Life Processes

Photosynthesis: The process by which green plants prepare food is called photosynthesis.

- During this process, the solar energy is converted into chemical energy and carbohydrates are formed.
- Green leaves are the main site of photosynthesis.
- The green portion of the plant contains a pigment chloroplast, chlorophyll (green pigment).
- The whole process of photosynthesis can be shown by the following equation:

$$\underset{\text{Carbon dioxide}}{6CO_2} + \underset{\text{Water}}{12H_2O} \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} \underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Oxygen}}{6O_2} + \underset{\text{Water}}{6H_2O}$$

Raw Materials for Photosynthesis:

- Sunlight
- Chlorophyll: Sunlight absorbed by chloroplast
- CO_2: Enters through stomata, and oxygen (O_2) is released as a byproduct through stomata on the leaf.
- Water: Water + dissolved minerals like nitrogen, phosphorous etc., are taken up by the roots from the soil.

How do raw materials for photosynthesis become available to the plant?

- Water comes from the soil, through the xylem tissue in roots and stems.
- Carbon dioxide comes in the leaves through stomata.

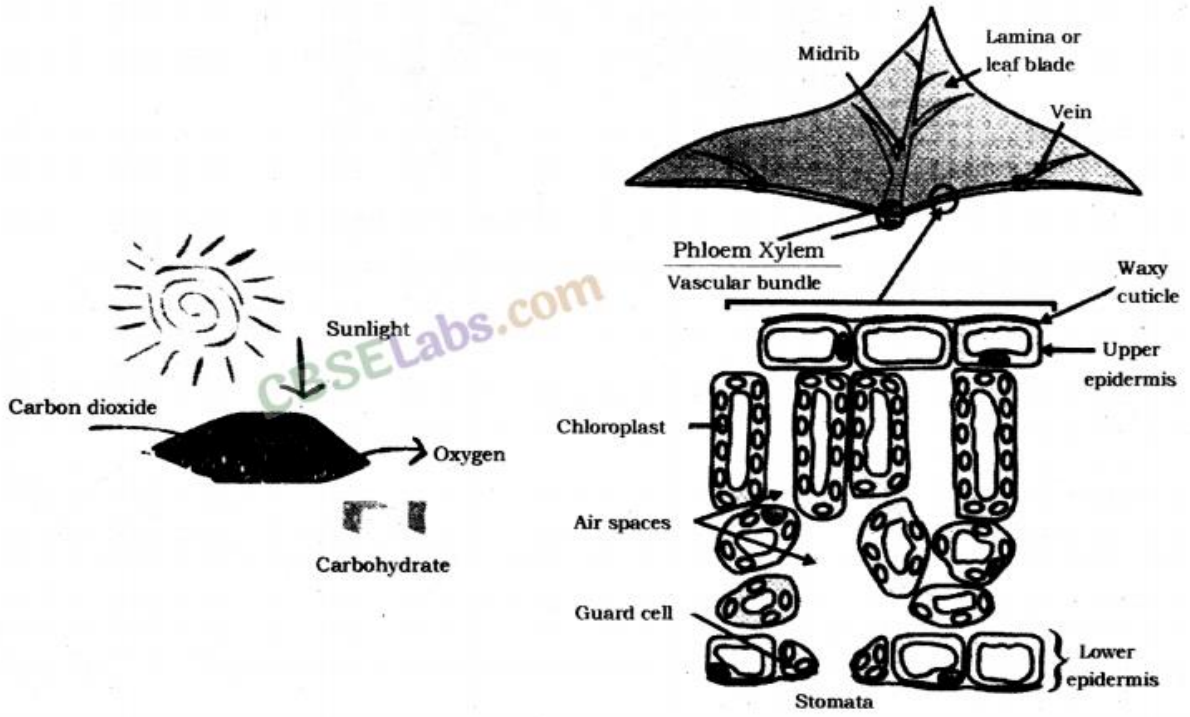
Site of Photosynthesis: Chloroplast in the leaf. Chloroplast contains chlorophyll (green pigment)

Main Events of Photosynthesis:

- Absorption of light energy by chlorophyll.
- Conversion of light energy into chemical energy + splitting (breaking) of water into hydrogen and oxygen.
- Reduction of CO_2 to carbohydrates.
- Sunlight activates chlorophyll, which leads to splitting of the water molecule.
- The hydrogen, released by the splitting of a water molecule is utilized for the reduction of carbon dioxide to produce carbohydrates.

- Oxygen is the by-product of photosynthesis.
- Carbohydrate is subsequently converted into starch and is stored in leaves and other storage parts.
- The splitting of water molecules is a part of the light reaction.

Other steps are part of the dark reaction during photosynthesis.

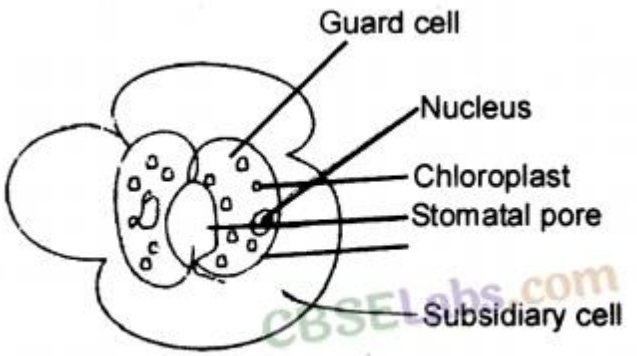


Stomata – Life Processes Class 10 Notes

- Stomata: These are tiny pores present in the epidermis of leaf or stem through which gaseous exchange and transpiration occur.

Functions of stomata

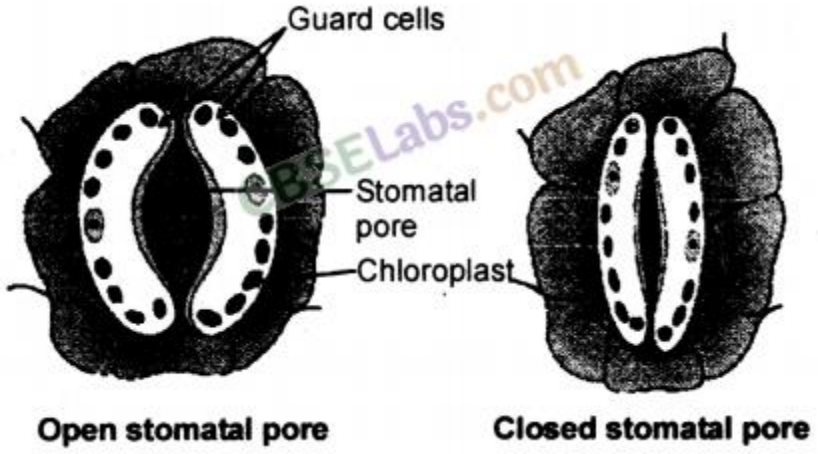
- Exchange of gases, O_2 and CO_2.
- Loses a large amount of water (water vapour) during transpiration.



Structure of stomata

Opening and closing of stomatal pores:

- The opening and closing of stomatal pores are controlled by the turgidity of guard cells.
- When guard cells uptake water from surrounding cells, they swell to become a turgid body, which enlarges the pore in between (Stomatal Opening).
- While, when water is released, they become flaccid shrinking to close the pore (Stomatal Closing).



Significance of Photosynthesis:

- Photosynthesis is the main way through which solar energy is made available for different living beings.
- Green plants are the main producers of food in the ecosystem. All other organisms directly or indirectly depend on green plants for food.
- The process of photosynthesis also helps in maintaining the balance of carbon dioxide and oxygen in the air.

Heterotrophic Nutrition – Life Processes Class 10 Notes

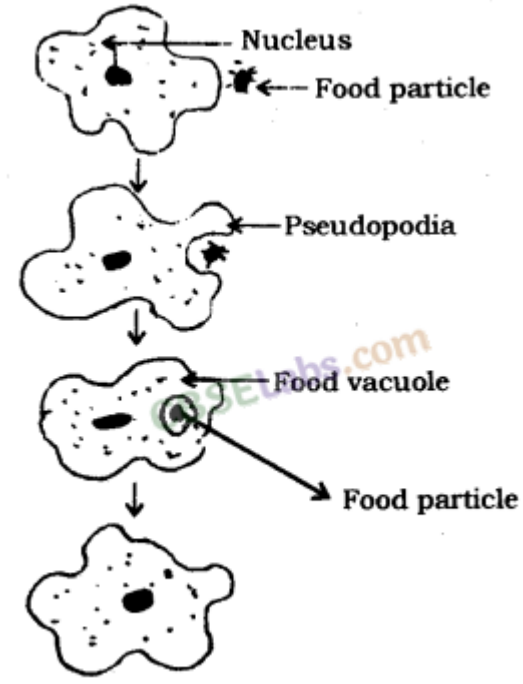
The mode of nutrition in which an organism takes food from another organism is called heterotrophic nutrition. Organisms, other than green plants and blue-green algae follow the heterotrophic mode of nutrition. Heterotrophic nutrition can be further divided into three types, viz. saprophytic nutrition, holozoic nutrition, and parasitic.

- **Saprophytic Nutrition:** In saprophytic nutrition, the organism secretes the digestive juices on the food. The food is digested while it is still to be ingested. The digested food is then ingested by the organism. All the decomposers follow saprophytic nutrition. Some insects, like houseflies, also follow this mode of nutrition.

- **Holozoic Nutrition:** In holozoic nutrition, the digestion happens inside the body of the organism. i.e., after the food is ingested. Most of the animals follow this mode of nutrition.
- **Parasitic Nutrition:** The organism which lives inside or outside another organism (host) and derives nutrition from it is known as parasites and this type of mode of nutrition is called parasitic nutrition. For example Cuscuta, tick etc.

Nutrition in Amoeba

- Amoeba is a unicellular animal which follows the holozoic mode of nutrition.
- In holozoic nutrition, the digestion of food follows after the ingestion of food. Thus, digestion takes place inside the body of the organism.
- Holozoic nutrition happens in five steps, viz. ingestion, digestion, absorption, assimilation and egestion.



Nutrition in Amoeba

Steps of Holozoic Nutrition:

- Ingestion: The process of taking in the food is called ingestion.
- Digestion: The process of breaking complex food substances into simple molecules is called digestion. Simple molecules, thus obtained, can be absorbed by the body.
- Absorption: The process of absorption of digested food is called absorption.
- Assimilation: The process of utilization of digested food, for energy and for growth and repair is called assimilation.

- Egestion: The process of removing undigested food from the body is called egestion.

Amoeba is a unicellular animal which follows the holozoic mode of nutrition. The cell membrane of amoeba keeps on protruding into pseudopodia. Amoeba surrounds a food particle with pseudopodia and makes a food vacuole. The food vacuole contains food particle and water. Digestive enzymes are secreted in the food vacuole and digestion takes place. After that, digested food is absorbed from the food vacuole. Finally, the food vacuole moves near the cell membrane and undigested food is expelled out.

Nutrition in Human Beings

Human beings are complex animals, which have a complex digestive system. The human digestive system is composed of an alimentary canal and some accessory glands. The alimentary canal is divided into several parts, like oesophagus, stomach, small intestine, large intestine, rectum and anus. Salivary gland, liver and pancreas are the accessory glands which lie outside the alimentary canal.

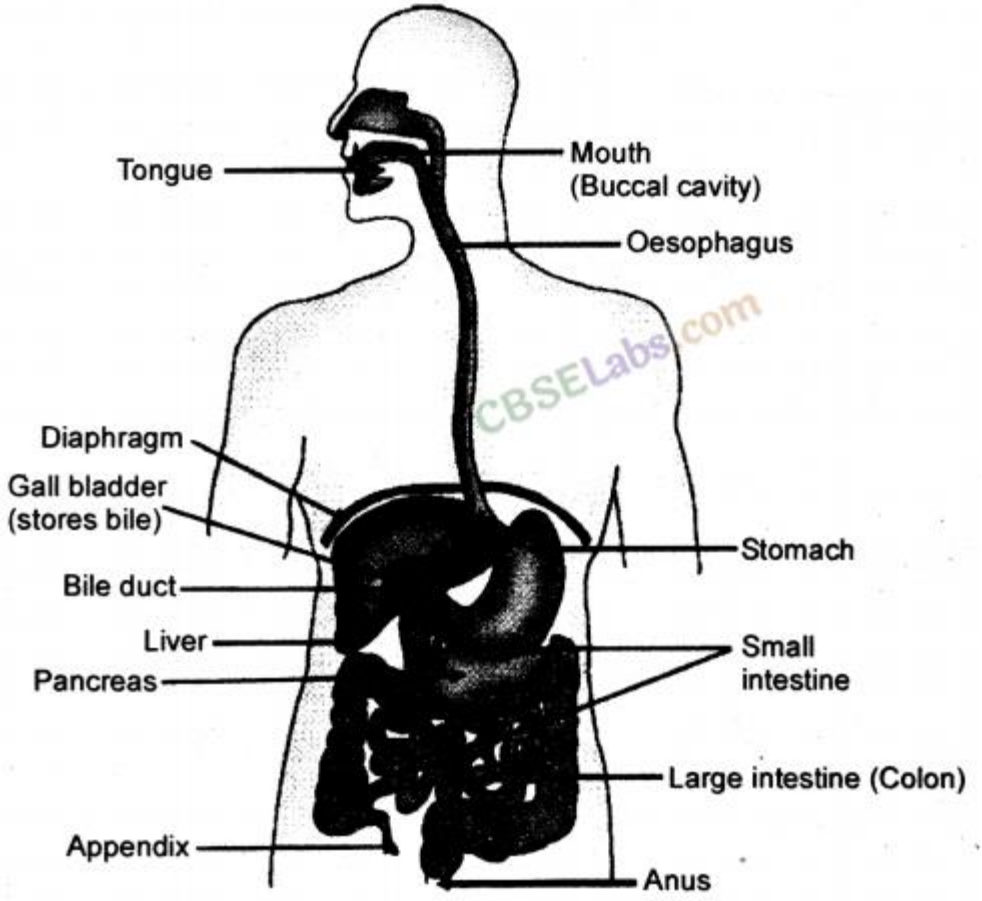
Structure of the Human Digestive System:
The human digestive system comprises of the alimentary canal and associated digestive glands.

- Alimentary Canal: It comprises of mouth, oesophagus, stomach, small intestine and large intestine.
- Associated Glands: Main associated glands are
    - Salivary gland
    - Gastric Glands
    - Liver
    - Pancreas

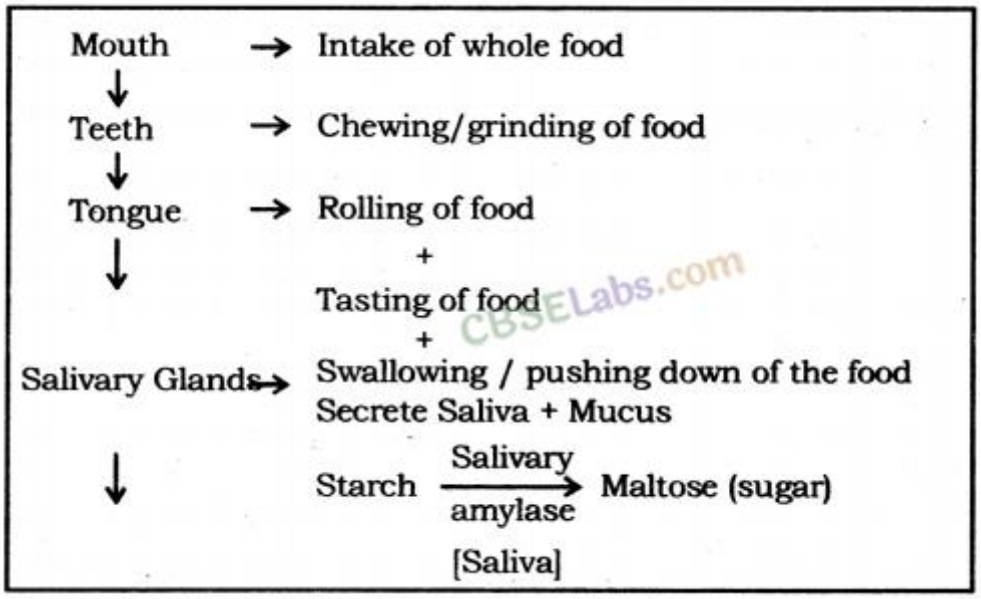
Mouth or Buccal Cavity:

- The mouth has teeth and tongue. Salivary glands are also present in the mouth.
- The tongue has gustatory receptors which perceive the sense of taste.
- The tongue helps in turning over the food so that saliva can be properly mixed in it.
- Teeth help in breaking down the food into smaller particles so that, swallowing of food becomes easier.
- There are four types of teeth in human beings. The incisor teeth are used for cutting the food.
- The canine teeth are used for tearing the food and for cracking hard substances.

- The premolars are used for the coarse grinding of food. The molars are used for fine grinding of food.



Salivary glands secrete saliva: Saliva makes the food slippery which makes it easy to swallow the food. Saliva also contains the enzyme salivary amylase or ptyalin. Salivary amylase digests starch and converts it into sucrose, (maltose).

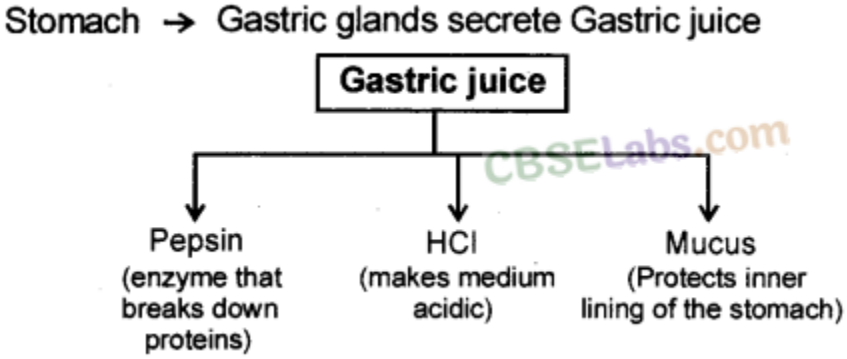


Oesophagus: Taking food from mouth to stomach by Peristaltic movement.

Peristaltic movement: Rhythmic contraction of muscles of the lining of the alimentary canal to push the food forward.

Stomach

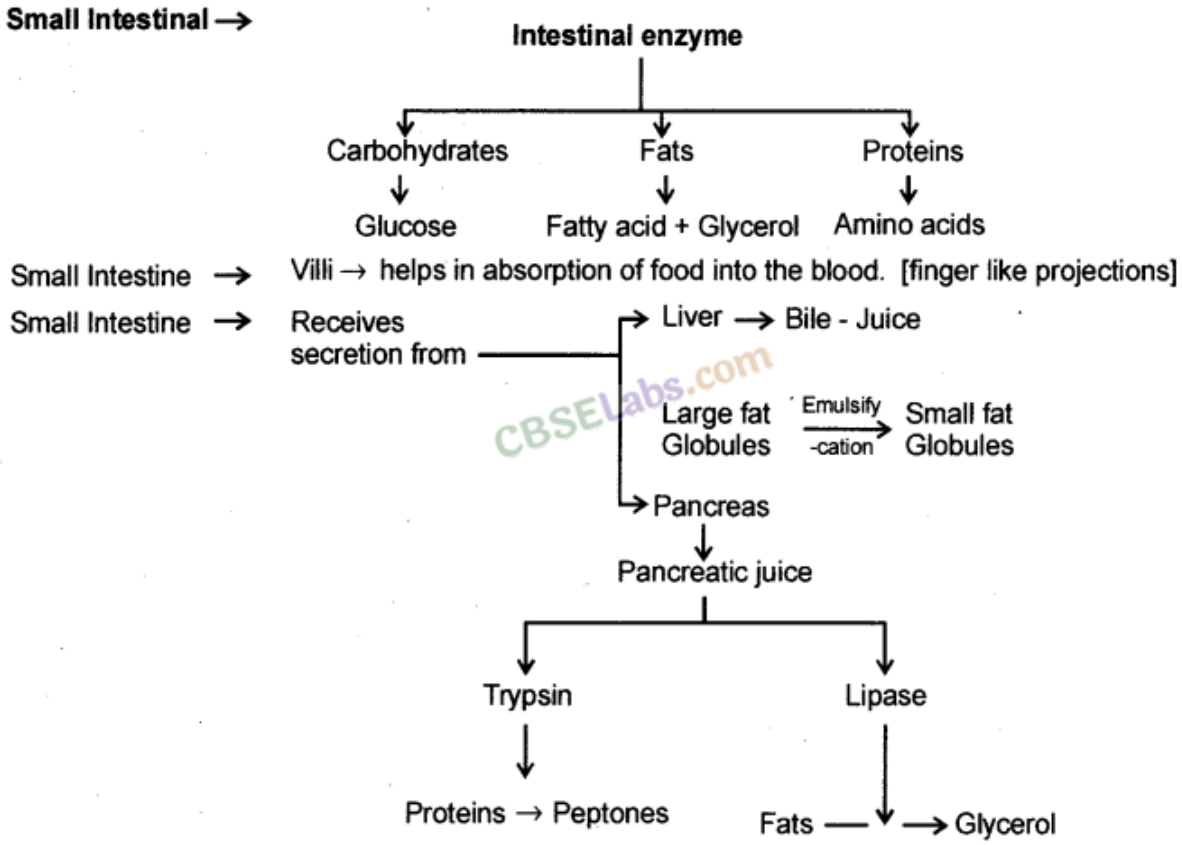
- Stomach is a bag-like organ. Highly muscular walls of the stomach help in churning the food.
- The walls of the stomach secrete hydrochloric acid. Hydrochloric acid kills the germs which may be present in food.
- Moreover, it makes the medium inside the stomach as acidic. The acidic medium is necessary for gastric enzymes to work.
- The enzyme pepsin, secreted in the stomach, does partial digestion of protein.
- The mucus, secreted by the walls of the stomach saves the inner lining of the stomach from getting damaged from hydrochloric acid.



Small Intestine: It is a highly coiled tube-like structure. The small intestine is longer than the large intestine but its lumen is smaller than that of the large intestine. The small intestine is divided into three parts, like duodenum, jejunum and ileum.

Liver: Liver is the largest organ in the human body. The liver manufactures bile, which gets stored in the gall bladder. From the gall bladder, bile is released as and when required.

Pancreas: Pancreas is situated below the stomach. It secretes pancreatic juice which contains many digestive enzymes.



Bile and pancreatic juice go to the duodenum through a hepatopancreatic duct. Bile breaks down fat into smaller particles. This process is called emulsification of fat. After that, the enzyme lipase digests fat into fatty acids and glycerol. Trypsin and chymotrypsin are enzymes which digest protein into amino acids. Complex carbohydrates are digested into glucose. The major part of digestion takes place in the duodenum.

No digestion takes place in the jejunum: The inner wall in the ileum is projected into numerous finger-like structures, called villi. Villi increase the surface area inside the ileum so that optimum absorption can take place. Moreover, villi also reduce the lumen of the ileum so that food can stay for a longer duration in it, for optimum absorption. Digested food is absorbed by villi.

Large Intestine:

- Large intestine is smaller than the small intestine.
- Undigested food goes into the large intestine.
- Some water and salt are absorbed by the walls of the large intestine. After that, the undigested food goes to the rectum, from where it is expelled out through the anus.
- Large Intestine absorb excess of water. The rest of the material is removed from the body via the anus. (Egestion).

Respiration

Types of respiration, aerobic and anaerobic respiration, human respiratory system, respiration in plants.

Respiration: The process by which a living being utilises the food to get energy, is called respiration. Respiration is an oxidation reaction in which carbohydrate is oxidized to produce energy. Mitochondria is the site of respiration and the energy released is stored in the form of ATP (adenosine triphosphate). ATP is stored in mitochondria and is released as per need.

Steps of respiration:

- **Breaking down of glucose into pyruvate:** This step happens in the cytoplasm. Glucose molecule is broken down into pyruvic acid. Glucose molecule is composed of 6 carbon atoms, while pyruvic acid is composed of 3 carbon atoms.
- **Fate of Pyruvic Acid:** Further breaking down of pyruvic acid takes place in mitochondria and the molecules formed depend on the type of respiration in a particular organism. Respiration is of two types, viz. aerobic respiration and anaerobic respiration.
- **Respiration involves**
    - Gaseous exchange: Intake of oxygen from the atmosphere and release of CO_2 → Breathing.
    - Breakdown of simple food in order to release energy inside the cell → Cellular respiration

Types of Respiration

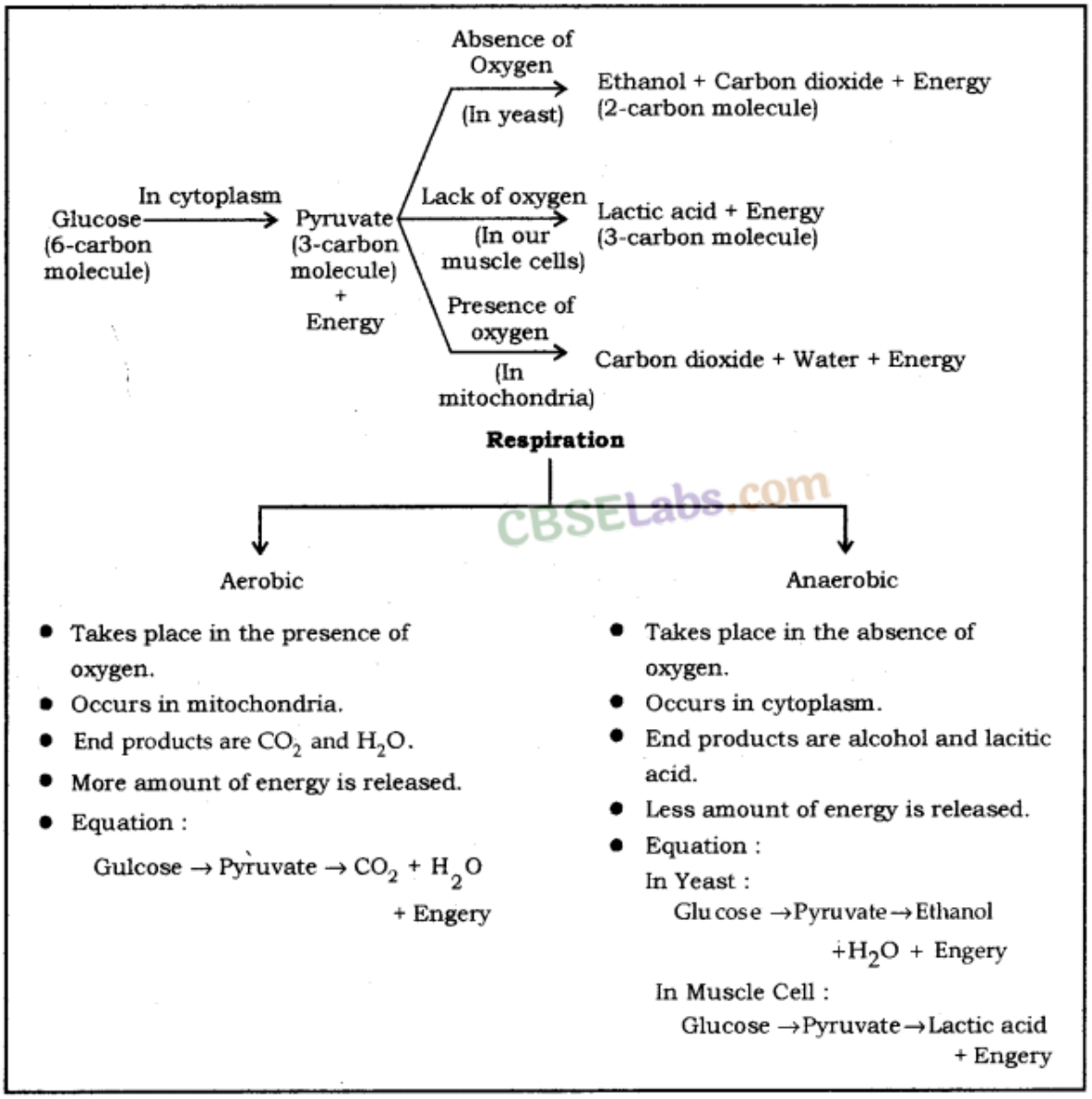
- **Aerobic respiration:** This type of respiration happens in the presence of oxygen. Pyruvic acid is converted into carbon dioxide. Energy is released and water molecule is also formed at the end of this process.
- **Anaerobic respiration:** This type of respiration happens in the absence of oxygen. Pyruvic acid is either converted into ethyl alcohol or lactic acid. Ethyl alcohol is usually formed in case of anaerobic respiration in microbes, like yeast or bacteria. Lactic acid is formed in some microbes as well as in the muscle cells.
    - Glucose (6 carbon molecule) → Pyruvate (3 carbon molecules) + Energy
    - Pyruvate (In yeast, lack of O_2) → Ethyl alcohol + Carbon dioxide + Energy
    - Pyruvate (In muscles, lack of O_2) → Lactic Acid + Energy
    - Pyruvate (In mitochondria; the presence of O_2) → Carbon dioxide + Water + Energy

The equations for the above reactions can be written as follows:

$$\underset{\text{Glucose}}{C_6H_{12}O_6} \xrightarrow{\text{presence of } O_2} 6CO_2 + 6H_2O + \text{Energy}$$

$$\underset{\text{Glucose}}{C_6H_{12}O_6} \xrightarrow{\text{absence of } O_2} \underset{\text{Ethanol}}{C_2H_5OH} + CO_2$$

$$\underset{\text{Glucose}}{C_6H_{12}O_6} \xrightarrow{\text{lack of } O_2} \underset{\text{Lactic acid}}{CH_3CHOHCOOH}$$



Pain in leg muscles while running:

- When someone runs too fast, he may experience throbbing pain in the leg muscles. This happens because of anaerobic respiration taking place in the muscles.

- During running, the energy demand from the muscle cells increases. This is compensated by anaerobic respiration and lactic acid is formed in the process.
- The deposition of lactic acid causes pain in the leg muscles. The pain subsides after taking rest for some time.

Exchange of gases:

- For aerobic respiration, organisms need a continuous supply of oxygen, and carbon dioxide produced during the process needs to be removed from the body.
- Different organisms use different methods for the intake of oxygen and expulsion of carbon dioxide.
- Diffusion is the method which is utilized by unicellular and some simple organisms for this purpose.
- In plants also, diffusion is utilized for exchange of gases.
- In complex animals, respiratory system does the job of exchange of gases.
- Gills are the respiratory organs for fishes. Fishes take in oxygen which is dissolved in water through gills.
- Since, availability of oxygen is less in the aquatic environment, so the breathing rate of aquatic organisms is faster.
- Insects have a system of spiracles and tracheas which is used for taking in oxygen.
- Terrestrial organisms have developed lungs for exchange of gases.
- Availability of oxygen is not a problem in the terrestrial environment so breathing rate is slower as compared to what it is in fishes.

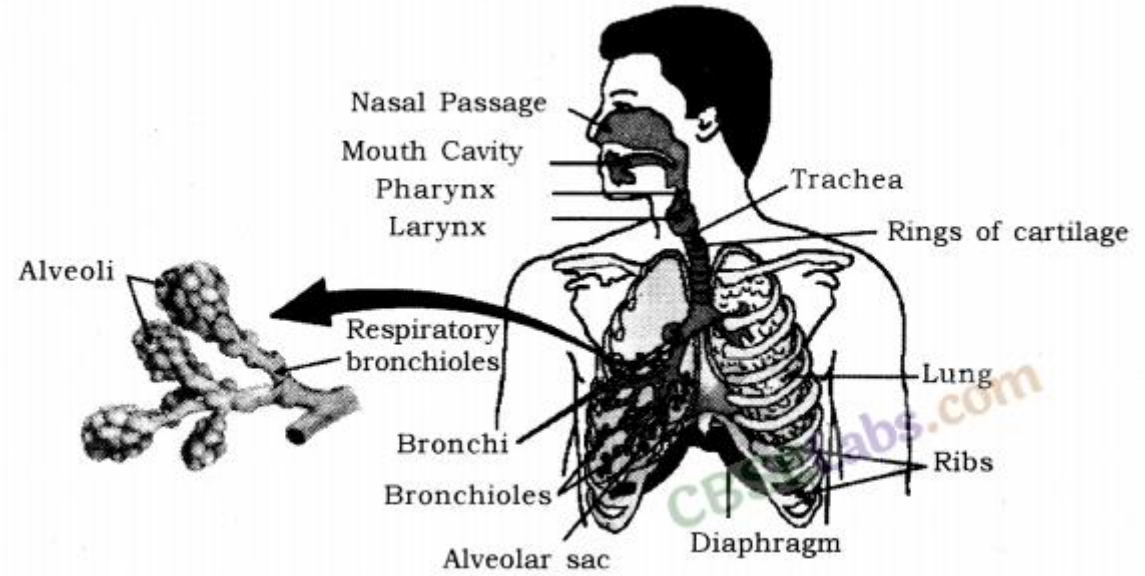
Terrestrial organisms: Use atmospheric oxygen for respiration.
Aquatic organisms: Use dissolve oxygen for respiration.

Human respiratory system – Life Processes Class 10 Notes

The human respiratory system is composed of a pair of lungs. These are attached to a system of tubes which open on the outside through the nostrils.
Following are the main structures in the human respiratory system:

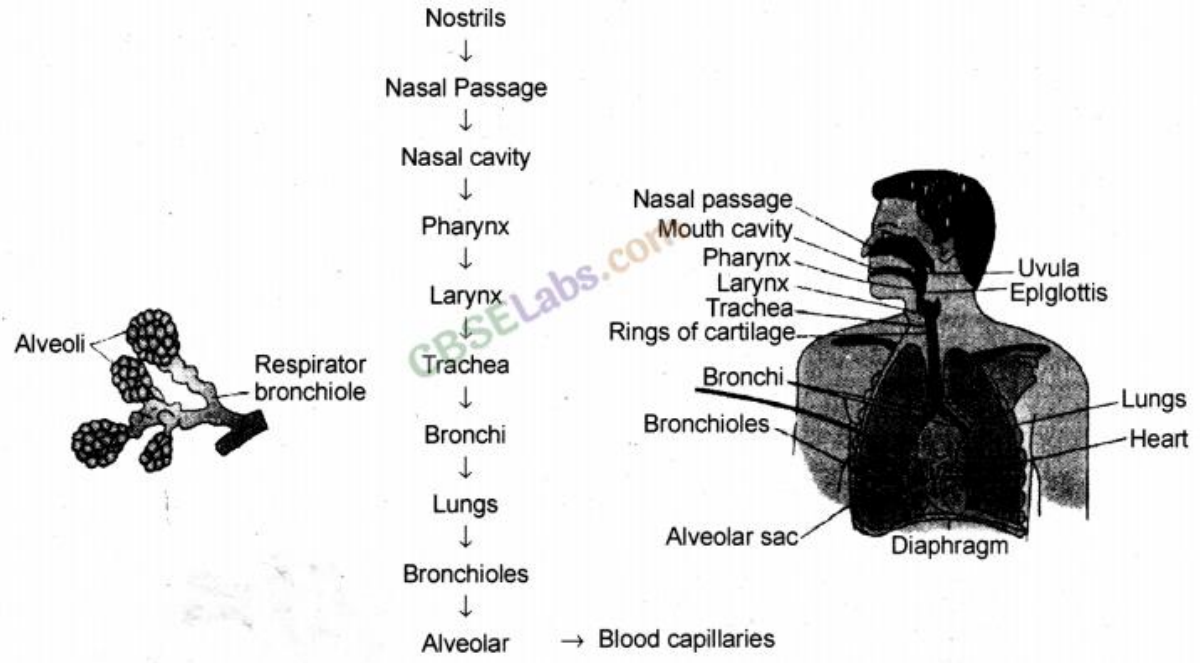
1. Nostrils: There are two nostrils which converge to form a nasal passage. The inner lining of the nostrils is lined by hair and remains wet due to mucus secretion. The mucus and the hair help in filtering the dust particles out from inhaled air. Further, air is warmed up when it enters the nasal passage.
2. Pharynx: It is a tube-like structure which continues after the nasal passage.
3. Larynx: This part comes after the pharynx. This is also called voice box.
4. Trachea: This is composed of rings of cartilage. Cartilaginous rings prevent the collapse of trachea in the absence of air.

5. Bronchi: A pair of bronchi comes out from the trachea, with one bronchus going to each lung.
6. Bronchioles: A bronchus divides into branches and sub-branches inside the lung.
7. Alveoli: These are air sacs at the end of bronchioles. The alveolus is composed of a very thin membrane and is the place where blood capillaries open. This is alveolus, where the oxygen mixes with the blood and carbon dioxide exits from the blood. The exchange of gases, in alveoli, takes place due to the pressure differential.



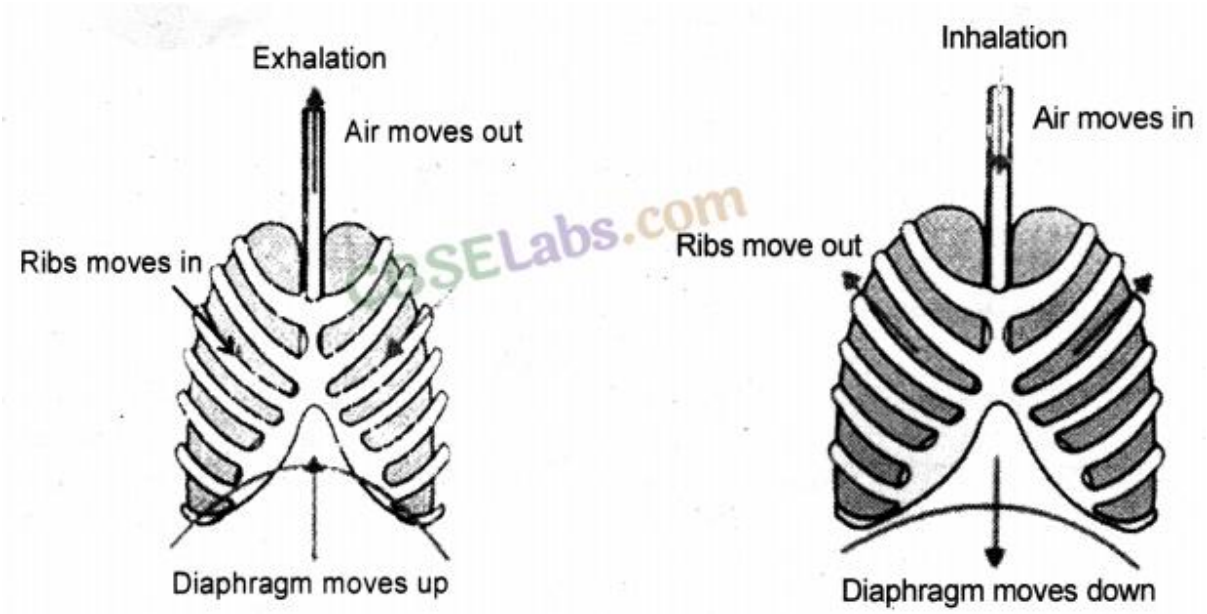
Human Respiratory System

Passage of air through the respiratory system in human beings:



Breathing Mechanism

- The breathing mechanism of lungs is controlled by the diaphragm and the intercostals muscles.
- The diaphragm is a membrane which separates the thoracic chamber from the abdominal cavity.
- When the diaphragm moves down, the lungs expand and the air is inhaled.
- When the diaphragm moves up, the lungs contract and air are exhaled.



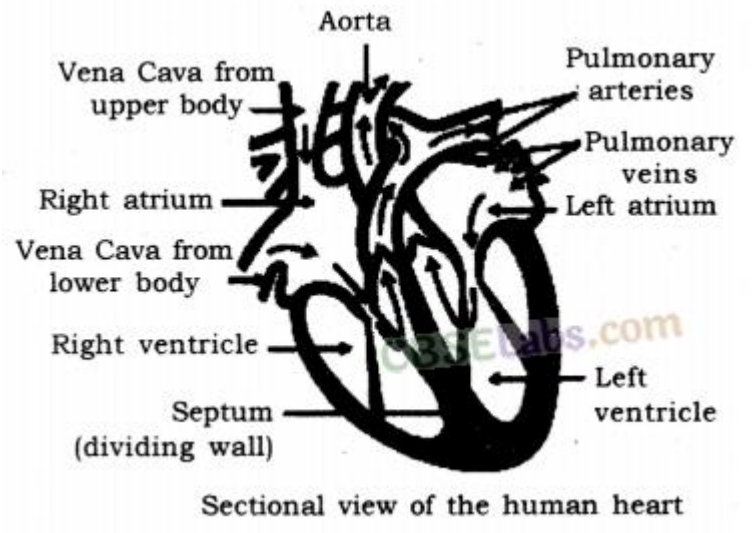
Mechanism of Breathing

Inhalation	Exhalation
• During inhalation, the thoracic cavity (chest cavity) expands	• Thoracic cavity contracts
• Ribs lift upwards	• Ribs move downwards
• Diaphragm become flat in shape	• Diaphragm become dome shaped
• Volume of lungs increases and air enters the lungs	• Volume of lungs decreases and air exits from the lungs.

Transportation

Circulatory system of human being, transportation in plants. Human beings like other multicellular organism need a regular supply of foods, oxygen etc. This function is performed by a circulatory system or transport system.

Transportation in Human Beings: The circulatory system is responsible for transport of various substances in human beings. It is composed of the heart, arteries, veins and blood capillaries. Blood plays the role of the carrier of substances.



Sectional view of the human heart

1. Heart: Heart is a muscular organ, which is composed of cardiac muscles.

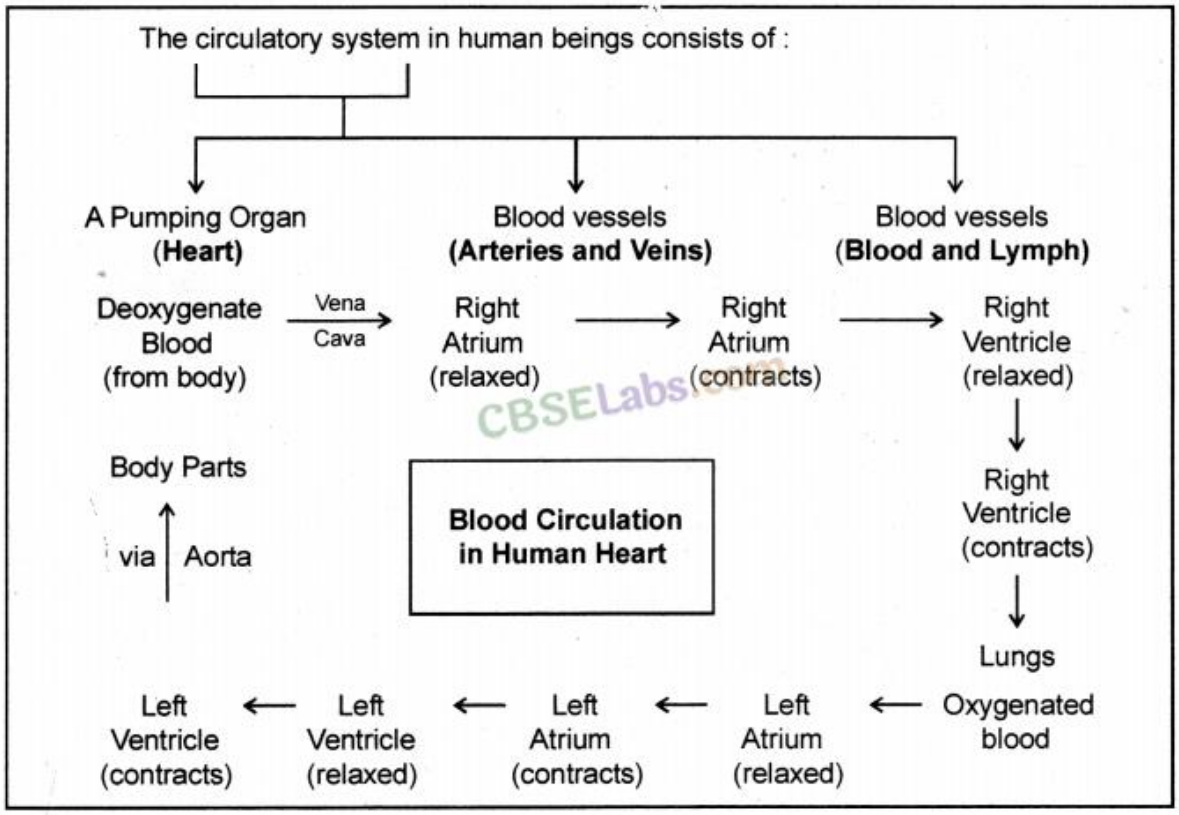
- It is so small that, it can fit inside an adult's wrist. The heart is a pumping organ which pumps the blood.
- The human heart is composed of four chambers, viz. right atrium, right ventricle, left ventricle and left atrium.
- Systole: Contraction of cardiac muscles is called systole.
- Diastole: Relaxation of cardiac muscles is called diastole.

2. Arteries:

- These are thick-walled blood vessels which carry oxygenated blood from the heart to different organs.
- Pulmonary arteries are exceptions because they carry deoxygenated blood from the heart to lungs, where oxygenation of blood takes place.

3. Veins:

- These are thin-walled blood vessels which carry deoxygenated blood from different organs to the heart, pulmonary veins are exceptions because they carry oxygenated blood from lungs to the heart.
- Valves are present in veins to prevent back flow of blood.



4. Capillaries: These are the blood vessels which have single-celled walls.

Blood: Blood is a connective tissue which plays the role of the carrier for various substances in the body. Blood is composed of 1. Plasma 2. Blood cells 3. Platelets.

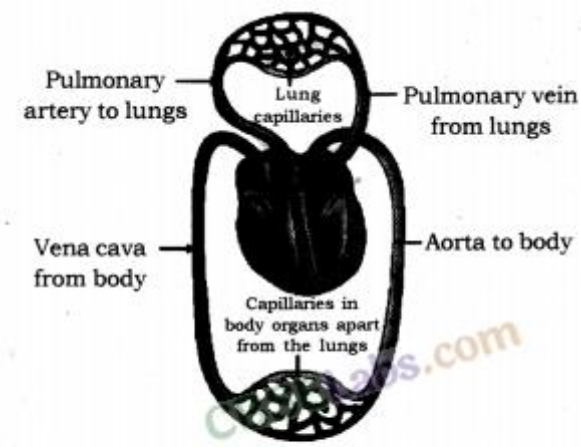
- **Blood plasma:** Blood plasma is a pale coloured liquid which is mostly composed of water. Blood plasma forms the matrix of blood.
- **Bloods cells:** There are two types of blood cells, viz. Red Blood Cells (RBCs) and White Blood Cells (WBCs).
  (a) Red Blood Corpuscles (RBCs): These are of red colour because of the presence of haemoglobin which is a pigment. Haemoglobin readily combines with oxygen and carbon dioxide. The transport of oxygen happens through haemoglobin. Some part of carbon dioxide is also transported through haemoglobin.
  (b) White Blood Corpuscles (WBCs): These are of pale white colour. They play important role in the immunity.
- **Platelets:** Platelets are responsible for blood coagulation. Blood coagulation is a defense mechanism which prevents excess loss of blood, in case of an injury.

Lymph:

- Lymph is similar to blood but RBCs are absent in lymph.

- Lymph is formed from the fluid which leaks from blood capillaries and goes to the intercellular space in the tissues. This fluid is collected through lymph vessels and finally return to the blood capillaries.
- Lymph also plays an important role in the immune system.
- Lymph a yellowish fluids escape from the blood capillaries into the intercellular spaces contain less proteins than blood.
- Lymph flows from the tissues to the heart assisting in transportation and destroying germs.

Double circulation: In the human heart, blood passes through the heart twice in one cardiac cycle. This type of circulation is called double circulation. One complete heartbeat in which all the chambers of the heart contract and relax once is called cardiac cycle. The heart beats about 72 times per minute in a normal adult. In one cardiac cycle, the heart pumps out 70 mL blood and thus, about 4900 mL blood in a minute. Double circulation ensures complete segregation of oxygenated and deoxygenated blood which is necessary for optimum energy production in warm-blooded animals.

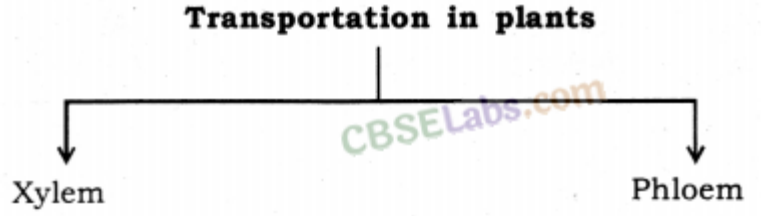


Schematic representation of transport and exchange of oxygen and carbon dioxide.

Transportation in plants: Plants have specialized vascular tissues for transportation of substances. There are two types of vascular tissues in plants.

- **Xylem:** Xylem is responsible for transportation of water and minerals. It is composed of trachids, xylem vessels, xylem parenchyma and xylem fibre. Tracheids and xylem vessels are the conducting elements. The xylem makes a continuous tube in plants which runs from roots to stem and right up to the veins of leaves.
- Carry water and minerals from the leaves to the other part of the plant.
- **Phloem:** Phloem is responsible for transportation of food. Phloem is composed of sieve tubes, companion cells, phloem parenchyma and bast fibers. Sieve tubes are the conducting elements in phloem.
- Carries product of photosynthesis from roots to other part of the plant.

Transportation in plants



Ascent of sap: The upward movement of water and minerals from roots to different plant parts is called ascent of sap. Many factors are at play in ascent of sap and it takes place in many steps. They are explained as follows :

- Root pressure: The walls of cells of root hairs are very thin. Water from soil enters the root hairs because of osmosis. Root pressure is responsible for movement of water up to the base of the stem.
- Capillary action: A very fine tube is called capillaiy, water, or any liquid, rises in the capillary because of physical forces and this phenomenon is called capillary action. Water, in stem, rises up to some height because of capillaiy action.
- Adhesion-cohesion of water molecules: Water molecules make a continuous column in the xylem because of forces of adhesion and cohesion among the molecules.
- Transpiration pull: Loss of water vapour through stomata and lenticels, in plants, is called transpiration. Transpiration through stomata creates vacuum which creates a suction, called transpiration pull. The transpiration pull sucks the water column from the xylem tubes and thus, water is able to rise to great heights in even the tallest plants.
- **Transport of food:** Transport of food in plants happens because of utilization of energy. Thus, unlike the transport through xylem, it is a form of active transport. Moreover, the flow of substances through phloem takes place in both directions, i.e., it is a two-way traffic in phloem.
  Transpiration is the process of loss of water as vapour from aerial parts of the plant.

Functions

- Absorption and upward movement of water and minerals by creating pull.
- Helps in temperature regulation in plant.

Transport of food from leaves (food factory) to different parts of the plant is called Translocation.

Excretion

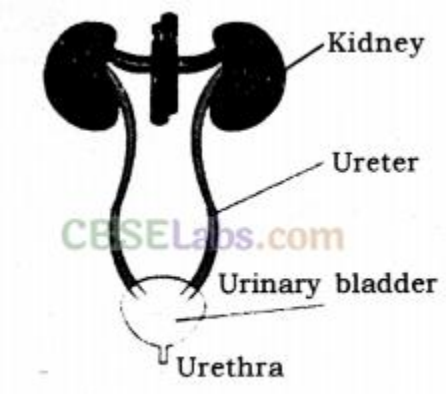
Human excretory system, excretion in plants.

Excretion in human beings:

- Removal of harmful waste from the body is called excretion.
- Many wastes are produced during various metabolic activities.
- These need to be removed in time because their accumulation in the body can be harmful and even lethal for an organism.

Human Excretory System:

- The human excretory system is composed of a pair of kidneys.
- A tube, called ureter, comes out of each kidney and goes to the urinary bladder.
- Urine is collected in the urinary bladder, from where it is expelled out through urethra as and when required.



Human Excretory System

Excretory system of human beings includes :

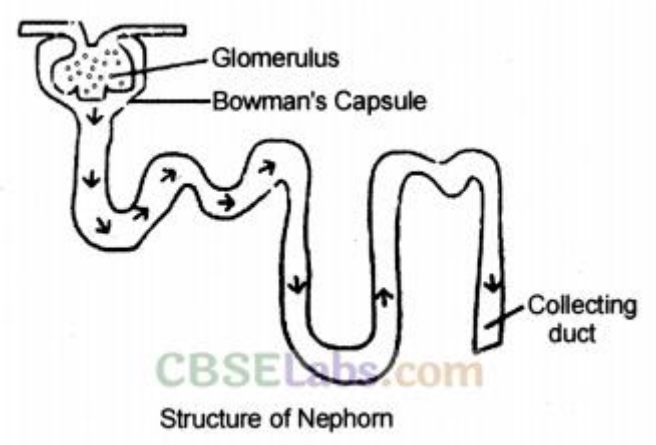
- A pair of kidneys.
- A urinary bladder.
- A pair of the ureter.
- A urethra.

Kidney:

- Kidney is a bean-shaped organ which lies near the vertebral column in the abdominal cavity.
- The kidney is composed of many filtering units, called nephrons.
- Nephron is called the functional unit of kidney.

Nephron

- It is composed of a tangled mess of tubes and a filtering part, called glomerulus.
- The glomerulus is a network of blood capillaries to which renal artery is attached.
- The artery which takes blood to the glomerulus is called afferent arteriole and the one receiving blood from the glomerulus is called efferent arteriole.
- The glomerulus is enclosed in a capsule like portion, called bowman's capsule. The bowman's capsule extends into a fine tube which is highly coiled.
- Tubes from various nephrons converge into collecting duct, which finally goes to the ureter.



Structure of Nephorn

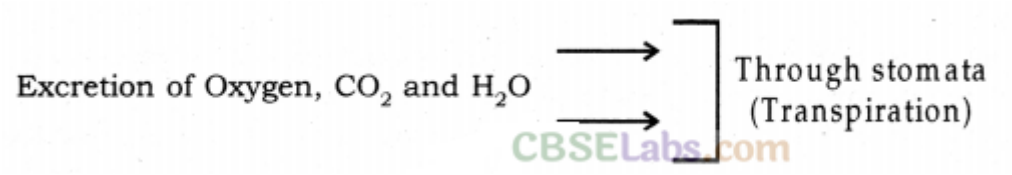
Urine formation in the kidney: The urine formation involves three steps:

- Glomerular filtration: Nitrogenous wastes, glucose, water, amino acid filter from the blood into bowman's capsule of the nephron.
- Tubular reabsorption: Now, useful substances from the filtrate are reabsorbed back by capillaries surrounding the nephron.
- Secretion: Extra water, salts are secreted into the tubule which opens up into the collecting duct and then into the ureter.

Urine produced in the kidneys passes through the ureters into the urinary bladder where it is stored until it is released through the urethra.
The purpose of making urine is to filter out waste product from the blood i.e., urea which is produced in the liver.

Haemodialysis: The process of purifying blood by an artificial kidney. It is meant for kidney failure patient.

Excretion in Plants



- Other wastes may be stored in leaves, bark etc. which fall off from the plant.
- Plants excrete some waste into the soil around them.
- Gums, resin → In old xylem
- Some metabolic wastes in the form of crystals of calcium oxalates in the leaves of colocasia and stem of Zamikand.

Nutrition in Plants and Animals

Nutrition: Process of obtaining and utilizing of food is known as nutrition.

Mode of nutrition:

- Autotrophic Nutrition (All green plants)
- Heterotrophic Nutrition (Animals, Man, Non-green plants)
    - Saprotrophic nutrition
    - Parasitic nutrition
    - Holozoic nutrition

Autotrophs: It is a mode of nutrition in which organisms can make their own food from simple raw material. Example, all green plants.

Heterotrophs: It is a mode of nutrition in which organisms cannot prepare their food on their own and depend on others. Example, animals.

Saprotrophic Nutrition: It is the process by which the organism feeds on dead and decaying matter. Example, Rhizopus, Mucor, yeast.

Photosynthesis: It is the process by which green plants prepare their own food.

Raw materials for photosynthesis:

- **Water and Minerals:** These are absorbed by the roots from the soil.
- **Carbon dioxide:** Carbon dioxide enters the leaves through tiny pores called stomata.
- **Sunlight:** Energy from the sun is called solar energy.
- **Chlorophyll:** Chlorophyll pigment helps leaves to capture solar energy.

Products of Photosynthesis: Carbohydrate-glucose- It is converted to starch.

Symbiotic relationship: Two organisms live in a close association and develop a relationship that is beneficial to both this is called a symbiotic relationship. Example, Lichen is a living partnership between a fungus an alga. Fungus absorbs water and provides shelter and alga prepare food by photosynthesis

Insectivores: Plants feed on insects for their nitrogen requirements.

Holozoic nutrition: It means feeding on solid food. Organism takes complex organic food into the body. Example, man, amoeba, dog, etc.

- **Herbivores:** Animals which feed on plants only. Example, deer, cow.
- **Carnivores:** Animals which feed on flesh or meat. Example, tiger.
- **Omnivores:** Animals which feed on both plant and flesh. Example, man, dog.

Steps of Holozoic nutrition:

- **Ingestion:** Taking food into the mouth.
- **Digestion:** Break down of large insoluble food into small water-soluble molecules by enzymes.
- **Absorption:** Digested food absorbed through the intestinal wall into the blood.
- **Assimilation:** Absorbed food is taken by body cells for releasing energy, growth and repair.
- **Egestion:** Eliminating undigested food from the body.

Digestive organs of human beings: Mouth, oesophagus, stomach, small intestine and large intestine with glands like salivary gland, liver, pancreas.

Teeth: An organ which breaks down the complex food and helps in chewing the food.

- **Milk teeth:** The first set of 20 small teeth when the baby is 6-7 months old.
- **Permanent teeth:** The second set of 32 larger teeth, when a child is 6-7 years old and comes by replacing milk teeth.

Enamel: A white, strong, shining, protective material covering on teeth.

Tongue: A muscular organ attached to the floor of the buccal cavity which helps in tasting and mixing the food with saliva for digestion.

Transportation in Plants and Animals

- **Vascular tissue:** A plant tissue which helps in transportation.
- **Xylem tissue:** It helps in transporting water and minerals in plants.
- **Phloem:** It helps in transporting food in plants.
- **Translocation:** The process of transporting food from leaves to other parts of plants.
- **Transpiration:** A loss of water from stomata in leaves.
- **Blood:** A red colour fluid which circulates in the body of animals.
- **Plasma:** Fluid part of the blood which consists of nutrients, hormones, and waste products.
- **Blood vessel:** Tube-like structure present in the body for carrying blood inside the body.
- **Artery:** It carries oxygenated blood from the heart to body parts.
- **Vein:** It carries deoxygenated blood from body parts to the heart.
- **Capillary:** A thin-walled narrow tube which connects artery and vein.
- **Heart:** A muscular organ present in the thoracic cavity and helps in pumping blood in the body.
- **Double circulation:** A circulatory system in which blood travels twice through the heart in one complete cycle.
- **Heartbeat:** One complete contraction and relaxation of the heart (72 times in a minute).
- **Stethoscope:** Instrument which measures heartbeat.
- **Systolic pressure:** Maximum pressure at which blood flows during contraction of the heart. (120 mm Hg)
- **Diastolic pressure:** Minimum pressure at which blood flows during relaxation of the heart. (80 mm Hg)
- **Sphygmomanometer:** Instrument which measures blood pressure.
- **Lymph:** A light yellow liquid flowing from body tissue to the blood circulatory system and provides immunity.

Excretion in Plants and Animals

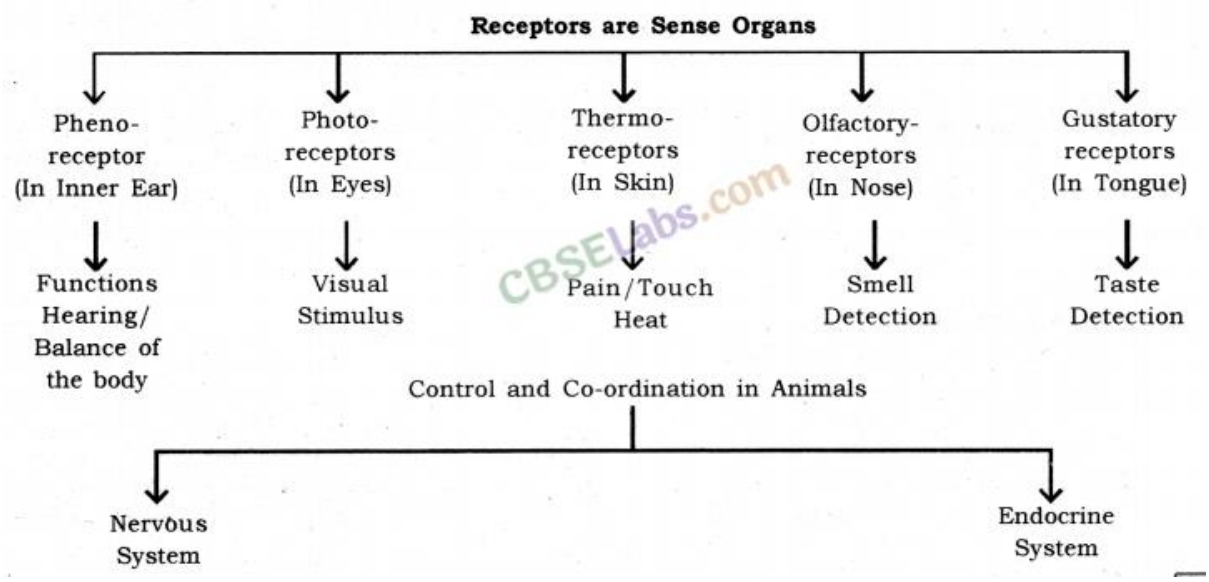
- **Excretion:** It is the process of removing waste products from the body.
- **Excretory products of plants:** CO_2, O_2, water vapour, peel of bark, fruits, leaves, gum, raisin, etc.
- **Excretory products of humans:** Carbon dioxide, urea, etc.
- **Kidney:** Organ which removes the toxic substance urea from blood and filters it.
- **Urine:** A yellowish liquid which contains water and urea.
- **Dialysis:** The procedure used for cleaning the blood of a person in case of kidney failure.
- **Nephron:** Functional unit of excretory system present in the kidney for filtering blood.
- **Renal Artery:** Blood vessels which bring blood from heart to kidney.
- **Renal Vein:** Blood vessel which brings blood from kidney to heart.

Control and Coordination

Control and Co-ordination in Animals: Nervous system and endocrine system.
In animals, the nervous system and hormonal system are responsible for control and co¬ordination.

Receptors: Receptors are the specialized tips of the nerve fibres that collect the information to be conducted by the nerves.
Receptors are in the sense organs of the animals.
These are classified as follows :

- Phono-receptors: These are present in inner ear.
  Functions: The main functions are hearing and balance of the body.
- Photo-receptors: These are present in the eye.
  Function: These are responsible for visual stimulus.
- Thermo-receptors: These are present in skin.
  Functions: These receptors are responsible for pain, touch and heat stimuli.
  These receptors are also known as thermoreceptors.
- Olfactory-receptors: These are present in nose.
  Functions: These receptors receive smell.
- Gustatory-receptors: These are present in the tongue.
  Functions: These helps in taste detection.



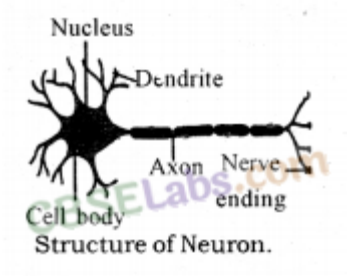
Nervous System: The nervous system is composed of specialized tissues, called nervous tissue. The nerve cell or neuron is the functional unit of the nervous system. It is the nervous system which is mainly responsible for control and coordination in complex animals.

Functions of the nervous system

- Nervous system receives information from the environment.
- To receive the information from the various body.
- To act according to through muscles and glands.

A neuron is the structural and functional unit of the nervous system.

Neuron: Neuron is a highly specialized cell which is responsible for the transmission of nerve impulses. The neuron consists of the following parts
(i) Cyton or cell body: The cell body or cyton is somewhat star-shaped, with many hair like structures protruding out of the margin. These hair-like structures are called dendrites. Dendrites receive the nerve impulses.
(ii) Axon: This is the tail of the neuron. It ends in several hair-like structures, called axon terminals. The axon terminals relay nerve impulses.
(iii) Myelin sheath: There is an insulator cover around the axon. This is called myelin sheath. The myelin sheath insulates the axon against nerve impulse from the surroundings.



Structure of Neuron.

Types of neuron

- Sensory neuron: These neurons receive signals from a sense organ.
- Motor neuron: These neurons send signals to a muscle or a gland.
- Association or relay neuron: These neurons relay the signals between sensory neuron and motor neuron.

Synapse: The point contact between the terminal branches of axon of one neuron with the dendrite of another neuron is called synapse.

Neuromuscular Junction (NMJ): NMJ is the point where a muscle fibre comes in contact with a motor neuron carrying nerve impulse from the control nervous system.

Transmission of nerve impulse: Nerve impulses travel in the following manner from one neutron to the next :
Dendrites → cell body → axon → nerve endings at the tip of axon → synapse → dendrite of next neuron.
Chemical released from axon tip of one neuron, cross the synapse or neuromuscular junction to reach the next cell.

Human Nervous System: The nervous system in humans can be divided into three main parts

1. Central Nervous System: The central nervous system is composed of the brain and the spinal cord. The brain controls all the functions in the human body. The spinal cord works as the relay channel for signals between the brain and the peripheral nervous system.

2. Peripheral Nervous System: The peripheral nervous system is composed of the cranial nerves and spinal nerves. There are 12 pairs of cranial nerves. The cranial nerves come our of the brain and go to the organs in the head region. There are 31 pairs of spinal nerves. The spinal nerves come out of the spinal cord and go to the organs which are below the head region.

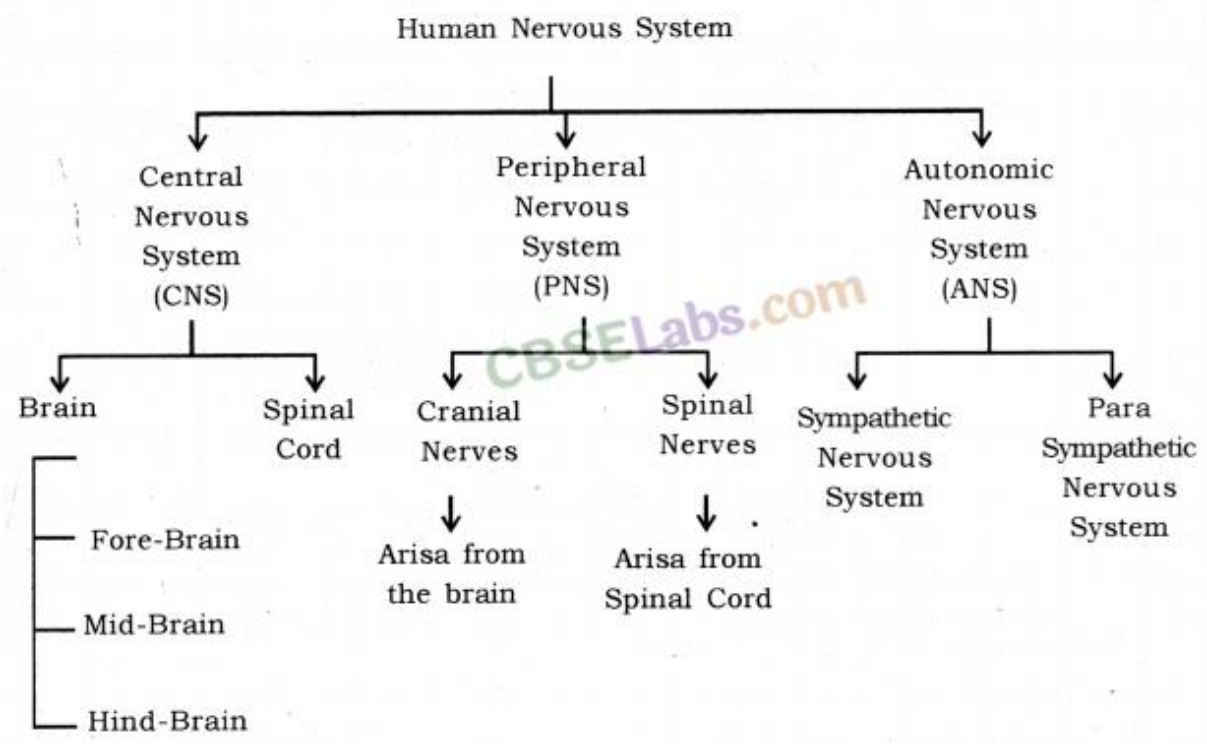
3. Autonomous Nervous System: The autonomous nervous system is composed of a chain of nerve ganglion which runs along the spinal cord. It controls all the involuntary actions in the human body. The autonomous nervous system can be divided into two parts :

- Sympathetic nervous system.
- Parasympathetic nervous system.

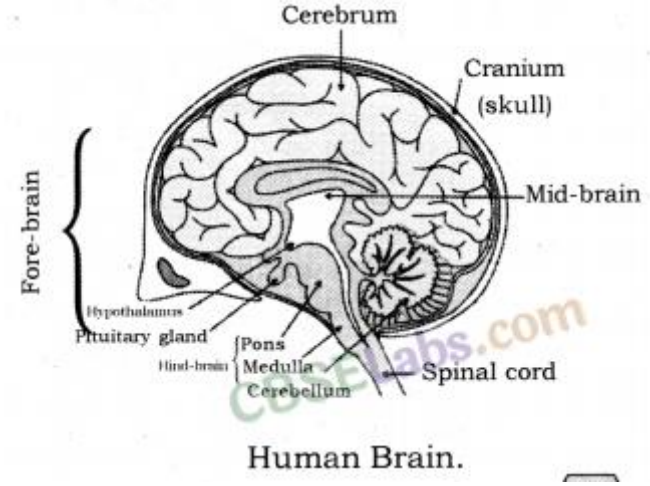
Sympathetic Nervous System: This part of the autonomous nervous system heightens the activity of an organ as per the need. For example, during running, there is an increased demand for oxygen by the body. This is fulfilled by an increased breathing rate and increased heart rate. The sympathetic nervous system works to increase the breathing rate the heart rate, in this case.

Parasympathetic Nervous System: This part of the autonomous nervous system slows the down the activity of an organ and thus has a calming effect. During sleep, the breathing rate slows down and so does the heart rate. This is facilitated by the parasympathetic nervous system. It can be said that the parasympathetic nervous

system helps in the conservation of energy.



Human Brain: Human brain is a highly complex organ, which is mainly composed of nervous tissue. The tissues are highly folded to accommodate a large surface area in less space. The brain is covered by a three-layered system of membranes, called meninges. Cerebrospinal fluid is filled between the meninges. The CSF providers cushion the brain against mechanical shocks. Furthermore, protection. The human brain can be divided into three regions, viz. forebrain, midbrain and hindbrain.



Human Brain.

Parts of Human Brain :

- Fore-brain: It is composed of the cerebrum.
- Mid-brain: It is composed of the hypothalamus.
- Hind-brain: It is composed of the cerebellum, pons, medulla, oblongata.

Some main structures of the human brain are explained below :
Cerebrum: The cerebrum is the largest part in the human brains. It is divided into two hemispheres called cerebral hemispheres.

Functions of cerebrum

- The cerebrum controls voluntary motor actions.
- It is the site of sensory perceptions, like tactile and auditory perceptions.
- It is the seat of learning and memory.

Hypothalamus: The hypothalamus lies at the base of the cerebrum. It controls sleep and wake cycle (circadian rhythm) of the body. It also controls the urges for eating and drinking.

Cerebellum: Cerebellum lies below the cerebrum and at the back of the whole structure. It coordinates the motor functions. When you are riding your bicycle, the perfect coordination between your pedalling and steering control is achieved by the cerebellum.

- It controls posture and balance.
- It controls the precision of voluntary action.

Medulla: Medulla forms the brain stem, along with the pons. It lies at the base of the brain and continues into the spinal cord. The medulla controls various involuntary functions, like hear beat respiration, etc.
It controls involuntary actions.
Example: Blood pressure, salivation, vomiting.

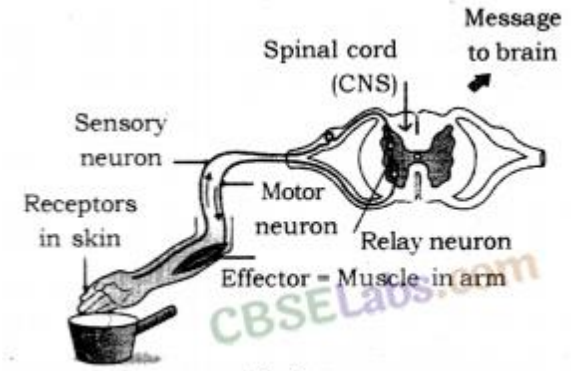
Pons: It relays impulses between the lower cerebellum and spinal cord, and higher parts of the brain like the cerebrum and midbrain, also regulates respiration.

Spinal cord: Spinal cord controls the reflex actions and conducts massages between different parts of the body and brain.

Reflex Action: Reflex action is a special case of involuntary movement involuntary organs. When a voluntary organ is in the vicinity of sudden danger, it is immediately pulled away from the danger to save itself. For example, when your hand touches a very hot electric iron, you move away your hand in a jerk. All of this happens in flash and your hand is saved from the imminent injury. This is an example of reflex action.

Reflex Arc: The path through which nerves signals, involved in a reflex action, travel is called the reflex arc. The following flow chart shows the flow of signal in a reflex arc.
Receptor → Sensory neuron → Relay neuron → Motor neuron → Effector (muscle)
The receptor is the organ which comes in the danger zone. The sensory neurons pick

signals from the receptor and send them to the relay neuron. The relay neuron is present in the spinal cord. The spinal cord sends signals to the effector via the motor neuron. The effector comes in action, moves the receptor away from the danger.

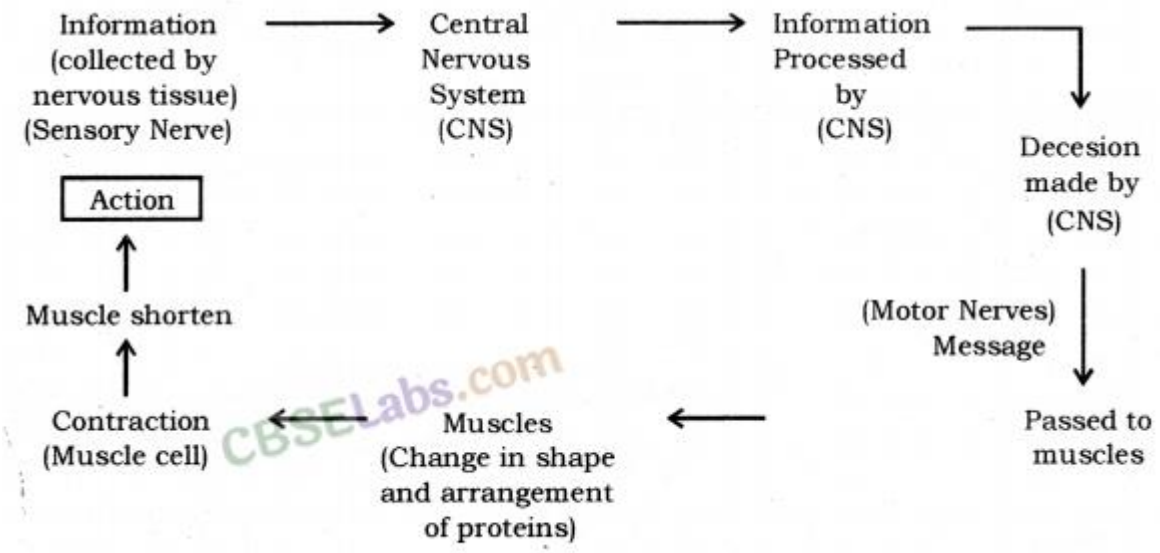


Reflex arc.

The reflex arc passes at the level of the spinal cord and the signals involved in reflex action do not travel up to the brain. This is important because sending signals to the brain would involve more time.
Although every action is ultimately controlled by the brain, the reflex action is mainly controlled at the level of spinal cord.

Protection of brain and spinal cord
Brain is protected by a fluid filled balloon which acts as shocks absorber and enclosed in cranium (Brain box)
Spinal chord is enclosed in vertebral column.

Muscular Movements and Nervous Control: Muscle tissues have special filaments, called actin and myosin. When a muscle receives a nerve signal, a series of events is triggered in the muscle. Calcium ions enter the muscle cells. It result in actin and myosin filaments sliding towards each other and that is how a muscle contracts. Contraction in a muscle brings movement in the related organ.

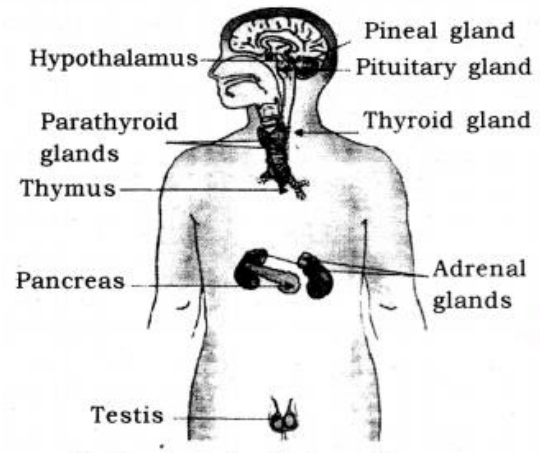


Muscular movement and nervous control

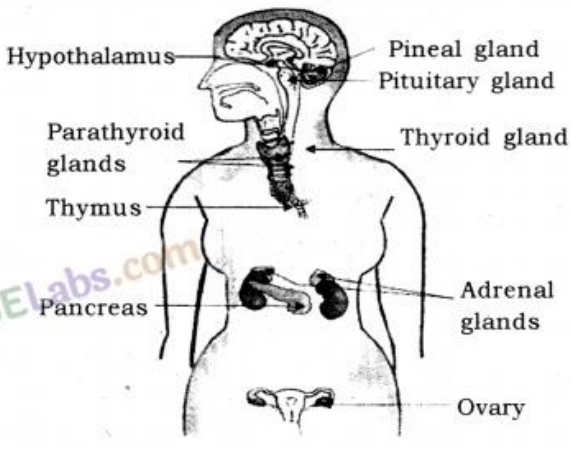
Endocrine System: The endocrine system is composed of several endocrine glands. A ductless gland is called endocrine gland. Endocrine gland secretes its product directly into the bloodstream. Hormones are produced in the endocrine glands. Hormone is mainly composed of protein. Hormones assist the nervous system in control and co-ordination. Nervous do not react to every nook and corner of the body and hence hormones are needed to affect control and coordination in those parts. Moreover, unlike nervous control, hormonal control is somewhat slower.

Hormones: These are the chemical messengers secreted in very small amounts by specialised tissues called ductless glands. They act on target tissues/organs usually away from their source. Endocrine System helps in control and coordination through chemical compounds called hormones.

Endocrine Gland: A ductless gland that secretes hormones directly into the bloodstream.



Endocrine glands in males.



Endocrine glands in females.

Endocrine Gland	Location	Hormones Produced	Functions
Pituitary gland (also known as the master gland)	At the base of the brain	Growth hormone (GH). Thyroid stimulating hormone (TSH).	GH stimulates growth. TSH stimulates the functioning of the thyroid gland. FSH stimulates the follicles during ovulation.

		Follicle stimulating hormone (FSH)	
Thyroid Gland	Neck	Thyroxine	Controls general metabolism and growth in the body.
Adrenal gland	Above kidneys	Adrenalin	Prepares the body for emergency situations and hence is also called 'Fight and flight' hormone.
Pancreas	Near stomach	Insulin	Controls blood sugar level
Testis (male)	In Scrotum	Testosterone	Sperm production, development of secondary sexual characters during puberty.
Ovary (female)	Near uterus	Oestrogen	Egg production, development of secondary sexual characters during puberty.

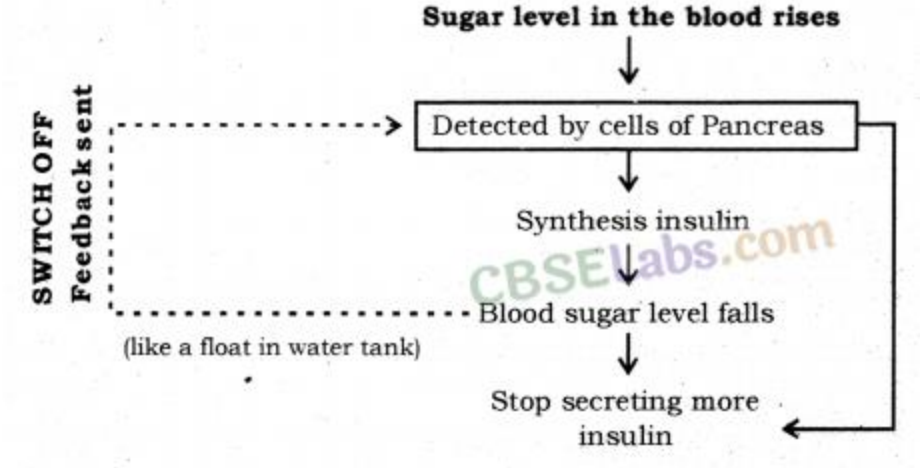
Iodised salt is necessary because: Iodine mineral is essential part of thyronine hormone so it is important that we must consume iodised salt as in turn it is essential for thyroid gland as it controls carbohydrate, proteins and fat metabolism for best balance of growth deficiency of iodine might cause disease called goitre.

Diabetes: Cause : It is due to deficiency of insulin hormone secreted by pancreas that is responsible to lower/control the blood sugar levels.

Treatment : Patients have to internally administer injections of insulin hormone which helps in regulating blood-sugar level.

In case of flight or fight reaction to an emergency situation, Adrenal glands → release adrenaline into blood → which acts on heart and other tissues → causes faster heart beat → more oxygen to muscles → reduced blood supply to digestive system and skin → diversion of blood to skeletal muscles → increase in breathing rate.

Feedback mechanism: A type of self-regulating mechanism in which the level of one substance in body influences the level of another.



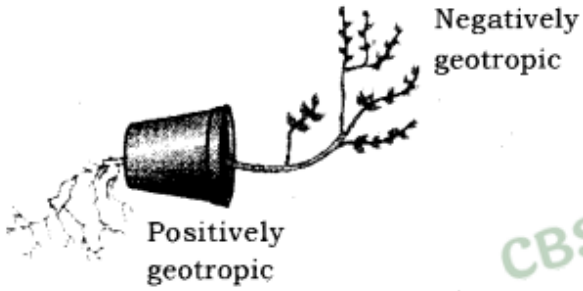
Control and Co-ordination in Plants: Movements in plants and plant harmones. Co-ordination in Plants: Unlike animals, plants do not have a nervous system. Plants use chemical means for control and co-ordination. Many plant hormones are responsible for various kinds of movements in plants. Movements in plants can be divided into two main types :

1. Tropic movement
2. Nastic movement

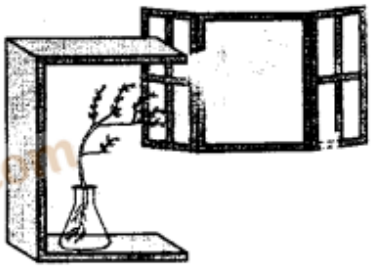
1. Tropic Movement: The movements which are in a particular direction in relation to the stimulus are called tropic movements. Tropic movements happen as a result of growth of a plant part in a particular direction. There are four types of tropic movements.

(i) Geotropic movement: The growth in a plant part in response to the gravity is called geotropic movement. Roots usually show positive geotropic movement, i.e. they grow in the direction of the gravity. Stems usually show negative geotropic movement.

(ii) Phototropic Movement: The growth in a plant part in response to light is called phototropic movement. Stems usually show positive phototropic movement, while roots usually show negative phototropic movement. If a plant is kept in a container in which no sunlight reaches and a hole in the container allows some sunlight; the stem finally grows in the direction of the sunlight. This happens because of a higher rate of cell division in the part of stem which is away from the sunlight. As a result, the stem bends towards the light. The heightened rate of cell division is attained by increased secretion of the plant hormone auxin in the which is away from sunlight.



Plant showing geotropism.

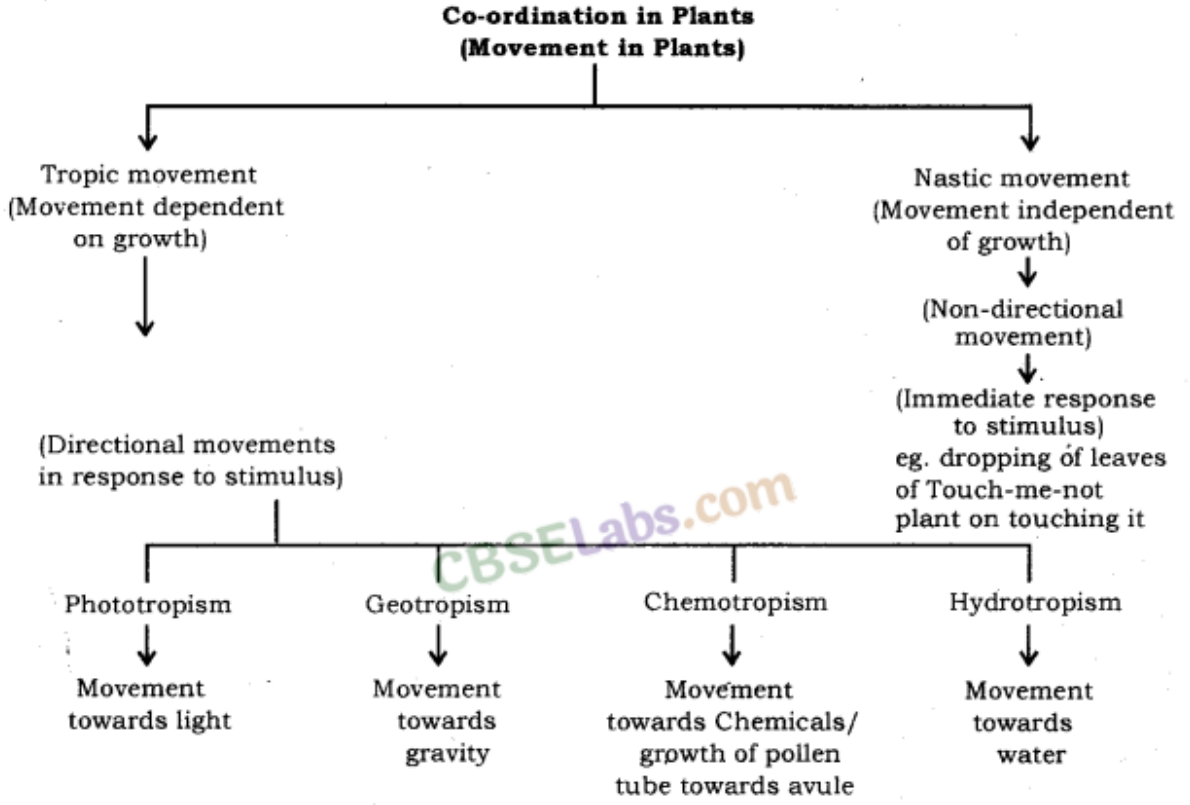

Plant showing phototropism

(iii) Hydrotropic Movement: When roots grow in the soil, they usually grow towards the nearest source of water. This shows a positive hydrotropic movement.

(iv) Thigmotropism Movement: The growth in a plant part in response to touch is called thigmotropism movement. Such movements are seen in tendrils of climbers. The tendril grows in a way so as it can coil around a support. The differential rate of cell division in different parts of the tendril happens due to action of auxin.

2. Nastic Movement: The movement which do not depend on the direction from the stimulus acts are called nastic movement. For example, when someone touches the leaves of mimosa, the leaves droop. The drooping is independent of the direction from which the leaves are touched. Such movements usually happen because of changing water balance in the cells. When leaves of mimosa are touched, the cells in

the leaves lose- water and become flaccid, resulting in drooping of leaves.



Plant hormones: Plant hormones are chemical which help to co-ordinate growth, development and responses to the environment.
Type of plant hormones: Main plant hormones are

- Auxin: (Synthesized at shoot tip).
  Function: Helps in growth.
  Phototropism: more growth of cells towards the light.
- Gibberellin: Helps in the growth of the stem.
- Cytokinins: Promotes cell division.
- Abscisic acid: Inhibits growth, cause wilting of leaves. (Stress hormone)

Control and Coordination in Plants

- **Stimuli:** The change in the environment to which an organism responds.
- **Co-ordination:** Working together of various organs of an organism in a systematic manner to produce a proper response.
- **Phyto-hormones:** These are plant hormones.
- **Auxin:** It is a plant hormone which promotes cell enlargement and growth in plants.
- **Gibberellins:** A plant hormone which promotes cell differentiation and breaking dormancy of seeds and buds.
- **Cytokinin:** A plant hormone which promotes cell division and the opening of stomata.

- **Abscisic Acid:** It helps in inhibiting the growth of the plant and promotes wilting and falling of leaves and food.
- **Tropism:** A growth movement of a plant which determines direction with the stimulus.
- **Nastism:** A growth movement of a plant which does not determine direction with a stimulus.
- **Phototropism:** Movement of plants towards a light.
- **Geotropism:** Movement of plants towards the gravity of earth.
- **Chemotropism:** Movement of plants towards chemicals.
- **Hydrotropism:** Movement of plants towards the water.
- **Thigmotropism:** Movement of plants towards a response to the touch of an object.

Control and Coordination in Animals

- **Stimuli:** The change in the environment to which the organism responds.
- **Co-ordination:** Working together of various organs of an organism in a systematic manner to produce a proper response.
- **Neuron:** Functional unit of the nervous system.
- **Synapse:** A microscopic gap between a pair of adjacent neurons.
- **Receptor:** A cell in a sense organ which is sensitive to stimuli.
- **Motor nerves:** It carries the message from the brain to body parts for action.
- **Sensory nerves:** It carries the message from body to brain.
- **Olfactory receptor:** It detects smell by the nose.
- **Gustatory receptor:** It detects taste by a tongue.
- **Thermoreceptor:** It detects heat and cold by a skin.
- **Photoreceptor:** It detects light by eye.
- **Reflex action:** Sudden movement or response to the stimulus which occurs in a very short duration of time and does not involve any will or thinking of the brain.
- **Brain:** An organ present in the skull which controls and regulates the activity of the whole body and is known as president of the body.
- **Cerebrum:** Main thinking part of brain present in the forebrain area which controls all voluntary actions.
- **Cerebellum:** It is present in the hindbrain area and helps in maintaining posture and balance of the body.
- **Medulla:** It is present in the hindbrain area and helps in controlling voluntary actions of the brain.
- **Spinal cord:** It is a cylindrical structure of nerve fibres enclosed in the vertebral column which helps in the conduction of nerve impulses to and from the brain.

How do Organisms Reproduce

Asexual Reproduction

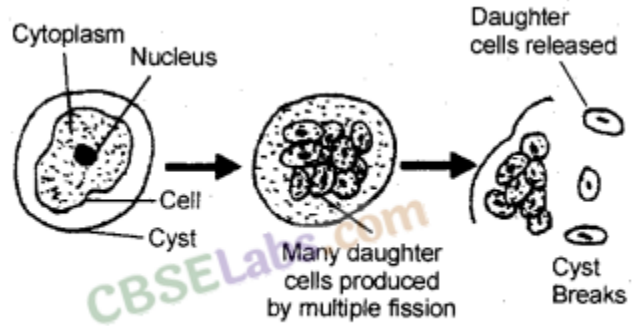
- It involves only one parent.
- There is no formation and fusion of gametes.
- The young ones formed are almost identical to each other as well as to the parent cell.
- Asexual reproduction generally occurs during favourable environmental conditions and when there is an abundance of food.
- It is a faster method of reproduction.

Types of Asexual Reproduction is Unicellular Organism
(i) Binary Fission: Seen in bacteria, protozoa like Amoeba, Paramecium. (In these first pseudopodia withdrawn (karyokinesis) the nucleus of the parent cell divides and then the cytoplasm divides (cytokinesis) resulting in the formation of two daughter cells). It occurs during highly favourable conditions. The cell division can occur in any plane as in case of Amoeba. However, organisms like Leishmania. (cause Kala-azar), which have a whip like flagella at one end, binary fission occurs in a definite orientation in relation to the flagellum.

Binary Fission in Amoeba

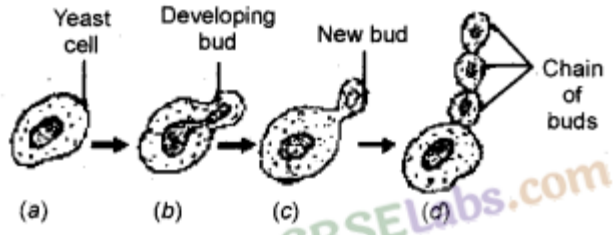
Cytokinesis: Division of cytoplasm.
Karyokinesis: Division of Nucleus.

(ii) Multiple Fission: Seen in Plasmodium, (a malarial parasite). In this during unfavourable conditions, the parent cell develops a thick resistant wall around itself forming a cyst. Within the wall, the cytoplasm divides many times to form many plasmodia. When conditions become favourable, the cyst wall breaks and the Plasmodium are released.



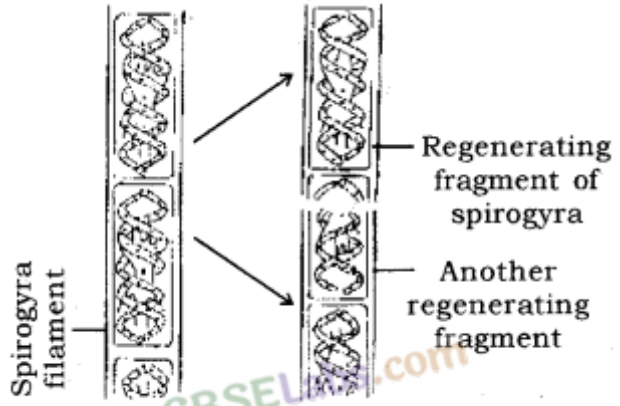
Multiple Fission in Plasmodium

(iii) Budding: Seen in Yeast (a fungus). The parent yeast cell develops a protrusion or an outgrowth at its upper end. The nucleus of the parent cell divides and one of them moves into the outgrowth which grows bigger and finally separates from the parent cell to lead an independent existence. Very often if the conditions are highly favourable, a chain of buds is formed.



Budding in Yeast

Types of Asexual Reproduction in Multicellular Organisms :
(i) Fragmentation: Seen in multicellular organisms which have a relatively simple body organisation like Spirogyra. Spirogyra has a filamentous body. (If it breaks into smaller pieces or fragments). Each fragment has the capacity to form a new individual.
However, all multicellular organisms cannot show cell-by-cell division as cells from tissues which form organs. These organs are placed at definite positions in the body. Hence, they need to use more complex methods of reproduction.



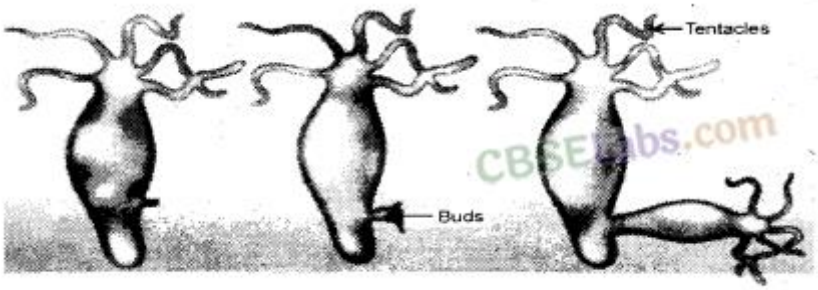
Fragmentation in Spirogyra

(ii) Regeneration: It is the ability of organisms to develop their lost parts. Some organisms show have high regenerative capacity it is also a means of reproduction for example; Planaria. (Regeneration is carried out by specialized cells which redivide to form a mass of cells from which different cells undergo changes to become different cell types and tissues. These changes occur in an organized

sequence known as development).

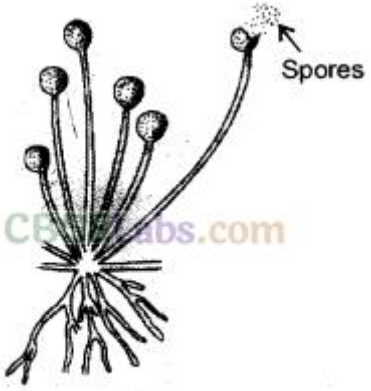
Regeneration in *Planaria*.

(iii) Budding: Seen in Hydra. Parent Hydra develops a bud at its lower end. This grows in size and finally breaks off to live independently.



Budding in *Hydra*.

(iv) Spore Formation: Seen in Rhizopus (a fungus). Rhizopus body is made up of thread-like structures called hyphae. The erect hyphae bear sporangia inside which reproductive structures called spores are formed. Spores are asexually reproducing bodies having a thick protective wall. They are produced during unfavourable times and help to tide over the unfavourable environmental conditions. When the spores fall on a suitable medium, each one forms a new individual.



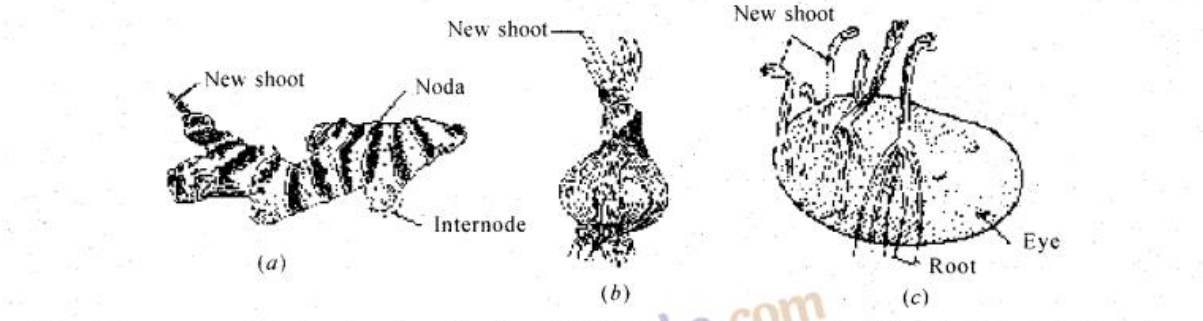
Spore formation in *Rhizopus*

(v) Vegetative Propagation: Method by which plants reproduce by their vegetative parts such as roots, stems, and leaves.

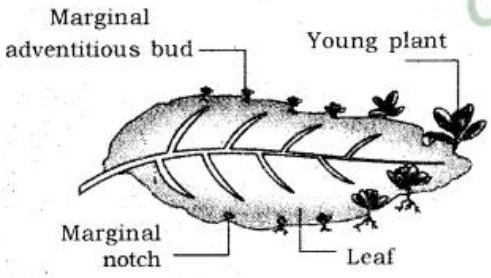
Types of Vegetative Propagation: It is two types

- Natural vegetative propagation.
- Artificial vegetative propagation (Tissue culture).

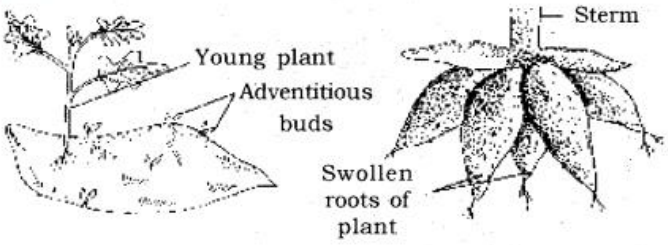
Mint reproduces naturally by roots. Sugarcane, jasmine by stems and Biyophyllum by leaves. In biyophyllum buds are produced in the notches along the leaf margins and when they fall on the soil, they develop into new plants.



Vegetative propagation by stem in— (*a*) ginger (rhizome) and (*b*) onion (bulb) and (*c*) potato (tuber).



Leaf of Bryophyllum with buds.



Vegetative propagation by roots in sweet potato.

Importance of Vegetative Propagation

- Plants can bear flowers and fruits earlier.
- Plants which have lost the ability to produce viable seeds can also reproduce by vegetative propagation.
- All plants are genetically almost similar to the parent plant.
- Seedless varieties can be obtained.
- The property of vegetative propagation is used by horticulturists in developing methods like layering, grafting to grow many plants like sugarcane, roses, or grapes.

Tissue Culture: The technique of developing new plants from a cell or tissue in a nutrient medium under aseptic conditions. The cell or tissue is placed in a nutrient medium where it forms a mass of cells called callus. This callus is then transferred to another nutrient medium where it differentiates and forms a new plant.

Sexual Reproduction: Sexual reproduction in plants, Sexual reproduction in human beings. The mode of reproduction that takes place with the involvement of two individuals of two different sexes i.e. male and female.
During sexual reproduction, male organism having male sex organs produces male gametes i.e. sperms which are small and motile and the female organism having female sex organs produces ova which are generally large and store food. Male and female gametes fuse to form a zygote that grows into a new organism.

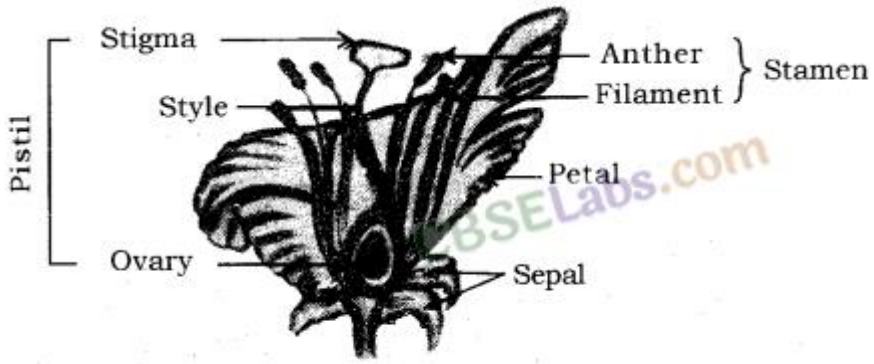
Significance of Sexual Reproduction :

- Sexual reproduction involves DNA as well as cellular apparatus of two different organisms which promotes diversity of characters in the offspring.
- Since gametes are derived from two different organisms, it results in a new combination of genes which increases the chances of genetic variations.
- Sexual reproduction results in the origin of. new species.
- Sexual reproduction involves division in the sex organs that reduces the DNA matter to half so that the zygote formed after fusion has the same amount of DNA as the parents it maintains DNA in a species.

Limitation of Sexual Reproduction: Sexual reproduction involves the process of combining DNA from two different organisms which may bring some undesirable features also.

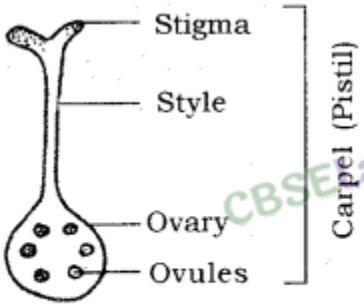
Sexual reproduction in flowering plants

- The reproductive parts are present in the flower.
- The parts of the flower are sepals, petals, stamens and carpels.
- Sepals are green structures that protect the inner parts when the flower is in bud stage.
- Petals are colourful and attract the insects for pollination.
- Stamens are male reproductive parts and produce pollen grains that contain male gametes. Each stamen has two parts—
- Filament i.e. stalk and Anther i.e. swollen top part which has large number of pollen grains.

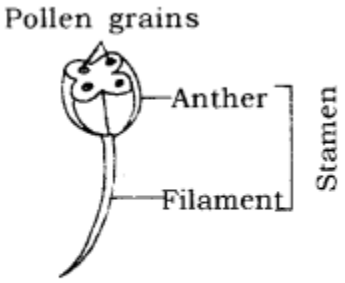


Longitudinal section of flower.

The carpel is the female reproductive part and produces ovules that contain female gametes. It has three parts—Stigma which is top sticky part and receives pollen grains during pollination. Style which is the middle long part and ovary which is the swollen part and contains ovules. Each ovule has an egg cell i.e. female gamete.



Female reproductive organ of a plant (Carpel)

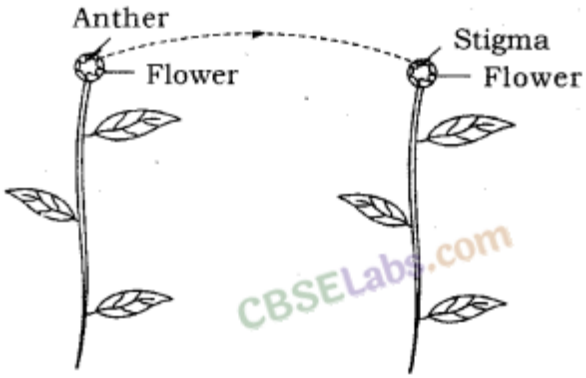


Male reproductive organ of a plant (Stamen)

The flowers may be bisexual i.e. having both stamens and carpels for example; Mustard China Rose (Hibiscus).
The flower may be unisexual i.e. paving either stamens or carpels for example; Papaya, Watermelon.

Pollination: The process of transfer of pollen grains from an anther to the stigma of the flower is pollination. Two types of pollination are:
(i) Self-pollination: The transfer of pollen grains from the anther to the stigma of the same flower or another flower of the same plant.
(ii) Cross-pollination: The transfer of pollen grains from the anther to the stigma of another flower or another flower of a different plant of the same species. It generally

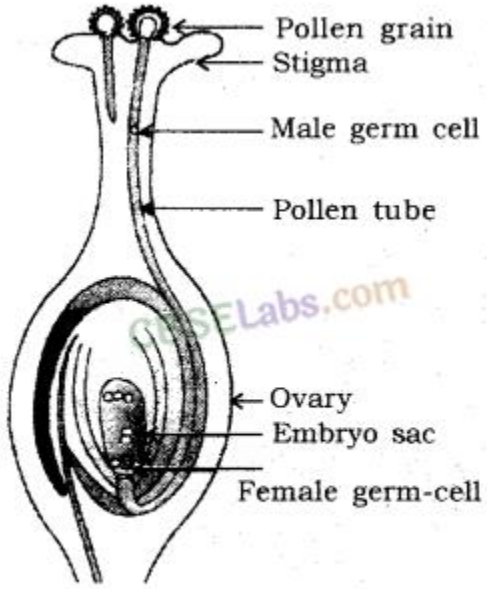
takes place with the help of some agents like insects, birds, wind and water.



Cross-pollination.

Fertilization: Fertilization is the process of fusion of male and female gamete to form a zygote during sexual reproduction. Pollination is followed by fertilisation in plants. The events are
Pollen grains land on the stigma of the ovary.
Pollen tubes grow out of the pollen grains, travel through the style and reach the ovary, through micro pyle.
Pollen tube has two male germ cells. Each ovule has two polar nuclei and a female germ cell (egg).

Pollen tube releases two male germ cells inside the ovule, one of them fuses with female germ cell and forms a zygote which grows into the baby plant i.e. embryo, the fusion is known as syngamy. The other male germ cell fuses with two polar nuclei, the process is known as triple fusion. So in flowering plants two fusions take place during fertilisation. It is called double fertilisation.



Fertilisation in flowering plant

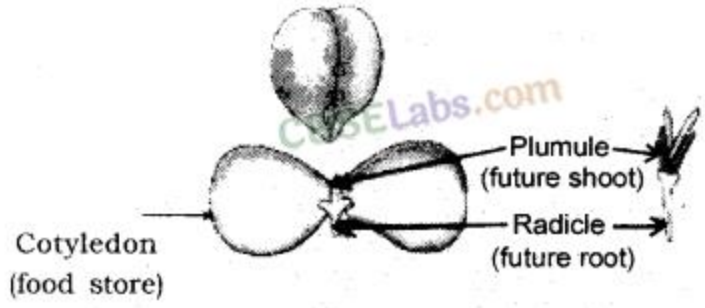
Post-fertilisation changes: After fertilisation the following changes takes place in the flower.
Zygote divides several times and forms an embryo inside the ovule.

- The ovule develops a tough coat and changes into the seed.
- The ovary grows rapidly and ripens to form a fruit.
- Petals, sepals, stamens, style and stigma shrivel and fall off.

Seed and its parts: The advantage of seed is that it protects the future plant i.e. embryo.

Seed has two parts: Cotyledons and Embryo Cotyledons store food for the future plant.

Embryo has two parts: plumule and radicle. Plumule develops into shoot and radicle develops into root.
The process of development of a seedling from the embryo under appropriate conditions is known as germination.



Germination.

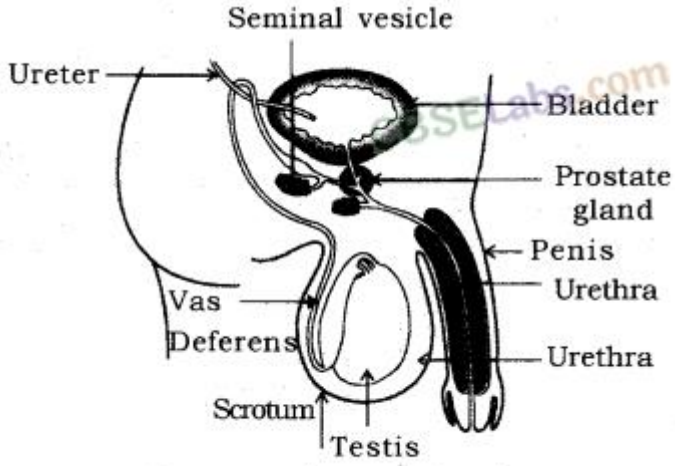
Reproduction in Human Being: Human beings show sexual reproduction. Male parent produces male gametes called sperms. Female parent produces female gametes called ova. Sperms have tail and are therefore, motile. They are produced in large numbers in the testes. Ovum is bigger, non-motile and only one ovary produces one ovum in one month. There is no food stored in the sperms whereas ova contain stored food. Both the gametes are microscopic unicellular and have half the number of chromosomes as compared to the body cells.

Human beings become reproductively active from the onset of puberty. Puberty is the period during adolescence when the rate of general body growth begins to slow down and reproductive tissues begin to mature. Onset of puberty in human males is between 11 to 13 yrs of age, while in human females is between 10 to 12 yrs. of age. Puberty is associated with many physical, mental, emotional and psychological changes in boys and girls which occur slowly over a period of time. These are called secondary sexual characters. For instance thick dark hair start growing in new parts of the body such as arm pits and genital area between the thighs. Thinner hair appear on legs, arms and face. Skin becomes oily and pimples may appear on the

face. Individuals become more conscious of their bodies become more independent, more aggressive etc.

In case of boys beard and mustache start appearing, voice begins to crack, reproductive organs develop and start producing releasing sperms.
In case of girls, breast size begins to increase, skin of the nipples darkens, menstruation starts.
The act of mating between the male and female partner is termed as copulation.

Male Reproductive System: Male reproductive system consists of the following components



Human male reproductive system.

- 1 pair of testes
- A system of ducts
    - Epididymis
    - Vas deferens or the sperm duct
    - Urethra
- A system of glands
    - Seminal vesicles
    - Prostrate gland
    - Cowper's gland
- A copulatory organ called a penis.

One pair of testes are present in a bag-like structure called scrotum which lies outside the abdominal cavity, hence they are extra abdominal in position. This is so because the testes have to be maintained at 1-3 degree lesser temperature than the body in order to produce functional sperms.

Functions of testes

- To produce male gametes i.e. the sperms.

- To produce a male reproductive hormone called testosterone which is responsible for producing sperms as well as secondary sexual characteristics in males.

Attached to each testis is a highly coiled tube called epididymis. The sperms are stored here and they mature in the epididymis.
Each epididymis leads into the sperm duct or the vas-deferens. Each vas-deferens rises up and enters into the abdominal cavity. It unites with the duct coming from the urinary bladder to form a common duct called urethra which passes through the penis and opens to the outside. Along the way the ducts of the three glands also open and pour their secretions into the vas deferens.

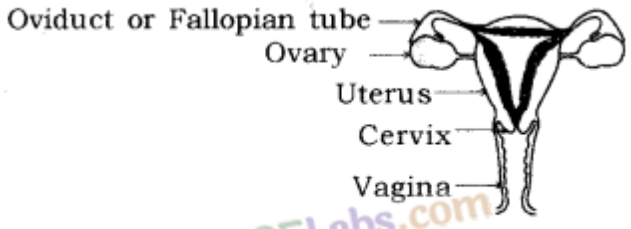
Function of the vas-deferens: It is meant for the passage of the sperms in the male body.

Functions of the glands: They produce different secretions which provide nutrition as well as medium for locomotion to the sperms.
The secretions of the three glands along with the sperms is known as semen.

Function of the urethra: It is the common passage for both semen and urine from the body to. the outside.

Penis: It is the organ which is used to introduce semen into the female body. It is richly supplied with blood vessels.

Female Reproductive System: It consists of the following components



Human female reproductive system.

- 1 pair of ovaries
- 1 pair of fallopian tubes or oviducts
- A uterus/womb
- A vagina/birth canal.

Each ovary is almond shaped and present inside the abdominal cavity. At the time of birth each girl child already contains thousands of immature ova. These ova start maturing only from the time of puberty. Only one ovum is produced by one ovary in one month and each ovary releases an ovum in alternate months. The release of an ovum from the ovary into the abdominal cavity is known as ovulation.

Functions of ovary

- To produce and release ova
- To produce female reproductive hormones: estrogen and progesterone.

There are two fallopian tubes. The end lying close to the ovary has finger like structures called fimbriae. The two fallopian tubes unite to form an elastic bag like structure called uterus.

Function of the fallopian tubes: It is the site of fertilization between the male and the female gametes and formation of the zygote early embryo.
The inner lining of the uterus is richly supplied with blood vessels and is known as endometrium. The narrow end of the uterus is called cervix.

Function of the uterus: The embryo formed in the fallopian tube comes down and gets attached to the endometrium (implantation) and develops for the next nine months till the baby is delivered.

Vagina: The uterus opens into the vagina through the cervix. The vagina is a muscular tube through which the baby is delivered at the end of nine months. It also serves as the canal for receiving the semen at the time of copulation.

The semen is discharged into the vaginal tract during copulation. The sperms travel upwards and reach the fallopian tube where one sperm fuses with the ovum to form the zygote. The zygote divides and redivides as it descends into the uterus and the embryo gets implanted in the endometrium. The endometrium thickens so as to receive the embryo.

The embryo gets nutrition from the mother's blood with the help of a special tissue called placenta, which is a disk-like structure embedded in the uterine wall. It contains finger-like villi on the embryo side, while on the mother's side blood spaces surround the villi. Villi provides a large surface area for glucose and oxygen to pass from the mother to the developing embryo and the wastes to pass from the embryo to the mother through the placenta. When the embryo starts resembling a human is formed, it is termed as a foetus. The foetus continues
to develop inside the uterus for almost nine months after which the baby is delivered as a result of rhythmic contractions of the uterine muscles.

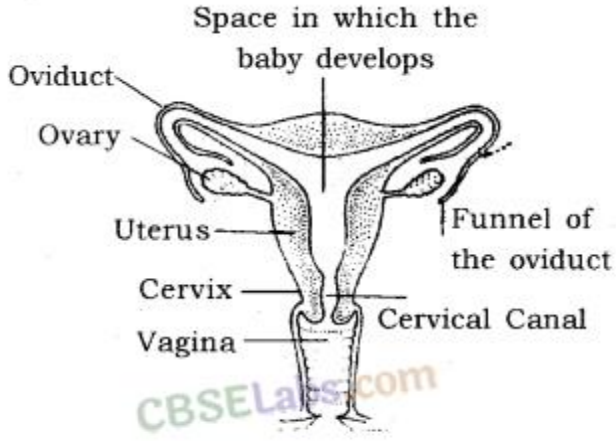
Menstruation: It is the loss of blood, mucous along with the unfertilized ovum and the ruptured cells and tissues of the endometrium through the vagina of the female. It is a 28-day cycle which occurs in every reproductively active female (from puberty). The flow of blood continues for 2 to 8 days. If the ovum does not get fertilized, then the endometrium starts sloughing off and there is loss of blood and mucous etc. through the vagina. In case the ovum gets fertilized, then the endometrium becomes thick and spongy for nourishing the embryo and hence menstruation does not occur. A lady with a developing embryo in her womb is

termed as pregnant. The beginning of menstruation at puberty is known as menarche. The stoppage of menstruation when the woman is 45-55 yrs of age is called menopause.

Reproductive Health: Sexually transmitted diseases and birth control.
A number of diseases occur as a result of sexual intercourse if one of the partners is infected. These are known as sexually transmitted diseases (STD's). They can be caused by bacteria for example; syphilis, gonorrhoea; or caused by a virus for example; HIV-AIDS, warts etc. The transmission of these diseases can be avoided by using birth control measures such as wearing a condom during the sexual act.

Birth control measures: They can be mechanical, chemical and surgical.

Mechanical methods: These are used to prevent the passage of semen to the fallopian tube :
(i) Use of condoms: Condoms are thin rubber tubes worn over the penis before sexual intercourse. The semen gets collected in this and is not discharged into the vagina.
(ii) Diaphragm: It is a thin rubber fixed over a flexible metal ring which is fitted over the cervix in a woman's body by a doctor.
(iii) Intra Uterine Contraceptive Device (IUCD) or loop: It is inserted in the uterus and its insertion causes certain secretion which prevents the implantation of the embryo in the uterine wall.
Both methods (ii) and (iii) cause side effects.



Reproductive organs in front view

Chemical methods

- Use of spermicides: These are strong sperm-killing chemicals available in the form of creams, jellies etc. which are injected into the vagina just before copulation.
- Oral contraceptive pills: These are hormonal pills which prevent ovulation but do not stop menstruation.

Surgical methods

- Vasectomy: It involves cutting and ligating the vas deferens in males.
- Tubectomy: It involves cutting and ligating Reproductive organs the fallopian tubes in females.
- Medical termination of pregnancy (MTP) or abortions is carried out to eliminate the developing embryo. This practice can, however, be misused to carry out female foeticide which involves the killing of the female foetus. It should be avoided at all cost as it disturbs the male-female ratio in a population.

Reproduction: It is the process by which living organisms produce new individuals similar to themselves.

- Reproduction ensured continuity of life on earth.
- It is a bridge to hereditary transmission.
- It involves a continuation of characters from the parents to daughter cells by copying of DNA (Deoxyribose Nucleic Acid) molecules present in the chromosomes of the cell.
- Copying of DNAs is also not a fool proof exercise, even minute changes bring about variation in the blue print of the offspring's.
- The useful variations are retained while the harmful ones do not go beyond.
- Actually, variations help the species to withstand drastic environmental changes, thus save the species from becoming extinct and promotes its survival for a longer time.
- This inbuilt tendency of variation is the "basis" for Evolution.

Asexual Reproduction: It is extremely useful as a means of rapid multiplication. It is common in lower plants and animals.
Different forms of Asexual Reproduction:

- **Fission:** The parent cell divides/splits into two daughter cells —Binary fission and splits into many cells —Multiple fission.
- **Budding:** A new organism is produced as an outgrowth of the parent body part.
- **Spore Formation:** Spores are small, the bulb-like structure which develops at the top of the erect hyphae of the fungus-plant, when released into the air germinate, into new individuals after landing into food or soil.
- **Fragmentation:** It is the accidental process when the broken pieces of an organism (fragments) grows into a complete organism. Example, fragmentation in Spirogyra.
- **Regeneration:** When simple animals like a hydra, planaria develop a new individual from their broken older part it is known as regeneration. It is carried out by specialised cells which grow large numbers of cells.

Vegetative Propagation: A mode of reproduction in which parts like the stem, root, leaves develop into new plants under favourable conditions.
Benefits:

- Plants can bear flowers, fruits more quickly than those produced from seeds.
- Growing banana, orange, rose, jasmine that have lost the capacity to produce seeds.
- The genetical similarity is maintained in the plants. Example, sugarcane, rose, grapes by layering or grafting.

Sexual Reproduction: When reproduction takes place as a result of the fusion between two gametes, one from each parent, it is called sexual reproduction.

- This process of fusion between two gametes is called fertilization.
- The formation of gametes involves an exchange of chromosomal (genetic) fragments between homologous chromosomes causing genetic recombination which leads to variation.

Sexual Reproduction in Plants: It occurs mostly in flowering plants.' In fact, flowers are the reproductive organ of plants.

- Pollen grains of a flower transfer to the stigma of the carpel of the same flower (Self-Pollination) or to the carpel of another flower (Cross-Pollination).
- This transfer of pollens is achieved by agents like wind, water or animals. After pollination, the pollen grains reach the egg cell in the form of a pollen tube.
- Fertilization. The fusion between the pollen grain and female egg cell. It occurs inside the ovary. The zygote is produced in this process.
- The zygote divides several times to form an embryo within the ovule. The ovule develops a rough coat and is converted into a seed.
- Ovary grows rapidly and ripens to form fruit, while the seed contains the future plant or embryo which develops into a seedling under suitable conditions. This process is known as Germination.

Reproduction in Human Beings:

- Humans use a sexual mode of reproduction.
- It needs sexual maturation which includes the creation of the germ cells, i.e., egg (ova) in the female and sperm in the male partner and this period of sexual maturation is called Puberty.
- Human beings have a well-developed male and female reproductive system.
- The formation of the male germ cell (sperms) takes place in the testes (male reproductive organ). Actually, a pair of testes are located inside scrotum situated outside the abdominal cavity. It is meant to keep a

relatively low temperature needed for the production of sperms by testes. Testes release a male sex hormone called testosterone whose function is to:

- regulate the production of sperms;
- brings about changes in appearance seen in boys at the time of puberty; and
- the sperms along with the secretion of the prostate gland and seminal vesicle, together constitute semen, which is released and made to enter into the female genital tract during Copulation.

Female Reproduction System:

- The female germ cells or eggs are made in the ovaries, a pair of which is located in both sides of the abdomen.
- When a girl is born, the ovaries already contain thousands of immature eggs. At the time of puberty, some of these eggs start maturing. One egg is produced every month by one of the ovaries.
- The egg is carried from the ovary to the womb through a fallopian tube. These two fallopian tubes unite into an elastic bag like structure known as the uterus.
- The uterus opens into the vagina through the cervix.
- Fertilization occurs in the fallopian tube of the female genital tract.
- The fertilized egg also called zygote gets implanted in the lining of the uterus, and starts dividing. The uterus is richly supplied with blood to nourish the growing embryo.
- If the zygote is not formed, the inner wall of uterus breaks which causes bleeding through vagina. This process is called Menstruation. It occurs at a regular interval of 28 days.
- The embryo gets nutrition from the mother's blood with the help of a special tissue called Placenta.
- Placenta provides a large surface area for glucose and oxygen to pass from the mother to the embryo. Similarly the wastes from developing embryo are removed to mother's blood through placenta.
- The child is born as a result of rhythmic contractions of the muscles in the uterus after nine months (36 weeks) of development inside the mother's womb, called Gestation Period.
- The sexual cycle in a woman continues upto the age of 45 to 50 years. After that the ovaries do not release eggs. This stage is called Menopause. It also marks the end of menstruation in the woman.

Reproductive Health: Reproductive health means total well-being in all aspects of reproduction, z.e., physical, emotional, social and behavioural.

Contraception: It is the avoidance of pregnancy through different methods—Natural methods, Barrier method, Oral contraceptives, Surgical methods.

Advantages of contraception: Help in birth control, prevent sexually transmitted diseases, prevent unwanted pregnancies, keep population explosion in check.

1. Reproduction is the process by which a living organism is able to produce new individuals of its own kind. Unlike other life processes such as nutrition, respiration, etc., it is not essential to, maintain the life of an individual organism. But it is important for the existence and continuity of the species.

2. Reproduction involves the creation of DNA copy and additional cellular apparatus by the cell involved in the process.

3. The process of DNA copying leads to variations. This inbuilt tendency for variations during reproduction is the basis for evolution.

4. Living organisms' reproduce mainly through :

- Asexual reproduction
- Sexual reproduction

5. ASEXUAL REPRODUCTION
(a) Single ceiled organisms reproduce through following ways:

(ii) Budding (also by multicellular organisms)
(iii) Spore formation (also by multicellular organisms)
(b) Asexual reproduction by multicellular organisms:
(i) Fragmentation and Regeneration

6. Fission: In unicellular organisms when cell becomes fully mature, it splits into two or more parts. It is called the fission. In organisms such as Amoeba, splitting can take place in any plane. But in organisms like Leishmania, having whip like structure at one end of the cell, binary fission occurs in a definite orientation in relation to these structures.

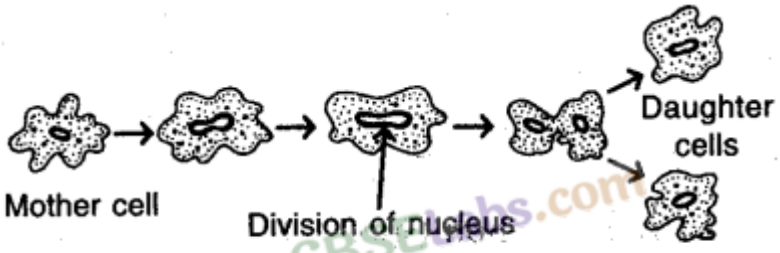


Fig. Binary fission in Amoeba.

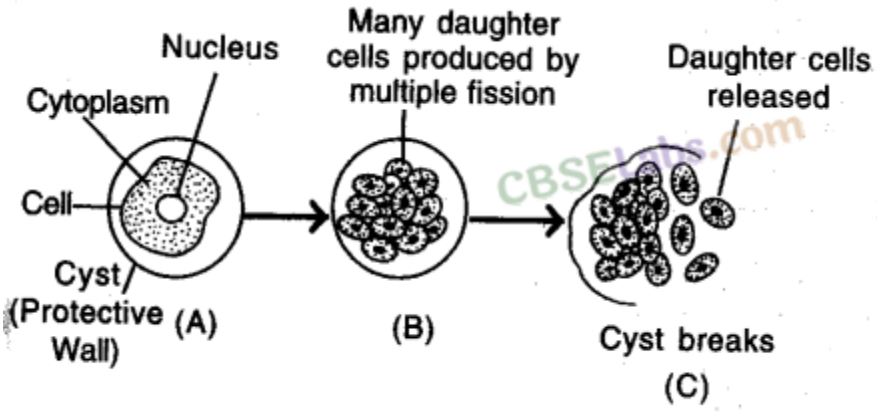


Fig. Multiple fission in Plasmodium.

7. Regeneration : It is the ability to give rise to new organism. When the individual is cut or broken up into many pieces. It can be seen in Hydra and Planaria and is known as regeneration.

Regeneration is carried out by specialised cells. These cells proliferate and regeared numbers of cells. From this mass of cells, different cells undergo changes to become various cell types and tissues. These changes take place in an organised sequence referred to as ” development. However, regeneration is not the same as reproduction, since most organisms would not normally depend on being cut up to be able to reproduce.

8. Budding: Organisms such as Hydra use regenerative cells for reproduction in the process of budding. In Hydra, a bud develops as an outgrowth due to repeated cell division at one specific site. These buds develop into tiny individuals and when fully mature, detach from the parent body and become new independent individuals.

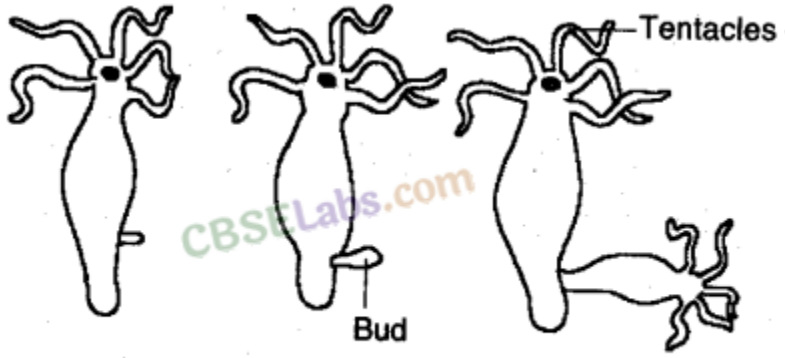


Fig. Budding in *Hydra*.

9. Spore Formation (Sporulation): Some bacteria and lower organisms make spores. During spore formation, knob like structure called sporangium develops from the fungal hypha. Sporangia contain spores that eventually develop into new individual. The spores are covered by thick walls that protect them until they come in contact

with moist surface or substratum and can begin to grow.

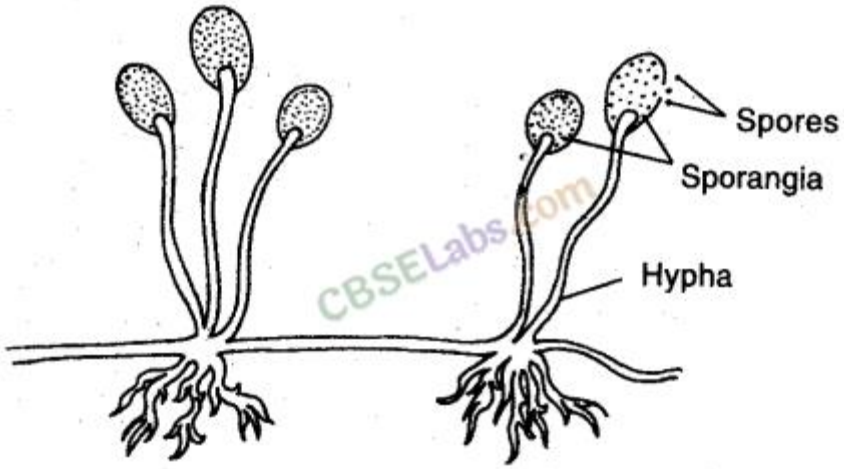
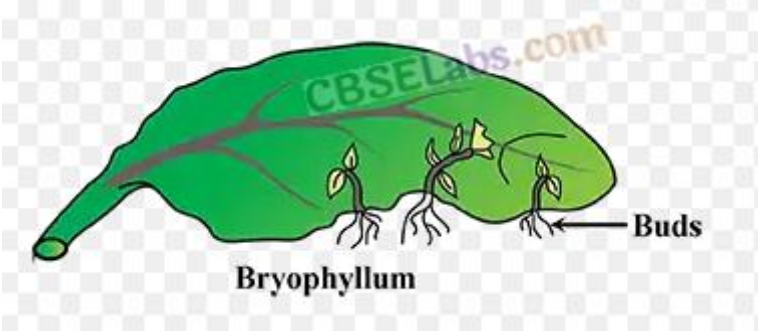


Fig. Spore formation in Rhizopus.

10. Fragmentation : It can be seen in Spirogyra. During this process filament of spirogyra simply breaks up into smaller pieces upon maturation. These pieces or fragments grow into new individuals. This process occurs under favourable conditions of moisture, temperature, light and nutrient availability.

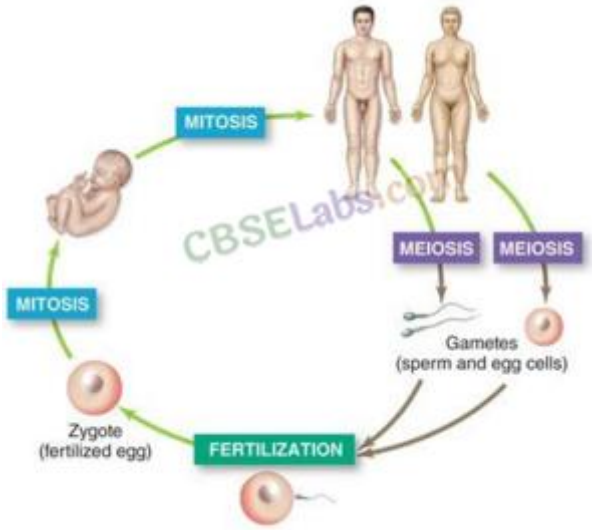
11. Vegetative propagation: It is the simplest method of reproduction in some higher plants in which new plant is produced from any vegetative part of the plant such as root, stem, leaf, etc.
Advantages of vegetative propagation : Vegetative propagation is useful for plants those have lost the capacity to produce seeds, e.g. banana, rose, jasmine. Moreover, all plants produced are genetically similar to the parent plant.
Natural Vegetative Propagation: In some plants like guava, sweet potato, dahlia, roots sprout and grow into new plants during favourable conditions. In some other, stems grow horizontally and develop root below and leaves above the ground. Many other common examples of vegetatively propagating plants are onion, banana, garlic, ginger, turmeric, bryophyllum and water hyacinth.

12. Vegetative propagation in Bryophyllum: Bryophyllum reproduces by the vegetative propagation method. During this method, buds produced in the notches along the leaf margin of bryophyllum fall on the soil and develop into new plants.



13. SEXUAL REPRODUCTION :
Sexual reproduction involves two individuals for producing a new individual. Sexual

reproduction begins with fertilization, which is defined as the union of two different gametes. The motile germ-cell is called the male gamete and germ-cell containing stored food (egg or ovum) is called the female gamete. The process of fusion of two gametes is called fertilization. After fertilization, a zygote is formed , which develops into a new organism.



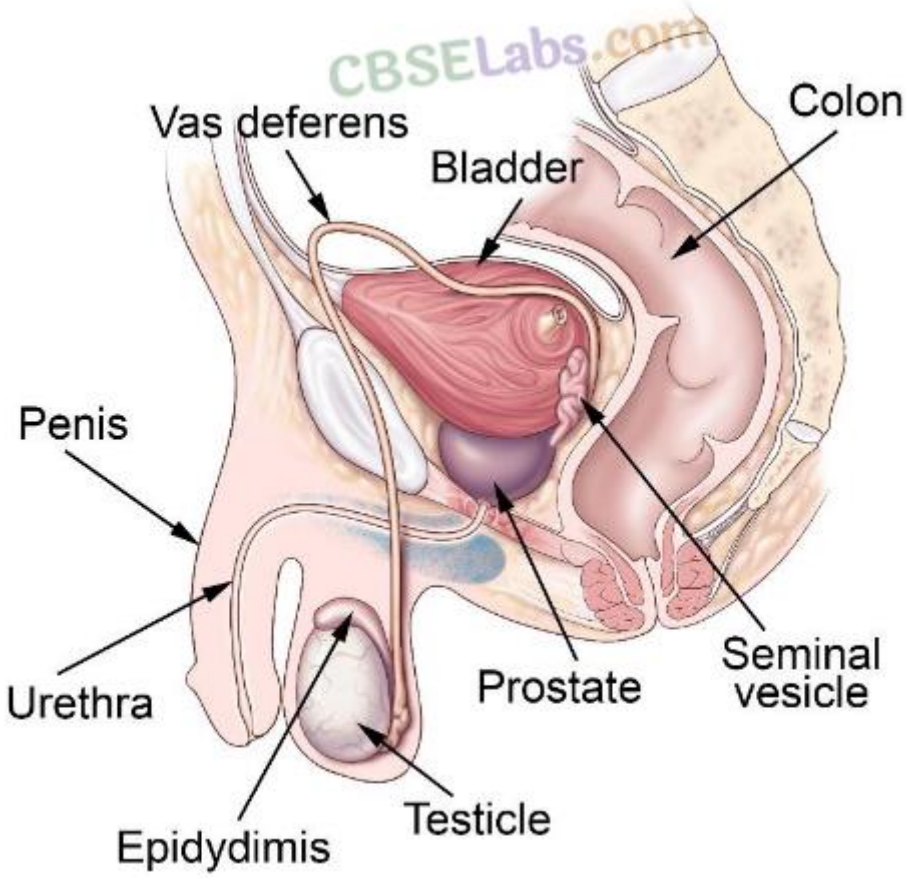
14. Sexual reproduction in Plants : The flowering plants or angiosperms bear special reproductive parts located in the flower. Various parts of flower are; sepals, petals, stamens and carpels.
Most flowers have both male and female reproductive organs. The flower may be unisexual (papaya, watermelon) when it contains either stamen or carpel or bisexual (Hibiscus, Mustard) when it contains both stamens and carpels. It has male reproductive part called stamen and a female reproductive part called carpel. Carpel is made of three parts. The swollen bottom part is the ovary, middle elongated part is the style and the terminal part which may be sticky is the stigma.

The ovary contains ovules and each ovule has an egg cell. Each stamen consists of stalk called filament, and a flattened fertile top called anther. The anthers produce the pollen grains. The pollen grains produce male gametes which fuse with (egg cel l) female gamete present in the ovule. This fusion of the germ-cells or fertilization gives zygote which grows into a new plant. Pollination: It is the process of transfer of pollen grains from the anther to the stigma of flower. If this transfer of pollen occurs in the same flower, it is referred to as self-pollination, whereas if the pollen is transferred from one flower to another, it is known as cross-pollination. This transfer is carried out by different agencies like wind, water, insects or animals.

Fertilization: A tube grows out of pollen grain and travels through the style to reach the female germ-cells present in ovule in the ovary. Out of two male gametes present in pollen tube one fuses with egg to form zygote. This fusion is called fertilization. After fertilization, the zygote divides several times to form an embryo within the ovule. The ovule develops a tough coat and gradually turns into a seed. The ovary grows rapidly and ripens to form a fruit. Meanwhile the petals, sepals, stamens, style and stigma may shrivel and fall off.

15. Reproduction in human beings : The reproductive organs of human beings are called gonads. These are testes in male and ovaries in female. The male gonad produces sperms and female gonad produces ova (eggs) at the age of puberty (after attainment of sexual maturity). Various changes occur in girls and boys at this age.

16. Male Reproductive System consists of the following organs:
Testes: A pair of testes are situated in scrotum that lie outside the abdominal cavity and behind the penis. Testes produce sperms and hormone, Testosterone hormone. Testosterone brings about changes in appearance of boys at the time of puberty.

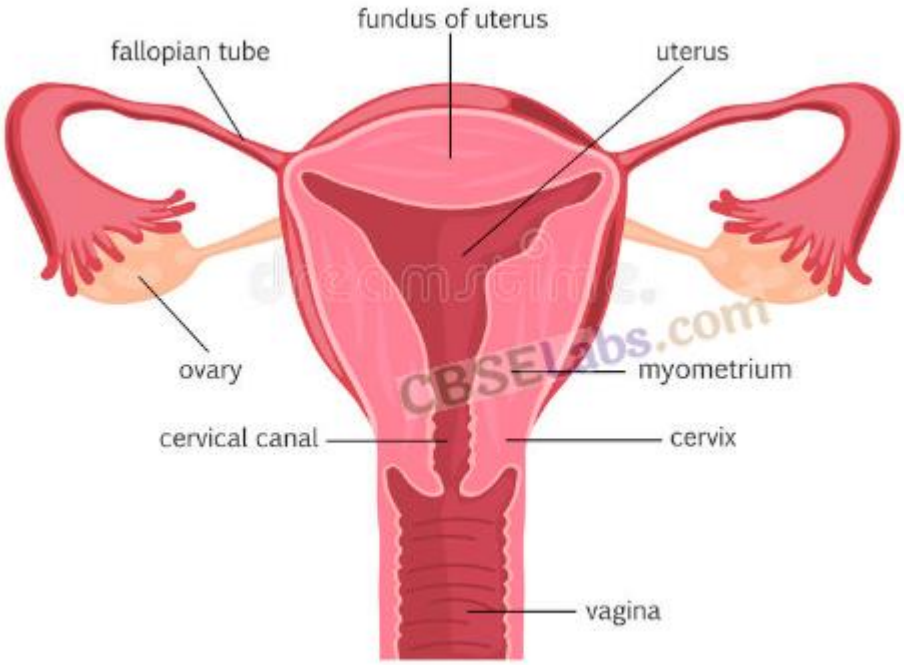


VAS deferens: From each testis, a duct arises which is known as vas deferens which unites with a tube coming from urinary bladder. It brings sperms from testis.

Urethra: Vas deferens tube opens into a common tube called urethra. It runs through a muscular organ called Penis. Penis is male copulatory organ.

Accessory Glands: Glands like prostate and seminal vesicles and Cowper's gland add their secretions which make transport of sperms easier and this fluid also provides nutrition.

17. Female Reproductive System: It consists of the following organs:



Ovaries: Paired ovaries are located in the abdominal cavity near the kidney. Ovaries produce female gamete (ovum or egg) and secrete female hormones (estrogen and progesterone). One egg is produced every month alternately by one of the ovaries.
Fallopian Tube: The egg is carried from the ovary to womb/uterus through a thin oviduct or fallopian tube.
Uterus: The two oviducts unite into an elastic bag like structure known as the uterus.
Vagina: Uterus opens into the vagina. It is a female copulatory organ.

18. Sexual Cycle in female: After puberty, only one egg is produced alternately from one ovary after a period of 28 days. Egg in fallopian tube encounter sperms which enter through the vaginal passage during sexual intercourse. This fertilized egg (zygote) gets implanted in the lining of uterus which later forms embryo. Embryo gets nutrition from the mother's blood with the help of special tissue called placenta.

If the egg is not fertilized, if lives for about one day since the ovary releases one egg every month, the uterus prepares itself every month to receive the fertilized egg. Thus, its lining becomes thick and spongy. If it does not get zygote, the developed lining slowly breaks down and comes out through the vagina as blood and mucus. This cycle takes place roughly every month and is known as menstruation. It usually lasts for about 2-5 days.

19. Reproductive Flealth: Reproductive organs need a lot of care and hygiene. Otherwise, they are susceptible to many infections or diseases. The diseases which spread through sexual routes are known as sexually transmitted diseases e.g., bacterial infections like syphilis, gonorrhoea and viral infections such as warts and HIV- AIDS. A condom helps to prevent transmission of many of these infections to some extent.

Frequent pregnancy causes many health problems and also adds to an already exploding population. Many ways have been devised to avoid pregnancy. Contraception can be achieved by:

- Mechanical barrier method (use of condoms).
- Chemical methods (use of pills).
- Use of contraceptive devices (copper-T).
- Surgical methods (vasectomy in males and tubectomy in females)

Heredity and Evolution

Heredity and Inherited Traits: Mendel's Experiment; Sex determination.
Heredity refers to the transmission of characters from parents to offspring's. An inherited trait is a particular genetically determined feature that distinguishes a person from the others for example; attached or free ear lobes in human beings.

Rules for the inheritance of traits:
Mendel's contribution: The rules for inheritance of traits in human beings are related to the fact that both mother and father contribute an equal amount of genetic material i.e. DNA to their offspring. So an offspring will get two versions of that trait from the two parents. Mendel worked out rules for inheritance of these traits. Gregor Johann Mendel regarded as the 'Father of Genetics' performed his experiments with garden peas (Pisum sativum) in the garden behind his monastery. He observed a number of contrasting characters in garden peas and observed their inheritance.

Some important terms
1. Chromosomes are long thread-like structures present in the nucleus of a cell which contain hereditary information of the cell in the form of genes.

2. DNA is a chemical in the chromosome which carries the traits in a coded form.

3. Gene is the part of a chromosome which controls a specific biological function.

4. Contrasting characters: A pair of visible characters such as tall and dwarf, white and violet flowers, round and wrinkled seeds, green and yellow seeds etc.

5. Dominant trait: The character which expresses itself in a (Ft) generation is dominant trait. Example : Tallness is a dominant character in pea plant.

6. Recessive trait: The character which does not express itself but is present in a generation is recessive trait. Ex. dwarfism in the pea plant.

7. Homozygous: A condition in which both the genes of same type are present for example; an organism has both the genes for tallness it is expressed as TT and genes for dwarfness are written as tt.

8. Heterozygous: A condition in which both the genes are of different types for example; an organism has genes Tt it means it has a gene for tallness and the other for dwarfness only tall character is expressed.

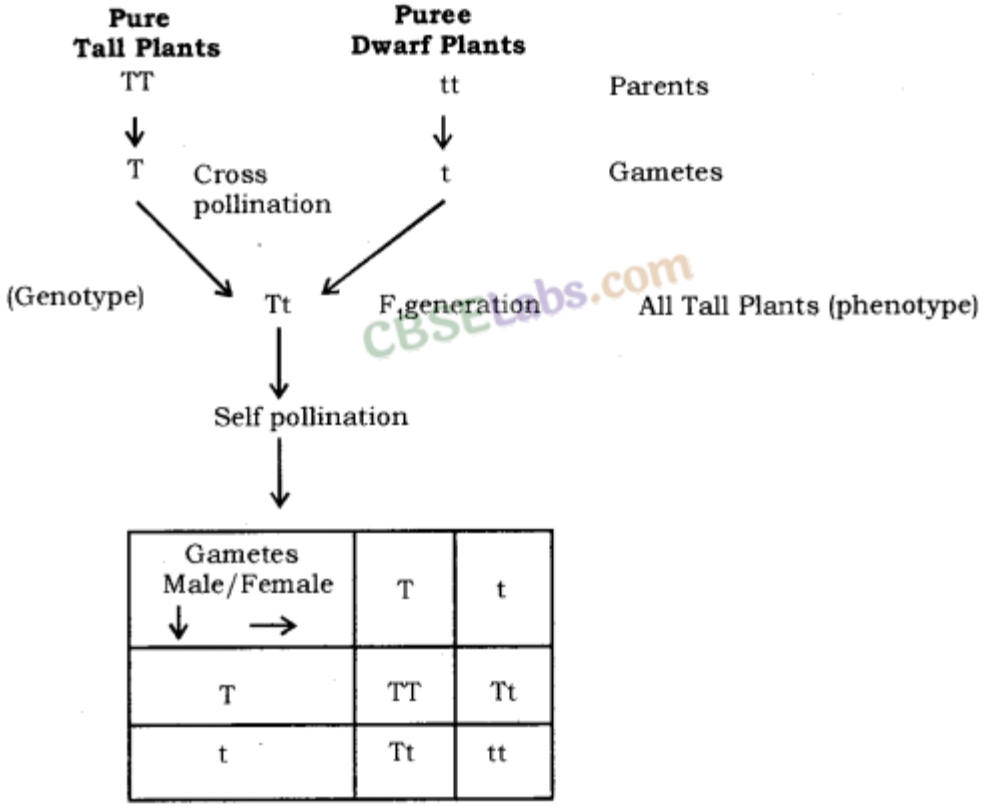
9. Genotype: It is genetic make up of an individual for example; A pure tall plant is expressed as TT and hybrid tall as Tt.

10. Phenotype: It is external appearance of the organism for example; a plant having Tt composition will appear tall although it has gene for dwarfness.

11. Homologous pair of characters are those in which one member is contributed by the father and the other member by the mother and both have genes for the same character at the same position.

Mendel's Experiment: Mendel started his experiment on the pea plants. He conducted first monohybrid and then dihybrid crosses.

Monohybrid Cross: The cross in which Mendel showed inheritance of dominant and recessive characters is monohybrid cross. To observe inheritance of single pair of contrasting characters



Gametes Male/Female ↓ →	T	t
T	TT	Tt
t	Tt	tt

he took pure tall (genotype TT) and pure dwarf (genotype tt) pea plants and cross pollinated them to obtain first generation or first filial generation. In this figuration (F1 generation) he obtained only tall plants. This meant that only one of the parental traits was seen, not the mixture of the two. The plants of F generation or progeny are then self pollinated to obtain F2 generation or progeny. Now all plants were not tall. He obtained 75% tall plants and 25% dwarf plants i.e. the phenotypic ratio was 3:1. This indicates that in the F, generation both tall and dwarf traits were inherited but tallness expressed it self. Tallness is a dominant trait and dwarfness is a recessive trait. F2 generation has a genotypic ratio of 1 : 2 : 1 of three types of plants represented by TT, Tt and tt as shown in the cross.

Conclusion: Phenotypic ratio—Tall : Dwarf 3 : 1
Genotype ratio—Pure Tall : Hybrid Tall : Pure Dwarf 1 : 2 : 1

Law of Dominance: When parents having pure contrasting characters are crossed then only one character expresses itself in the Ft generation. This character is the dominant character and the character/factor which cannot express itself is called the recessive character.

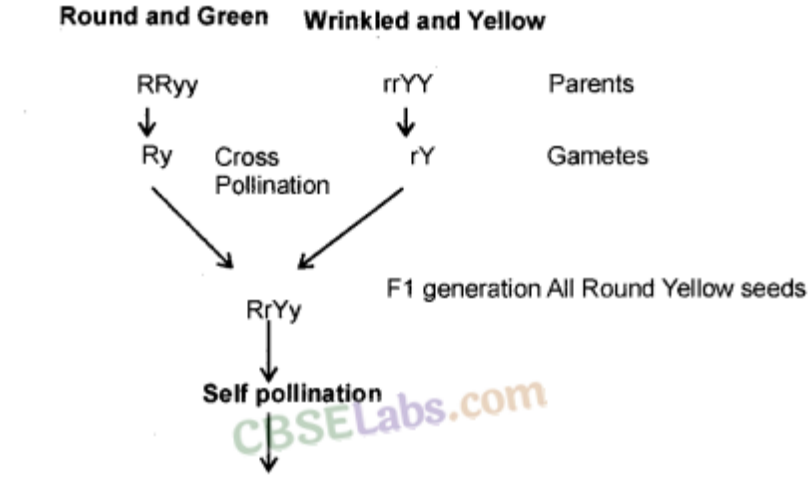
Dihybrid Cross: Mendel also carried out experiments to observe inheritance of two pairs of contrasting characters, which is called dihybrid cross. He cross breed pea plants bearing round green seed with plants bearing wrinkled and yellow seeds. In the Fx generation he obtained all round and yellow seeds it means round and yellow traits of seeds are dominant features while wrinkled and green are recessive. He self-pollinated the plants of F: generation to obtain F2 generation, he obtained four different types of seeds round yellow, round green, wrinkled yellow and wrinkled green in the ratio of 9 : 3 : 3 : 1. He concluded that traits are independently inherited

Conclusion

- Round and yellow seeds-9.
- Round and green seeds-3.
- Wrinkled and yellow seeds-3.
- Wrinkled and green seeds-1.

How do traits get expressed?
Cellular DNA is the information source for making proteins in the cell.
A part of DNA that provides information for one particular protein is called a gene for that protein for example; the height of a plant depends upon the growth hormone which is in turn controlled by the gene. If the gene is efficient and more growth hormone is secreted the plant will grow tall. If the gene for that particular protein gets altered and less of it is secreted when the plant will remain short. Both the parents contribute equally to the DNA of next generation during sexual reproduction. They actually contribute a copy of the same gene for example; when tall plant is crossed with short plant the gametes will have single gene either for tallness or for

shortness. F1 generation will get one gene for tallness and other for shortness also.



Gametes	RY	Ry	rY	ry
RY	RRYY	RRYy	RrYY	RrYy
Ry	RRYy	RRyy	RrYy	Rryy
rY	RrYY	RrYy	rrYY	rrYy
ry	RrYy	Rryy	rrYy	rryy

How do germ cells i.e. gametes get single set of genes from parents who have two copies in them ?
Each gene set is present, not as a single long thread of DNA, but as separate independent pieces each called a chromosome. Each cell gets two copies of the chromosome, one from each parent. Each germ cell or gamete has one copy of it because there is reductional division in the sex organs at the time of formation of gametes. When fertilization takes place normal number of chromosomes is restored in the progeny ensuring the stability of DNA of the species.

How is the sex of a new born individual determined?
It is the process by which sex of a new born can be determined.

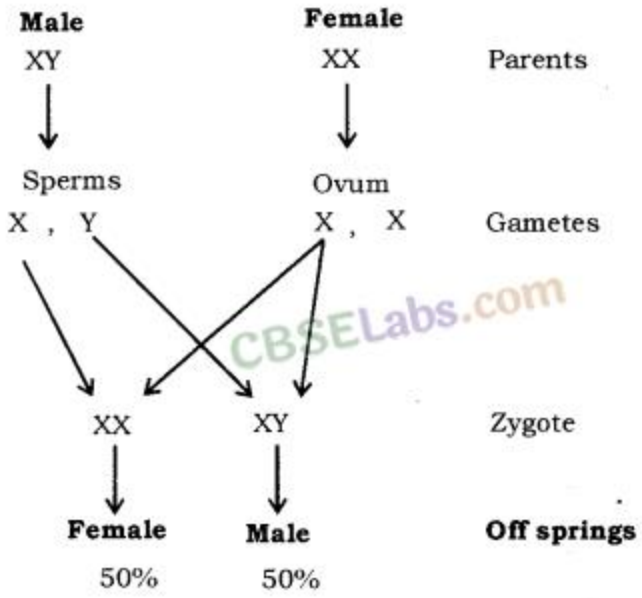
Different species use different strategies for this :

- In some animals the temperature at which fertilized eggs are kept determines whether the developing animals will be males or females.
- Some animals like snails can change sex indicating that sex is not genetically determined.
- In human beings sex of the individual is determined genetically; means genes inherited from the parents decide the sex of the offspring.

Sex determination in human beings: In human beings, all chromosomes are not paired. 22 chromosomes are paired but one pair called sex chromosome is odd in

not having a perfect pair in males. Females have a perfect pair both represented by XX. On the other hand males have a normal sized X but the other is short called Y so it is shown as XY. All gametes or ova formed by the homogenetic female are similar i.e. have X chromosome. Males heterogenetic form two types of sperms i.e. half with X chromosome and the other half with Y chromosome. Sex of the baby will depend on fertilization. There are two possibilities :

Sex determination in human being (flow chart)



Autosomes: Those chromosomes which do not play any role in sex determination.

Sex chromosomes: Those chromosomes which play a role in determining sex of the new-born.

- If the sperm having X chromosome fertilizes with ovum with X chromosome, then the baby will have XX chromosome and it will be female.
- If the sperm having Y chromosome fertilizes with ovum with X chromosome, then the baby will have XY chromosomes and it will be male.

Evolution: Acquired and inherited traits, Speciation, Evolution and classification, Evolution by stages, Human evolution.

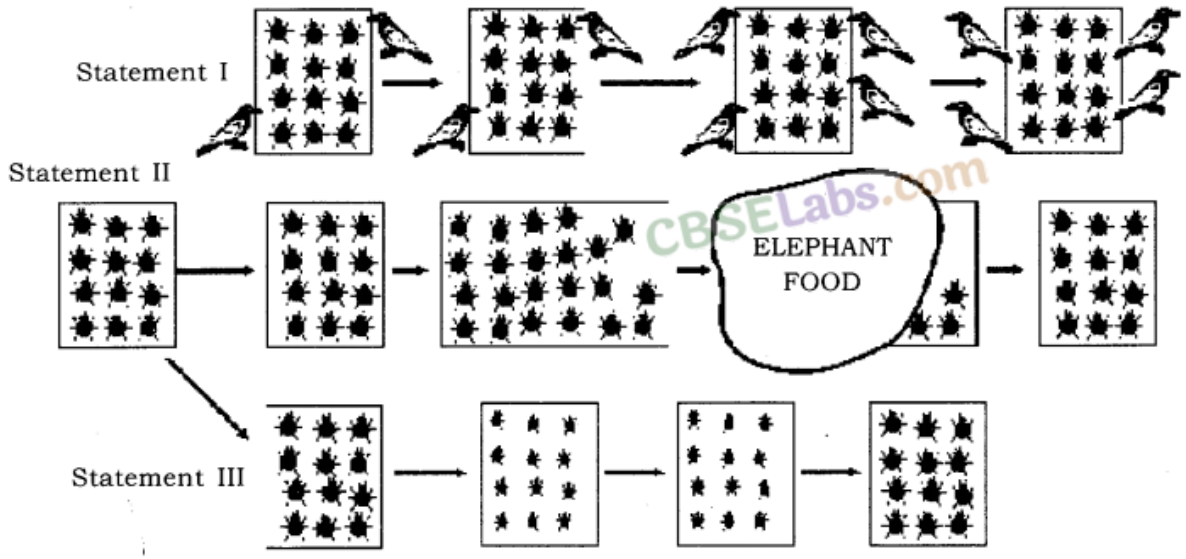
Evolution: It is the sequence, of gradual, irreversible changes which took place in the primitive organisms over millions of years to form new present-day species. Variations that resulted in formation of new species occurred basically due to errors in DNA copying as well as due to sexual reproduction.

An Illustration to show variations in a population: A group of twelve red beetles live in green bushes and reproduce sexually so are likely to develop variations. There are the following possibilities

First situation: Crows eat these beetles as they can easily pick up red ones in the green bushes There is a colour variation during sexual reproduction and green beetles appears, it reproduces and its population increases. Crows are not able to see green beetles so their population continues to increase but that of red beetles decreases. This type of variation gives a survival advantage.

Second situation: Due to a colour variation few blue beetle appear forming blue population. Crows can see both red and blue and eat them. Initially there are more of red beetles and less of blue. There is sudden calamity, an elephant kills red beetles by stamping on bush, blue beetles survive reproduce and increase in number. In this case there is no survival advantage but provides diversity without any adaptation.

Third situation: As the population of beetles increases, the bushes suffer from a disease and the availability of food for beetles decreases. The size of beetles decrease but after a few years as the plant disease is eliminated and enough food is available for the beetles they come back to their normal size. This type of change is not inherited.



Acquired Traits: Acquired traits are those which are not inherited over generations as they are caused due to change in the non-reproductive tissue and are not passed on the DNA of the germ cells for example; the size of the beetles in the population decreased due to scarcity of food.

Inherited Trait: Inherited traits are caused due to changes in the DNA of germ cells which are inherited from generation to generation, for example; formation of green beetles in the population of red beetles.

Acquired Traits and Inherited Traits

Acquired Traits	Inherited Traits
(i) These are the traits which are developed in an individual due to special conditions.	(i) These are the traits which are passed from one generation to the next.
(ii) They cannot be transferred to the progeny.	(ii) They get transferred to the progeny.
(iii) They cannot direct evolution, e.g. low weight of starving beetles.	(iii) They cannot direct evolution, e.g. low weight of starving beetles.

Charles Darwin's Idea of Evolution: His concept of evolution was based on the idea that new species were formed due to variations that occurred in the organisms Nature played an important role in selecting the organisms having suitable variations.

Speciation: It means the development of one or more species from an existing species The factors that could lead to rise of a new species are :

Gene flow: It means the exchange of genetic material by interbreeding between populations of the same species or between individuals within a population. It increases the variation in the genetic composition of a population.

Genetic drift: It is random change in the frequency of alleles in a populate over successive generation due to errors in the gametes. The process is rapid in smaller population. Genetic drift can lead to accumulation of changes in the generations.

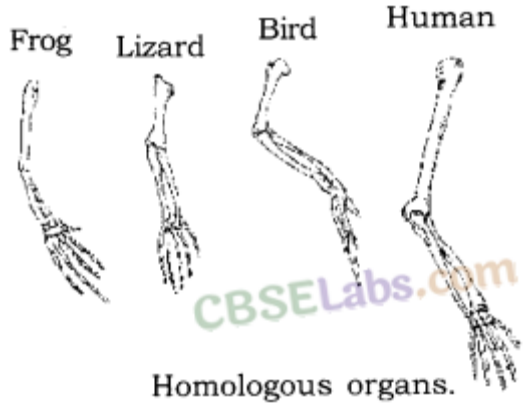
Natural selection: According to Darwin, natural selection also plays an important role in bringing about evolution of new species of plants and animals. According to him variations existed between the individuals of a population and some natural phenomena eliminated those individuals which were less adapted. The surviving

population would pass the hereditary advantageous features to their offsprings. With time this process would give rise to organisms different from the original population and new species are formed.

Isolation: When a population of a species splits into two, it cannot reproduce with each other and forms a new species, for example; when a population of beetles feed on bushes on a mountain range, some may start feeding on nearby bushes finding entry into a new subpopulation. They reproduce with them so genes enter in a new population. Ultimately the two groups will be incapable of reproducing with each other and new species will be formed.

Evolution and Classification: The organisms show certain features, like appearance and behaviour which are called characteristics for example; Plants can perform photosynthesis. The basic characteristics are shared by a large number of organisms. More characteristics which two species have in common more closely are related, if they are more closely related then they have common ancestors (explain the example of brother sister and cousins). Evolutionary relationships can be traced with the help of the following :

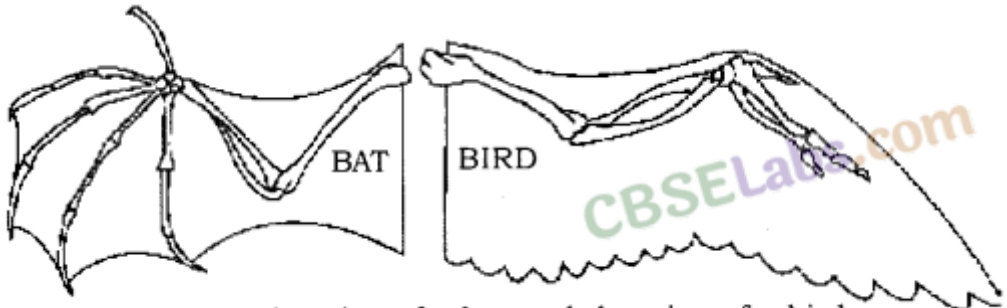
Homologous organs: Those organs which have the same basic structural design and developmental origin but perform different functions and appearance, for example; Forelimbs of frog, lizard, bird, bat and human beings. They have same design of bones but they perform different functions.



Homologous organs.

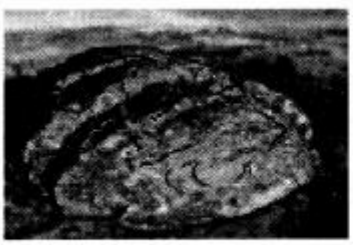
Analogous organs: Those organs which have different basic design and developmental origin but have similar appearance and perform a similar function, for example; wings of bat and bird. Wings of bat are folds of skin attached between

fingers. But wing of birds are modified forelimbs.

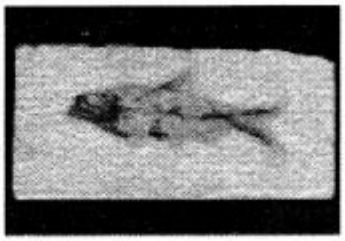


Analogous organs : The wing of a bat and the wing of a bird.

Study of Fossils: Fossils are preserved remains of living organisms that lived in the past. When living organisms die their bodies decompose but some parts of their body may be in such an environment that they do not decompose for example; if a dead insect gets caught in hot mud it will not decompose quickly but the mud will harden and retain impressions of the body parts of the insects. These impressions are also called fossils: The age of fossil can be estimated in two ways :
The fossils that occur closer to earth surface are more recent to those found in deeper layers.
The second method is isotope dating i.e. detecting the ratio of different isotopes of the same element in the fossil material.

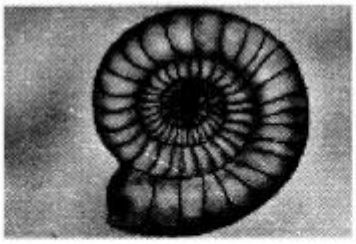


Fossil— tree trunk



Fossil— Fish (Knightia)

Fossil— invertebrate (Trilobite)



Fossil— invertebrate (Ammonite)

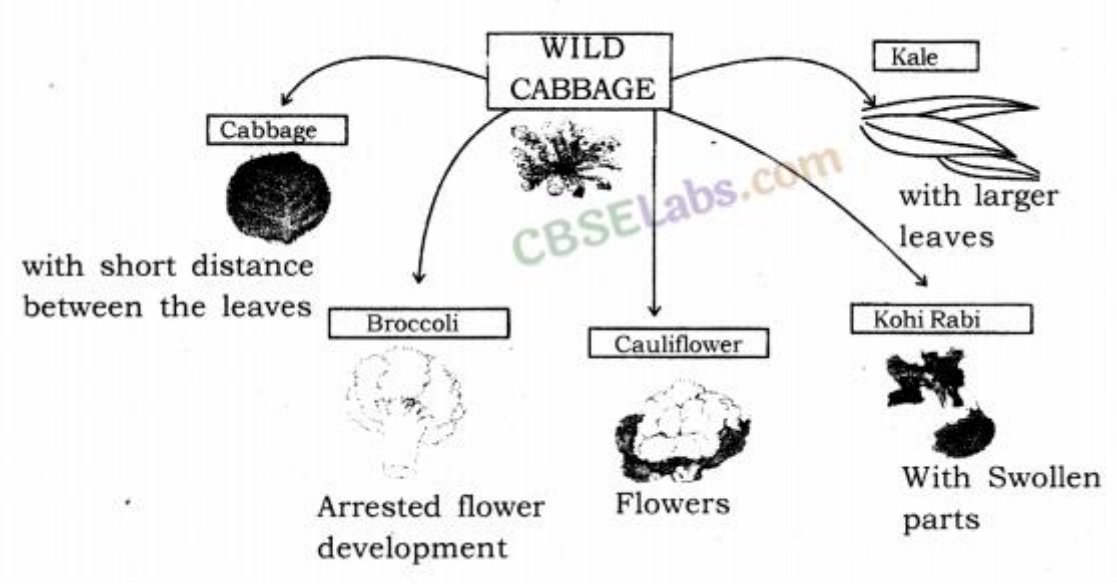
Fossil—dinosaur skull (Rajasaurus)

Significance of fossils: Fossils are formed layer by layer in the earths crust. The animals and plants which existed earlier are buried in the deeper layer which ones found in the upper layer. It is found that, deeper fossils have simpler structure than found than upper layer. Complete fossil record of animals like horse, camel, man has helped us to study the stages of evolution.

Evolution by stages: Evolution is a continuous and gradual process, complicated organs did not evolve by a single DNA change but were formed by bit by bit change

over generations for example; complex organs like eyes were created by bit by bit changes, in between the rudimentary eye in some insects also provided a fitness advantage. The structure of eye in all organisms is different enough to have evolutionary origins. Some organs even developed for one particular function but later become useful for quite a different function, e.g Feathers developed to provide warmth to the animal but later helped in flight.

Some dinosaurs had feathers although they could not fly, this shows that birds are closely related to reptiles, since dinosaurs were reptiles Some dissimilar looking structures also evolved from common ancestors. The current example of such a process is wild cabbage plant from which different vegetables are generated by artificial selection rather than natural selection



- Selection of short distance between the leaves has led to formation of cabbage that, we eat.
- Selection for arrested flower development had led to broccoli,
- Selection for sterile flowers had made cauliflower,
- Selection for swollen-stem had formed kohlrabi.
- Selection for large leaves had formed leafy vegetable kale,
- Selection for colored leaves formed red cabbage.

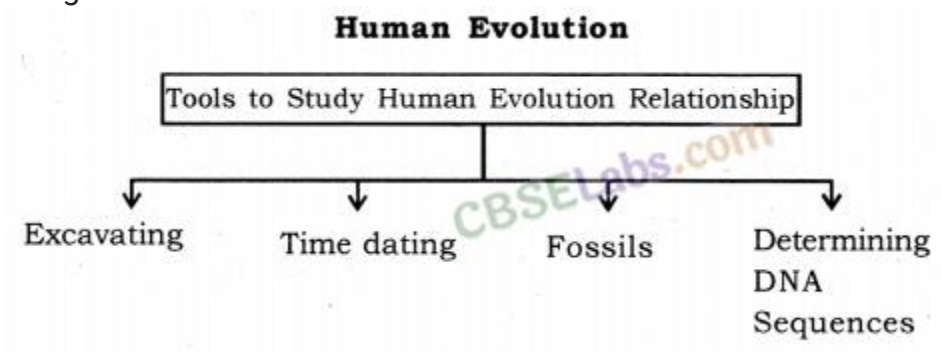
To sum up we can say that evolutionary relationships can be established by

- Study of Homologous organs
- Study of Analogous organs
- Study of fossils
- Changes in DNA during reproduction

Evolution versus Progress: Evolution can not be called progress from lower forms to higher forms. It is basically forming more complex designs while the simpler once also keep growing. Evolution is generation of diversity with the help of environmental selection. Bacteria which were formed first have the capacity to live in diverse

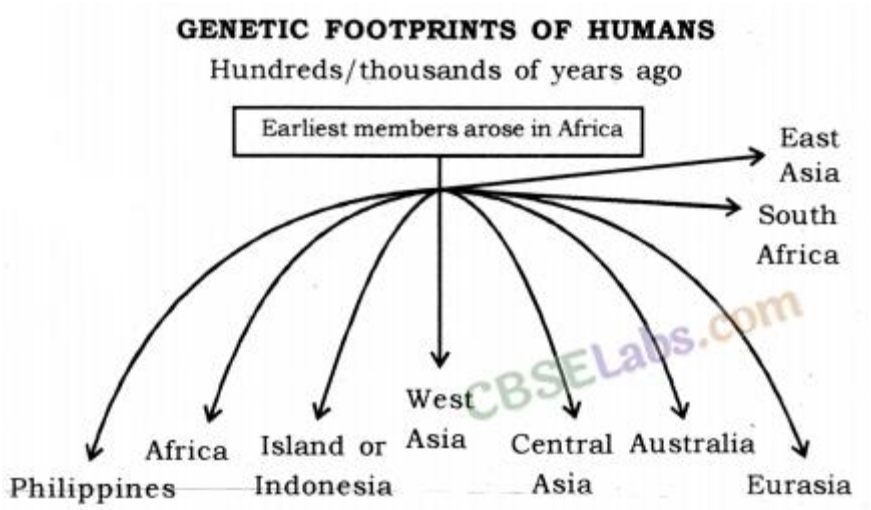
conditions and are still flourishing; on the other hand human beings which are highly evolved species can not be called the pinnacle of evolution but yet another species in the evolving life forms.

Human Evolution: Human evolution has been studied with the help of excavation; time dating and fossil study All human beings belong to single species i.e. Homo sapiens. Human species have come from Africa. Some of our ancestors left Africa while others stayed on. These migrants slowly spread across the planet i.e. West Asia, Central Asia, Eurasia, South Asia and East Asia They traveled to Indonesia, the Philippines, Australia and America They traveled forward and backward sometimes separating and sometimes coming back to mix with each other. They had come into being as an accident of evolution.



Although there is a great diversity of human forms all over the world get all humans are single species.

- They didn't go in a single line.
- They went forward and backward.
- Moved in and out of Africa.
- Sometimes come back to mix with each other.



Genetics: Branch of science that deals with heredity and variation.

Heredity: It means the transmission of features/characters/traits from one generation to the next generation.

Variation: The differences among the individuals of a species/population are called variations.

Mendel and his work on Inheritance.
Gregor Johann Mendel started his experiments on plant breeding and hybridisation. Mendel was known as Father of Genetics.
The plant selected by Mendel was Pisutn sativum (garden pea). Mendel used a number of contrasting characters for garden pea.

Sex Determination: Phenomenon of decision or determination of sex of an offspring.

Factors Responsible for Sex Determination:

- **Environmental:** In some animals, the temperature at which the fertilised eggs are kept decides the gender. Example, in turtle.
- **Genetic:** In some animals like humans gender or individual is determined by a pair of chromosomes called sex chromosomes (XX – female; XY – male).

Sex Chromosomes: In human beings, there are 23 pairs of chromosomes. Out of these 22 chromosome pairs are called autosomes and the last pair of chromosomes that help in deciding the gender of that individual are called sex chromosome.
XX – female; XY – male
The cross done shows that half the children will be boys and half will be girls. All children will inherit an X chromosome from their mother regardless of whether they are boys or girls. Thus sex of children will be determined by what they inherit from their father, and not from their mother.

Acquired Traits:

- These are the traits which are developed in an individual due to special conditions.
- They cannot be transferred to the progeny.
- They cannot direct evolution, for example, the low weight of starving beetles.

Inherited Traits:

- These are the traits which are passed from one generation to the next.
- They get transferred to the progeny.
- They are helpful in evolution, for example, the colour of eyes and hair.

Microevolution: It is the evolution which takes place on a small scale. Example, change in body colour of beetles.

Speciation: It is the process of formation of new species. A species is a group of similar individuals that belong to a population that can interbreed and produce fertile offspring. Speciation takes place when the variation is combined with geographical isolation.

Gene flow: It is the exchange of genetic material by interbreeding between populations of the same species or individuals. Gene flow occurs between populations that are partly but not completely separated.

Genetic Drift: It is the random change in the frequency of alleles (gene pair) in a population over successive generations.
Genetic drift takes place due to:

- severe changes in the DNA.
- change in the number of chromosomes.

Natural Selection: The process by which nature selects and consolidates those organisms which are more suitably adapted and possesses favourable variations.

Evolution and classification. Both evolution and classification are interlinked.

- Classification of species is a reflection of their evolutionary relationship.
- The more characteristics two species have in common the more closely they are related.
- The more closely they are related, the more recently they have a common ancestor.
- Similarities among organisms allow us to group them together and to study their characteristics.

Tracing Evolutionary Relationships:

- **Homologous Organs:** Morphological and anatomical evidences. These are the organs that have same basic structural plan and origin but different functions.
  Example, forelimb of a horse (running), wings of bat (flying), paw of a cat (walk/ scratch/ attack) — same basic structure but different functions.
- **Analogous Organs:** These are the organs that have different origin and structural plan but same functions.
  Example, wings of a bat (elongated fingers with skin folds), wings of bird (feathery covering along the arm) — different structures but same functions.

- **Fossils:** The remains and relics of dead organisms that lived in the remote past. Fossils provide evidence of evolution. Example, a fossil called Archaeopteryx has feathered wings like birds but teeth and tail like reptiles hence suggesting that birds and reptiles had a common ancestor.

Artificial Selection: Humans have been a powerful agent in modifying wild species to suit their own requirement throughout ages by using artificial selection. Example, wheat (many varieties obtained due to artificial selection).

1. Heredity : It refers to the transmission of characters or traits from the parents to their offspring. Heredity is the continuity of features from one generation to another which are present in fertilised egg or zygote. The zygote develops into an organism of a particular type only.

2. Genetics : It is the branch of biology which deals with heredity and variation. Genetics is to help our understanding of heredity by knowing how offspring inherit characteristics from their parents.

3. Variation : It means the differences in the characters or traits among the individuals of a species. Variations occur during reproduction both because of error in DNA copying and as a result of sexual reproduction. Variations contribute to evolution.

Causes of variations:

- Different combinations of genetic material.
- Some positive gene mutations.
- Interaction of genes with environmental changes (adaptations).

Importance of variations:

- It forms, the. basis of heredity.
- It causes adaptations due to which organism can easily adjust to its changing environment.
- Accumulation of variations forms the basis of evolution.

Remember!

Variations are produced both in sexual and asexual reproduction but amount of variations produced in asexual reproduction are subtle (so little) that they are hardly noticeable as compared to variations caused due to sexual reproduction.

4. Genotype : The genetic constitution of an organism e.g., Genotype of human male is 44 + XY and
genotype of human female is 44 + XX

5. Phenotype : The appearance of the organism, i.e., the way in which genotype is expressed. Phenotype is the result of interaction of genes with the environment. e.g., Red colour may be controlled by a pair of genes RR. Now if genotype is RR phenotype will be red only but if genotype is Rr then also phenotype will be red since R is a dominant gene.

6. Gene : It is the basic unit of inheritance by which characters are transferred from parents to their offspring. Gene consists of a specific length of DNA on a chromosome. A specific Segment of DNA that provides the information for one protein is called gene for that protein.
According to Mendel, both parents must contribute equally to the DNA of the progeny during sexual reproduction. As both parents determine the trait in the progeny, so both parents must be contributing a copy of the same gene.

7. Chromosomes : These are the long threads present in the nucleus of every cell. Chromosomes are made- up of DNA and protein. Each chromosome contains very long molecule of DNA.
Remember!
Each gene set is present as separate independent pieces each called a chromosome. Each cell have two copies of each chromosome, one each from male and female parents. Every germ cell will take one chromosome from each pair and these may be of either maternal or paternal origin. When two germ cells combine, they will restore the normal number of chromosomes in the progeny, ensuring the stability of the DNA of the species. Such mechanism of inheritance is used by all sexually and asexually reproducing organisms.

8. Allele: It is an alternative form of a gene occupying the same position on a chromosome and affecting the same characters but in two alternative ways, e.g., the free and attached ear lobe are the alleles of ear lobe character.
Expressing allele of a gene :

- Homozygous dominant in capital letters, e.g., tallness(TT)
- Homozygous recessive in small Metters, e.g., shortness or dwarfness (tt)
- Heterozygous (Tt)-It will be called hybrid tall.

9. Dominant allele: An allele that affects the phenotype of an organism both in heterozygous and homozygous condition. It is denoted by a capital letter, e.g., tallness in pea plant is denoted by 'T.

10. Recessive allele: An allele that affects the phenotype of the organism in absence of a dominant allele, i.e., in homozygous recessive individuals. It is denoted by a small alphabet, e.g., dwarfness in pea plant is denoted by't'.

11. Homozygous: When both alleles of a particular gene are the same, e.g., TT

12. Heterozygous : When both alleles of a particular gene are different, e.g., Tt

13. Diploid : Cells or organism containing two sets of genes, e.g., human body cells. Diploid cells have genetic constitution of 2n.

14. Haploid : Cells or organism containing one set of genes, e.g., human reproductive cells (sperms and ova). Haploid cells have genetic constitution of n.

15. Monohybrid cross : A cross between two parents taking the alternative traits of one single character, e.g., A cross between tall and dwarf pea plants.
Monohybrid Ratio :

- In F_1 generation : 100% hybrid
- In F_2 generation : phenotypic ratio is 3 : 1 and genotypic ratio is 1 : 2 : 1

16. Dihybrid cross: A cross between two parents taking into consideration alternative traits of two different characters, e.g., A cross between two pea plants one having round, green seeds and the other having wrinkled, yellow seeds.
Dihybrid Ratio :

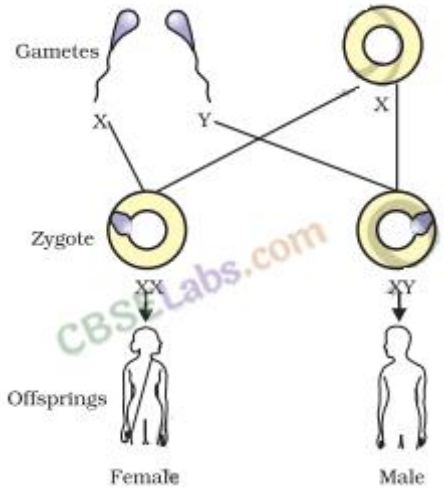
- F_1 ratio is 100% Hybrid type.
- F_2 ratio : Phenotypic is 9 : 3 : 3 : 1 and Genotypic . ratio is very complex.

17. Human Blood Groups: There are four types of blood groups A, B, AB or O. These are controlled by a gene which is denoted by symbols I^A, I^B and I^O (sometimes also denoted as i). The genes I^A and I^B show no dominance over each other (they are codominant, i.e., both expresses themselves independently). But these both genes are dominant over the gene I^O. Therefore, blood group of a person depends on the type of genes present, e.g., (i) Blood group A has the following gene types :

18. Determining sex of a newborn individual genetically:

- In human beings the sex of the individual is ” determined genetically.
- There are 23 pairs of chromosomes of which 22 are similar in male and female and are known as autosomes.
- The remaining one is sex chromosome which is XY in males and XX in females.
- Males produce two types of sperms X and Y, while female produces one type of egg X.
- If a X type of sperm fertilizers the egg then the sex of baby will be female (XX).

- If Y type of sperm fertilizers the egg then the sex of the baby will be male (XY).



19. Mendel's experiment to show that traits may be dominant or recessive:

- Mendel conducted breeding experiments in garden pea.
- selected pure plant of a tall/short plant.
- produced first generation plants by crossing them.
- found that all plants were tall.
- produced the second generation by self-fertilization of hybrids.
- found that three-quarter of the plants was tall and one quarter was short.

20. Homologous chromosomes: A pair of corresponding chromosomes of the same shape and size, one from each parent.

21. Autosomes and Sex chromosomes : The identical » chromosome pairs are called autosomes. The
chromosome pair which is different are called sex chromosomes. Humans have 23 pairs of chromosomes. 1-22 pairs are autosomes while 23rd pair (XX in females and XY in males) which are designated as X and Y are sex chromosomes.

22. Molecular Phylogeny: It is the study of evolutionary relationships by comparing DNA of different species.

23. Natural selection : Natural selection is one of the basic mechanisms of evolution, along with mutation, migration and genetic drift. Natural selection means the environmental conditions prevailing around an organism against which organism adapts itself, grows – and reproduces further. This leads to a change in the composition of genes within a population further causing evolution. Thus, it can be said that,
Natural selection results in adaptation in population to fit their environment better. Thus, natural selection direct evolution in the population of a particular species.

24. Fossils of the information which they provide regarding evolution: Fossils are the remains of ancient life forms, which got preserved somehow in the layers of earth, snow or oil.
Information given by fossils:

- They reveal that the life forms which existed earlier do not exist today which indicate that the living forms are ever changing (evolving).
- They are used to guess the time when a particular organism existed on earth. It is done through carbon dating.

25. Genetic drift: The change in the frequency of some genes in a population which provides diversity without any survival advantage is called genetic drift.

26. The various ways in which individuals with a particular trait may increase in a population : Differences in population are responsible for the diversity such as, colour of eyes, hair, shape of ear lobes. This occurs due to : (i) Sexual reproduction (ii) Inaccuracies during DNA replication (iii) Due to environmental changes. This diversity will increase with time as these variations can be passed on only through DNA/genes during reproduction through reproductive tissue (germ cells or gametes).

- If these variations give survival advantage, then such traits are selected in nature and such traits increase in a population.
- Due to genetic drift. This occurs due to geographical or reproductive isolation. It results in the change in gene frequency in a particular: population.
- Migration which leads to gene flow in and out of the population.
- The mutation caused due to particular type of environment. ,
- Acquired traits due to particular type of environment.

27. Evidence of evolution: Errors in DNA copying (mutation) and sexual reproduction lead to variations which form the basis of evolution. Characteristics that are common in different kinds of living organisms provide evidence in favour of evolution.

28.Evolution : Evolution can be defined as a naturally occurring slow, continuous and irreversible process of change. The gradual change of living organisms from pre-existing organisms since the beginning of life is called organic evolution. Whereas, gradual change in elements from one form to another with time is termed as inorganic evolution, i.

29.Inherited traits : are those traits which are passed from one generation to another through specific genes. Any change in DNA of the germ cells will be passed.
30. Acquired traits : are those traits which are acquired by the organism in its lifetime, e.g., removal of tail cannot change the genes of the germ cells of the mice thus cannot be passed to next generation.

31. Speciation : It means the origin of new species from the existing ones. It happens when different populations of the same species evolve along different lines.

How speciation occurs ?

- It occurs when two populations are isolated (both geographically and reproductively) leading to almost no gene flow between the two populations.
- Over generations, genetic drift will accumulate different changes in each sub-population.
- Natural selection may also operate differently in these different locations.
- Together natural selection and genetic drift will cause such changes (severe changes in the DNA) that these two groups will not be able to reproduce with each other even if they happen to meet.
- When DNA changes occur to larger extent, it may lead to change in the number of chromosomes or gene expression, eventually the germ cells of the two groups cannot fuse with each other. This leads to emergence of new species.

32. Estimating Age of Fossil: There are 2 methods :

- **Relative method :** On digging, the fossils which are closer to the surface are more recent than the fossils found in deeper layers.
- **Dating fossils (carbon dating method):** It is done by detecting the ratios of different isotopes of the same element (i.e., isotope of C-14 which is radioactive) in the fossil material.

33. Evolution by stages :

Complex organs like eye has evolved from rudimentary organs, (e.g., rudimentary eye in flatworm might be useful enough to give only a fitness advantage and the structure of eye in different organisms is different indicating them to have different evolutionary origins) not by a single DNA change but created bit-by-bit over generations.

A change that is useful for one property to start with can become useful later for quite a different
function (e.g., Feathers might start as providing insulation in cold weather. But later, they might be useful for flight. Some heavy birds and reptiles also have feathers but they do not fly.

Some very dissimilar looking structures evolve from a common ancestral design, e.g., wild cabbage was cultivated as a food plant and many different vegetables were generated by selection over last two thousand years, (a) Selection of very small distances between the leaves gave rise to cabbage we eat. (b) Selection for arrested

flower development gave rise to broccoli, (c) Selection for sterile flowers gave rise to cauliflower (d) Selection for swollen parts gave rise to kohlrabi.(e) Selection for larger leaves gave rise to leafy vegetable kale. It suggests that, if these selections were not done then there would have been only wild cabbage.

34. Homologous organs are organs having same origin and basic structure but they appear different and perform different functions in various organisms,
e.g.,

- Forelimbs of horse and arms of man.
- Wings of birds and flippers of whale.

Similarities in basic structure of (homologous) organs in different organisms, indifferent groups indicate common ancestry.

35. Analogous organs are organs, which look similar because they perform same function, but they do not have same origin and basic structure.
e.g.,

- Wings of birds and wings of insects.
- Fins of fish and flippers of the whale.