands which are associated with the human digestive system and form a part of the human digestive system are: salivary glands, liver and pancreas.

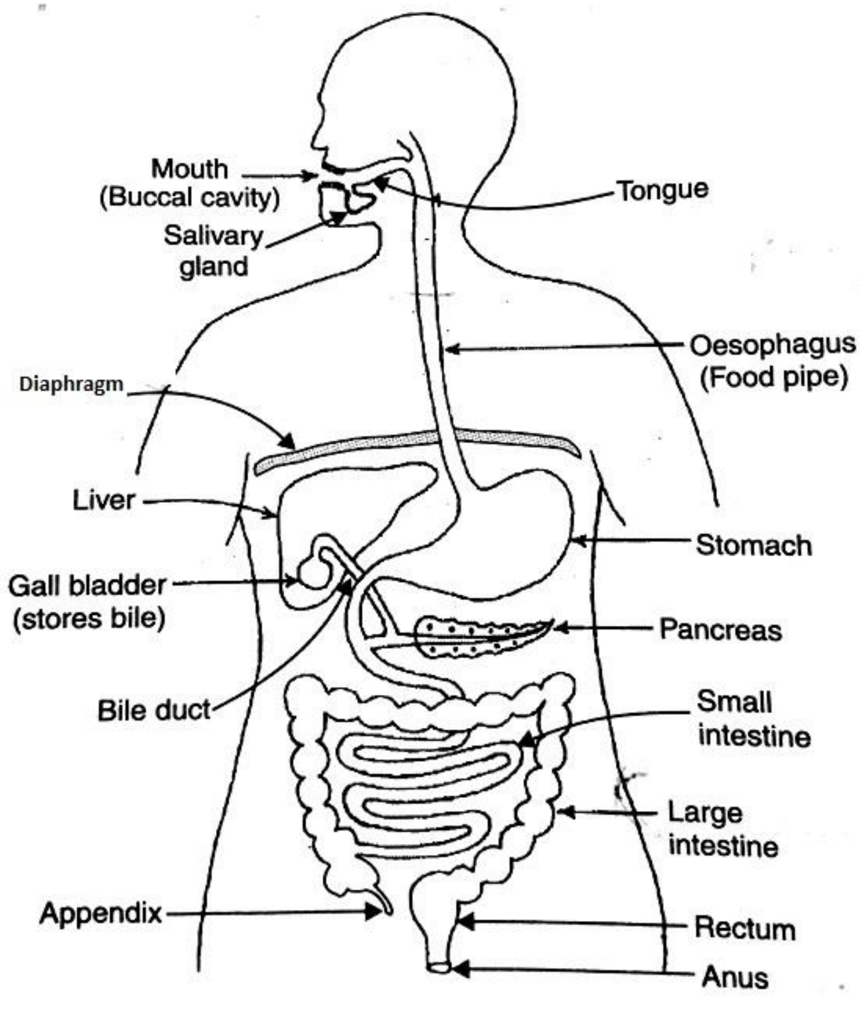


Figure The human digestive system.

1. Ingestion

- The human beings have a special organ for the ingestion of food. It is called mouth.
- So, in human beings, food is ingested through the mouth. The food is put into the mouth with the help of hands.

2. Digestion in Mouth

In human beings, the digestion of food begins in the mouth itself. In fact, the digestion of food starts as soon as we put food in our mouth. This happens as follows:

- The mouth cavity (or buccal cavity) contains teeth, tongue, and salivary glands. The teeth cut the food into small pieces, chew and grind it. So, the teeth help in physical digestion. The salivary glands in our mouth produce saliva. Our tongue helps in mixing this saliva with food. Saliva is a watery liquid so it wets the food in our mouth.
- The salivary glands help in chemical digestion by secreting enzymes. The human saliva contains an enzyme called salivary amylase which digest the starch present in food into sugar. Thus, the digestion of starch (carbohydrates) begins in the mouth itself. Since the food remains in the mouth only for a short time, so the digestion of food remains incomplete in mouth.

3. Role of Oesophagus

- The slightly digested food in the mouth is swallowed by the tongue and goes down the food pipe called oesophagus.
- The oesophagus carries food to the stomach.
- The contraction and expansion movement of the walls of food pipe is called peristaltic movement. The peristaltic movement of food pipe (or oesophagus) pushes the slightly digested food into the stomach.

4. Digestion in Stomach

- The stomach is a j – shaped organ presents on the left side of the abdomen. The food is further digested in the stomach. The food stays in the stomach for about three hours. During this time, the food breaks down into still smaller pieces ad forms a semi – solid paste.
- The stomach wall contains three tubular glands in its walls. The glands present in the walls of the stomach secrete gastric juice.
- The gastric juice contains three substances: hydrochloric acid, the enzymes pepsin and mucus.
- Due to the presence of hydrochloric acid, the gastric juice is acidic in nature. In the acidic medium, the enzymes pepsin begins the digestion of proteins present in the food to form smaller molecules.
- Thus, the protein digestion begins in the stomach.
- Another function of hydrochloric acid is that it kills any bacteria which may enter the stomach with food.
- If mucus is not secreted, hydrochloric acid will cause the erosion of inner lining of stomach leading to the formation of ulcers in the stomach.
- The exit of food from stomach is regulated by a 'sphincter muscle' which releases it in small amounts into the small intestine.

5. Digestion in Small intestine

- From the stomach, the partially digested food enters the small intestine. The small intestine is the largest part of the alimentary canal. It is about 6.5 meters long in an adult man. Though the small intestine is very long, it is called small intestine because it is vey narrow. The small intestine is arranged in the form of a coil in our belly.
- The small intestine in human beings is the site of complete digestion of food (like carbohydrates, proteins and fats). This happens as follows:

a. The small intestine receives the secretions of two glands: liver and pancreas. Liver secretes bile. Bile is a greenish yellow liquid made in the liver which is normally stored in the gall bladder. Bile is alkaline, and contains salts which help to break the fats (or lipids) present in the food. Thus, bile performs two functions: (i) makes the acidic food coming from the stomach alkaline so that pancreatic enzymes can act on it, and (ii)bile salts break the fats present in the food into small globules making it easy for the enzymes to act and digest them.

Pancreas secretes pancreatic juice which contains digestive enzymes like pancreatic amylase, trypsin and lipase. The enzyme amylase breaks down the starch, the enzymes trypsin digests the proteins and the enzyme lipase breaks down the emulsified fats.

b. The walls of small intestine contain glands which secrete intestinal juice. The intestinal juice contains a number of enzymes which complete the digestion of complex carbohydrates into glucose, proteins into amino acids and fats into fatty acid and glycerol.

Glucose, amino acids, fatty acids and glycerol are small, water soluble molecules.

6. Absorption

- The small intestine is the main region for the absorption of digested food.
- The inner surface of small intestine has millions of tiny, finger like projections called villi. The presence of villi gives the inner walls of the small intestine a very large surface area. And the large surface area of small intestine helps in the rapid absorption of digested food. The digested food which is absorbed through the walls of the small intestine, goes into our blood.

7. Assimilation

- The blood carries digested and dissolved food to all the parts of the body where it becomes assimilated as part of the cells. This assimilated food is used by the body cells for obtaining energy as well as for growth and repair of the body.
- The digested food which is not used by our body immediately is stored in the liver in the form of a carbohydrates called glycogen. This stored glycogen can be used as a source of energy by the body as and when required.

8. Egestion

- This undigested food cannot be absorbed in the small intestine. So, the undigested food passes from the small intestine into a winder tube called large intestine.
- The walls of large intestine absorb most of the water from the undigested food (with the help of the villi).
- The last part of the large intestine called rectum stores this undigested food for some time. And when we go to the toilet, then its undigested food is passed out (or egested) from our body through anus as faeces or stool. The act of expelling the faeces is called egestion or defecation.

Dental Caries

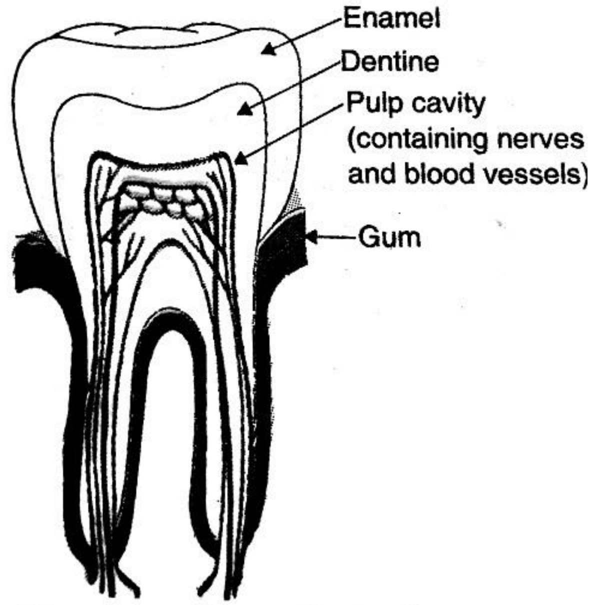


Figure Parts of a tooth.

- The hard, outer covering of a tooth is called enamel. Tooth enamel is the hardest material, in our body. It is harder than even bones.
- The part of tooth below enamel is called dentine. Dentine is similar to bone.
- Inside the dentine is pulp cavity. The pulp cavity contains nerves and blood vessels. The formation of small cavities(or holes) in the teeth due to the action of acid – forming bacteria and improper dental care is called dental caries.
- When we eat sugary food, the bacteria in our mouth act on sugar to produce acids. These acids first dissolve the calcium salts from the tooth enamel and then from dentine. Forming small cavities (or holes) in the tooth over a period of time.
- The formation of cavities reduces the distance between the outside of the tooth and the pulp cavity which contains nerves and blood vessels.
- The acids produced by bacteria irritate the nerve endings inside the tooth and cause toothache.
- If the teeth are not cleaned regularly, they become covered with a sticky, yellowish layer of food particles and bacteria cells called 'dental plague'.

RESPIRATION

The assimilation food is used mainly for two purposes:

1. Assimilated food is used as a fuel to get energy for various life processes, and
2. Assimilated food is used as a material for the growth and repair of the body.

- Food is the 'fuel' for energy production in cells.
- The process of releasing energy from food is called respiration.
- The process of respiration involves taking in oxygen (of air) into the cells, using it for releasing energy by burning food, and then eliminating the waste products (carbon dioxide and water) from the body.
- The process of respiration which releases energy takes place inside the cells of the body.
- Respiration is essential for life because it provides energy for carrying out all the life processes which are necessary to keep the organisms alive.

Breathing and Respiration

- The mechanism by which organisms obtain oxygen from the air and release carbon dioxide is called breathing.
- The main purpose of respiration is the release of energy from the oxidation of simple food molecules like glucose.
- Respiration is just opposite of photosynthesis.

How Energy Released During Respiration is Stored

- The energy produced during respiration is stored in the form of ATP molecules in the cells of the body.
- ADP is a substance called Adenosine Di-Phosphate.
- ADP has low energy content. ATP is a substance called Adenosine Tri-Phosphate. It is also present inside a cell. ATP has a high energy content.

i. **The energy released during respiration is used to make ATP molecules from ADP and inorganic phosphate.** This happens as follows: ADP combines with inorganic phosphate by absorbing the energy released during respiration to form ATP molecules. That is:

ADP + phosphate + energy ⟶ ATP
(low energy) (from respiration) (high energy)

Thus, energy is stored in the cells in the form of ATP.

ii. when the cell needs energy, then ATP can be broken down using water to release energy. Thus:

ATP ⟶ ADP + Phosphate + Energy
(for use in cells)

- ADP can be converted to ATP by absorbing energy produced during respiration, and ATP can be converted back to ADP releasing energy to be used by the cells, again and again. This ensures a continuous supply of energy to the organism.
- The energy stored in ATP is used by the badly cells for various purposes like contraction of muscles, conduction of nerve impulses, synthesis of proteins, and many other activities related to the functioning of cells.

Note:

- **Glucose is $C_6H_{12}O_6$.** It is a six-carbon atom compound.
- **The oxidation of glucose to pyruvic acid (or pyruvate)** is called glycolysis.
- **Pyruvic acid is a three-carbon atom compound:** it is also called pyruvate.
- **Latic acid is also a three-carbon atom compound:** it is also called lactate.

TYPES OF RESPIRATION

There are two types of respiration:

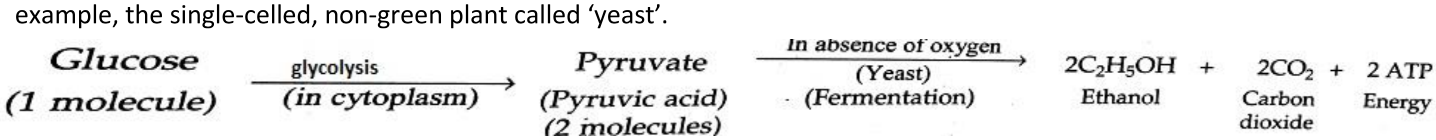
1. Aerobic Respiration and
2. Anaerobic Respiration

<u>1. Aerobic Respiration</u>

- Mitochondria are the sites of aerobic respiration in the cells.
- Most of the living organisms carry out aerobic respiration (by using oxygen of air). For example, humans (man), dogs, cats, lions, elephants, cows, etc.

<u>2. Anaerobic Respiration</u>

- The respiration which takes place without oxygen is called anaerobic respiration.
- In anaerobic respiration, the micro organisms like yeast break down glucose (food) into ethanol and carbon dioxide, and release energy.
- During anaerobic respiration, 1 molecule of glucose (food) produces only 2 energy-rich ATP molecules. A few organisms such as yeast plants and certain bacteria (called anaerobic bacteria). can obtain energy from food in the absence of oxygen by the process of anaerobic respiration. All the organisms which obtain energy by anaerobic respirationcan live without oxygen. For example, the single-celled, non-green plant called 'yeast'.



<u>FERMENTATION OF SUGAR</u>

- We can carry out the fermentation of sugar by using anaerobic respiration of yeast as follows:

Take some sugar solution in a test-tube and add a little of yeast to it. Close the mouth of the test-tube with a cork and allow it to stand for some time. Now, open the cork and smell. A characteristic smell of ethanol is obtained from the test-tube. A gas also evolved during the process. when this gas is passed through lime-water, the lime-water turns milky showing that it is carbon dioxide gas.

CRAMPS

- We (the human beings) obtain energy by aerobic respiration. But anaerobic respiration can sometimes take place in our muscles (or the muscles of other animals). For example, anaerobic respiration takes place in our muscles during vigorous physical exercise when oxygen gets used up faster in the muscle cells than can be supplied by the blood.
- When anaerobic respiration takes place in human muscles (or animal muscles), then glucose (food) is converted into lactic acid with the release of a small amount of energy. The breaking down of glucose (food) during anaerobic respiration in muscles can be represented as follows:

$$\underset{\text{(1 molecule)}}{\text{Glucose}} \xrightarrow[\text{(in cytoplasm)}]{\text{Glycolysis}} \underset{\text{(Pyruvic acid)}}{\text{Pyruvate}} \xrightarrow[\text{(muscle tissue)}]{\text{In absence of oxygen}} \text{2 Lactic acid} + \underset{\text{Energy}}{\text{2ATP}}$$

- The anaerobic respiration by muscles brings about partial breakdown of glucose (food) to form lactic acid. This lactic acid accumulates in the muscles.
- The accumulation of lactic acid in the muscles causes muscle **cramps**.
- We can get **relief** from **cramps** in muscles caused by heavy exercise by taking a hot water bath or a message. Hot water bath (or massage) improves the circulation of blood in the muscles. Due to improved blood flow the supply of oxygen to the muscles increases. This oxygen breaks down lactic acid
- accumulated in muscles into carbon dioxide and water, and hence gives us relief from cramps.
- The similarity between aerobic respiration and anaerobic respiration is that in both the cases, energy is produced by the breakdown of food like glucose.

Aerobic respiration	*Anaerobic respiration*
1. Aerobic respiration takes place in the *presence* of oxygen.	1. Anaerobic respiration takes place in the *absence* of oxygen.
2. Complete breakdown of food occurs in aerobic respiration.	2. Partial breakdown of food occurs in anaerobic respiration.
3. The end products in aerobic respiration are carbon dioxide and water.	3. The end products in anaerobic respiration may be ethanol and carbon dioxide (as in yeast plants), or lactic acid (as in animal muscles).
4. Aerobic respiration produces a considerable amount of energy.	4. Much less energy is produced in anaerobic respiration.

RESPIRATION IN PLANTS

The respiration in plants differs from that in animals in three aspects:

1. All the parts of a plant (like root, stem and leaves) perform respiration individually. On the other hand, an animal performs respiration as a single unit.
2. During respiration in plants, there is a little transport of respiratory gases from one part of the plant to the other. On the other hand, respiratory gases are usually transported over long distances over long distances inside an animal during respiration.
3. The respiration in plants occurs at a slow rate. On the other hand, the respiration in animals occurs at a much faster rate.

Plants get Oxygen by Diffusion

Diffusion occurs in the roots, stems and leaves of plants.

RESPIRATION IN ROOTS

- Air is present in between the particles of soil. The roots of a plant take the oxygen required for respiration from the air present in between the soil particles by the process of diffusion.
- The root hairs are in contact with the air in the soil. Oxygen (from air in the soil particles) diffuses into roots hairs and reaches all other cells of the root for respiration. Carbon dioxide gas produced in the cells of the root during respiration moves out through the same root hairs by the process of diffusion. Thus, the respiration in roots occurs by the diffusion of respiratory gases (oxygen and carbon dioxide) through the root hairs.

RESPIRATION IN STEMS

- The oxygen from air diffuses into the stem of an herbaceous plant through stomata and reaches all the cells for respiration. The carbon dioxide gas produced during respiration diffuses out into the air through the same stomata.
- In woody stems, the bark (outer covering of stem) has lenticels for gaseous exchange. The oxygen from air diffuses into the stem of a woody plant through lenticels and reaches all the inner cells of the stem for respiration. The carbon dioxide gas produced in the cells of the stem during respiration diffuses out into the air through the same lenticels.

RESPIRATION IN LEAVES

- The leaves of a plant have tiny pores called stomata. The exchange of respiratory gases in the leaves takes place by the process of diffusion through stomata.
- Respiration in leaves occurs during the day time as well as at night. On the other hand, photosynthesis occurs only during the day time (no photosynthesis occurs at night). Due to this, the net gaseous exchange in the leaves of a plant is as follows:

(i) During day time, when photosynthesis occurs, oxygen is produced. The leaves use some of this oxygen for respiration and the rest of the oxygen diffuses out into air. Again, day time, carbon dioxide produced by respiration is all used up in photosynthesis by leaves. Even more carbon dioxide is taken from air. Thus, the net gas exchange in leaves during day time is: O_2 diffuses out; CO_2 diffuses in.

(ii) At night time, when no photosynthesis occurs and hence oxygen is produced, oxygen from air diffuses into leaves to carry out respiration. And carbon dioxide produced by respiration diffuses out into air. So, the net gas exchange in leaves at night is: O_2 diffuses in; CO_2 diffuses out.

RESPIRATION IN ANIMALS

1. All the respiratory organs (whether skin, gills, trachea or lungs) have three common features:
2. All the respiratory organs have a large surface area to get enough oxygen.
3. All the respiratory organs have thin walls for easy diffusion and exchange of respiratory gases.
4. All the respiratory organs like skin, gills, and lungs have a rich blood supply for transporting respiratory gases (only in the tracheal system of respiration, air reaches the cells directly)

The rate of breathing in aquatic animals in much faster than in terrestrial animals (or land animals). A faster rate of breathing provides more oxygen to the aquatic animal.

RESPIRATION INAMOEBA

- Amoeba is a single-celled animal. Amoeba depends on simple diffusion of gases for breathing. The diffusion of gases takes place through the thin cell membrane of amoeba.
- Amoeba lives in water. This water has oxygen gas dissolved in it. The oxygen from water diffuses into the body of amoeba through its cell membrane. Since the amoeba is very small in size, so the oxygen spreads quickly into the whole body of amoeba. This oxygen is used for respiration (energy released) inside the amoeba cell. The process of respiration produces carbon dioxide gas continuously. This carbon dioxide gas diffuses out through the membrane of amoeba into the surrounding water.
- Thus, amoeba, paramecium and planaria all breathe through their cell membranes.
- Diffusion is insufficient to meet the oxygen requirements of large multicellular organisms like humans because the volume of human body is so big that oxygen cannot diffuse into all the cells of the human body quickly.

- Human blood contains a respiratory pigment called haemoglobin which carries the oxygen from lungs to all the body cells very efficiently.

RESPIRATION IN EARTHWORMS

The earthworm absorbs the oxygen need for respiration through its moist skin. This oxygen is then transported to all the cells of the earthworm by its blood where it is used in respiration. The carbon dioxide produced during respiration is carried back by the blood. This carbon dioxide is expelled from the body of the earthworms through its skin.

RESPIRATION IN FISH

- The fish breathes by taking in water through its mouth and sending it over the gills. When water passes over the gills, the gills extract dissolved oxygen from this water. The water then goes out through the gill slits.
- The extracted oxygen is absorbed by the blood and carried to all parts of the fish. The carbon dioxide produced by respiration is brought back by the blood into the gills for expelling into the surrounding water.

RESPIRATION IN HUMANS

- The process by which energy is released from food in our body is called respiration.
- The function of respiratory system is to breathe in oxygen for respiration (producing energy from food), and to breathe out carbon dioxide produced by respiration.
- The gases exchanged between blood and air are oxygen and carbon dioxide.
- Breathing is the process by which air rich in oxygen is taken inside the body of an organism and air rich in carbon dioxide is expelled from the body.
- A breath means 'one inhalation plus one exhalation'.

MECHANISM OF BREATHING

INHALATION	EXHALATION
1. Musclesbetween ribs make ribs move upward and outward.	1. Muscles between ribs make ribs and breastbone return to original position.
2. Diaphragm pushes down.	2. Diaphragm move upward.
3. Breastbone move forward.	3. The chest contract and volume decreases.
4. Air flows from outside into lungs.	4. Air flows from inside of lungs to outside.
5. low pressure is created in chest.	5. high pressure is created in chest.

RESPIRATORY SYSTEM IN HUMANS

The main organs of human respiratory system are: **Nose, Nasal passage (or Nasal cavity), Trachea, Bronchi, Lungs and Diaphragm.**

- The nasal passage is lined with fine hair and mucus. When air passes through the nasal passage, the dust particles and other impurities present in it are trapped by nasal hair and mucus so that clean air goes into the lungs. The part of throat between the mouth and wind pipe is called pharynx. From the nasal passage, air enters into pharynx and then goes into the wind pipe.
- The trachea is a tube which is commonly known as wind pipe. The air coming from the nostrils during breathing passes through trachea. Trachea does not collapse even when there is no air in it because it is supported by rings of soft bones called cartilage.
- The upper end of trachea has a voice box called larynx.
- The trachea runs down the neck and divides into two smaller tubes called bronchi.
- The two bronchi are connected to the two lungs.
- The lungs lie in the chest cavity or thoracic cavity which is separated from abdominal cavity by a muscular partition called diaphragm.

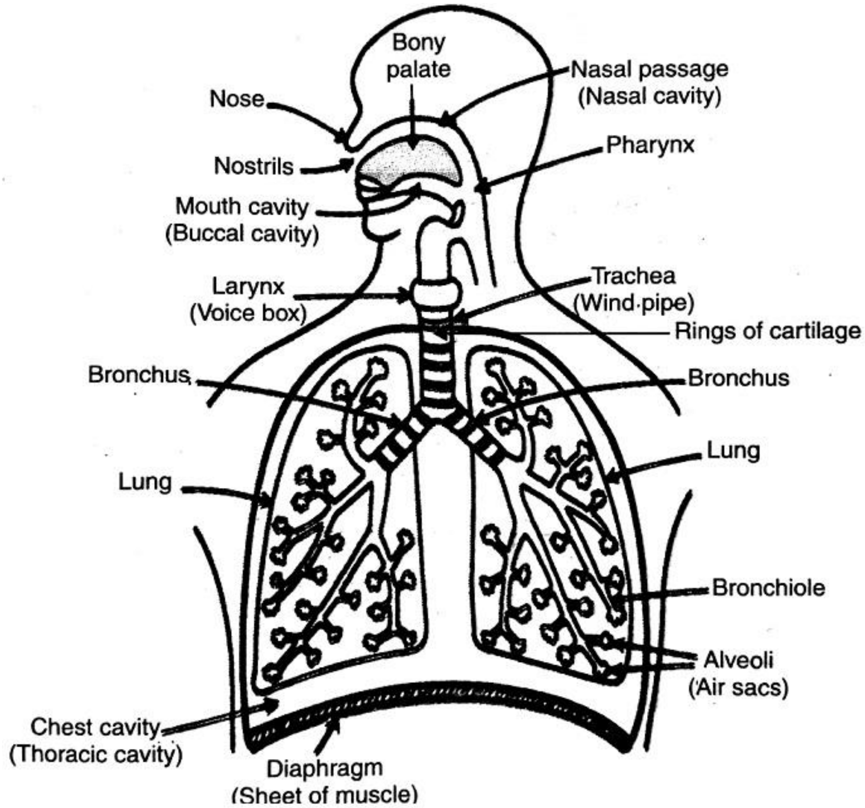


Figure The human respiratory system.

- The lungs are covered by two thin membranes called pleura. The lungs are enclosed in a 'rib cage' made of bones called ribs.
- Each bronchus divides in the lungs to form a large number of still smaller tubes called 'bronchioles'.
- The pouch-like air-sacs at the ends of the smallest bronchioles are called 'alveol' (singular alveolus). The walls of alveoli are very thin and they are surrounded by very thin blood capillaries.
- It is in the alveoli that gaseous exchange takes place.
- There are millions of alveoli in the lungs.
- The presence of millions of alveoli in the lungs provides a very large area for the exchange of gases.
- When we breathe in air. The air pressure decreases inside the chest cavity and air from outside (being at higher pressure) rushes into the lungs through the nostrils, trachea and bronchi. In this way, during the process of 'breathing in' the air sacs or alveoli of the lungs get filled with air containing oxygen.
- The alveoli are surrounded by very thin blood vessels called capillaries carrying blood in them. So, the oxygen of air diffuses out from the alveoli walls into the blood. The oxygen is carried by blood to all the parts of the body (this oxygen is carried by a red pigment called haemoglobin present in blood).
- As the blood passes through the tissues of the body, the oxygen present in it diffuses into cells (due to its higher concentration in the blood). This oxygen combines with the digested food (glucose) present in the cells to release energy. Carbon dioxide gas is produced as a waste product during respiration in the cells of the body tissues. This carbon dioxide diffuses into the blood (due to its higher concentration in body tissues).
- When we breathe out air, the diaphragm and the muscles attached to the ribs relax due to which our chest cavity contracts and becomes smaller. This contraction movement of the chest pushes out carbon dioxide from the alveoli of the lungs into the trachea, nostrils and then out of the body into body into air.
- In this way the process of gaseous exchange is completed in the human respiratory system.

Rate of Breathing

• The average breathing rate in an adult man at rest is about 15 to 18 times per minute. This breathing rate increases with increased physical activity.

• Rapid breathing supplies more oxygen to body cells from producing more energy required for doing physical exercise.

• The deficiency of haemoglobin in the blood of a person reduces the oxygen-carrying of blood resulting in breathing problems, tiredness and lack of energy.

Carbon monoxide poisoning

• This happens as follows: carbon monoxide gas (CO) is formed whenever a fuel burns in an insufficient supply of air.

• Now, we know that haemoglobin present in our blood carries oxygen to all the parts of our body. Haemoglobin has more affinity (or attraction) for carbon monoxide than oxygen.

• So, if carbon monoxide gas is inhaled by a person, then this carbon monoxide binds very strongly with haemoglobin in the blood and prevents it from carrying oxygen to the brain and other parts of the body.

• If carbon monoxide is inhaled for a long time, then the person becomes unconscious and can even die due to oxygen starvation.

TRANSPORT

• Some arrangement is required inside an organism which can carry the essential substances to all its parts so that they reach each and every cell of its body.

• In biology, transport is a life process in which a substance absorbed (or made) in one part of the body of an organism is carried to other parts of its body.

TRANSPORT IN PLANTS

• Plants are less active, so their cells do not need to be supplied with materials so quickly.

• Also, due to the branching shape of a plant, all the cells of a plant can get oxygen for respiration and carbon dioxide for photosynthesis directly from the air by diffusion.

• So, the only substances which are to be supplied to a plant through a transport system are water and minerals.

• The plants have two transport systems:

1. Xylem which carries water and minerals, and
2. Phloem which carries the food materials which the plant makes (phloem also carries the hormones made by the plants in their root and shoot tips).

Transport of water and minerals

The water and animals dissolved in food move from the roots of the plant to its leaves through the two kinds of elements of the xylem tissue called xylem vessels and tracheids.

1. Xylem Vessels

• The xylem vessel is a non-living, long tube which runs like a drainpipe through the plant. A xylem vessels is made of many hollow, dead cells (called vessels elements), joined end to end. The end walls of the cells have broken down so a long, open tube is formed. Xylem vessels run from the roots of the plant right up through the stem and reach the leaves.

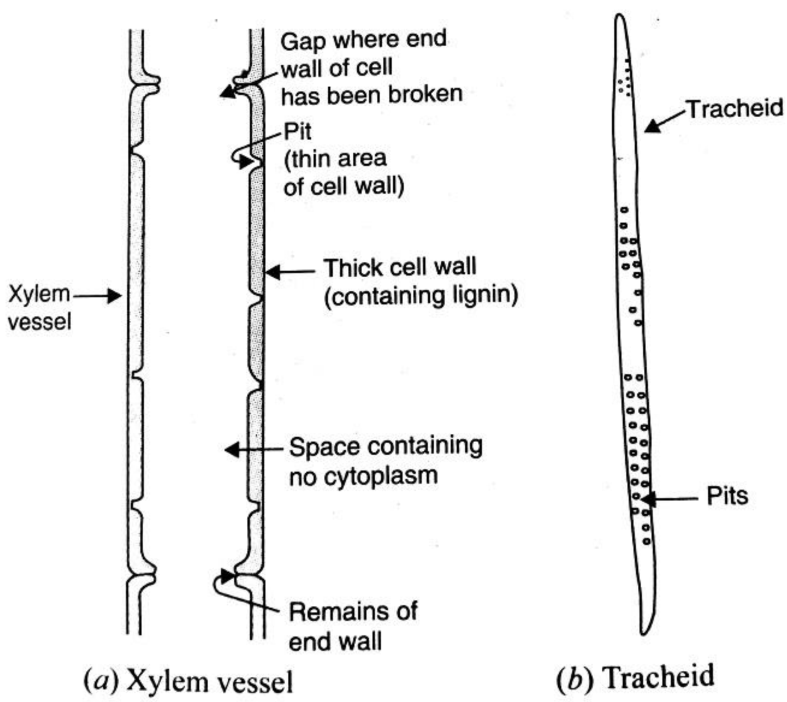


Figure . The structure of xylem vessels and tracheids.

- Xylem vessels do not contain the cytoplasm or nuclei. The walls of xylem vessels are made of cellulose and lignin. Lignin is a very hard and strong substance, so xylem vessels also provide strength to the stems and help to keep the plant upright.
- Wood is made almost entirely of lignified xylem vessels.
- Xylem vessels have pits in their thick cell walls. Pits are nit open pores.
- Pits are the thin areas of the cell wall where no lignin has been deposited. Pits have unthickened cellulose cell wall. In flowering plants, either only xylem vessels transport water or both xylem vessels and tracheids transport water.

2. Tracheids

- Tracheids are long, thin, spindle shaped cells with pits in their thick walls. Water flows from one tracheid to another through pits.
- Tracheids are dead cells with the lignified walls but they do not have open ends, so they do not form vessels.
- They are elongated cells with tapering ends. Even though their ends are not completely open, tracheids have pits in their walls, so water can pass from one tracheid to another through these pits.
- Although all the plants have tracheids, they are the only water conducting tissues in non-flowering plants.
- The outer layer of cells in the root is called epidermis.
- Epidermis is only one cell thick. The layer of cells around the vascular tissues (xylem and phloem) in the root is called endodermis.
- The part of root between the epidermis and endodermis is called root cortex.
- And the xylem tissue present in roots is called root xylem.
- Minerals needed by the plants are taken up by the plants in inorganic form such as nitrates and phosphates. These minerals are present in the soil.

Mechanism of transport of water and minerals in a plant

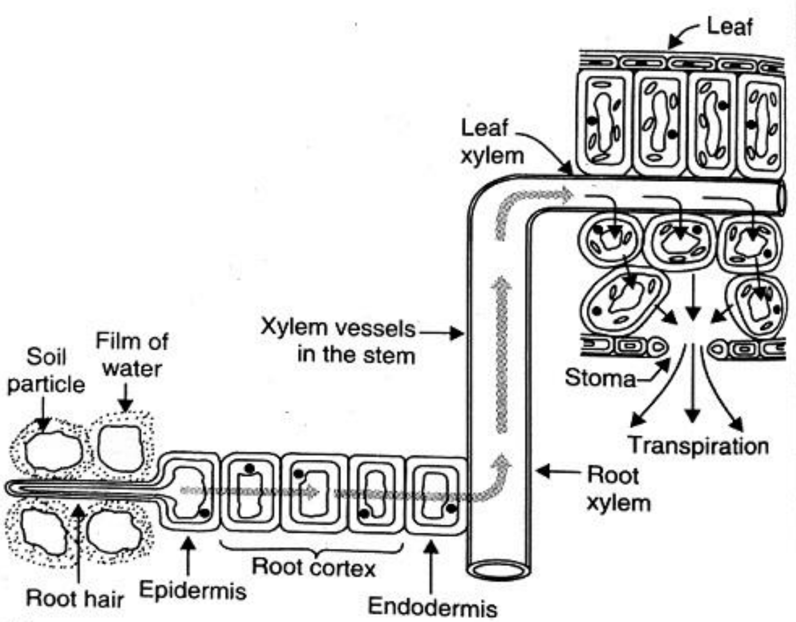


Figure . Diagram to show how water (and dissolved minerals) are transported from the soil up to the leaf of a plant.

- The plants take in water from the soil through their roots.
- This water (containing minerals) called xylem sap is carried by the xylem vessels to all the parts of the plant.
- This happens as follows: the roots of a plant have hair called root hairs. The function of root hairs is to absorb water and minerals from the soil. The root hairs are directly in contact with the film of water in-between the soil particles. Water (and dissolved minerals) gets into the root hairs by the process of diffusion.
- The water and minerals absorbed by the root hair from the soil pass from cell to cell by osmosis through the epidermis, root cortex, endodermis and reach the root xylem.
- Only about 1 to 2 percent of the water absorbed by the plant is used up by the plant in photosynthesis and other metabolic activities. The rest of water is lost as water vapour to the air through transpiration.

Water is sucked up by the xylem vessels

- The pressure at the top of xylem vessels in a plant is reduced due to transpiration.
- The evaporation of water from the leaves of a plant is called transpiration. The leaves of plant have tiny pores on their surface which are called stomata.
- A lot of water from the leaves keeps on evaporating into the air through stomata.
- This loss of water (as water vapour) from the leaves of a plant is called transpiration.

• The continuous evaporation of water (or transpiration) from the cells of a leaf creates a kind of suction which pulls up water through the xylem vessels.

• In this way, the process of transpiration helps in the upward movement of water (and dissolved minerals) from the roots to the leaves through the stem.

Transport of food and other substances

• The food manufactured by the leaves of a plant is transported to its all other parts through a kind of tubes called **phloem** (which are present in all parts of a plant). The transport of food from leaves to other parts of the plant is called **translocation**.

• Like xylem vessels, phloem is made of many cells joined end to end to form long tubes.

• The end walls of cells in the phloem from sieve plates, which have small holes in them.

• The cells of phloem are called **sieve tubes**.

• Sieve tubes which form phloem are living cells which contain cytoplasm but no nucleus.

• The sieve tube cells do not have lignin in their walls.

• Each sieve tube cell has a companion cell next to it.

• Companion cells supply the sieve tubes with some of their requirements.

• The food is made in the mesophyll cells (or photosynthetic cells) of a leaf.

• The food (like sugar) made by the mesophyll cells of a leaf enters into the sieve tubes of the phloem. Interconnected phloem tubes are present in all the parts of the plant.

• So, once the foods (like sugar) enters the phloem tubes in the leaves, it is transported (or carried) to all other parts of the plant by the network of phloem tubes present in all parts of the plant like stem and roots.

• The movement of water (and dissolved salts) in xylem is always upward.

• The movement of food in phloem can be, however, upwards or downwards depending on the needs of the plant.

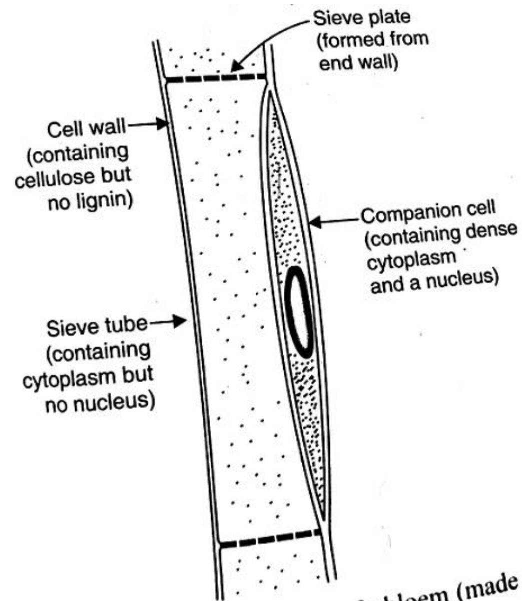


Figure The structure of phloem (made of sieve tubes).

Mechanism of transport of food in a plant

• The movement of food in phloem (or translocation) takes place by utilising energy. This happens as follows:

The sugar (food) made in leaves is loaded into the sieve tubes of phloem tissue by using energy from ATP. Water now enters into sieve tubes containing sugar by process of osmosis due to which the pressure in the phloem tissue rises. This high pressure produced in the phloem tissue moves the food to the parts of the plants having less pressure in their tissues. This allows the phloem to transport food according to the needs of the plants.

Blood

• Blood is a red coloured liquid which circulates in our body. Blood is red because it contains a red pigment called haemoglobin in its red cells.

• Blood is a connective tissue.

• The main components of blood are:

i. Plasma
ii. Red blood corpuscles (or red blood cells),
iii. White blood corpuscles (or white blood cells), and
iv. Platelets.

Plasma

- The liquid part (or fluid part) of blood is called plasma. Plasma is a colourless liquid which consists mainly of water with many substances dissolved in it. Plasma contains about 90 percent water.
- Plasma also contains dissolved substances such as proteins, digested food, common salt, waste products (like carbon dioxide and urea and hormones.
- Plasma carries all these dissolved substances from one part to another part in the body.

Red blood cells

- Red blood cells are red in colour due to the presence of a red pigment called haemoglobin inside them. Red blood cells (RBC) are carriers of oxygen. Red blood cells carry oxygen from the lungs to all the cells of the body.
- It is actually the haemoglobin present in red blood cells which carries oxygen in the body.
- Haemoglobin performs a very important function of carrying oxygen from lungs to body tissues. Haemoglobin also carries some of the carbon dioxide from body tissues to the lungs.
- Red blood cells are circular in shape. Red blood cells do not have nuclei.
- Each red blood cells lives for about four months. One reason for the short life of red blood cells is that they do not have nuclei.
- It has been estimated that about three million red blood cells of the human blood die every day but four times that number are made in the bone marrow every day.
- When we donate blood to save the life of a person, then the loss of blood from our body can be made up very quickly, within a day. This is because red blood cells are made very fast in our bone marrow.

White blood cells

- White blood cells fight infection and protect us from diseases.
- Some white blood cells can eat up the germs (like bacteria) which cause diseases.
- Other white blood cells make chemicals known as ‘antibodies’ to fight against infection.
- In other words, white blood cells manufacture antibodies which are responsible for providing immunity in our body (due to which we are protected from disease and infection). In fact, white blood cells are called soldiers of the body.
- White blood cells are either spherical in shape or irregular in shape.
- All the white blood cells have a nucleus though the shape of nucleus is different in different types of white blood cells.
- White blood cells (WBC) in the blood are much smaller in number than red blood cells.

Platelets

- Platelets are tiny fragments of special cells formed in the bone marrow.
- Platelets do not have nuclei.
- Platelets help in the coagulation of blood (or clotting of blood) in a cut or wound.
- For example, when a cut or wound starts bleeding, then platelets help clot the blood (make the blood semi-solid) due to which further bleeding stops.
- All the blood cells are made in the bone marrow from the cells called stem cells.

Functions of blood

- The important functions of blood in our body are as follows:
- Blood carries oxygen from the lungs to different parts of the body.
- Blood carries carbon dioxide from the body cells to the lungs for breathing out.
- Blood carries digested food from the small intestine to all the parts of the body.
- Blood carries hormones from the endocrine glands to different organs of the body (where they are needed).
- Blood carries a waste product called urea from the liver to the kidneys from excretion in urine.
- Blood protects the body from diseases. This is because white blood cells kill the bacteria and other germs which cause disease.

• Blood regulates the body temperature. This is because the blood capillaries in our skin help to keep our body temperature constant at about 37°C.

Transport in humans

• The main transport system in human beings (or man) is the 'blood circulatory system'.

• The human blood circulatory system consists of the heart (the organs which pumps and receives the blood) and the blood vessels (or tubes) through which the blood flows in the body.

• In blood circulatory system, the blood flows through three types of blood vessels:

i. Arteries,
ii. Veins, and
iii. Capillaries.

• In human beings, the various substances are transported through two liquids called 'blood' and 'lymph'.

HUMAN CIRCULATORY SYSTEM

• The various organs of the circulatory system in humans are: heart, arteries, veins and capillaries.

• The human circulatory system consists of the heart, arteries, veins, capillaries, and blood.

• Arteries, veins and capillaries act as pipes (or tubes) through which the blood flows. These tubes which carry blood are called blood vessels.

• The heart is roughly triangular in shape. It is made of special muscle called cardiac muscle. The size of our heart is about the same as our 'clenched fist'. The heart has four compartments called 'chambers' inside it.

• The upper two chambers of heart are called atria (singular atrium), and the lower two chambers of heart are called ventricles. The two atria receive blood from the two main veins.

• And the two ventricles transport blood to the entire body and the lungs.

• The left atrium is connected to the left ventricle through a valve V_1. Similarly, the right atrium is conned to the right ventricle through another valve V_2.

• These valves prevent the backflow of blood into atria when the ventricles contract to pump blood out of the heart to the rest of the body.

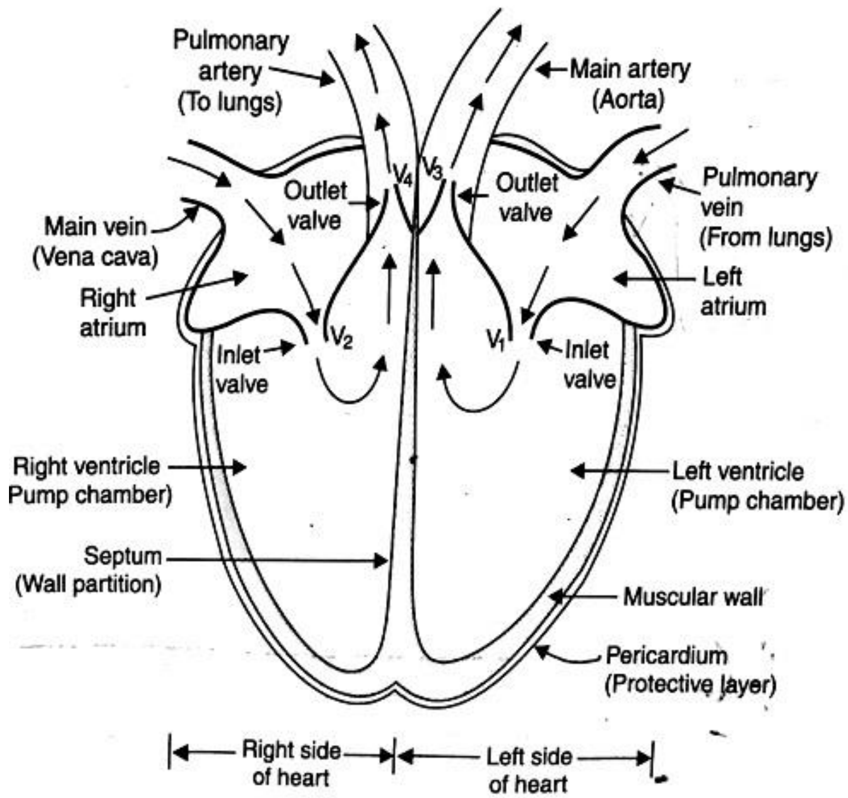


Figure . Diagram to show the inside structure of human heart.

• This is because when the ventricles contract, the valve V_1 and V_2 close automatically so that the blood may not go back into atria.

• The job of heart is to pump blood around our body.

• A sheath of tissue called 'pericardium' protects the muscular heart. The chambers of the heart are separated by a partition called **septum**.

BLOOD VESSELS

- Arteries are the thick-walled blood vessels which carry blood from the heart to all the parts of the body. Arteries have thick walls because blood emerges from the heart under high pressure.
- The main artery carries oxygenated blood from the left ventricle to all the parts of the body (except the lungs).
- Another artery called pulmonary artery is connected to the right ventricle of the heart through another valve V_4. The pulmonary artery carries deoxygenated blood from the right ventricle to the lungs.
- The capillaries are thin walled and extremely narrow tubes or blood vessels which connect arteries to veins.
- The capillaries are in-between the arteries and veins. The blood from arteries enters the capillaries in the body. Every living cell of our body is close to a capillary. The walls of capillaries are only one-cell thick. The various dissolved substances (like oxygen, food etc.) present in blood pass into the body cells through the thin walls of the capillaries. At the same time, the waste substances (like carbon dioxide) formed in the cells enter into capillaries.
- The exchange of various materials like oxygen, food, carbon dioxide, etc., between the blood and the body cells takes place through capillaries. The other end of capillaries is joined to some wider tubes called veins.
- Veins are the thin walled blood vessels which carry blood from all the parts of the body back to the heart.
- Veins do not need thick walls because the blood flowing through them is no longer under high pressure. Veins have valves in them is no longer under high pressure. Veins have valves in them allow the blood in them to flow in only one direction (towards the heart). The valves prevent the backflow of blood in veins.
- The pulmonary vein carries oxygenated blood from lungs back to the heart.
- The main vein is connected to the right atrium of the heart. The main vein carries deoxygenated blood from all the parts of the body (except lungs), back to the heart.
- The main difference between an artery and a vein is that an artery carries blood from the heart to the body organs whereas a vein carries blood from the body organs back to the heart.

HEART IS A DOUBLE PUMP

- Heart is really a double pump. The left sides of heart (left atrium and left ventricle) acts as one pump which pumps blood into the whole body, except the lungs. The right side of heart (right atrium and right ventricle) acts as another pump which pumps blood only into the lungs. We can see that the left side of heart is completely separated from the right side by a partition called spectrum. So, the two pumps in the heart work independently.
- The heart beats non-stop all the time.

CIRCULATION OF BLOOD

The heart beats (or beating of heart) circulates the blood in the human body.

1. When the muscles of all the four chambers of the heart are relaxed, the pulmonary vein brings the oxygenated blood (oxygen-carrying blood) from the lungs into the left atrium of the heart.
2. When the left atrium contracts, the oxygenated blood is pushed into the left ventricle through the valve V_1.

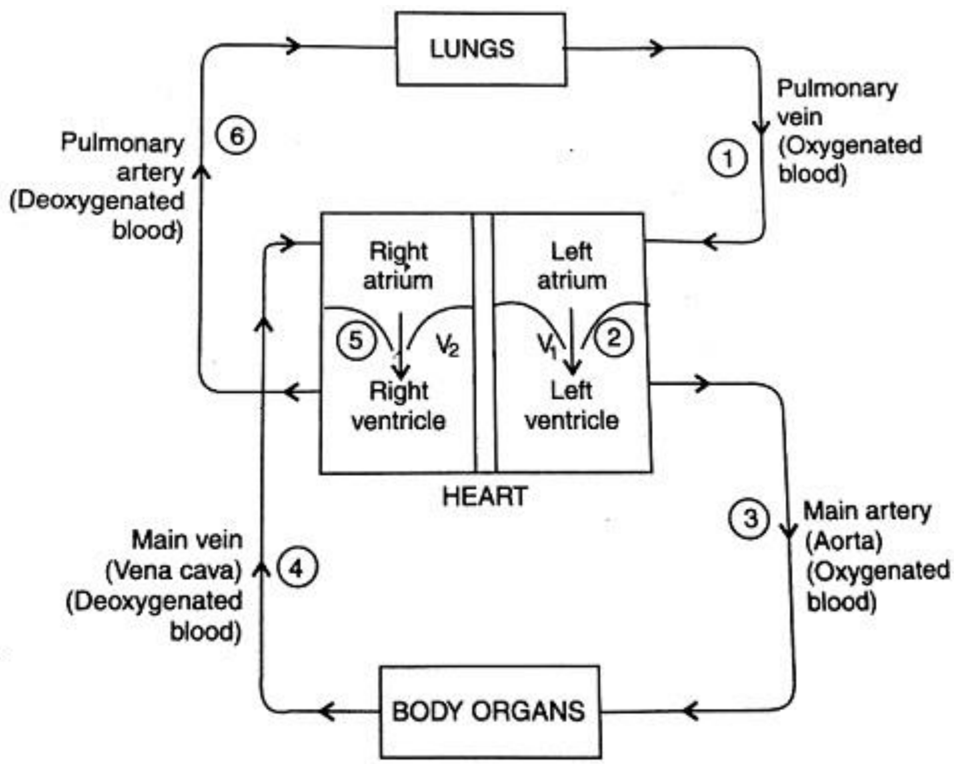


Figure . Diagram to show blood circulation in human body.

3. When the left ventricle contracts, the oxygenated blood is forced into the main artery called 'aorta'. This main artery then branches into smaller arteries which go into different body organs (except the lungs). The smaller arteries (called arterioles) further branch into capillaries.

4. The main artery carries blood to all the organs (or parts) of the body like head, chest, arms, stomach, intestines, liver, kidney, trunk and legs (except the lungs). When the oxygenated blood passes through the capillaries of the body organs, then it gives oxygen to the body cells. Since the blood loses oxygen here, we say that the blood has been deoxygenated. The blood also gives the digested food and other dissolved materials to the body cells. At the same time, carbon dioxide produced as a waste material during respiration enters into the blood. The deoxygenated blood (carrying carbon dioxide) from the body organs enters into the main vein called vena cava. The main vein carries the deoxygenated blood to the right atrium of the heart.

5. When the right atrium contracts, deoxygenated blood is pushed into the right ventricle through the valve V_2.

6. And when the right ventricle contract, the deoxygenated blood is pumped into the lungs through the pulmonary artery. In the lungs, deoxygenated blood releases its carbon dioxide and absorbs fresh oxygen from air. So, the blood becomes oxygenated again. This oxygenated blood is again sent to the left atrium of heart by pulmonary vein for circulation in the body.

- The whole process is repeated continuously. In this way, the blood keeps on circulating in our body without stopping due to which all the body parts keep on getting oxygen, digested food and other materials all the time. The blood circulation also keeps on removing waste products formed in the cells of the body.

DOUBLE CIRCULATION

- A circulatory system in which the blood travels twice through the heart in one complete cycle of the body is called double circulation.
- The animals such as mammals (including human beings), and birds have four-chambered heart (which consists of two atria and two ventricles).
- In a four-chambered heart, the left side and right side of the heart are completely separated to prevent the oxygenated blood from mixing with deoxygenated blood. Such a separation allows a highly efficient supply of oxygen to the body cells which is necessary for producing a lot of energy. This energy is useful in warm-blooded animals (like mammals and birds) which have high energy needs because they constantly require energy to maintain their body temperature. All the animals having four-chambered hearts have double circulation.
- The animals such as amphibians and many reptiles are cold-blooded animals whose body temperature depends on the temperature in the environment.
- The amphibians (like frogs) and reptiles (like lizard) have a three-chambered heart (which consist of two atria and one ventricle). Due to incomplete division within their heart the oxygenated and deoxygenated bloods mix to some extent in amphibians and reptiles. This reduces the production of energy.
- The fish has a two-chambered heart (which consists of one atrium and one ventricle).
- The flow of blood in a fish is called single circulation because the blood passes through the heart of fish only once in one complete cycle of the body.

Heart Beats

- One complete contraction and relaxation of the heart is called a heart beat. The heart usually beats about 70 to 72 times in a minute when we are resting.
- The average number of heart beats of a person at rest is about 70 to 72 per minute but the number of heart beats increases too much after a physical exercise or when a person is excited. For example, if we count our heart beats after running for a while, we will find it to be more than 100 per minute.
- The heart beats faster during and after an exercise because the body needs more energy under these conditions.

Pulse

- The expansion of an artery each time the blood is forced into it is called pulse. Each heartbeat generates one pulse in the arteries, so the pulse rate of a person is equal to the number of heart beats per minute. Since the heart beats about 70 to 72 times per minute, therefore, the pulse rate of an adult person while resting is 70 to 72 per minute.
- Body like the wrist, temple and neck, the arteries are close to the surface of skin and pass over bones.

Blood Pressure

- The pressure at which blood is pumped around the body by the heart is called blood pressure. The blood pressure of a person is always expressed in the form of two values called 'systolic pressure' and 'diastolic pressure'.
- The maximum pressure, at which the blood leaves the heart through the main artery (aorta) during contraction phase, is called the systolic pressure.
- The minimum pressure in the arteries during the relaxation phase of heart is called the diastolic pressure.
- The normal blood pressure values are:

Systolic pressure: 120 mm Hg
Diastolic pressure: 80 mm Hg
This is usually written as 120/80

- A young person may have blood pressure of 110/75 but at the age of 60 years it could be 145/90.
- High blood pressure is called hypertension. High blood pressure is caused by the constriction (narrowing) of very small arteries (called arterioles) which results in increased resistance to blood flow very high blood pressure can lead to rupture of an artery and internal bleeding.

How to measure blood pressure

- Blood pressure is measured by using an instrument called sphygmomanometer.
- Two readings of blood pressure are taken: systolic pressure (when the heart is contracting and pumping out blood), and diastolic pressure.
- The various steps in measuring the blood pressure of a person are as follows:

i. A rubber cuff (which is a flat rubber tube) is wrapped around the person's arm. The rubber cuff is inflated by pumping air into it to give a pressure of about 200 mm Hg to the brachial artery (which runs down the arm). This pressure can be seen on the scale of the instrument sphygmomanometer. If a stethoscope is now placed on the artery of the arm, no sound is heard through it.

ii. With the stethoscope still placed on artery, the cuff pressure is reduced gradually by deflating it. The cuff pressure when the heart beat is first heard as a soft trapping sound through the stethoscope gives us the systolic pressure.

iii. The cuff pressure is reduced further by deflating it more and more. The cuff pressure when the trapping sound in stethoscope just disappears, gives us the diastolic pressure.

How do food and oxygen reach body cells

➢ How do food and oxygen get from the blood to the blood to the body cells where they are needed?

- This happens with the help of plasma which leaks from the blood capillaries around the body cells. This plasma which leaks out from the blood capillaries is called tissue fluid.
- The liquid from the blood which is forced out through the capillary walls and moves between all the body cells (providing them with food and oxygen, and removing carbon dioxide) is called tissue fluid.
- The tissue fluid carries food and oxygen from the blood to the cells, and picks up their waste products like carbon dioxide. After doing its job, most of the tissue fluid seeps back into blood capillaries. The remaining tissue fluid carrying large protein molecules, digested fat, germs from the cells and fragments of dead cells, enters into another type of tiny tubes called lymph capillaries and it becomes lymph.

LYMPHATIC SYSTEM

- A system of tiny tubes called lymph vessels (or lymphatic's) and lymph nodes (or lymph glands) in the human body which transports the liquid called lymph from the body tissues to the blood circulatory system is called lymphatic system.

- The lymphatic system consists of the following parts:

i. Lymph capillaries,
ii. Larger lymph vessels,
iii. Lymph nodes (or lymph glands), and
iv. Lymph.

- Lymph is another medium of circulation in the human body.
- But lymph flows in only one direction.
- Lymph contains a special type of white blood cells called lymphocytes which help in fighting infection and disease.
- In the lymph nodes, lymph is cleaned by white blood cells called lymphocytes.

The functions of lymph (or lymphatic system)

- Lymph (or lymphatic system) takes part in the nutritive process of the body. For example, it puts into circulation large protein molecules by carrying them from the tissues into the blood stream.
- Lymph (or lymphatic system) protects the body by killing the germs drained out of the body tissues with the help of lymphocytes contained in the lymph nodes, and by making antibodies.
- Lymph (or lymphatic system) helps in removing the waste products like fragments of dead cells, etc.

EXCRETION

The process of removal of toxic wastes from the body of an organism is called excretion

EXCRETION IN PLANTS

- The main waste products produced by plants are carbon dioxide, water vapour and oxygen.
- The gaseous wastes of respiration and photosynthesis in plants (carbon dioxide, water vapour and oxygen) are removed through the 'stomata' in leaves and 'lenticels' in stems are released to the air.
- Waste water is got rid of by transpiration
- The plants also store some of the waste products in their body parts. For example, some of the waste products collect in the leaves, bark and fruits of the plants (or trees). The plants get rid of these wastes by shedding of leaves, peeling of bark and felling of fruits.
- Various methods used by the plants to get rid of their waste products are the following:

i. The plants get rid of gaseous waste products through stomata in leaves and lenticels in stems.
ii. The plants get rid of stored solid and liquid wastes by the shedding of leaves, peeling of bark and felling of fruits.
iii. The plants get rid of wastes by secreting them in the form of gums and resins.
iv. Plants also excrete some waste substances into the soil around them.

EXCRETION IN ANIMALS

- In Amoeba (and other single celled animals), the waste material carbon dioxide is removed by diffusion through the cell membrane, but nitrogenous wastes (like ammonia) and excess water are removed by the contractile vacuole.
- In earthworm, the tubular structures called nephridia are the excretory organs. In addition to nephridia, the moist skin of earthworm also acts as an excretory organ.

Removal of waste products in humans

- The major wastes produced by the human body are: carbon dioxide and urea.
- Waste removal is called excretion.
- Our lungs excrete carbon dioxide. Our kidneys excrete urea.
- Our lungs act as the excretory organs for removing the waste product carbon dioxide from the body.

EXCRETION IN HUMANS

- The excretory system of human beings consists of the following main organs:

i. Two kidneys,
ii. Two ureters,
iii. Bladder and (iv) Urethra.

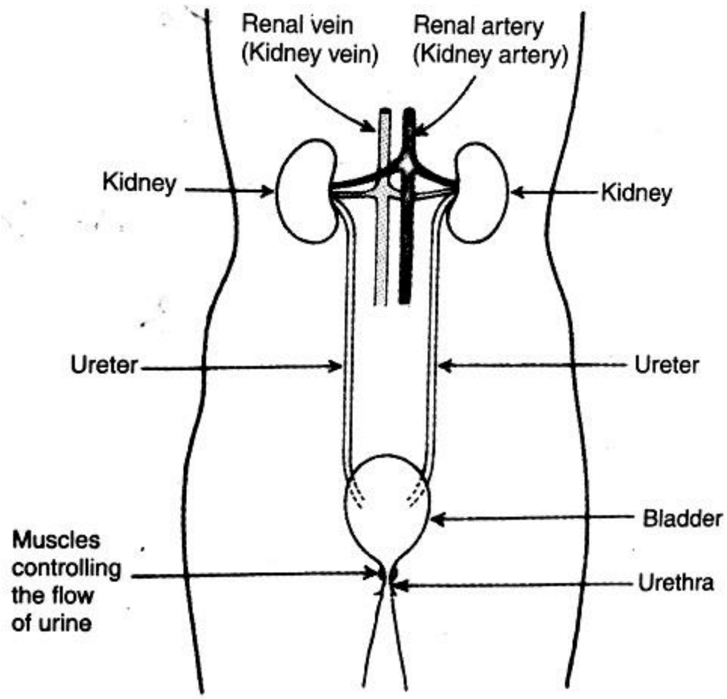


Figure . The human excretory system (or urinary system).

• The kidneys are bean shaped organs towards the back of our body just above the waist.

• Every person has two kidneys. The blood in our body is constantly passing through our kidneys. The renal artery (or kidney artery) brings in the dirty blood (containing waste substances) into the kidneys.

• The function of kidneys is to remove the poisonous substances urea, other waste salts and excess water from the blood and excrete them in the form of yellowish liquid called urine.

• Kidneys clean our blood by filtering it to remove unwanted substances present in it. The cleaned blood is carried away from the kidneys by the renal vein (or kidney vein).

• The ureters (or excretory tubes), one from each kidney, opens into urinary bladder. Ureters are the tubes which carry urine from the kidneys to the bladder. Urine is stored in the bladder. The bladder is a bag which stores urine till the time we go to the toilet.

• The urethra is a tube. The urine collected in the bladder is passed out from the body through the urethra.

• Each kidney is made up of a large number of excretory units called nephrons.

• The nephron has a cup-shaped bag at its upper end which is called Bowman's capsule.

• The lower end of Bowman's capsule is tube-shaped and it is called a tubule. The Bowman 's capsule and the tubule taken together make a nephron.

• One end of the tubule is connected to the Bowman 's capsule and its other end is connected to a urine-collecting duct of the kidney.

• The Bowman 's capsule contains a bundle of blood capillaries which is called glomerulus.

• One end of the glomerulus is attached to the renal which brings the dirty blood containing the urea waste into it . The other end of glomerulus comes out of Bowman 's capsule as a blood capillary, surrounds the tubule of nephron and finally joins a renal vein.

• The function of glomerulus is to filter the blood passing through it. Only small molecules of substances present in blood like glucose, amino acid, salts, urea and water, etc., pass through the glomerulus and collect as filtrate in the Bowman 's capsule.

• The large molecules like proteins and blood cells cannot pass out through the glomerulus capillaries and hence remain behind in the blood.

• The function of tubule of nephron is to allow the selective reabsorption of the useful substances like glucose, amino acids, salts and water into the blood capillaries (which surrounded it). But the waste material like urea remains behind in the tubule. It does not get reabsorbed into blood capillaries.

Working of human excretory system

• The dirty blood containing waste like urea (brought by renal enters the glomerulus. The glomerulus filters this blood. During filtration, the substances like glucose, amino acids, salts, water and urea, etc., present in the blood pass into Bowman's capsule and then enter the tubule of nephron.

• When the filtrate containing useful substances as well as the waste substances passes through the tubule, then the useful substances like all glucose, all amino acids, most salts, and most water, etc., are reabsorbed into the blood through blood capillaries surrounding the tubule.

• Only the waste substances urea, some unwanted salts and excess water remain behind in the tubule. The liquid left behind in the tubule of nephron is urine. The nephron carries this urine into the collecting duct of the kidney from where it is carried to ureter.

• From ureter, urine passes into urinary bladder. Urine is stored in the bladder for some time and ultimately passed out of the body through urethra. Please note that the human urine contains water, some salts and nitrogenous, most of which is urea (and some uric acid).

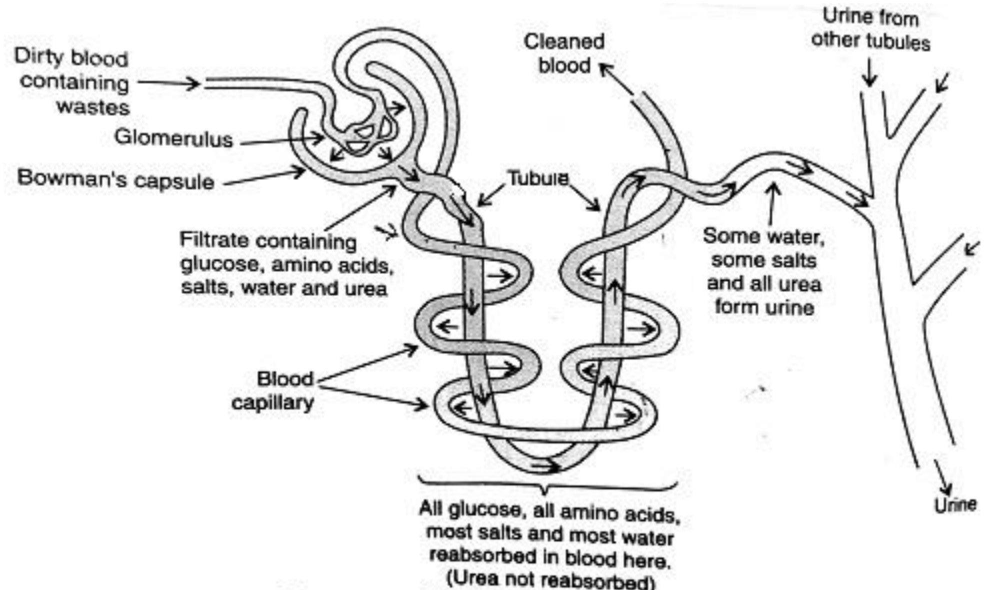


Figure Diagram to show the working of human excretory system.

Renal failure (kidney failure) and technology for survival

• Complete failure of the kidneys allows the urea and other waste products to build up in the blood.

• The best long term solution for kidney failure is the kidney transplant.

• The patient with kidney failure is treated periodically on a kidney machine (by a procedure called dialysis).

• The kidney machine is sometimes called 'artificial kidney'.

Dialysis

• The procedure used for cleaning the blood of a person by separating the waste substances (urea) from it is called dialysis.

• The blood from an artery in the patient's arm is made to flow into the dialyser of a dialysis machine made of long tubes of selectively permeable membrane (like cellulose) which are coiled in a tank containing dialysing solution. The dialysing solution contains water, glucose and salts in similar concentrations to those in normal blood.

• As the patient's blood passes through the dialysing solution, most of the wastes like urea present in it pass through the selectively permeable cellulose tubes into the dialysing solution. The clean blood is pumped back into a vein of the patient's arm.