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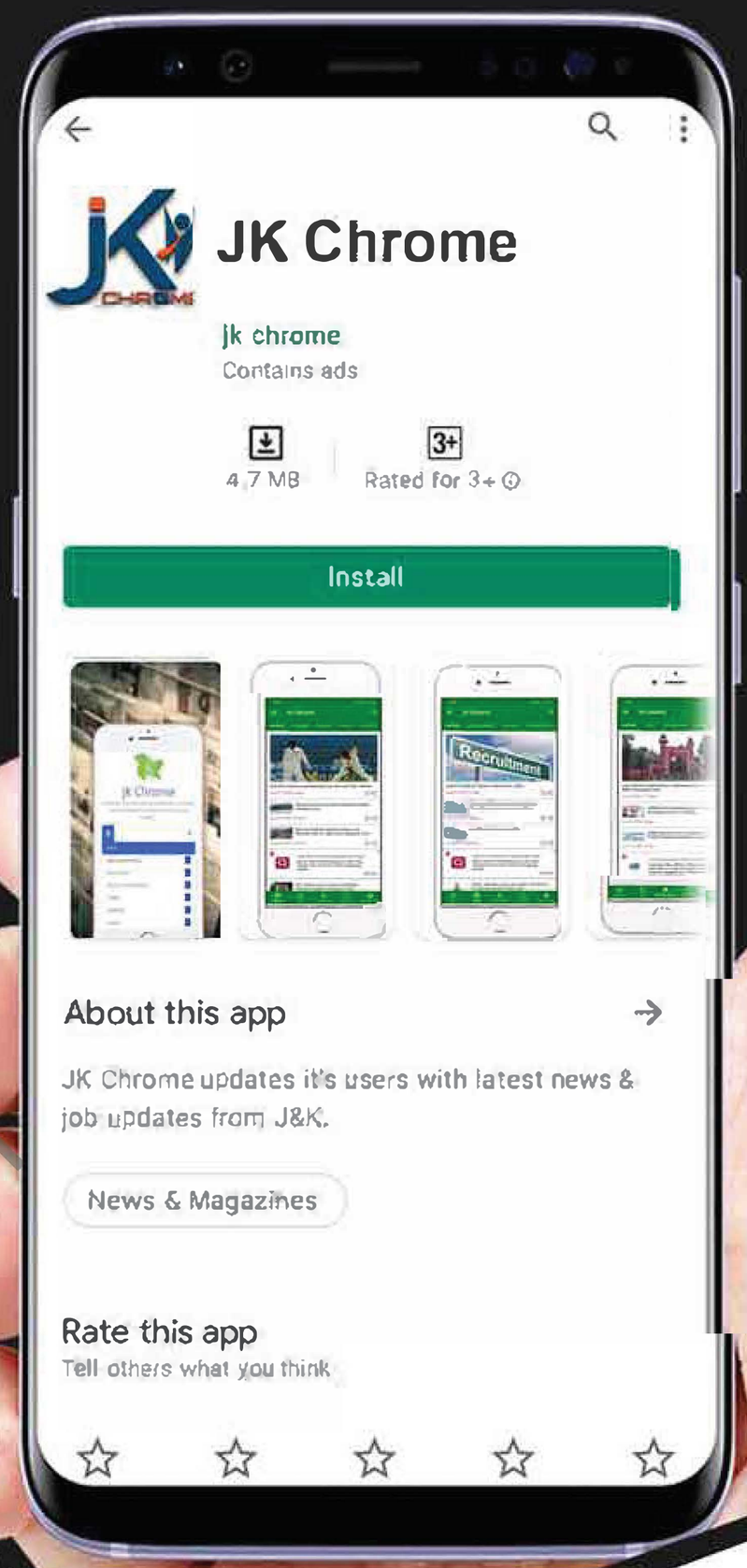

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Chapter 1

Nutrition in Plants

All living organisms require food. The food gives energy to the organisms for growth and maintenance of their body functions. Carbohydrates, proteins, fats, vitamins and minerals are the components of food. These components of food are necessary for our body and are called nutrients.

Nutrition is the process of taking food by an organism and its utilisation by the body. Green plants prepare their own food while humans and animals are directly or indirectly dependent on plants for their food.

Modes of Nutrition
On the basis of a different mode of nutrition, organisms are categorised into two major types, i.e.

(i) Autotrophs (auto-self, trobpos-nourishment) Autotrophic nutrition is the mode of nutrition in which organisms make their own food from the simple substance (e.g. CO_2 and H_2O) by the process of photosynthesis. Therefore, plants are called autotrophs.

(ii) Heterotrophs (heteros-other) Humans and animals do not contain chlorophyll and are dependent on plants for their food in readymade form. Those organisms which cannot prepare their own food and take food from green plants or animals are called heterotrophs and the mode of nutrition is called heterotrophic nutrition.

Photosynthesis: Food Making Process in Plants
The process by which autotrophic green plants make their own food from simple inorganic substances (carbon dioxide and water) in the presence of sunlight and green pigment or chlorophyll is known as photosynthesis.

Site of Photosynthesis

The process of photosynthesis takes place in green leaves, therefore leaves are referred to as the food factories of plants. The. the photosynthetic process can occur in other green parts of the plant-like stem but is not enough for meeting all the needs of the plant.

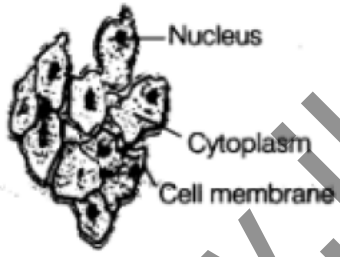
Reactions Involved in Photosynthesis

The whole process of photosynthesis can be given by the following equation:

$$\underset{\text{(from air)}}{\text{Carbon dioxide}} + \underset{\text{(from soil)}}{\text{Water}} \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} \underset{\text{(food)}}{\underset{\text{Carbohydrate}}{\text{Glucose}}} + \underset{\text{(released in air)}}{\text{Oxygen}}$$

Cells

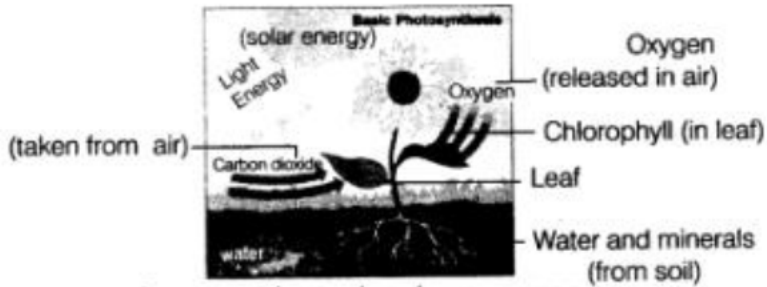
All living organisms are made from small building units of catted cells. Cells are the structural and functional units of the body of all living organisms. They can only be seen under a microscope. The cell has a thin outer boundary called cell membrane, a distinct, centrally located spherical structure called nucleus and jelly-the substance surrounding the nucleus called cytoplasm.



Cell showing its parts

The inorganic raw material, i.e. CO2 is taken from the air through the tiny pores present on the surface of leaves called stomata and water is absorbed through the roots of plants (from the soil) and is transported to leaves by vessels which act like pipes. These vessels form the continuous path from

roots to leaves for the movement of nutrients.

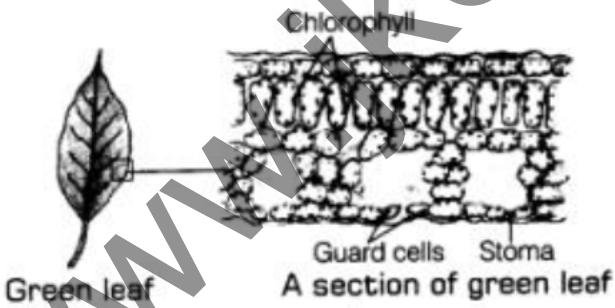


A green plant showing process of photosynthesis

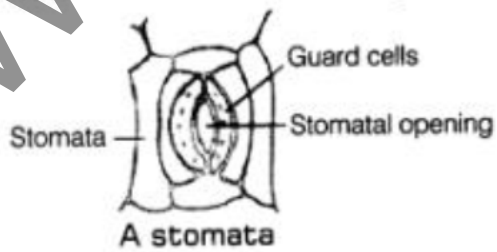
Green plants possess chlorophyll in their leaves which captures the energy of the sunlight. This light energy is used to prepare food (starch). During the process, oxygen is also released. Photosynthesis is the unique process in which solar energy is captured by the leaves and stored in the plants in the form of food. Thus, 'Sun is the ultimate source of energy for all the living organisms.'

Products of Photosynthesis

The food produced by the process of photosynthesis is mainly carbohydrate. It produces glucose as food material which later gets converted into starch. The presence of starch in leaves indicates the occurrence of photosynthesis.



A section of green leaf



A stomata

Importance of Photosynthesis

If the plants do not perform photosynthesis, there would be no food on earth. Photosynthesis is also necessary for the production of oxygen gas in the atmosphere which is necessary for the respiration of organisms. Therefore, it can be said that no life is possible in the absence of photosynthesis.

Photosynthesis in Leaves of Various Colours

In green pants, chlorophyll absorbs light energy from the sun to perform photosynthesis. Besides some green colour plants like Croton, maple, Colocasia, etc., have leaves that are red, brown, violet colour (variegated). These colours are present in large amounts and masks the green colour of chlorophyll in leaves. Thus, these leaves also perform photosynthesis and synthesise starch in them.

Synthesis of Plant Food other than Carbohydrates

The starch or glucose is the simplest form of carbohydrate synthesised by the plants which is composed of carbon, hydrogen and oxygen. Sometimes these simplest forms of carbohydrate are utilised to synthesise other food nutrients like fats (oils), proteins, etc. Starch or glucose is rich in seeds like wheat, rice and various parts of plants like potato tuber. Sometimes the starch or glucose is stored in the form of oil in their seeds (oilseed), e.g. sunflower seed.

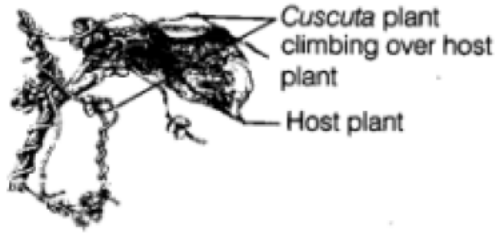
When the plant nutrient contains, carbon, hydrogen and oxygen along with nitrogen elements, it is called protein. The element nitrogen comes from soil in the form of nitrate by the actions of some bacteria present in soil and forms amino acid which is then converted into proteins. Therefore, plants also make fats and proteins as their food.

Other Modes of Nutrition in Plants

There are some plants which do not contain chlorophyll in them and thus, cannot prepare their own food. These plants obtain their food from other plants or animal, i.e. they are heterotrophic in nature.

Parasitic Plants

A parasitic plant is one that lines inside or outside the other organism and derive their food from them. The plant (non-green) which obtains their food from other organism is called a parasite and the living organism from whose body, food is obtained is called host, e.g. amarbel or Cuscuta. It takes readymade food from host through special type of roots called sucking roots which penetrate into host plant and suck food material from the host.



Cuscuta plant (parasite)

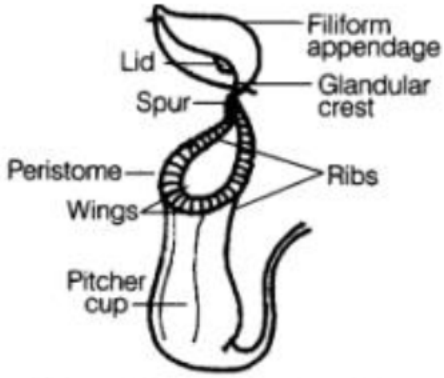
Insectivorous Plants

There are some plants which can trap insects and digest them for their nutrition. These plants are green in colour but lack nitrogen elements. To overcome this problem, these plants eat insects. Hence they are called insectivorous plant or carnivorous plants. These have specialised leaves, the apex of which forms a lid that can open and close the mouth of pitcher. There are hair inside the pitcher which are used to entangle the insects.

When an insect comes in contact of the lid, it gets closed and traps the insects. The insect inside the pitcher is digested by digestive juices secreted by the pitcher to obtain nitrogen compounds (amino acids) from them.
e.g. pitcher plant, sundew, Venus flytrap and bladderwort.

Since these can synthesise their own food but fulfil their nitrogen deficiency by eating insects, therefore these are called as partial

heterotrophs.



Nepenthes of pitcher plant

Saprotrophic Plants

The mode of nutrition in which organisms take their nutrients from dead and decaying matter is called saprotrophic nutrition.

Plants which use the saprotrophic mode of nutrition are called saprotrophs, e.g. fungi like mushrooms are non-green plants that grow on the dead and decaying matter for their food. Bread moulds (fungi) and yeast are saprophytic plants.

Symbiotic Plants

Sometimes, two plants of different species live together and help each other in obtaining food and shelter. This association is called symbiosis and such plants are called symbiotic plants.

The relationship in which two different organisms live together and share shelter and nutrients is called symbiotic relationship, e.g. lichens and Rhizobium.

Lichen is an association in which algae and a fungus live together. The fungus provides shelter, water and minerals to the algae and in return, the algae provide food which it prepares by photosynthesis.

Replenishment of Nutrients in Soil

Crops require a lot of nitrogen to make proteins. After the harvest, the soil becomes deficient in nitrogen. Plants cannot use the nitrogen gas available in the atmosphere directly. The action of certain bacteria can convert this

nitrogen into a form readily used by plants. Rhizobium bacteria live in the root nodules of leguminous plants. These bacteria take nitrogen gas from the atmosphere and convert it into water-soluble nitrogen compounds making it available to the leguminous plants for their growth.

In return, leguminous plants provide food and shelter to the bacteria as Rhizobium cannot prepare its food. They, thus have a symbiotic relationship. This association is very important for the farmers, as they do not need to add nitrogen fertilisers to the soil in which leguminous plants are grown.

Chapter 2

Nutrition in Animals

All animals require food for obtaining energy, growth, repair of damaged parts and functioning of the body. The process of taking food by an animal and its utilisation in the body is called animal nutrition.

Plants can prepare their own food by the process of photosynthesis but animals get their food from plants, either directly by eating plants or indirectly by eating other animals that eat plants. Some animals eat both plants and other animals.

Animal nutrition includes nutrient requirements mode of intake of food and its utilisation in the body.

The components of food such as carbohydrates are complex substances which cannot be utilised by the body. So, they are broken down into simpler substances. The process of breakdown of complex components of food into simpler substances is called digestion. There are two methods of digesting food, i.e. physical method (including chewing and grinding of food in mouth) and chemical method (addition of digestive juices to the food by the body itself).

Different Ways of Taking Food

Different types of animals show different modes of nutrition. Some animals filter tiny food particles and feed upon them, while some swollen the animals they prey upon. The mode of nutrition in different animals depends upon the special structure or organ for taking food inside the body.

Various modes of feeding in different Animals

Name of the animal	Kinds of food	Modes of feeding
Snail	Algae	Scraping from rocks
Ant	Plant material and other animals	Biting and chewing
Eagle	Flesh of prey	Tearing
Humming Bird	Nectar from flower	Sucking
Lice	Blood from the skin of scalp	Sucking
Mosquito	Blood from animals	Sucking
Butterfly	Nectar from flower	Syphoning

Housefly	Filth and refuses	Sucking
Amoeba	Tiny aquatic animals	Capturing and Swallowing
Snake (Python)	Animal as a whole	Swallowing

Starfish

It is a marine animal which is covered by hard shells of calcium carbonate. It has a unique mode of nutrition. It opens the shell of its prey and pops out its stomach through its mouth surrounding the soft body of its prey. The starfish after capturing its prey brings bach its stomach inside its own body. This food is then digested slowly by starfish.

Digestion in Humans

The food components pass through a continuous canal and get digested in each compartment. This is called an alimentary canal, it is 'the tract or canal running from mouth to anus of human being where digestion and absorption of food take place.'

The alimentary canal can be divided into various compartments:

- The buccal cavity
- Food pipe or oesophagus
- Stomach
- Small intestine
- Large intestine ending in the rectum
- The anus

The main digestive glands which secrete digestive juices are

- salivary gland
- liver
- pancreas

Various processes involved in utilisation of food in humans are

- The process of taking food into the body is called ingestion.
- The process by which the food containing large insoluble substances is broken down into small water-soluble substances is called digestion. There are two methods of digesting food, i.e. physical method (including chewing and grinding of food in mouth) and chemical method (addition of digestive juices to the food by the body itself).
- The process by which the digested food passes through the intestinal wall into the bloodstream is called absorption
- The process by which the absorbed food is taken in body cells and used for energy, growth and repair is called assimilation.
- The process by which the undige ted food is removed from the body is called egestion.

Carbohydrates, fats and protein are large insoluble substances which cannot pass through the wa ls of our intestine and get absorbed in that form. Therefore, these substances are broken down into small water-soluble substances. This is done by the process of digestion.

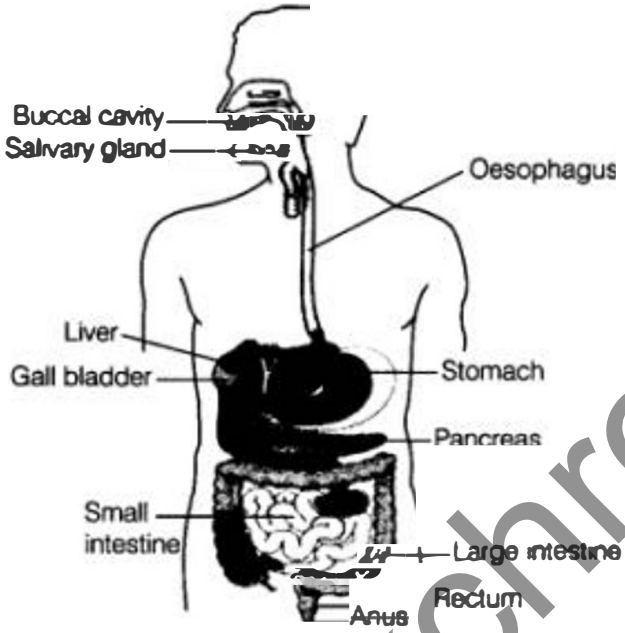
The carbohydrates get broken down into simple sugar called glucose, while fats in fatty acid and glycerol and proteins get broken down into amino acids during digestion. These simpler compounds are easily absorbed by the walls of small intestine into the blood.

Human Digestive System

The system that consists of the digestive tract along with glands is called the digestive system. Now, let us know what happens to the food in different parts of the digestive tract.

1. Mouth and Buccal Cavity

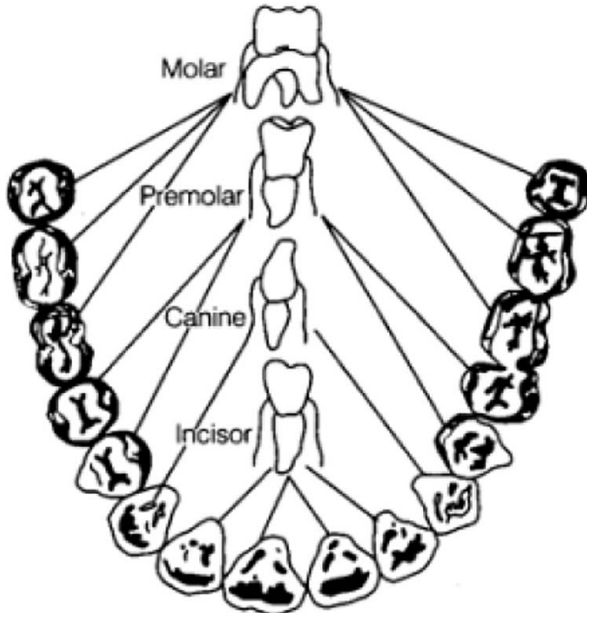
The process of ingestion starts from the mouth or buccal cavity. As we ingest, food the salivary glands present in the mouth start its digestion. The teeth present in the buccal cavity cut the food into small pieces by chewing and grinding it. Salivary glands secrete a watery liquid, saliva. This saliva contains digestive enzymes which help in partial digestion of food (starch). The tongue helps in mixing saliva with food. This partially digested food is swallowed by the tongue and passed down to oesophagus or food pipe.



Digestive system of human

Teeth

The food is cut by the teeth inside the mouth. Teeth mechanically break the food into small pieces. These teeth vary in appearance. Each tooth is rooted in a separate socket in the gums.



Types and arrangement of teeth

There are four types of teeth:

- Incisors These are four chisel-shaped incisors at centre of each jaw for biting and cutting the food
- Canines These are two large pointed teeth just behind incisors in each jaw, for piercing and tearing the food.
- Premolars These are four (two on each side) large premolars with the flat surface behind the canines in each jaw, for grinding and chewing.
- Molars In an adul these are six (three on each side) large molars with the flat surface behind the premolars in each jaw, for grinding.

Milk Teeth and Permanent Teeth

In human being , teeth grow twice. The sets of teeth that grow during infancy when one is a small baby), are called milh teeth. These are also called as temporary teeth. These teeth get loosen and fall off at the age of 6 8 years. When milh teeth fall off, a new sets of teeth grow in their place. This second set of teeth is called permanent teeth because these remain till the old age. But if these teeth fall down, no new teeth arise on its place.

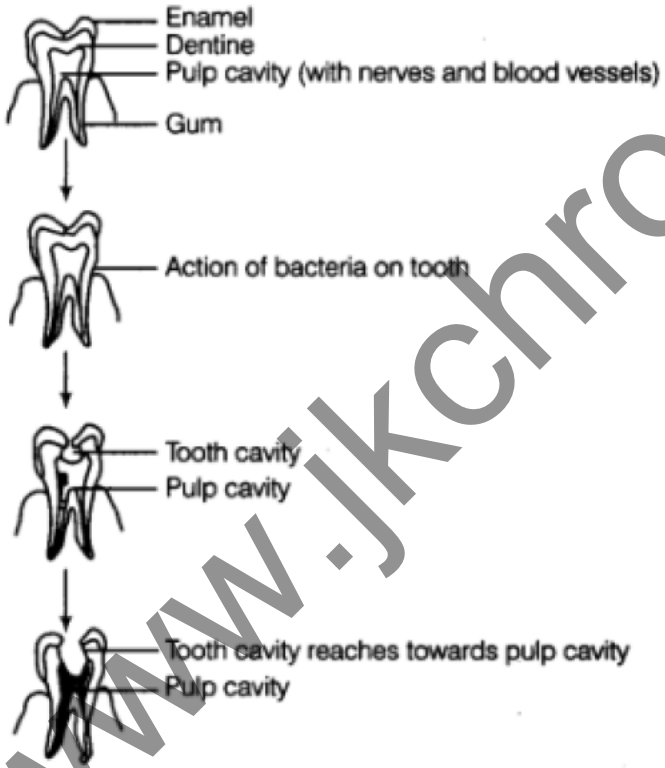
Sweets and Tooth Decay

The tooth is covered by white, hard outer covering of tooth called enamel below which dentine is present. It is similar to bone which protects the

pulp cavity having nerves and blood vessels. Bacteria are present in our mouth but they are not harmful to us. However, if we do not clean our teeth and mouth after eating, many harmful bacteria also begin to live and grow in it. These bacteria breakdown the sugars present from the leftover food and release acids. The acids gradually damage the teeth. This is called tooth decay.

Therefore, tooth decay is defined as the process of rotting of tooth and formation of cavity or holes in it which leads to the toothache.

When the holes or cavity reaches to the pulp cavity, it causes pain. If these cavities are not treated on time it causes severe toothache and may result in tooth loss.



Gradual decaying of human tooth

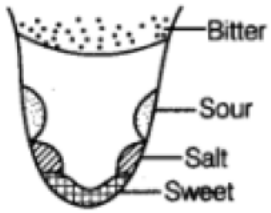
Tooth decay can be prevented by adopting the following measures.

- One should rinse and clean its teeth thoroughly after every meal.

- We should clean our teeth with the help of datun or brush and toothpaste, twice a day.
- We should use dental floss which is a special strong thread. It is moved between two teeth to take out trapped food particles.
- Dirty fingers or unwashed objects must be avoided to put in the
- We should avoid the use of sweets, chocolates, toffees, ice-cream, be avoided.

Tongue

It is a muscular organ attached at the back to the floor of the buccal cavity. It is free from the front and can help in mixing saliva with the food, swallowing the food, talking or speaking and tasting with the help of taste buds for sweet, salt, sour and bitter food. Salivary glands secrete saliva which breaks down starch into sugars.



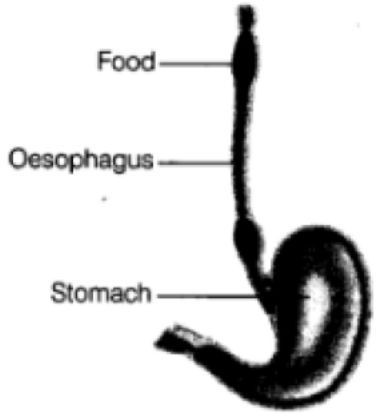
A tongue showing different regions for taste buds

2. The food pipe or Oesophagus

It is the tube-like structure which connects the mouth to the stomach and runs along neck and chest. It carries slightly digested food from the mouth to the stomach. Food is pushed downward by a wave like movement of the wall of foodpipe as a result of alternate contraction and relaxation. This movement is called peristalsis.

The chewed food that enters the oesophagus from mouth and is passed down to stomach is called bolus.

Sometimes, food is not accepted by our stomach and is vomited out because the food moves in the opposite direction, i.e. from stomach to mouth by anti-peristaltic movement in oesophagus.



Movement of food in oesophagus

Our windpipe (that carries air from nostril to our lungs) and foodpipe runs adjacent to each other. Air and food share a common passage in the throat. When we swallow food, a flap-like valve closes the passage of the windpipe and guides the food into the foodpipe. But if we laugh or talk while eating, the windpipe remains open and food particle enters into the windpipe and we experience hiccups, cough or choking si characteristic 'gulping sound' repeatedly and coughing clears the blockage of windpipe

3. The Stomach

The stomach was first discovered by an American doctor William Beaumont in 1822 accidentally in the man named Alexis St. Martin. It is a thick walled bag-like structure which is present on the left side of the abdomen. Its shape is like flattened U and it is the widest part of the alimentary canal. The semi-digested food from oesophagus enters into stomach where further digestion takes place.

The churning of food into stomach takes place for three hours. The food is broken down into smaller pieces and forms semi-solid paste. The inner lining of stomach secretes mucus, hydrochloric acid and digestive enzymes or juices. The function of mucus is to protect the lining of stomach from the action of hydrochloric acid. The secretion of hydrochloric acid makes the medium acidic inside the stomach. It kills the harmful bacteria present in the food and also helps in the digestion of proteins in the stomach. The partially digested food which moves from stomach to the small intestine is called chyme.

4. The Small Intestine

It is highly coiled long tube with length of about 7.5 metres. The small intestine is a narrow tube which receives secretions from the liver and pancreas. The wall of small intestine also secretes digestive juices. The complete digestion of food takes place inside the small intestine and the food components are also absorbed here.

The largest gland of the body, i.e. liver is the reddish-brown coloured gland, situated in the upper part of the abdomen on the right side. It secretes bile juices which is stored in a sac-like structure called as gall bladder. The bile helps in the digestion of fats. It breaks the fat molecules into tiny droplets so that its further breakdown into simpler compounds, becomes easy. The complete digestion of fats is done by pancreatic juice.

The pancreas is a large cream coloured gland which is located just below the stomach and secretes pancreatic juices. It breaks down fats into simpler compounds like fatty acid and glycerol, carbohydrate into simple sugars and proteins into simpler amino acids. The intestinal juices secreted by the walls of small intestine also help in the digestion of carbohydrate and proteins into simpler and water soluble substance. Now, the food is said to be digested. This digested food is now absorbed by the walls of small intestine.

Absorption in the Small Intestine

The blood vessels in the walls of the intestine absorb the digested and water soluble substance to produce energy for growth and development of animals. The inner walls of small intestine have thousands of finger-like outgrowths called villi. These villi help in increasing the surface area of small intestine for the absorption of digested food. Villi possess a network of thin and small blood vessels close to its surface. These blood vessels absorb the digested food material and transport it to the different organs of the body where these are used to build repair the body and to provides energy.

The glucose breaks down into carbon dioxide and water and releases huge amount of energy with the help of oxygen inside the cell. Fatty acid and

glycerol help in building the component of cells and form fats which is stored in the body as food reserve while amino acid is used in growth and repair of the body. The undigested food material is not absorbed by the small intestine and it passes from here to the large intestine.

5. Large Intestine

It is a 1.5-meter long tube. It is wider and shorter than the small intestine. The undigested semi-solid food is passed from small intestine to large intestine. The large intestine absorbs water and salt from the undigested food. The remaining waste material then passes to the rectum and remains there for some time in the form of semi-solid faeces. This waste faecal matter is then removed through the anus from the body by the process called egestion.

Diarrhoea

It is a condition in which a person passes out watery stools frequently. It is a disease which is caused by an infection, food poisoning or indigestion. It usually occurs In children and may be fatal. In this condition, there is a loss of water and salts from the body of a person through frequent watery stools. This loss of water from the body of a person through watery stool is called dehydration and it may be fatal under severe conditions. Diarrhoea should never be neglected. In order to prevent dehydration, the person suffering from diarrhoea should be given a solution of sugar and salt in the clean water for several times in a day.

This solution is called Oral Rehydration Solution (ORS). The ORS makes up the loss of water and salt in the body and sugar provides energy which helps in the recovery of disease. The dehydration of body can be prevented during diarrhoea by giving ORS solution regularly to the patients. In the mean time, the doctors should be called for medicines to cure of diarrhoea.

Digestion in Grass-Eating Animals

The herbivorous animals such as cow, buffaloes, etc eat grass. These animals quickly swallow the grass and store it in a part of stomach called rumen. The food is not chewed completely. Rumen possess cellulose

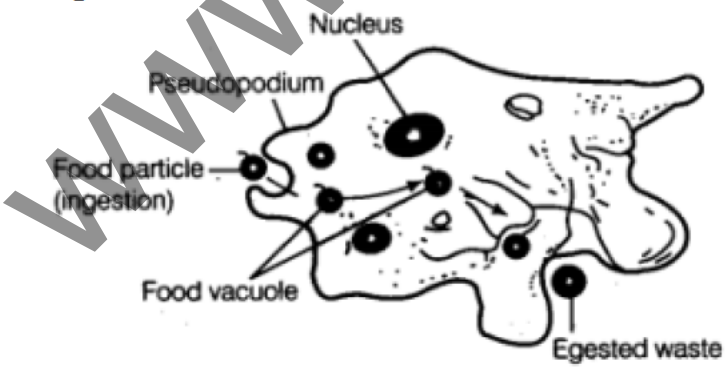
digesting bacteria which breakdown the food by fermentation. This partially digested food or grass present in the rumen of cow is called cud.

This cud is brought back into the mouth of the cow from the rumen into small lumps and animal chews it again. This process is called rumination and animals are called ruminants.

When this cud is thoroughly chewed in the mouth of the cow, it is swallowed again. This time the chewed cud does not go back to rumen but enter into the other compartments of cow's stomach and then into the small intestine for complete digestion and absorption of food. The cellulose digesting bacteria are not present in the body of human being, therefore human beings and other carnivore cannot digest cellulose present in plant food items.

Feeding and Digestion in Amoeba

Amoeba is a microscopic single-celled organism, which is found in pond water. It is a very simple animal and cannot be seen by naked eyes. Amoeba has a cell membrane, a rounded dense nucleus and many small bubble-like vacuoles in its cytoplasm. These vacuoles are of two types, i.e. food vacuole and contractile vacuole. Food vacuole contains food surrounded by water while contractile vacuole contains liquid or water and controls water regulation activity in Amoeba. Its shape is not fixed, i.e. it constantly changes its shape and position. The body of Amoeba has finger-like projections, called pseudopodia or false feet. It captures food and helps in locomotion of Amoeba.



Amoeba

The food of Amoeba are microscopic organisms like tiny plants and

animals present in pond water. When Amoeba senses its food, it pushes out pseudopodia around the food particle and engulfs it. The two pseudopodia join around the food particle and trap the food particle with a little water forming vacuole around food, thus the food gets trapped. Digestive juices present inside the vacuole, acts on the food and break it into simpler substances. This digested food is then absorbed and is used for growth, maintenance and multiplication of Amoeba. The undigested food residue is expelled outside by the vacuole. The basic process of digestion of food and release of energy is as similar to the other organisms.

Chapter 3

Fibre to Fabric

Fibres are very thin, thread-like strands from which fabrics (or cloths) are made. Some examples of fibres are cotton, wool, silk, flax, jute, nylon, polyester and polyacrylic. The fibres are spun into yarn (long continuous thread) which can then be woven on a loom to make a fabric (or cloth). Yam is a kind of long, twisted thread. Yarn is made from fibres by the process of spinning.

There are two types of fibres, i.e. natural fibre and man-made fibre (nylon, rayon). Some of our clothes are made from yarn derived from the animal fibre. These are the types of natural fibres as they are obtained from nature. Natural fibres are the fibres which are obtained from natural sources like plants and animals.

In Class VI, we have learnt about some fibres obtained from plants. In this chapter, we will study about some fibres obtained from animals. Wool and silk fibres are obtained from animals. Wool is obtained from the fleece (hair) of sheep or yak and silk fibres come from cocoons of the silk moth.

Wool

The wool comes from animals like sheep, goat, yak, camel, llama and alpaca. The wool yielding animals bear a thick coat of hair on their body. The hair which gives us wool and keeps them warm during the cold winter season. The hair (wool) on the body of wool-yielding animals trap a lot of air. Air spaces between the wool fibres trap air. Since the air is a poor conductor of heat. So, the air trapped in hair shields the body from cold and keeps them warm in winter.

The hair close to our skin, i.e. hair on our body and arms are soft and the hair on our head is coarse hair. Like us, the hairy skin of sheep has two types of fibres that form its fleece (or wool), i.e.

- the coarse beard hair and
- the fine soft under-hair close to the skin.

The fine soft under-hair provide the fibre for making wool. To obtain breeds of sheep that possess only fine under hair, their parents are carefully chosen. This process of selecting parents for obtaining special characters in their offspring such as soft under hair in sheep is termed as selective breeding. Such sheep give not only better quality of wool but the yield per sheep is also higher.

Animals that Yield Wool

Wool commonly available in the market is sheep wool. Several breeds of sheep are found in different parts of our country. However, the fleece of sheep is not the only source of wool, there are other sources of wool also. Other sources of wool are

- Yak wool is common in Tibet and Ladakh.
- Angora wool is obtained from angora goats in hilly regions such as Jammu and Kashmir.
- The underfur of Kashmiri goat is soft and it is woven into fine shawls called pashmina shawls.
- The fur (hair) on the body of camels is used as wool.
- Llama and Alpaca found in South America are also yielding wool.

Some Indian breeds of sheep which provide wool

Name of a breed of sheep	Quality of wool	Name of the state where found
Lohi	Good quality wool	Rajasthan, Punjab

Rampur bushier	Brown fleece	Uttar Pradesh, Himachal Pradesh
Nali	Carpet wool	Rajasthan, Haryana, Punjab
Bakharwal	For woollen shawls	Jammu and Kashmir
Marwari	Coarse Wool	Gujarat
Patanwadi	For hosiery	Gujarat

From Fibres to Wool

The wool comes mainly from sheep. For obtaining wool, sheep are reared and bred, their hair is cut and processed into wool. We will first discuss the rearing and breeding of sheep.

Rearing and Breeding of Sheep

Rearing of sheep means to look after the sheep by providing them feed (food), shelter and health care. The persons who look after the sheep (or rearers) are called shepherds. Sheep are herbivores and prefer to eat grass and leaves. So, shepherds take their herds of sheep to the countryside for

grazing. Apart from grazing, sheep rearers also feed them a mixture of pulses, corn, jowar, oil cakes (material left after taking out oil from seeds) and minerals. In winter, sheep are kept indoors and fed on leaves, grain and dry fodder.

So, the breeding of sheep is done to obtain such breeds of sheep which yield good quality of wool in large quantities. These breeds of sheep have a thick coat of hair on their body and are called sheep of good breeds. This raises the quality and quantity of wool produced.

Once, the reared sheep have developed a thick coat of hair, the hair is shaved off for getting wool. The cut off 'wool coat' of a sheep (along with a thin layer of skin) is called fleece. The fleece consists of soft woollen fibres. The fleece of sheep is usually kept in one piece.

Processing of Fibres into Wool

The wool which is used for knitting sweaters or for weaving shawls is the finished product of a long process. Processing of fibres into wool involves the following steps:

Step I: The fleece of the sheep along with thin layer of skin is removed from the body. This process is called shearing. The hair of the sheep are shaved off by using a saving machine similar to that used by barbers. Shearing does not hurt the sheep because the uppermost layer of the skin of sheep is 'dead'. The shearing (cutting the hair) of sheep is done in hot weather of summer so that sheep may survive without their protective coat of hair. The hair of sheep grow again before the onset of winter and protect them in cold weather. The fleece (or hair) of sheep provides woollen fibres. Woollen fibres are then processed to obtained woollen yarn.

Step II: The fleece of sheep (or cut the hair of sheep) contains dust, dirt, dried sweat and grease, etc. So, the sheared hair of sheep is thoroughly cleaned by washing with soap (or detergent) and a lot of water in tanks. This process of washing of sheared hair is called scouring. Scouring makes the fleece of sheep clean. The scoured fleece is then dried. Now-a-days scouring is done by machines.

Step III: After scouring, sorting is done. The process of separating the fleece of a sheep into sections according to the quality of woollen fibres (such as fine, coarse, long, short, etc) is called sorting. In sorting, the hairy skin is sent to a factory where hair of different textures is separated or sorted. Every section of wool obtained after sorting contains the same quality wool. The same quality wool obtained is then mixed together.

Step IV: The small fluffy fibres, called burrs, are picked out from the hair (burrs are soft, fluffy fibres in wool).
(After this, the fibres are scoured again and dried. The wool obtained after this is ready to be drawn into fibres).

Step V: The natural fleece or hair of sheep (or goat) is white, brown or black in colour. The white woollen fibre obtained by sorting can be dyed in different colours.

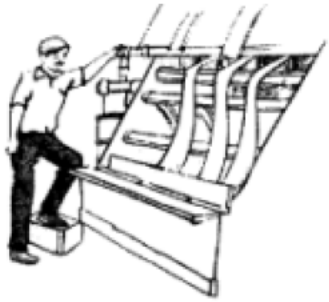
Step VI: The fibres are straightened, combed and rolled into yarn. The long woollen fibres are spun (or twisted) into thick yarn called wool which is used for knitting sweaters, etc.
The short woollen fibres are spun into fine yarn and then woven on a loom to make woollen clothes (like shawls, etc).

Finally, we conclude that the sheep's hair is sheared off from the body, scoured, sorted, dyed, combed and spun to obtain wool (for knitting sweaters) and woollen yarn (for weaving cloth). The quality of woollen

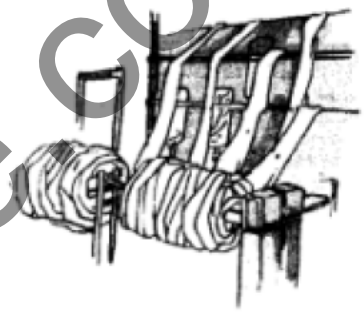
cloth depends on the breed of sheep from which wool is obtained.

(a) Shearing a sheep (cutting the hair of sheep along with a thin layer of skin in one piece)

(b) Scouring in tanks



(c) Scouring by machines



(d) Rolling into yarn

Processing fibres into wool

Occupational Hazard

The wool industry is an important source of livelihood for many people in our country. The people who do the job of sorting (separating) the fleece of sheep into fibres of different qualities are called sorters. The sorter's job is very risky because sometimes, they get infected by the bacteria called anthrax which cause a deadly blood disease called sorter's disease. The risks faced by people working in any industry due to the nature of their work are called occupational hazard. Sorter's disease is an occupational disease.

Silk

Silk is a natural fibre which is obtained from an insect (called silk moth). So, silk fibres are also animal fibres. Silkworms spin the silk fibres. The silk fibre is made up of a protein. Silk is the strongest natural fibre.

Sericulture

Sericulture means 'silk farming'. The rearing of silkworms for obtaining silk is called sericulture. Sericulture is a very old occupation in India. India produces a lot of silk on a commercial scale. Before we discuss the process of obtaining silk, it is necessary to know the interesting life history of the silk moth.

Life History of Silk Moth Formation of Silkworm

The female silk moth lays eggs on mulberry leaves. The eggs are hatched into very small larvae within a week. The larvae of silk moth are called caterpillar or silkworm. The silkworms feed on the leaves of mulberry tree and grow bigger in size.

Development of Cocoon

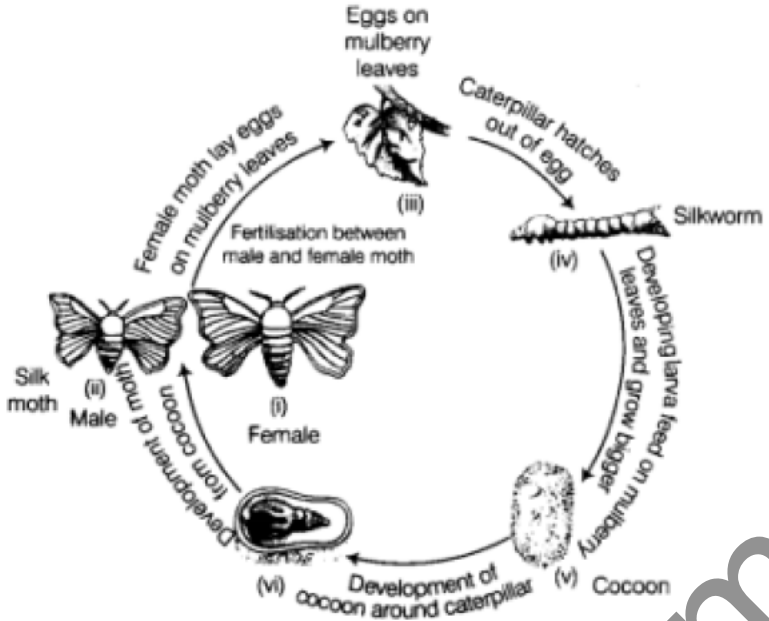
When the silkworm (or caterpillar) is ready to enter the next stage of its development called pupa, it first weaves a net to hold itself. Then, it swings its head from side to side. During these movement of head, the silkworm secrets fibre made of protein which hardens on exposure to air and becomes silk fibre (or silk thread). Soon the silkworm (or caterpillar) covers itself by silk fibres and turns into pupa. This covering is known as cocoon. The silkworm continues to develop in the form of pupa inside the cocoon to form the silk moth.

Production of Silk

In order to produce silk, the silkworm developing inside the cocoon (as pupa) is not allowed to mature into an adult silk moth. So, as soon as the cocoon is formed, it is used to obtain silk fibres and the developing silkworm (as pupa) gets killed. Some of the silkworms (as pupae) are however, allowed to live and mature into silk moths so that they can lay eggs to produce more silkworms.

There is a variety of silk moths which look very different from one another and the silk yarn they yield is different in texture (coarse, smooth, shiny, etc). Thus, tassar silk, kosa silk, mooga silk, etc are obtained from cocoons spun by different types of moths. The most common silk moth is the mulberry silk moth. The silk obtained from the cocoons of mulberry silk

moth is called mulberry silk. Mulberry silk is soft, lustrous (shiny) and elastic and can be dyed in beautiful colours.



Life cycle of silk moth

Pure and Artificial Silk

Pure silk is obtained from the cocoons of silkworm and it is made up of protein. Artificial silk is obtained from wood pulp and it is made of modified plant material 'cellulose'. Just like silk, wool is also made up of proteins. So, a piece of woollen fabric also burns giving the smell of burning hair. The thread which burns giving a smell of burning paper will be cotton fibres. Cotton and paper both are carbohydrates. Paper is made of cellulose obtained from wood pulp. So, on burning cotton and paper both give similar smell.

From Cocoon to Silk

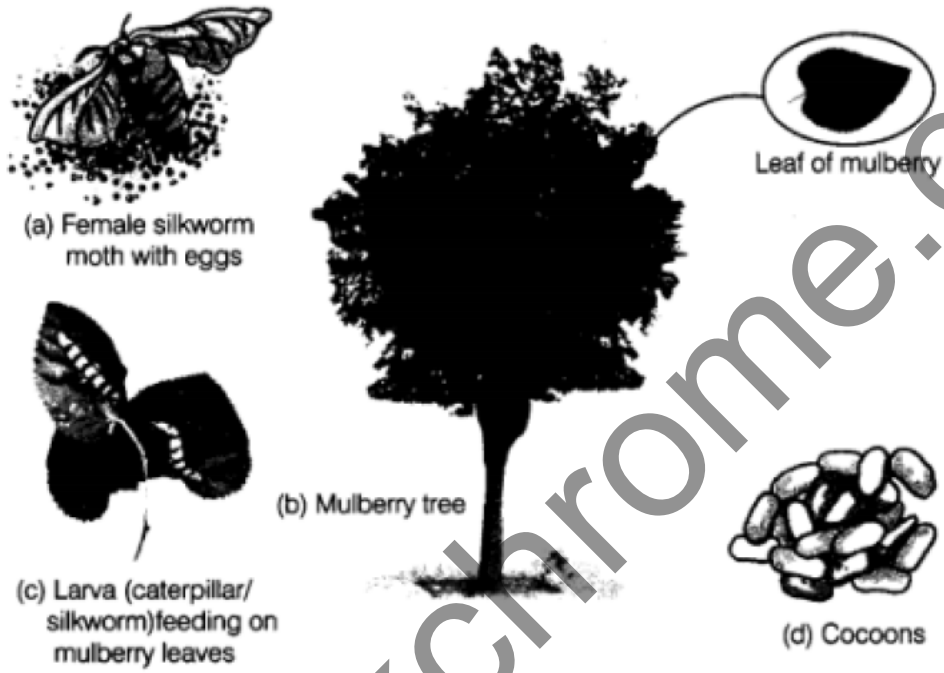
For obtaining silk, silk moths are reared and their cocoons are collected to get silk thread.

Rearing Silkworms

A female silk moth lays hundred of eggs at a time. The eggs are stored carefully on strips of paper or cloth and sold to silkworm farmers. The

farmers keep eggs under hygienic condition. They warm them to a suitable temperature for the larvae to hatch from egg.

The larvae are kept in clean bamboo trays along with young and freshly chopped mulberry leaves. After 25-30 days, the silkworms stop eating and start spinning the cocoons. Small racks or twigs may be provided in the trays to which cocoons get attached.



Rearing silkworms

Processing Silk

The cocoons are collected and boiled in water to kill the insect inside them. The resulting fibre is known as raw silk. The silk fibres separate out.

Reeling the Silk

The process of taking out fibres from the cocoon for use as silk is known as reeling the silk. Reeling is done in special machines. Silk fibres are spun into silk threads which are woven into silk cloth by weavers.

Discovery of Silk

The discovery of silk was made in China a long time bach. According to an old Chinese legend, the empress Si-tung-Chi was ashed by the emperor

Huang-ti to find the cause of the damaged leaves of mulberry trees growing in their garden. The empress found white worms eating up mulberry leaves. She also noticed that they were spinning shiny cocoons around them. Accidentally, a cocoon dropped into her cup of tea and a tangle of delicate threads separated from the cocoon. Silk industry began in China and was kept a closely guarded secret for hundreds of years. Later on, traders and travellers introduced silk to other countries. The route they travelled is still called the 'silk route'.

Even today, China leads the world in silk production. India is also among the leading silk producing countries of the world. In India, a large number of women are engaged in various activities related to the silk product such as the rearing of silkworms, reeling of silk from cocoons and processing of raw silk into fabrics.

Chapter 4

Heat

Heat is a form of energy which makes the substance hot. In winter, it is our common experience that we feel cold inside the house and if we come out in front of sun rays, then we feel warm. Now, if we know that how do we feel this sensation of warm or cold? Then, what will be our answer? Think. In this chapter, we will try to find out the answer to such kind of question.

Hot and Cold

In our daily routine, we come across a number of objects, out of which some are hot while other objects are cold, e.g. when a frying pan kept on a burning gas stove becomes hot but the handle of the pan is cold. Even among the hot objects, some objects may be hotter than the other. In the same manner, among the cold objects, some objects may be colder than the other. So, if I ask you how you decide the relative hotness or coldness of objects, then your answer will be 'by simply touching the objects'. But our sense of touch is not enough in telling us whether an object is really hot or cold so, this can be understood by performing a simple activity.

Temperature and Thermometer

The degree of hotness or coldness of the object is known as the temperature of an object. The temperature of an object is an only property that indicates which object is hot and which one is cold. A high temperature of a body indicates that it is very hot whereas a low temperature of the object indicates that it is quite cold, e.g. the temperature of boiling water is quite high, so boiling water appears to be very hot. On the other side, the temperature of melting ice is quite low. So, ice appears to be very cold on touch.

It is measured by using an instrument called thermometer, which has a scale marked on it which is used to read the temperature, e.g. the scale in laboratory thermometer is marked along the length of thermometer's tube

between 0° mark and 100° mark into 100 equal divisions. So, each division is called a degree. The temperature of an object should always be stated with its unit. So, the most common unit for measuring temperature is degree Celsius (°C).

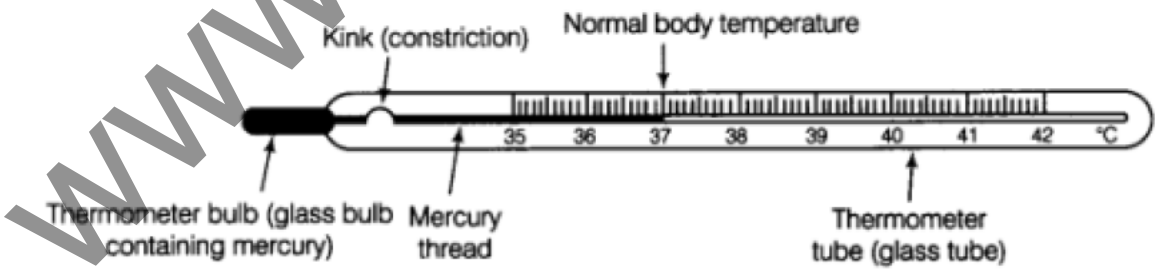
Both the clinical thermometer and laboratory thermometer are mercury thermometers. So, when a particular amount of heat is supplied to the thermometer bulb consisting of mercury (by the hot body whose temperature is to be measured), then the mercury expands and get rises in the glass tube of the thermometer. This fact is used in measuring the temperature.

Clinical Thermometer

It is the thermometer which is used for measuring the temperature of the human body. In case of fever, it is used by a doctor (or at home) to measure the temperature of the patient. This thermometer consists of a long glass tube having a thin and uniform bore. There is a glass bulb at one end of the glass tube which consists of mercury as shown in the figure given below:

Features of a Clinical Thermometer

There is a very short range of temperature of a clinical thermometer, i.e. from 35°C to 42°C. The short range of a clinical thermometer is because of the fact that the temperature of human body normally does not go below 35°C or above 42°C.



A clinical thermometer

Just above the bulb containing mercury, a clinical thermometer has a kink in its glass tube which is to prevent the back flow of mercury into the thermometer bulb when the thermometer bulb is removed from the mouth of a patient. This kink prevents the mercury level in the thermometer tube

from falling on its own. Due to this, we can read the correct body temperature of the patient even after removing the thermometer bulb from his mouth.

Note: After noting the body temperature, the level of mercury can be brought down by giving jerk to the thermometer tube.
As mercury is very toxic and is difficult to dispose off, so thermometer must be handled carefully. Clinical thermometer should not be used to measure the temperature of objects other than the human body. It should not be kept in the sun or near a flame, otherwise, it may break. Nowadays, digital thermometers are used which do not use mercury.

Reading a Clinical Thermometer
There are following steps to read the temperature on a thermometer.
Step I: Firstly, wash the thermometer with an antiseptic solution and if in case, the antiseptic solution is not available, then wash it with clean water.
Step II: Gently, hold the thermometer tube in your hand and give it a jerk in such a way that the mercury thread in the thermometer tube falls below the reading of 35°C.
Step III: Now, put the bulb of the thermometer under the tongue of the patient for about one minute. Then take out the thermometer from the patient's mouth.
Step IV: In order to read the temperature, hold the thermometer horizontally in your hand and rotate it slowly. When we see a magnified image of the mercury thread in its tube, then a position will come. Now, read the temperature on thermometer tube in level with the top of the mercury thread.

Precautions while Reading the Thermometer
A clinical thermometer should not be used for any object other than the human body. There are some following precautions which are to be observed while reading a clinical thermometer.

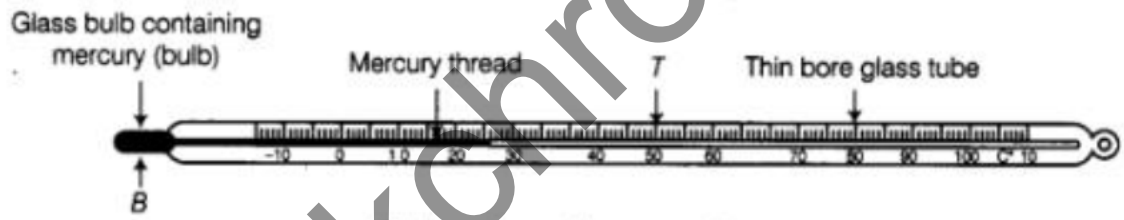
- Wash the clinical thermometer before and after using preferably with an antiseptic solution.

- Be ensure that the mercury level before using the clinical thermometer should be below 35°C.
- The clinical thermometer should be read by keeping the level of mercury along the line of sight.
- While reading the clinical thermometer, it should never be held by the bulb.
- The clinical thermometer should be carefully handled.

Laboratory Thermometer

A device which is used for measuring the temperature in a science laboratory is called a laboratory thermometer.

This thermometer is made up of a long glass tube having a thin bore. The graduation marked on the tube of a laboratory thermometer can measure the temperature from -10°C to 110°C, this is known as the range of a laboratory thermometer. Also, determine how much a small division on this thermometer reads (this is also known as least count of the thermometer), it is due to the fact that this information is required to read the thermometer correctly.



A laboratory thermometer

Maximum-Minimum Thermometers

These are the special thermometers which automatically record the maximum and minimum temperature of the day. The maximum S and minimum temperature of the last day reported in weather reports in TV and newspapers are measured by the maximum-minimum thermometers.

Reading a Laboratory Thermometer

There are following steps to read the temperature on a thermometer.

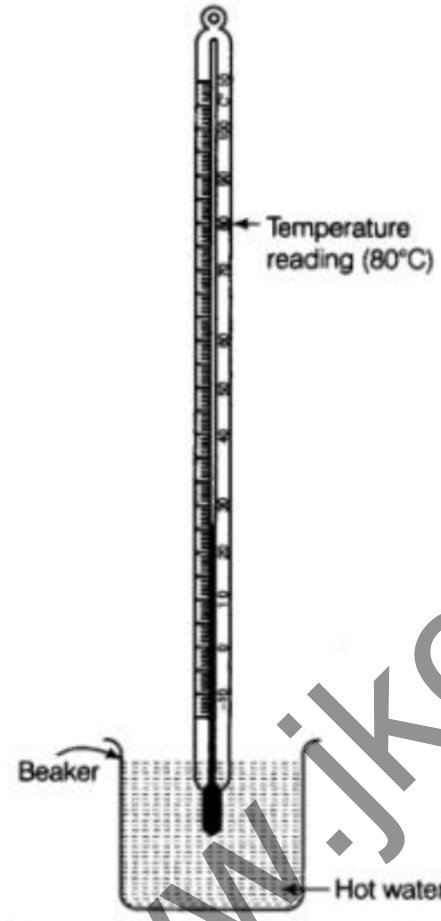
Step I: First of all, take some hot water in a beaker.

Step II: Now, try to hold the laboratory thermometer from its glass tube and immerse the bulb of the thermometer in hot water taken in the beaker. Notice that the bulb of the thermometer should not touch the sides or the

bottom of the beaker as shown in the figure.

Step III: Here, we will observe the shining thread of mercury moving up in the thermometer tube. After some time, the mercury will stop rising and stand at one place.

Now, read the temperature on the thermometer tube which corresponds to the top of the mercury thread. This will give us the temperature of hot water taken in the beaker.



Measuring temperature of hot water with a laboratory thermometer

Note: To measure the human body temperature a laboratory thermometer cannot be used because as soon as we tahe out the bulb of the laboratory thermometer from the mouth of a patient, the mercury level wilt starts falling quickly (due to cooling of its bulb by air). So, this will provide a wrong value of the body temperature.

Precautions in Using a Laboratory Thermometer

- While -measuring temperature, the laboratory thermometer should be held vertically.
- The thermometer bulb should be surrounded from all sides by the substance whose temperature is to be measured.
- The thermometer reading should be taken while its bulb is still in touch with the substance whose temperature is being measured and by keeping the mercury level along the line of sight.
- The thermometer should not be held by the bulb.
- The thermometer should be carefully handled.
- We should note down the temperature reading by keeping the thermometer bulb immersed in hot water because if the thermometer bulb is taken out of hot water, then its mercury thread will start falling and this will give a wrong reading for the temperature of hot water.

Digital Thermometer

There are most of the common thermometers like mercury thermometers which use a liquid metal called mercury for their working. Mercury is a toxic substance (a poisonous substance) and thus it is very difficult to dispose of safely, if a thermometer breaks. So, there is a lot of concern over the use of mercury in thermometers. Also, during these days, digital thermometers are available which do not use mercury.

Transfer of Heat

Heat flows from a hot object to a cold object or heat flows from an object at the higher temperature to another object which is at a lower temperature. This flow of heat is known as the transfer of heat, e.g. if you dip a steel spoon into a cup of hot tea, then we will find that the temperature of spoon rises and it becomes hot. In this case, some of the heat contained in hot tea has been t ansferred to spoon which is placed inside it.

When the two objects attain the same temperature, then the flow of heat stops. This means that no heat will be transferred from one object to another if the temperature of the two objects is the same.

There are three ways through which heat can be transferred from a hot object to a cold object.

- By conduction (in solid, heat is transferred by conduction)
- By convention (in liquid and gases, heat is transferred by convection)
- By radiation (in free space or vacuum, heat is transferred by radiation)

Let us discuss all the three ways of heat transfer.

1. Conduction

The mode of transfer of heat from hotter part of a material to its colder part or from a hot material to a cold material in contact with it, without the movement of material as a whole, is known as conduction. In all the solids, heat is transferred by the process of conduction.

Conductor and Insulator of Heat

Materials which allow heat to be conducted through them easily are conductors of heat. Those metals such as iron, copper, silver, aluminium, etc., are good conductors of heat.

Bad conductors of heat are those materials which do not allow heat to be conducted through them easily. These materials are also known as insulators of heat. Wood, plastic and glass are insulators of heat.

Uses of Good and Bad Conductors of Heat

During the winter season, we generally wear woollen clothes. If we compare them with cotton clothes, then we will find that the wool fibres have much more space between them. These get filled with air which is a bad conductor of heat. Hence, being an insulator, both wool and air together prevent the heat from our bodies from escaping out.

Also, jute and sawdust are bad conductors of heat. We cover the ice with a jute cloth of sawdust to prevent it from gaining heat from the surroundings and melting.

The double walls of the refrigerators having space inside which is filled with an insulating material, prevent the heat of the surroundings from reaching the inside of the refrigerator.

The two thinner blankets (one on top of the other) during the winter season are very much effective because the air layer trapped between the thinner blankets creates insulation and provides the protection from cold.

Sometimes, there are two things which are at the same temperature. It seems like they are at different temperatures, one being cold and the other being warm. This happens because some things are a good conductor of heat while others are poor conductors of heat.

e.g. during winter season, a metal object kept in a room feels very cold to touch but a wooden object in the same room feels warmer to touch. Metal object is a good conductor of heat. So, when we touch the metal object, it conducts away heat from our hand quickly. And by losing heat, our hand feels cold. On the other side, the wooden object (being a poor conductor of heat) does not allow the heat of our hand to escape and hence feels warmer to touch.
The water (or most liquids) and air (or gases) are bad conductors of heat.

2. Convection
The mode of transfer of heat from the hotter part of a fluid (liquid or gas) to its colder parts by the movement of the liquid (or gas) itself is known as convection. The transfer of heat by convection can take place only in liquids and gases. It is due to the reason that the particles in liquids and gases can move about freely.

So, the transfer of heat by convection cannot take place in solids because the particles in the solids are fixed at a place and cannot move about freely. It is also not occurred in empty space or vacuum because there are no particles of any kind in empty space which can move and transfer heat.

Convection in Water

Water is a poor conductor of heat. So, due to this reason, it cannot transfer heat by conduction but it transfers heat by the process of convection.

Convection in Air

Air is a very poor conductor of heat, Air transfers heat from its hotter parts to the colder parts by the process of convection.

Sea and Land Breezes

The blowing of sea breeze and land breeze in coastal areas is generally occurred due to the convection of heat in air.

In coastal areas during the day time, the breeze generally flows from the sea towards the land and during the night time, blows from the land towards the sea. Sea and land breezes are actually convection of heat.

During the day, the land heats up more than water. Due to this, the air over the land becomes hotter and lighter and rises up. So, the air from the sea which is cooler and heavier rushes to take the place created by hot rising air. Therefore, a sea breeze blows during the day.

During the night, the land loses heat faster than water and becomes cooler and the air over the sea is now warmer due to which, it rises up and the cooler air over the land rushes to take its place. Therefore, we observe a land breeze at night.

3. Radiation

The mode of transfer of heat through which heat energy from a hot body to a cold body by means of heat rays without any material medium between them is known as radiation, e.g. the sun's heat reaches the earth by the process of radiation. The sun is very far away from the earth, and there is mainly an empty space (vacuum) between the sun and the earth even, then the heat from the sun reaches the earth. This is due to the fact that the sun

being extremely hot, emits invisible heat radiation (or infrared rays) in all directions.

These radiations travel through the vacuum between the sun and the earth at a very high speed and ultimately, reach us on the earth. Therefore, we can say that the transfer of heat from a hot object to a cold object by the process of radiation does not require any medium.

In our daily life activities, we have many situations where heat is transferred by radiation through air, e.g.

- Depending on the temperature of surroundings, our body too gives heat to the surroundings or receives heat from the surroundings by radiation.
- If a hot utensil filled with hot milk is kept away from the flame, then it cools down by transferring its heat to the surroundings by radiation.
- If we stand next to a burning fire, then we will feel the heat of the fire falling on our face. The heat is transferred from the fire to our face by the process of radiation.

Clothes

During hot summer days people prefer to wear white clothes or light coloured clothes because light coloured clothes absorb less heat from the sun and hence keep us cool and comfortable in hot weather while in the cold winter days people prefer to wear dark clothes because the dark coloured clothes absorb more heat rays from the sun and keep us warm in winter season.

Thus, we can say that dark coloured objects absorb heat better and also emit heat better than light coloured objects. Now, let us try to study this concept on the basis of the given activity.

In the winters, we use woollen clothes. Wool is a poor conductor of heat. Moreover, there is air trapped in between the wool fibres. This air prevents the flow of heat from our body to the cold surroundings. So, we feel warm.

Chapter 5

Acids, Bases and Salts

In our daily life, we use a large number of edible substances such as lemon, baking soda, tamarind, common salt, sugar, curd and vinegar. Some of these substances taste sour, some taste bitter, some taste sweet and some taste salty.

Acids, bases and salts are the three important groups of chemical substances that are used by us in different ways. Some of the acids, bases and salts occur in nature and they can be made artificially in factories also.

Edible substances and their tastes

Substance	Taste (Sour/Bitter/Any other)
Lemon Juice	Sour
Orange Juice	Sour
Vinegar	Sour
Curd	Sour

Tamarind(imli)	Sour
Sugar	Sweet
Common Salt	Salty
Amla	Sour
Baking Soda	Bitter
Grapes	Sweet/Sour

Acids and Bases

The word acid has been derived from a Latin word 'acidus' which means 'sour'. Thus, all sour substances essentially contain acids. Substances like lemon juice, orange juice, unripe mango and curd taste sour. They taste sour because they contain substances called acids in them. The chemical nature of such substances is acidic. The acids in these substances are natural acids.

However, there are other substances like baking soda it does not taste sour.

It means that it has no acids in it. It is bitter in taste. And if prepare a solution of baking soda in water and rub it between your fingers, it feels soapy. Substance like these which are bitter in taste and feel soapy on

touch are known as bases. The chemical nature of such substances is said to be basic. All the acids mentioned in table occur in nature.

Acids and their Sources

Name of Acid	Found in
Acetic Acid	Vinegar
Formic Acid	Ant's Sting
Citric Acid	Citrus fruits such as oranges, lemons, etc..
Lactic Acid	Curd
Oxalic Acid	Spinach
Ascorbic Acid(Vitamin C)	Amla, Citrus fruits
Tartaric Acid	Tamarind, grapes, unripe mangoes, etc..

Bases and their Sources

Name of Base	Found in
Calcium Hydroxide	Lime Water
Ammonium Hydroxide	Window Cleaner
Sodium Hydroxide/Potassium Hydroxide	Soap
Magnesium Hydroxide	Milk of Magnesia

Natural Indicators Around Us

It is not safe to taste every substance to find out if it is acidic or basic. There are some special substances that have different colours in acidic and basic mediums. These substances are known as indicators. The indicators change their colour when added to a solution containing an acidic or a basic substance.

Some naturally occurring indicators are litmus, turmeric, China rose petals (gudhal) and red cabbage juice. These indicators show different colours in acidic and basic media. They are used to test whether a substance is acidic or basic in nature.

Litmus- A Natural Dye

A naturally occurring indicator, i.e. litmus is obtained from certain lichens (small plants) and used as a dilute solution. Litmus has mauve (purple) colour in water. In an acidic solution, it turns red. When it is added to a

basic solution, it turns blue. Usually, it is available as a red and blue litmus paper.

Turmeric is Another Natural Indicator

Turmeric is a bright yellow powder obtained from a plant. It is is called 'Haldi' in Hindi. Turmeric contains a yellow dye. Turmeric turns red in basic solution. It is used as indicator in the form of turmeric paper.

China Rose as an Indicator

China rose is a natural indicator. It is called 'Gudhal' in Hindi. It is a extracted from the red flowers of China rose plant with water.

Acid Rain

The rain containing excess of acids called an acid rain. The rain becomes acidic because carbon dioxide, sulphur dioxide and nitrogen dioxide dissolve in rain drops to form carbonic acid, sulphuric acid and nitric acid respectively. It can cause damage to buildings, historical monuments, plants and animals.

This happens as follows:

- Acid rain makes the water of lakes, ponds and rivers too acidic due to which fish and other aquatic animals get killed.
- Acid rain eats up the leaves of the trees gradually. By losing leaves, the trees die. Acid rain also damages crop plants in the fields.
- Acid rain damages the metal structures like steel bridges, etc when it falls on them
- Acid rain damages the surfaces of buildings and monuments made up of marble.

Neutralisation

Acids and bases are chemically opposite substances. So, when an acid is mixed with a base, they neutralise (or cancel) the effect of each other. When an acid solution and a base solution are mixed in suitable amounts, both the acidic nature of the acid and the basic nature of the base are destroyed. The resulting solution is neither acidic nor basic. So, the reaction between an acid and base is known as neutralisation. In the

process of neutralisation, salt and water are produced with the evolution of heat.

Salt produced in the reaction may be acidic, basic or neutral in nature. The evolved heat raises the temperature of the reaction mixture.
Acid + Base → Salt + Water (Heat is evolved)
e.g. Hydrochloric acid (HCl) (Acid) + Sodium hydroxide (NaOH) (Base) → Sodium chloride (NaCl) (Salt) + Water (H_2O)

If dilute sulphuric acid is added to lime water (which is a base), then neutralisation reaction takes place and the reaction mixture becomes hot. We are going to use an indicator which you have not used so far. It is called phenolphthalein.

Note: Phenolphthalein is an indicator used in the neutralisation process. When the solution is basic, phenolphthalein gives a pink colour but if the solution is acidic, it remains colourless.

Neutralisations in Everyday Life
The neutralisation reactions involving acids and bases play a very important role in our everyday life. The treatment of an ant's sting, remedy for indigestion, soil treatment and the treatment of factory wastes, all involve neutralisation reaction.

Indigestion
Our stomach produces hydrochloric acid. This hydrochloric acid helps in digesting our food. Sometimes, excess of hydrochloric acid is produced in the stomach which causes indigestion. Due to indigestion, sometimes a person feels pain in the stomach and irritation. To relieve indigestion, we take an antacid such as milk of magnesia. Milk of magnesia contains a base called magnesium hydroxide. Magnesium hydroxide neutralises the excess acid present in the stomach and cures indigestion. Another antacid is baking soda which contains a base sodium hydrogen carbonate.

Ant Bite
When an ant bites, it injects an acidic liquid into the skin of the person

which causes burning pain. The sting of an ant contains an acid called formic acid. The effect of the acid can be neutralised by rubbing a mild base like baking soda solution (sodium hydrogen carbonate) or calamine solution. Calamine solution contains a base called zinc carbonate. Thus, being a base, baking soda solution or calamine solution neutralises the acidic liquid injected by the ant and cancels its effect.

Soil Treatment

The soil may be acidic or basic naturally. The plants do not grow well, if the soil at a place is too acidic or too basic. Excessive use of chemical fertilisers makes the soil acidic. When the soil is too acidic, it is treated with bases like quicklime (calcium oxide) or slaked lime (calcium hydroxide). These bases neutralise the excess acid present in the soil and reduce its acidic nature. If the soil is basic, organic matter called manure or compost is added to it. The organic matter releases acids which neutralise the excess bases present in the soil and reduce its basic nature.

Factory Wastes

The waste substances discharged by many factories contain acids. If these factory wastes are allowed to flow into the water bodies (like rivers, ponds, lakes, etc), then the acid present in them will kill fish and other organisms which live in the water bodies. The factory wastes are therefore neutralised by adding basic substances before discharging them into water bodies.

Chapter 6

Physical and Chemical Changes

Every day we come across many changes that are taking place all around us. These changes may involve one or more substances. Sometimes, milk becomes sour. Souring of milk is a change. Making a sugar solution is a change. Similarly, setting of curd from milk is a change.

Some changes that we have noticed around us are melting of ice, making of ice cream, melting of wax, stretching a rubber band, evaporation of water, cutting of paper, breaking of glass pane, bending of glass tube by heating, boiling of water, sublimation of camphor, etc.
Broadly, these changes are of two kinds:

- Physical changes
- Chemical changes

Physical Changes
In a physical change, a substance undergoes changes only in its physical properties such as shape, size, colour and state, and no new substance is formed. First, we shall perform some activities to show the physical changes that are taking place all around us are:

Characteristics of Physical Changes
The physical changes are temporary changes which can be easily reversed to form the original substance. In such a change, no new substance is formed.
Thus, we noticed that the important characteristics of physical changes are as follows:

- No new substance is formed in this change.
- It is a temporary change and is generally reversible.
- A temporary change in colour may take place.

- Very little energy (heat, etc) is either absorbed or evolved.

Chemical Changes

Chemical changes are also called chemical reactions. A chemical change occurs when two substances react chemically to form a new substance with different chemical properties. All the new substances which we use in various fields of our life are produced as a result of chemical changes (or chemical reactions).

A change with which we are quite familiar is the rusting of iron. Almost every iron (or steel) object kept in the open gets rusted slowly. It acquires a coating of a brownish substance called rust and the process is called rusting. We can usually see iron gates of parks or farmlands, iron benches kept in lawns and gardens, almost every article of iron, kept in the open gets rusted. The agricultural tools such as spades and shovels, also get rusted when exposed to the atmosphere for some time. In the kitchen, a wet iron pan (tawa) often gets rusted if left in that state for some time. Rust is not iron. It is different from iron on which it gets deposited.

Now, we shall perform some activities to show the chemical changes where new substances are formed.

When baking soda ($NaHCO_3$) reacts with vinegar which contains acetic acid carbon dioxide comes out, which turns lime water milky, therefore it is a chemical change. In all these activities, we saw that in each change, one or more new substances are formed. When the magnesium ribbon was burnt, the ash was the new substance formed.

The reaction of copper sulphate with iron produced two new substances, i.e. iron sulphate and copper. Vinegar and baking soda together produced carbon dioxide which turned lime water milky. So, all those changes in which one or more new substances formed, are called chemical changes. These are permanent changes which can usually not be reversed to form the original substance.

In addition to new products, the following may accompany a chemical change:

- Heat, light or any other radiation (e.g. ultraviolet) may be given off or absorbed.
- The sound may be produced.
- A change in smell may take place or a new smell may be given off.
- A colour change may take place.
- A gas may be formed.

Chemical Changes in Our Daily Life

Chemical changes are very important in our lives. Indeed, every new material is discovered by studying chemical changes, e g. If metal is to be extracted from an ore such as iron from iron ore, we need to carry out a series of chemical changes. Medicine is the end pr duct of a chain of chemical reactions. Important and useful new materials such as plastics and detergents are produced by chemical reactions.

Let us consider some more examples of chemical changes. We saw from the activity that burning of magnesium ribbon is a chemical change. Burning of coal, wood or leaves is also a chemical change. In fact, burning of any substance is a chemical change. Burning is always accompanied in the production of heat and light.

- An explosion of a firework (or crackers) is also a chemical change which produces heat, light, sound and unpleasant gases that pollute the atmosphere.
- When food gets spoiled, it produces a foul smell. This shows that new substances have been formed in the spoiled food which has a foul smell. So, the spoilage of food is a chemical change.
- If we cut an apple into slices and kept in the open for some time, we will find that the cut surface of apple acquires a brown colour. This change in colour is due to the formation of the new substance by the action of oxygen (or air). So, this change in colour is a chemical change.

- Similarly, the cut surface of potato or brinjal turns black on keeping in air for some time due to the chemical change.
- When an acid reacts with a base, then a neutralisation reaction takes place in which two new substances, salt and water, are formed. So, neutralisation is a chemical change.
- During photosynthesis, the plants intake carbon dioxide and water in the presence of chlorophyll and sunlight to form two new substances, glucose (food) and oxygen. So, photosynthesis is a chemical change.
- In the process of digestion, the various food materials break down to form new substances which can be absorbed by the body, so the process of digestion is a chemical change.

Rusting of Iron

When an iron object is left exposed to moist air, it chemically reacts with oxygen and water in the air to form a red-brown flaky substance called rust. The process of rusting can be represented by the following equation:
Iron (Fe) + Oxygen (O_2) (From air) + Water (H_2O) → Rust (Iron oxide, Fe_2O_3)

Rusting occurs in the presence of both oxygen and water. The more humid the air, the faster the rusting occurs. The rust slowly eats away or corrodes the iron, leading to considerable loss. Since iron is used in making bridges, ships, * cars, truck bodies and many other articles, the monetary loss due to the rusting is huge.

Preventions of Rusting

Rusting can be prevented by not allowing the iron to come in contact with moisture and air. The simplest method is to coat the iron with oil, grease or paint. These coats should be applied regularly to prevent rusting.

A more efficient method is to coat the iron with another metal such as zinc or chromium. The process of depositing a layer of zinc on iron is called galvanisation. The iron pipes we use in our homes to carry water are galvanised to prevent rusting.

Rusting of ships is a major problem in the shipping industry as the body of a ship is always in contact with water and the air around it is also very

humid. The salt in water speeds up the process of rusting. This leads to huge monetary loss to the shipping industry. Rusting of iron can be prevented by allowing it to make stainless steel. Stainless steel is made by mixing iron with carbon and metals like chromium, nickel and manganese. It does not rust.

Crystallisation

Seawater contains salts dissolved in it which makes it salty. We have learnt in Class VI that salt can be obtained from seawater by the process of evaporation. The salt obtained in this manner is not pure and its crystals are small. The shape of the crystals cannot be seen clearly. Large crystals of pure substances can, however, be obtained from their solutions by the process of crystallisation. It is an example of a physical change. The process of cooling a hot concentrated solution of a substance to obtain crystals is called crystallisation. The process of crystallisation is used to obtain crystals of a pure solid substance from the impure solid substance.

Impure copper sulphate powder can be purified by the process of crystallisation to obtain large crystals of pure copper sulphate.

Chapter 7

Weather, Climate and Adaptations of Animals to Climate

Weather influences our lives in different ways. During summer, we switch on fans to keep ourselves cool, we use light coloured clothes in order to reflect the heat. During winter, we use dark colour clothes and wrap ourselves in warm clothes to protect us from cold environment. Similarly, during the rainy season, we use umbrella or raincoat as it may rain anytime. The weather of a place changes day after day and week after week. It is a complex phenomenon that may vary over very short periods of time (like hour to hour).

Therefore, our daily activities are planned according to the weather predicted for a particular day. The daily report of weather is provided on television, radio and even in newspaper.

Weather

It may be defined as the day to day condition of the atmosphere at a place with respect to the temperature, humidity, rainfall, wind speed, etc.

Elements of Weather

The temperature, humidity, rainfall, wind speed and other factors are called the elements of the weather which are described below:

1. Temperature

The weather is mainly affected by the sun that produces heat and raise the temperature. The sun provides light as well as heat on the earth. It is necessary for the production of energy. The < heat from the sun is absorbed by the earth's surface, oceans and atmosphere which plays an important role in determining the weather of any place.

Therefore, it is clear that change in weather is caused due to the sun because the changes occurring in the sun's heat will change the atmosphere more frequently. The time of sunrise and sunset also changes throughout the year.

2. Rainfall

The amount of water droplets that fall back on the earth after condensation of water vapours is called rainfall. When the temperature is too low, these droplets in the cloud get freezed into crystals of ice and comes on the earth as snowfall. During winters, the temperature falls after sunset causing condensation of water vapours near the ground. These droplets hang in the air to form fog.

Note: Rainfall is generally measured in millimetre. The instrument that is used to measure the rainfall is called rain guage. It is a measuring cylinder with a funnel kept on its top which collects the rainwater. The rainwater collected in the measuring cylinder gives the measure of rainfall.

3. Humidity

It is defined as 'the amount of water vapour in air which causes dampness of air'. Air has the ability to hold certain . amount of water vapour. The capacity of air to hold water increases with rise in temperature and falls if heavy rainfall occurs. The humidity is measured by the instrument called hygrometer which consists of two thermometers.

The bulb of one thermometer is wet and the other is dry.

4. Wind Speed

It is caused due to the difference in air pressure. During summer, the wind blows from Indian ocean and Bay of Bengal and causes rain in India while during winter, it blows from the mountain of north India towards northern plain and causes cold weather (winter season).

Weather Prediction

The prediction of weather is done by scientists, called meteorologist, who study the changes in the weather. The weather is predicted by studying the patterns of weather and factors affecting them. The science which deals

with the study of weather is called meteorology. In India, the weather reports are prepared by the Meteorological Department of Government. This department collects the data of temperature, wind, etc., and predicts whether on television or radio or newspaper. The weather report is recorded everyday in the form of graph and published in a table form showing readings of different elements of weather.

Difference in Time of Sunrise and Sunset

There is the difference in the time of sunrise during summer and winter. In summer the sun rises earlier in the morning and the sun sets late in the evening during the month of June, while sun rises late and sets early in the month of December.

Therefore, days are longer and night shorter in summers while day is shorter and night is longer during winter.

Climate

'The average weather pattern taken over a long time, is called the climate of that place.' Different places in the world have different types of climate. The annual record of long term average temperature and rainfall at a particular place is called climate chart. It gives an idea about the climate at a particular place during a specific period of the year. The major factor which determines the climate of a place is called latitude (imaginary lines on earth).

Factors that Determine the Climate

The several factors that determine the climate at a place are

- Distance from the sea Climate of a place varies according to the closeness of the sea. The places that are near the sea, are moderate (not too hot nor too cold), e.g. Mumbai, Chennai. While the places that are away from the sea have extreme climate, having very hot summer or too cold winter, e.g. Delhi.
- Altitude or height above sea level Climate also varies according to the altitude. The higher altitudes are cooler, e.g. Himalaya.

- Humidity It also determines the climate of a place. Kolkata and Kerala have high humidity, while. Rajasthan and Haryana have low humidity.

Climates in India

The climate of India varies in different regions. These can be described as below:

- The northern region of Himalayas has cold and moderately wet climate (e.g. Kashmir).
- Plains has a moderately hot and wet climate (e.g. Uttar Pradesh).
- South has very hot and wet climate (e.g. Kerala).
- The western region has hot and dry climate (e.g. Rajasthan).
- North-Eastern India has wet climate (e.g. Assam) and receives rain for a major part of the year.

Climate and Adaptation

The ability of an organism to develop certain features which improve the chances of its survival in the environment in which they live, is known as adaptation. Animals are adapted to survive in the conditions in which they live. In other words, an adaptation is a trait of an organism that has been favoured by natural selection.

Adaptations are of three types:

(i) Structural adaptations Adaptation of special body parts of an organism that helps it to survive in its natural habitat, e.g. skin colour, shape, body covering.

(ii) Behavioural adaptations Adaptation of special ways in a particular organism that helps it to survive in its
natural habitat. It usually occurs in response to some external stimuli, e.g. frogs and bear undergoes hibernation or winter sleep during hard winter season.

(iii) Physiological adaptations Adaptation of body systems presents in an organism that allows it to perform the certain biochemical reaction, e.g. warm-blooded animals are able to keep the constant body temperature.

Animals that live in a very cold or hot climate must possess special features to protect themselves against extreme cold or heat. The features and habits that help an animal to adapt to their surrounding are a result of the process of evolution. According to their habitat animals adapt themselves. These animals may be grouped as polar region and tropical rainforest animals.

The Polar Regions

The polar regions as the name suggest are situated near the poles, i.e. north pole and south pole. The countries that belong to the polar regions are Canada, Greenland, Iceland, Norway, Sweden, Finland, Alaska in USA and Siberian region of Russia.

Polar regions show' extremely colder climate which is covered with snow and remain cold for most part of the year. In this region, the sun does not set for six months and even does not rise for other six months. The temperature goes down below -37°C, during winters in polar regions. The ground remains frozen most of the year and water becomes available only during the short summer when snow melts. Mosses and short lived flowering plants grow in these regions.

Animals living in these regions are adapted in different ways to cope with the conditions of temperature, light and moisture and also according to the availability of food in that region. Polar bears and penguins are the animals that live in polar region. Besides these whales, seals are the other animals are also found in polar regions. Some fishes, foxes, musk oxen, reindeer and birds also live in polar regions.

Adaptations in Polar Bear

Polar bear is a large and white bear that lives in the north polar region of the earth. The polar bear mainly feeds on fishes and seal and can survive in

the extremely cold climate of polar regions due to the following adaptations:

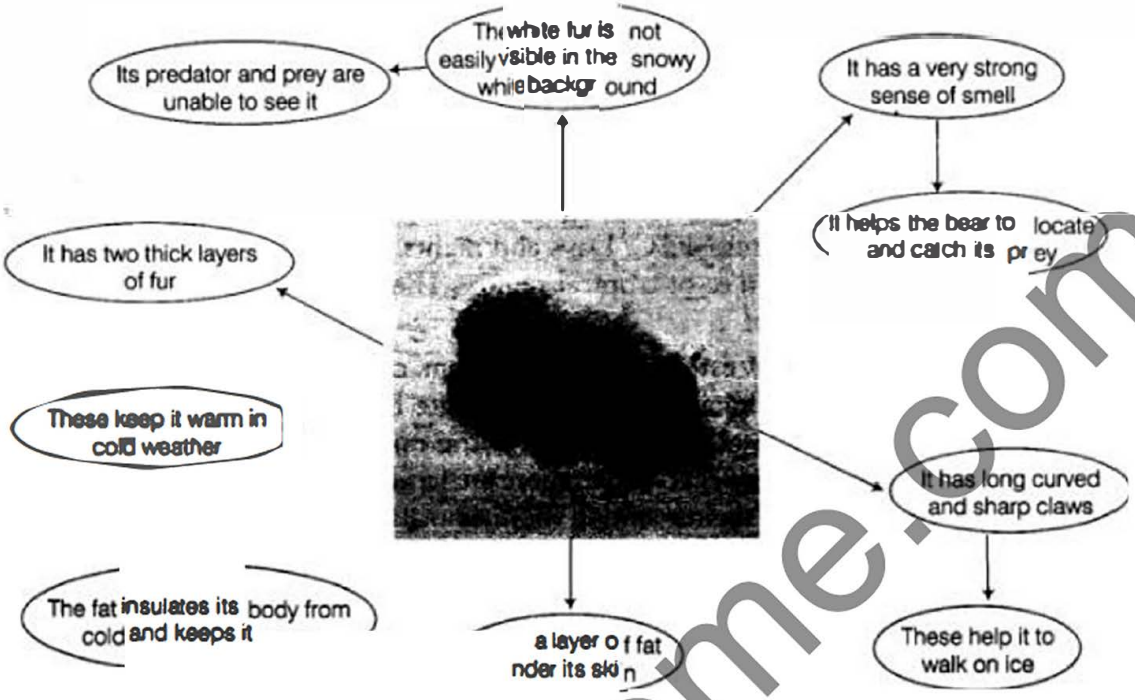
(i) Their body is covered by a thick coat of white fur. It helps them to blend with their surrounding snow white back ground and cannot be noticed by their predators. Beneath the fur is a thick coat of fat which insulates the body from cold and keeps the bear warm.

(ii) A polar bear is a good swimmer which has wide and large paws that help it to swim. These paws also help bear to walk on the snow easily.

(iii) They have a strong sense of smell so that they can locate their prey easily. They also possess small ears to keep the body surface area to the minimum and reduce the heat loss from the body.

(iv) The thick layer of fat beneath the skin also stores food in winter when food is scarce. This stored food (fat) also helps the mother polar bear to survive in the winter when they undergo hibernation beneath the snow

with their newborn cubs.



Adaptations of polar bear to survive in polar region

Adaptations in Penguins

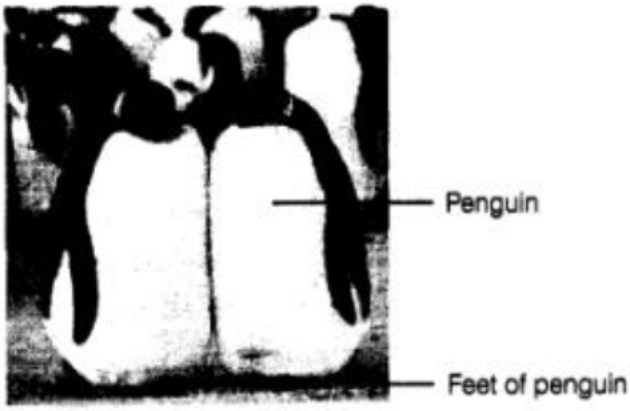
Another well-known animal living in the polar regions is the penguin which can survive due to the following adaptations:

(i) These are black and white in colour which merges well with the white background of ice and snow.

(ii) They have thick skin and a thick layer of fat below their skin which protects them from extreme cold.

(iii) They possess a streamlined body, flipper-like wings and webbed feet which make it a good swimmer. This adaptation helps penguin to catch fish as prey. They live together in large numbers and huddle together to

keep themselves warm.



Migration

Migration is the seasonal journey taken by different animals or birds to escape the extreme climatic condition and the search of food, e.g. Siberian cranes migrates towards warmer region in the autumn by travelling several thousands of kilometers. They are seen in the . Bharatpur, Rajasthan and Sultanpur, Haryana and sometimes in wetland of North-East and other parts of India. Migratory birds / sometimes travel as much as 15000 km to escape the extreme climatic condition of their habitat.

These birds fly high where the wind flow is helpful and cold conditions allow them to disperse the heat generated by their flight muscles. These birds have a built in sense of direction and know in which direction they have to travel. Some birds use landmarks to guide them. Some birds are guided by the sun during daytime and by stars during night. Some birds can use the magnetic field of the earth to fnd the direction. Besides birds some fishes, insects and mammals also migrate seasonally in search of more hospitable climates.

The Tropical Rainforest

The tropical region lies near both the sides of equator line on the earth. These regions are hot but get plenty of rainfall. Therefore, this region is humid. Even in coldest month, the temperature is generally higher than about 15°C. During hot summers, the temperature may cross 40°C. Days and nights are almosts equal in length throughout the year. Tropical

rainforest is the important feature of tropical region. These regions are rich in vegetation and large diversity in animals is also seen in this region.

In India, tropical rainforests are found in Western Ghats and Assam, other countries of the world like South, East Asia, Central America, Malaysia, Indonesia, Brazil, Republic of Congo, Kenya, Uganda, Nigeria and Central Africa also have tropical rainforest. The major type of animals living in the rainforest are monkeys, apes, gorillas, tigers, elephants, leopards, lizards, snakes, birds and insects. Since, there are large number of animals found in these regions. There is an intense competition for food and shelter among these animals. So, the animals are adapted in such a way that they eat different kinds of food and live in different kinds of places to overcome competition for food and shelter respectively. The adaptations in different animals living in tropical rainforests can be discussed as follows:

Adaptations in Red-eyed Frog

The red-eyed frog lives on trees in tropical rainforest. They have sticky pads on their feet that help them to climb trees. It does not live in water and has a green back and a creamy underside. It has big and bulging bright-red eyes and it is a nocturnal. It sleeps during the day and becomes active during night and feeds on the insects present on the tree. The bulging eye of frog protects it from its predator. The sudden opening of big and bright-red eyes frightens the predator for a while and in the meantime the frog gets time to jump to a safe place. The green colour of the frog helps it to hide within the green leaves of the tree and helps it to protect from predators.

Adaptations in Monkey

The monkeys living in tropical rainforests have long tails for grasping branches. Their hands and feet are adapted in such a way that they can easily hold the branches of trees. The eyesight of monkeys is very good which helps them in leaping between the branches to escape from their predators. Monkeys eat fruits, seeds, leaves, root and insects as their food which is present in abundance in tropical rainforest.

Adaptations in Lion-Tailed Macaque

It is also called as beard ape and lives in the rainforest of Western Chats in India. It has silver-white mane which surrounds the head from the cheeks down to its chin which is the specific characteristic of this animal. It is called lion-tailed because its tail is like that of lion having bunch or tuft of hair at the end.

They spend most of their time feeding in the upper canopy of trees (i.e. arboreal animal). It mainly feeds on fruits, seeds, young leaves, stems, flowers and buds. They also can eat insects present under the bark of the tree. Since, it is able to get sufficient food on trees. It rarely comes down on the ground and spends a major part of its life on the tree. It is a good climber with its hand and feet adapted to hold the branches of trees firmly.

Adaptation in Toucan

Toucan is a bird, which is found in tropical rainforest and which possesses a long strong and large beak. This bird is adapted for tropical rainforest in several ways. It is a colourful bird which possesses a strange beak. It lives most of the time in the holes of big trees.

The long and large beak helps Toucan to reach the fruits attached to the ends of even thin branches of tree that are weak enough to support its weight. It is an adaptation of this bird to get the unreachable fruits. Its large beak also helps in temporary storage of fruits which is collected by Toucan. These possess feet that are adapted for grasping the branches of trees firmly. Toucan can change the colour of its feather, so as to get mixed up with the surrounding and they are not easily noticed by predators and remain safe.

Adaptations in Lion and Tiger

These are also called as big cats and are carnivore which eat only flesh of other animals. These have following adaptations to survive in tropical rainforest:

- They have thick skin and skin colour helps them to camouflage (ability of the animal to match their surrounding, e.g. chameleon, butterfly). The yellow brown colour of lion and black stripes of tiger helps them to hide in the forest by blending with the surroundings. It helps these carnivores to catch their prey.
- They have strong sense of smell which helps them to locate their prey.
- They also develop sensitive hearing capacity to find its prey.
- They have eyes in front of their head which enable them to have a correct idea of the location of their prey. They also have good eyesight.
- Their strong legs help them to run fast and long, sharp and strong claws in front of their legs help them to catch and tear their prey.

Adaptations in Elephant

Elephant is a well-known animal of Indian tropical rainforest. These are plant eaters and are adapted in many remarkable ways to survive in tropical rainforest. These adaptations can be discussed as follows:

(i) The elephant has a long trunk which is used as nose and has a strong sense of smell. It also helps elephant to pick up the food. The long trunk is also used for breathing. It can reach up to the branches of trees and help it to eat tree leaves. It is used for sucking water from lakes or rivers (drinking).

(ii) The elephant possesses tusks (long pointed teeth) that are used in tearing the bark of trees which the elephant loves to eat as food. It also helps elephant to fight their enemies and protecting themselves.

(iii) The elephant has large ears that help it to hear even very soft sounds and can sense the danger. It also helps the elephant to keep it cool in the hot and humid climate of the tropical forest.

(iv) The feet of the elephant is large and round which help it to provide good stability and also prevent it from sinking into soft ground due to its heavy weight.

Chapter 8

Winds, Storms and Cyclones

We live on the earth which is surrounded by air. The layer of air surrounding the earth is called atmosphere. The moving air is called wind. It is formed by the heat of the sun or it may be said that unequal he ting of different parts of the earth forms wind.

Air Exerts Pressure

The continuous physical force exerted on an object or against an object when something comes in contact with it, is called pressure. Air exerts pressure in different ways under different situations and on all objects and in all directions. Air pressure helps the leaves of trees, banners or flags to flutter when the wind is blowing. It causes the tyres, balloons to inflate.

Importance of Air pressure

The importance of air pressur can be discussed as follows:

- It creates wind The difference in atmospheric pressure gives rise to the wind on the ea th
- It influences weather Air movement, i.e. downward or upward movement of air caused due to differences in pressure creates the cloudy and clear sky, brings rain or fine weather.
- Weather forecasting The changes in air pressure gives important clues for weather forecasting. The air pressure is measured by an instrument called barometer.

Similarly, when we ride a bicycle against the direction of the wind, boat against wind direction or flying of kite against the direction of the wind, we can feel the air pressure.

When we pump air or fill air into the bicycle tube, the air molecules inside the tube collide with the walls of the tube and exerts air pressure. The air

pressure exerted from inside inflates the bicycle tube. The pressure exerted by air filled in a bicycle tube keeps the tube tight and makes the bicycle tyre feel hard. If we continuously fill more and more air into the bicycle tube, the air pressure in the bicycle tube will increase too much that tube may get burst. These observations also show that air exerts pressure.

High-Speed Winds

High-speed winds are accompanied by reduced air pressure.
Air moves from the region of higher pressure to the lower pressure. The greater the difference in pressure, the faster the air moves. It is due to the heat of the sun from which air becomes warm producing a low pressure. So, the warm air rises up and the cool air from the surroundings moves towards the sea.

The fast-moving air blowing over an object helps in lifting the object up by producing a region of low pressure above it. This can be shown by the following activity.

Air pressure is caused due to the constant bombardment by moving air molecules on the surface of the paper strip.
We have learnt that when high-speed air is blown over a strip of paper, it is lifted up. Similarly, if the high wind blows over the roof of houses, it will reduce the air pressure above the roofs and if the roofs of houses are weak then higher air pressure from below will lift up the roofs which can then be blown away by the fast winds. Therefore, weak roofs of houses can be lifted and blown away by the high-speed wind that is called a storm.

Air Expands on Heating

Gases or air expand more than solid and liquid on heating. Air is a mixture of gases. On heating, the molecules of air gain kinetic energy. It moves away from each other, thus occupying more space. Therefore, the air becomes lighter. Warm air rises up whereas comparatively cool air tends to sink towards the earth's surface.

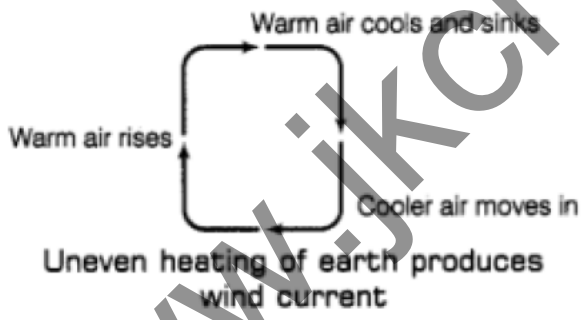
The term 'expansion of air' means the increase in the volume of air. When the air is heated, its volume increases and occupies a bigger space.

When the air is heated, it becomes lighter and rises up in the sky. This is the reason that when we burn woods, the smoke rises along with the hot air near the place of fire. This can be demonstrated by the following activities.

This fact of air is utilised in launching hot air balloons. In nature, there are several situations where warm air rises at a place. The air pressure at that place is lowered. The cold air from the surrounding areas rushes in to fill its place.

Wind Currents

The wind is the movement of air which depends on the difference in air pressure in two regions. Air moves from the region of high pressure to the region of low pressure in the atmosphere. This difference in air pressure is created by uneven heating or unequal heating on the earth. The region where the air rises, an area of low pressure is created while the region where the air sinks, an area of high pressure is created.



The uneven heating on the earth takes place in two situations:

1. Uneven Heating between the Equator and the Poles

The region of the earth which is closed to the equator of the earth gets the maximum heat from the sun. Therefore, the air in these regions gets warm and rises, creating an area of low air pressure. The cooler air from the region of upto 30 degrees latitudes belt on either side of the equator moves or rushes towards the equator and replaces the warm rising air. This makes

the wind to blow from the North and South directions towards the equator. At the poles, the air is colder than at latitudes about 60 degrees.

Therefore, the warmer air moves upward and colder air rushes in. This makes the wind blow from the poles of the earth towards the warmer region up to about 60-degree latitudes.

2. Uneven Heating of Land and Water

(i) During summer, the earth near the equator warms faster than the water in the oceans. The air above the land gets warmer and rises up in the sky creating a low-pressure area. Therefore, the winds flow from the oceans towards the land. These winds carry a lot of moisture with them and bring rain. It is a part of the water cycle. These rain-bearing winds are called the monsoon winds.

(ii) During winter, the direction of the wind gets reversed. The wind blows from the land to the sea due to the difference in air temperature between the land and sea. This happens so because during winter, the land cools down faster than the water in the oceans and the temperature of water in the ocean is higher than that of land. The warm air over the ocean rises up creating a region of low pressure and cooler air from the land rushes towards the ocean. Thus, the air flows from land to ocean carrying only a little water vapour. Hence, bring only a small amount of rain in the winter season.

Note: The word monsoon is taken from the Arabic word 'Mausam' which means 'season'

The summer monsoon which brings heavy rain is very important to the farmers because this annual rainfall helps in growing crops. Farmers depend on the rain for the irrigation of their crops. Sometimes, rain creates some problem also. In nature itself, there are certain situations that can sometimes create disasters and can pose a threat to humans, animals and plant life. Wind speed and wind direction play an important role in the

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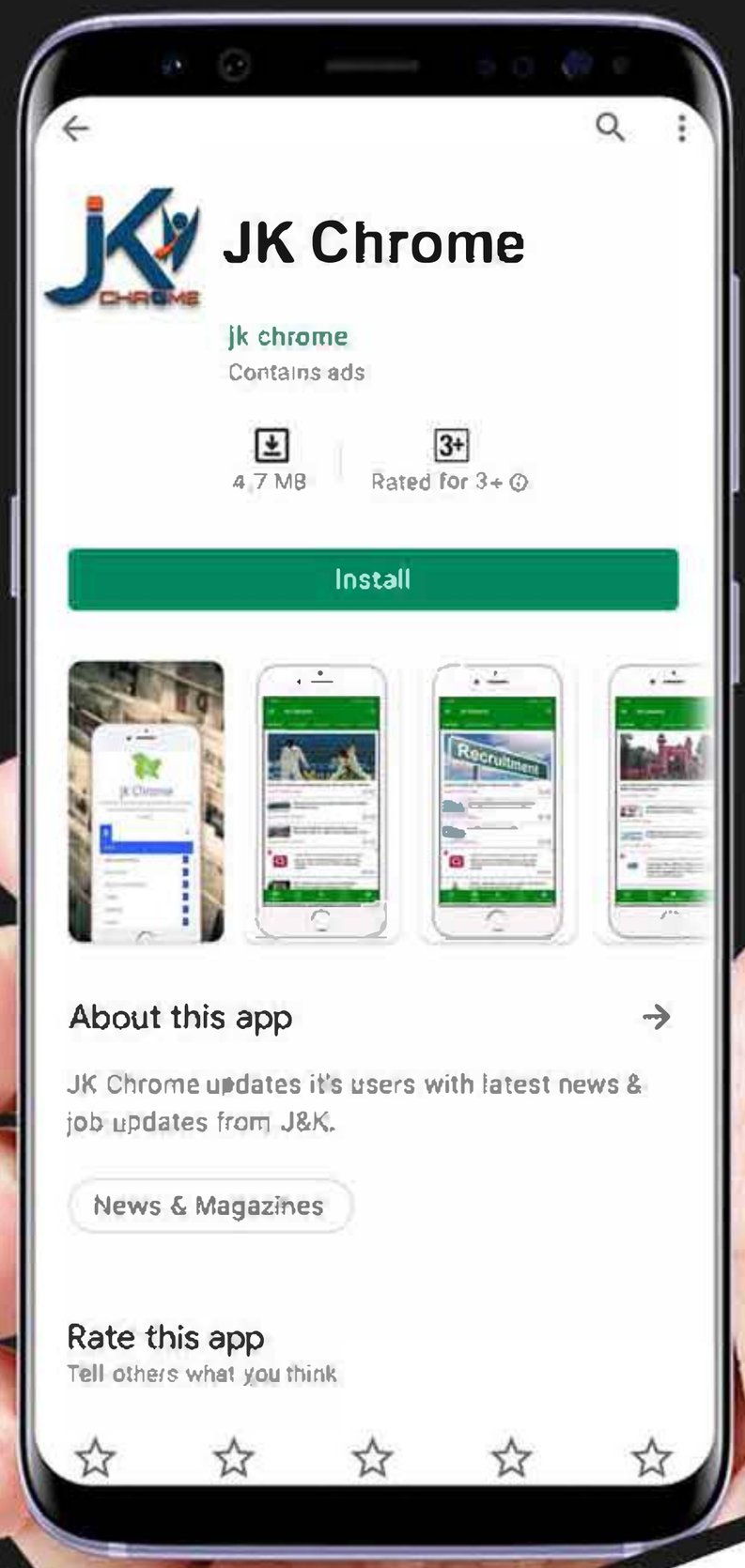

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formation of storms, cyclone, thunderstorms, etc. The instrument used to measure the wind speed is called anemometer.

Thunderstorms

When air moves gently (low speed), it is called a breeze while when it moves violently (high speed), it is called a storm. When the pressure of air drops, it indicates the possibility of a storm.

The swift movement of the falling water along with the rising warm air producing sound, lightning, heavy rain and • strong wind is call d thunderstorm. It develops in hot and humid tropical areas like India and is accompanied by heavy rains or hail. Thunderstorms are produced by the dark clouds which form at fairly low altitude in the atmosphere. In the tropical area, the air gets warmed up and makes it to rise, whereas humidity provides the water vapour for the formation of cloud. Therefore, it can be said that to occur a thunderstorm, it requires moisture, rapidly rising warm air and sea breeze or mountains.

Precautions to be Taken During a Thunderstorm

A thunderstorm is accompanied by lightning which is a giant electric spark. It may kill people, animal and can damage buildings, etc. Therefore, you must take the following precautions during a thunderstorm to protect ourselves from the lightning.

When you are in open area

- Do no take shelter under an isolated tree or building. If you are in a forest, take shelter under a small tree. Do not lie on the ground.
- Do not take shelter under an umbrella having a metallic end.
- Never sit near a window, open garages, storage sheds, metal sheds, etc, to take shelter.
- One can take shelter in a car or a bus.
- Do not go in the water. If you are in the water, get out and go inside a building.

When you are inside

- Do not sit near an open window. Close the doors and windows properly.
- Do not touch/operate any electrical devices or telephone.
- Do not watch TV

Cyclones

A cyclone is a weather condition consisting of a system of high-speed winds revolving around a central area of very low pressure. Cyclones develop over tropical seas. It is a violent storm with a wind speed of 150-250 km/h. It is accompanied by strong winds and heavy rains.

Structure of a Cyclone

The centre of a cyclone is a calm area and is called the eye of the storm. The diameter of the eye varies from 10 to 30 km. It is a region free of clouds and has light winds. Around this calm and clear eye, there is a cloud region of about 150 km in size. In this region, there are high speed winds (150-250 km/h) and thick clouds with heavy rains. Away from this region, the winds speed gradually decreases.

Note: Cyclones are developed over the Indian Ocean, Bay of Bengal and Arabian sea. The whole coastline of India is vulnerable to cyclones. Meteorologists study weather and give various names to the cyclones as Hugo, Katrina, Rita, Hud-Hud, Phailin, etc.

Formation of Cyclones

Factors like temperature, humidity, wind speed, wind direction and rotation of the earth, contribute to the development of a cyclone. The energy required to form and sustain a cyclone comes from the heat of condensation of water vapour present in moist air rising from the surface of hot seawater that condenses at altitudes to form a 0cloud. When the air above the seawater is heated, a region of low pressure is created because warm and moist air rises up. * The cool air rushes in forcing up more hot air.

The process of moving warm air up and its replacement by cool air is repeated again and again making or setting up a cycle or air current.

Once the cyclone is formed, it begins to move over the surface of the sea. The strongest wind and the heaviest rain occur in the towering thunder clouds about 20-30 kilometres from the centre of the cyclone. Cyclone comes to an end quickly if a cyclone moves over land because it no longer receives heat energy and moisture from warm seawater.

Note: A cyclone is known by different names in different parts of the world. It is called a hurricane in the American continent. In the Philippines and Japan, it is called a typhoon.

Destruction Caused by Cyclones

Cyclones are very destructive. These are the greatest storm on earth. Cyclones cause widespread destruction and loss of life in coastal areas. When the strong winds push water towards the shore even if the storm is hundreds of kilometre away, it gives the first indication of an approaching cyclone.

The high-speed wind accompanying cyclone produces a tremendous force of the high-speed wind. It causes damage by toppling trees, electric poles, telephone poles and vehicles, damage houses and even hurt people, thus causing a great loss of life and property.

The low pressure in the eye lifts the water surface in the centre. The rising water may be as high as 3-12 m and appears like a water-wall moving towards the shore. As a result, the seawater enters the low-lying coastal areas and can destroy roads and railway tracks, wash away vehicles, damage houses, drown people and animals, damage crops causing a great loss of life and property. The cyclone also reduces the fertility of the soil.

Continuous heavy rains caused by cyclones may further worsen the flood situation in the area and affect the people in coastal area. The flood may pollute drinking water and may cause several water-borne diseases.

Effective Safety Measures

On the part of the government

- Cyclone forecast and warning system must be installed.
- Information about cyclone should be given to the people in time through rapid communication system.
- Construction of cyclone-shelter in cyclone-prone areas.
- An administrative arrangement should be taken to move people faster to safer places.

On the part of the people

- People should follow the essential guidelines provided by the agencies through TV radio, phones, etc.
- A proper arrangement should be made to shift the essential household goods, domestic animals, etc. to the safer places.
- Avoid driving on a road which is underwater because flood might have damaged the road.
- Phone numbers of all the emergency services like police, fire brigade, hospitals, etc. should be kept ready.

Some other precautions to be taken when you are staying in a cyclone hit area

- Do not drink water that could be contaminated, store drinking water for emergencies.
- Do not touch wet switches and fallen power lines.
- Do not go out just for the sake of fun.
- Cooperate and help your neighbours and friends.
- Do not pressurise the rescue force by making under demands.

- Do not enter into damaged buildings.

Tornadoes

A tornado is a violent spinning storm in the shape of a dark funnel with a narrow end on the land.

These are formed over the sea and are called water spouts. Tornado develops from the thunderstorm and is formed mostly on the land. These are violent and can reach the speeds of more than 500 km/h destroying everything in their path. These are not very common in India but occurs in Canada and the USA.

Most of the tornadoes are weak. When the warm air from the earth's surface rises up, it whirls around it and causes very high-speed winds. These are much smaller than cyclones, i.e. from a few meters to a few hundred meters but the wind speed can rise as high as 500 km/h. The funnel of tornado sucks up everything at its bases like dust, debris, cars, trees and even houses.

Destruction Caused by Tornadoes

Tornado causes much damage due to the heavy force of its high-speed winds. A tornado causes considerable damage when it passes over land. Tornado causes the following destructions:

- It uproots trees, electric poles and telephone poles, it disrupts power supply and telecommunications.
- It lifts the people and vehicles off the ground and hurls them hundreds of metre away. This may lead to the death of people and damage to vehicles.
- Tornado causes extensive damage to buildings. It creates lower pressure outside the building much lesser than inside the building and the building can explode.

Protection from Tornado

The following precautions should be taken for protection during a tornado:

- One should take the shelter in a room situated deep inside the home having no windows or in a basement.
- Shut all the doors and windows and take shelter under the study table.
- Bend down on your knees and protect your head and neck using your arms. Stay indoors until it is safe to come out.
- If someone is in the vehicle and tornado begins, he should get out of the vehicle and take shelter in a ditch or low-lying area and lie flat in it.
- Keep distance from electric wires and damaged areas.

Protection of head and neck during tornado in bent position

Advanced Technology has Helped

During the early part of the last century, the people residing in coastal regions have less than a day for the preparations or to evacuate their homes from an overcoming cyclone. But, today's situation is very different. Today we are much protected. We have satellites and radars which can issue the cyclone watch or cyclone alert before 48 hrs (in advance) of any expected storm and a cyclone warning is issued 24 hrs in advance.

Therefore, coastal residents have sufficient time to prepare and evacuate their homes. The message related to the cyclone is broadcasted over the radio every hour or half hour when a cyclone is nearer the coast.

In this way, the advanced technology has helped us in giving better protection from cyclones. Several national and international organisations cooperate to monitor cyclone-related disasters.

Chapter 9

Soil

Soil is one of the most important natural resources. It is the uppermost layer of earth's crust which is blackish-brown in colour. Major functions of the soil are:

- It supports plant growth by holding the roots firmly and supplying water and nutrients to the plants.
- It acts as a natural habitat for many organisms like an earthworm, fungi, bacteria, ants, etc.
- It is also essential for agriculture which provides us with food, clothing and shelter for all.
- It supplies water and nutrients to plants

Therefore, we can say that soil is an inseparable part of our life.

Soil Teeming with Life

Soil contains air, water and countless living organisms like fungi, bacteria, insects (like ants and beetles), earthworms, rodents, moles and plant roots. Some organisms are too small that they cannot be seen by naked eyes (e.g. fungi and bacteria). An important soil organism is an earthworm, it is visible only in the rainy season. It increases the fertility of soil. An analysis of different soil samples is summarised in the table given below:

Soil Source	Plants	Animals	Any other observations

Garden soil	Grasses and roots	Ants, earthworms, termites and beetles	Concrete
Soil from roadside	Dry roots	Ants and termites	Concrete, plastic bags and glass particles
Soil from the area where construction is going on	No plants	Ants	Gravels, plastic articles, polythene bags, sand, etc
Soil from agricultural land	Grass roots and plant roots	Earthworms, milipedes, centipedes, fungi and bacteria	Concretes, glass materials and manure (cow dung)
Soil from river	Dry grasses, hays	Milipedes,	Glass particles,

side	and humus	centipedes, and lichens	concrete, plastic articles, and polythene bags

Therefore, we see that different soils from different sites have various plants, animals and waste materials in them.

Soil Pollution

Sometimes people throw polythene bags and plastic articles in the soil. They pollute the soil and also hill the useful organisms living in the soil. Some other substances like chemicals and pesticides also pollute the soil.

To prevent the soil pollution, the use of polythene bags must be banned, and the waste products and chemicals must be treated before they are released into the soil. The use of pesticides in the agricultural field must also be minimised in order to prevent soil pollution.

Soil Profile

Soil is formed by breaking down of rocks by the action of wind, water or climate by the process called weathering. During this process, the rocks are worn away to form small particles by long exposure to the elements of weather.

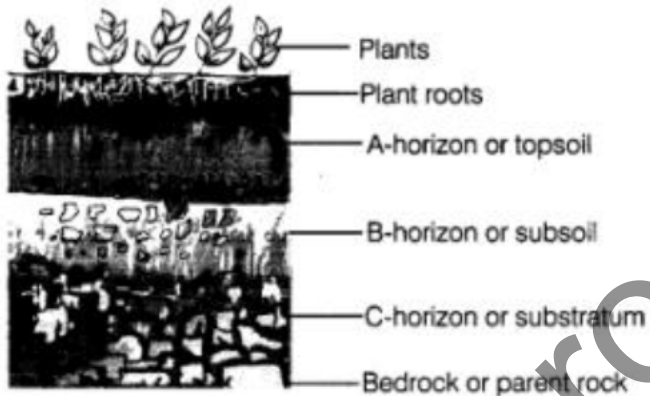
Weathering is a very slow process as it takes thousands of years for a huge rock to turn into fine particles. The nature of the soil depends upon the rocks from which it has been formed and types of vegetation that grow on it.

The soil profile is a vertical section through different layers of the soil.

Soil profile consists of different layers of soil which are called horizon. Each horizon differs in texture, colour, depth and chemical composition. Different horizons of the soil are discussed further.

1. A-Horizon or Topsoil

It is the uppermost layer of soil and is usually dark in colour because of the presence of minerals and humus in it. It provides the nutrients in plants since the roots of most plants are confined to this layer. Humus is the dark brown coloured layer which consists of dead, rotting remains of plants and animals.



Soil profile

Humus helps in making the topsoil porous. This layer is generally soft and retains more water in it. This layer provides shelter for many living organisms like earthworm, rodents, moles and beetles.

2. B-Horizon or Subsoil

This layer of soil lies just below the topsoil. It is made up of slightly bigger rock particles than that of the topsoil. It does not have much humus and is lighter in colour than topsoil. It is somewhat harder and more compact than the topsoil. This layer is less fertile than topsoil and contains few living organisms. The subsoil is rich in minerals and iron oxides.

3. C-Horizon or Substratum

The layer of soil which lies just below the subsoil is called C-horizon. It consists of small pieces of broken rocks with cracks and crevices, formed by the weathering of bedrock or parent rock.

4. Bedrock or Parent Rock

Below the C-horizon unweathered solid rock is found which is called as bedrock. It is non-porous and can produce the soil over a long period of time. Rainwater gets collected over it to form the water table.
This layer is hard enough and is difficult to dig with a spade.

Soil Types

The weathering of rocks produces small particles of various materials, these include sand and clay. The relative amount of sand and clay depends upon the rock from which the particles were formed. The rock particles present in soil are of different sizes and chemical compositions. On the basis of sizes, the rock particles present in soil can be divided mainly into four major groups:
(i) Clay, These are formed by the smallest rock particles. These are so small that we cannot see a single clay particle and it feels smooth.

(ii) Silt These are made up of somewhat bigger rock particle than clay. It is not so smooth as clay. Silts are found deposited at river beds. Floods deposit the silt from rivers in the field.

(iii) Sand, These are made up of larger particles enough than that of silt and can be easily seen. These are coarse to touch due to their larger size.

(iv) Gravel These are the largest sized rock particles that are present in the soil. These are the tiny stones that are present in topsoil in very small quantity.

The soil in different geographical areas contains different proportions of sand, clay and silt in them. It also contains a small amount of hummus in them. Depending upon its composition, soil can be classified as sandy soil, clayey soil and loamy soil. The size of the particles in the soil influences its properties.

(i) Sandy soil These contain mainly sand. These are quite large particles. There are large spaces between them which are filled with air. Water can drain quickly through these spaces. The sandy soil tends to be light, well aerated and rather dry. Since it is aerated, can be ploughed easily and cannot retain water, so it is not good for plants. Since it is light, it can be easily blown away if left bare. It does not possess humus, thus it is less fertile. It can be made fertile by adding manure in them which increases its water-holding capacity. This soil is not sticky and therefore, these cannot be used to make pots, bricks, toys and statues.

(ii) Clayey soil' Clay particles are smaller and packed tightly so that it leaves a little space for air. Water drains very slowly through clayey soil. These also contain very little humus. It is heavier than sandy soil. Clayey soil is more fertile than sandy soil.
The fertility of clayey soil can be improved by adding some sand and humus to it. Clayey soil is very sticky and c n be used to make pots, bricks, toys, statues, etc.

(iii) Loamy soil It is a mixture of sand, clay and silt with a small amount of humus in it. Therefore, it is very fertile and the best topsoil for growing plants. It has water holding capacity and excess water can also be drained out through it easily. It is a smooth, partially gritty and sticky soil.

Properties of Soil
Soil possesses various pr perties like:

- It on ains air.
- It can hold water or moisture.
- It can absorb or soak water
- It allows water to pass down through it.

Percolation Rate of Water in Soil
Soil is porous, i.e. it has tiny pores in it. When water is poured over it, then some water gets absorbed in the soil and rest passes down the soil. The process of passing down water slowly through the soil is called percolation

of water. Percolation rate is the amount of water (in mL) that is percolated through the soil in unit time, i.e. in minutes. The percolation rate differs in different soil types.

The rate of percolation can be calculated by using the following formula:

Percolation rate (mL/min) = $\frac{Amount of water(mL)}{Percolation time(min)}$

For example, if water in bottle 'A' percolates in 20 min, in 'B ', it percolates in f 15 min in bottle. While in bottle 'C', it percolates in 25 min, then the percolation rate (mL/min) will be calculated as follows:

For bottle 'A', Rate of percolation = $\frac{200mL}{20min}$ =10 mL/min
For bottle 'B Rate of percolation = $\frac{200mL}{15min}$ = 13 mL/min
For bottle 'C', Rate of percolation = $\frac{200mL}{25min}$ = 8 mL/min

Percolation rate is highest in sandy soil because it is very loose. On the other hand, clayey soil is very compact and therefore has the lowest rate of percolation. The rainwater moves or reaches to well faster and in a greater amount from sandy soil.

Since clayey soil can retain water in them. These are the best soil to grow paddy because paddy requires standing water in fields. The kutcha (unpaved) road due to percolation of water becomes dry after rain while pakka road does not.

Moisture in Soil

The soil contains some water in it which is called soil moisture.
Usually, 'moisture is present as a thin film around the soil particles. This moisture is absorbed by the roots of plants. Thus, the moisture content of the soil is very important for the growth of crops.

Absorption of Water by Soil

Soil contains moisture in it but it can still absorb or soak a lot of water. But

soil has the limit to absorb water in it. The ability or capacity of the soil to absorb a limit of water is called absorption percentage. It can be calculated as follows:

$$\text{Percentage of water absorbed} = \frac{Amount\ of\ water\ absorbed\ (in\ mL)}{Amount\ of\ Soil\ (g)} \times 100$$

Different types of soil can absorb water to a different extent, i.e. some absorb more water while other absorbs less water. When we talk about the percentage of water absorbed by the soil, it means the mass of wate absorbed by 100 g of soil.

Water Retention

The ability of soil to hold water is called water retention. The space between soil particles is called pores provide the passage for gases and moisture within the soil.

The ability of soil to retain water is strongly related to the particle size. Water molecules hold more lightly to the fine particles of the clayey soil than the coarser particle of sandy soil.

When we perform this a tivity with different soil samples, we will see that.

- Sandy soil will absorb less water and allows more water to percolate.
- A clayey soil will absorb more water but allow less water to percolate.
- Sandy soil will absorb less water than clayey soil because of the large spaces between the soil particles. The area where, there is a lot of clay in the soil, stagnant water collects above the soil whenever it rains.

Soil and Crops

Different types of soil are found in different parts of India. Soil is mainly affected by wind, rainfall, temperature, light and humidity. Some climatic

factors also affect the soil profile and bring changes in the soil structure. The plants that grow on the surface of the earth are called vegetation. It includes green grass, herbs, shrubs, bushes, crop plants and trees.

Types of Soil	Crop Grown
Clayey Soil	Wheat, Gram and Paddy
Loamy Soil	Lentil, Tomatoes, Corn and Oats
Sandy-loam Soil	Potatoes, Cotton and Cereal Rye

Vegetation is mostly in the fertile topsoil of the earth and covers the soil like a green sheet spread on the surface of the earth.
The component of soil along with various climatic factors determine the type of vegetation in a particular region.

- Clayey and loamy soils are both suitable for growing cereals like wheat and gram. Such soils are good at . retaining water.
- For paddy, soils rich in clay and organic matter and having a good capacity to retain water are ideal.
- For lentils (masoor) and other pulses, loamy soils which drain water easily, are required.
- For cotton, sandy-loam or loam, which drain water easily and can hold plenty of air, are more suitable.
- Crops such as wheat are grown in the fine clayey soils because they are rich in humus and are very fertile.

A Case Study

John, Rashida and Radha went to Leeladhar Dada and Santosh Malviya ofSohagpur in Madhya Pradesh. Leeladhar Dada was preparing the soil to make items like surahi, matki, kalla (earthen frying pan), etc. John asked him the complete procedure of making such items. A summary of conversation they all had with Leeladhar Dada is given below:

- Leeladhar and other porters, bring the black soil from a piece of barren land.
- Dry soil is then placed in a large tank and would be cleaned of pebbles, etc. After removing these things the soil is then soaked for around 8 hours. This soil would be kneaded after mixing burnt horse dung.
- This kneaded soil is then placed on the wheel and appropriate shape is given. The final shape of the material s given with hands. These are kept for drying for three days. These it ms are baked at high temperature after drying in air and then coloured.

Soil Erosion

The removal of land surface by water wind or ice is known as erosion. The topsoil is very fertile and in the absence of it, the plants cannot grow. In the absence of plants, the soil becomes loose. As the plant roots bind to the soil. Soil erosion is mainly caused by the large scale cutting of forest trees and plants. This process of cutting down of trees is called deforestation. Erosion of soil is more severe in the areas of little or no surface vegetation like the desert or barren land. Therefore, cutting of trees and deforestation must be prevented. The effects of soil erosion are, famines, flood desertification and damage or spoilage of environment.

Chapter 10

Respiration in Organisms

Each cell of an organism performs functions like nutrition, transport, excretion and reproduction for this purpose, it needs energy. Our food is stored energy which is released during respiration. Breathing is the process during which, we breathe in air having oxygen and we breathe out air rich in carbon dioxide. The air rich in oxygen is transported to all parts of the body and ultimately to each cell. This oxygen is utilised by the cell for respiration. Tbe process of breakdown of food in the cells of an organism with the release of energy is called cellular respiration.

Types of Respiration

On the basis of the presence or absence of oxygen, respiration is classified into two types:

1. Aerobic Respiration

When the breakdown of glucose occurs with the use of oxygen, it is called aerobic respiration. During aerobic respiration, glucose is completely broken down into carbon dioxide and water and energy is released. Aerobic respiration takes place in mitochondria.

It can be shown by the following equation:

Glucose(food) $\xrightarrow{Oxygen}$ Carbon dioxide + Water + Energy

Aerobic respiration is seen in most of the organisms such as humans (man), dogs, cats, lions, elephants, cows, buffaloes, goats, snakes, earthworms, frogs, fishes, etc.

2. Anaerobic Respiration

When a breakdown of glucose takes place without using oxygen, it is

called anaerobic respiration. The glucose is not completely broken down into carbon dioxide and water. An intermediate compound is formed with the release of less amount of energy during this process. It can be shown as follows:

Glucose $\xrightarrow{No\ \ oxygen\ \ or\ \ air}$ Alcohol + Carbon dioxide + Energy

Yeasts such as Saccharomyces cerevisiae and certain bacteria carry out anaerobic respiration. These organisms that carry out respiration in the absence of oxygen are called anaerobes.

Yeast is a single-celled organism. During anaerobic respiration (also called fermentation), yeast produces ethanol or alcohol as a byproduct which is used in making wine and beer. The carbon dioxide produced by yeast is used in the bread making industry. The C02 gas released during this process causes the bread dough to rise.

Anaerobic Respiration in Muscles

Usually, aerobic respiration takes place in humans, but under certain conditions, anaerobic respiration may also occur in our muscles for a short time, due to temporary deficiency of oxygen. When we perform a heavy exercise like running, cycling, walking, weight lifting, etc., we require a large amount of energy. To meet the energy requirement our muscle cells perform anaerobically. respiration. During this process, the glucose or food in the muscle cells is partially broken down in the absence of oxygen to form lactic acid and some extra energy is released.

The following equation shows the production of lactic acid:

Glucose(Food) $\xrightarrow[No\ \ oxygen\ \ or\ \ air]{(Anaerobic\ \ respiration\ \ in\ \ muscles)}$ Lactic acid + Energy

This ours because during vigorous physical activity, the utilisation of oxygen ours at a faster rate in the muscles that can be supplied by the blood.

When the lactic acid produced during anaerobic respiration, gets accumulated in the muscles, it causes muscle cramps. The muscle cramps

can be relieved by taking a hot water bath or a massage. This improves the circulation of blood and oxygen supply to the muscle cells increases. The increased supply of oxygen results in the complete breakdown of lactic acid into carbon dioxide and water, thereby giving relief from cramps.

Differences between aerobic and anaerobic respiration

Aerobic respiration	**Anaerobic respiration**
It occurs in the presence of oxygen.	It takes place in the absence of oxygen.
The complete breakdown of food takes place in aerobic respiration.	Partial breakdown of food occurs in anaerobic respiration.
End products of aerobic respiration are CO_2 and water.	End products of anaerobic respiration are alcohol and CO_2 or lactic acid (in muscles).
A large amount of energy is produced during aerobic	Less amount of energy is produced during

respiration.	anaerobic respiration.

Breathing

It is the process in which air rich in oxygen is taken inside and air rich in CO_2 is given out, with the help of respiratory organs. Thus, breathing involves two steps which take place alternately.

- **Inhalation:** Taking in of air rich in oxygen into our body is called inhalation.
- **Exhalation:** Giving out air rich in carbon dioxide from our body to the external environment is called exhalation.

This activity must be performed under the sup rvision of your teacher or parent. Close your nostrils and mouth tightly and look at a watch. Note down the time for which you could hold your breath. We will soon start feeling uneasy and cannot hold our breath for even one minute.

Breathing Rate

The number of times a person breathes in a minute is termed as breathing rate. An adult human being can inhale and exhale 15-18 times in a minute. It is the average breathing rate of an adult human being.

The breathing rate of a person is not always constant. It changes according to the oxygen requirement of the body. Breathing rate is somewhat faster in women than in men and in children, it is higher (20-30 times/min) than adults. Breathing rate is slowest while sleeping (as less energy is required) while maximum during heavy exercise like running, weight lifting, etc. (much energy is required). Increased breathing rate provides a greater amount of air entry into the lungs, hence blood can absorb oxygen at a faster rate. Faster breathing supplies more oxygen to the body cell for producing more energy, required for heavy exercises.

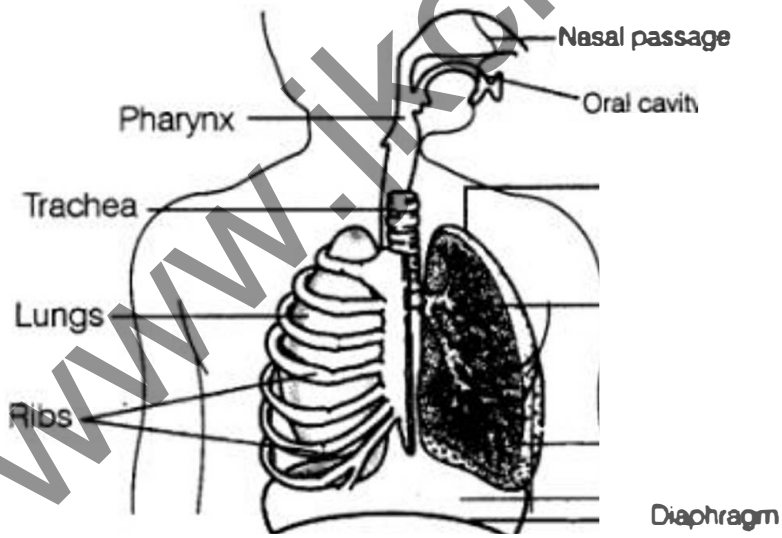
During heavy exercise, the breathing rate can increase to 25 times per minute. Because of this, food gets broken down at a faster rate and thus make us feel hungry.

When we feel drowsy, sleepy or tired, we yawn (i.e. open our mouth wide to take a long and deep breath, of air), because our breathing rate slows down and the body does not receive sufficient oxygen.

Mechanism of Breathing

The mechanism of breathing can be understood by the following points:

- Normally, we take in air through our nostrils. When we inhale air, it passes through our nostrils into the nasal cav ty.
- From the nasal cavity, the air reaches our lungs through the windpipe.
- Lungs are present in the chest cavity. This cavity is surrounded by ribs on the sides.
- A large, muscular sheet called diaphragm forms the floor of the chest cavity.



Human respiratory system

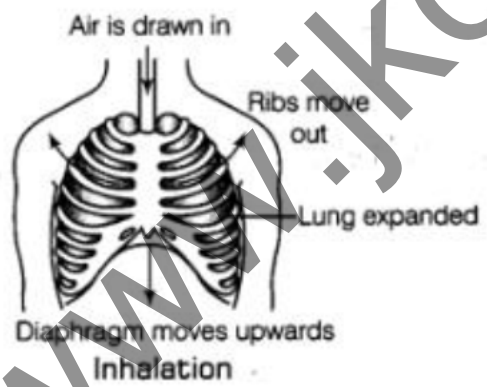
Smoking

Lungs are very delicate organs and essential for breathing, thus beeping us alive. Smoking tobacco in the form of beedi, cigarette or cigar damages our lungs gradually and causes ill health. While smoking, smoke along with chemicals present in tobacco enters our body. These chemicals present in tobacco damages the lungs in many ways like breathing becomes difficult causes lung cancer, heart diseases, etc. Smoking also affects people around smokers as they also inhale air containing tobacco. This is called passive smoking.

The mechanism of breathing involves the movement of the diaphragm and ribcage. The complete process of breathing can be discussed as follows:

Breathing In or Inhalation

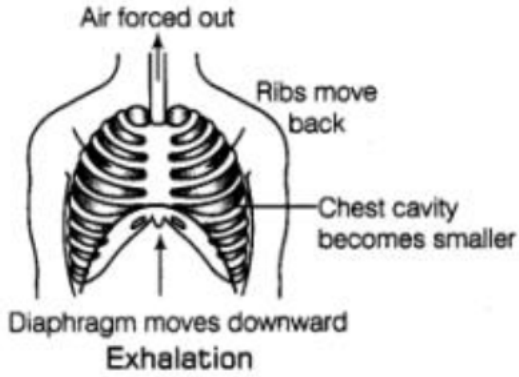
When we breath air in (or inhale) two processes occur together, i.e. the muscles between the ribs contract causing the ribcage to move upward and outward, while the diaphragm contracts and moves downwards. This upward and downward movement of ribcage and diaphragm respectively increases the space in the chest cavity and makes it larger. As the chest cavity becomes larger, it sucks air from outside the lungs and lungs get filled up with air and expand.



Breathing Out or Exhalation

When we breath air out or exhale the reverse process takes place, i.e. the muscles of the ribs release causing the ribcage to move downward and inward, while diaphragm releases and moves upward. This downward movement of the rib cage and upward movement of diaphragm decreases

the space in our chest cavity and makes it smaller. When the chest cavity becomes smaller, the air is pushed out of the lungs.



Exhalation

Sneezing

The air we inhale contains various types of unwanted particles like smoke, dust, pollen, etc. Their particles are allergens. During inhalation, these particles get trapped in the hair present in our nasal cavity. They cause irritation in the lining of the nasal cavity, as a result of which we sneeze. Sneezing expels the foreign particles from the inhaled air so that dust-free, clean air may enter into the lungs.

We should take care while sneezing in that we must cover our nose so that foreign particles expelled during sneezing may not be inhaled by another person nearby us.

Exhaled Air Contains Carbon Dioxide

The air is a mixture of gases like nitrogen, oxygen, carbon dioxide and water vapour, etc. The difference between inhaled air and exhaled air is that the inhaled air contains more oxygen while exhaled air contains more carbon dioxide. Besides oxygen and carbon dioxide, the air also contains more water vapour. Exhaled air contains more water vapour than the inhaled air.

The air which we inhale and exhale is a mixture of gases and water vapours. The inhaled air is rich in oxygen while exhaled air is rich in carbon dioxide. The percentage of O_2 and CO_2 in inhaled and exhaled air can be shown as follows:

	Percentage of O_2	Percentage of CO_2
Inhaled air	21%	0.04%
Exhaled air	16.4%	4.4%

Breathing in Other Animals

Different animals possess different organs for the exchange of oxygen and carbon dioxide. Animals such as elephants, lions, cows, goats, frogs, lizards, snakes, birds have lungs in their chest cavities like humans for respiration. The smaller animals like cockroaches, earthworms, fishes, ants and mosquitoes do not have lungs. Therefore, respiration in these animals takes place by other means.

Cockroach

Insects like the cockroach, grasshopper, etc., have tiny holes on the sides of their body. Their openings are called spiracles. The spiracles on the body of insects are connected to a network of thin air tubes called tracheae which; spreads into the whole body of the insect, where the exchange of gases takes place. Air rich in oxygen rushes through spiracles into the tracheal tubes, diffuses into the body tissue and reaches every cell of body. Similarly, CO_2 from the cells enters into tracheal tubes and moves out through spiracles.

The blood in these animals do not contain haemoglobin and is not red in colour. They cannot carry oxygen to all the parts of the body. Therefore, transport of air takes place through the spiracles in these organisms. The tracheal system or spiracles are only seen in insects, not in any other group of animals.

Earthworm

Earthworms and leeches absorb the atmospheric oxygen through their moist and slimy skin because gases can easily pass through the moist and slimy skin. They absorb the atmospheric oxygen through their moist skin and transport it through the blood to all the cells.

Frog

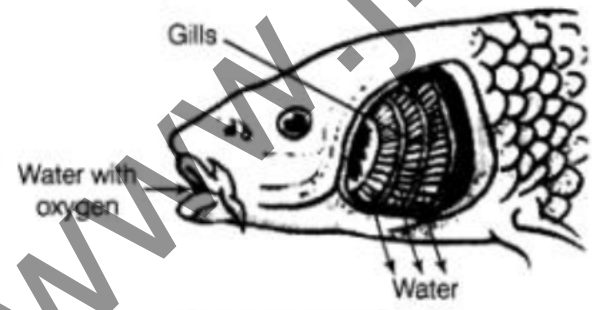
A frog-like human possesses a pair of lungs but when they are in the water, they breathe through their moist and slippery skin. When they are on land they breathe through their nostrils and a pair of lungs.

Breathing Under Water

There are many organisms which live in water. They do also breathe underwater. Some of them given below:

Fish

Fishes are the aquatic animals that live in water. These have a special organ for breathing called gills. The oxygen dissolved in water enters through the gills. Gills are actually the projections of skin and have blood vessels for the exchange of respiratory gases. The fishes breathe by taking in water through its mouth and sending it over the gills. The oxygen dissolved in the water is extracted by the gills and the extracted oxygen is absorbed by the blood.



Breathing in fish

This oxygen is then carried to all the parts of fishes for respiration. The carbon dioxide produced during respiration is brought back by the blood into the gills and expelled into the surrounding water.

Dolphins and Whales

Sea animals like dolphins and whales live in water but unlike fishes, they do not possess gills for respiration. These possess nostrils which are called blowholes. Their blowholes are located on the upper parts of their heads. These animals breathe in through their nostrils and lungs. Dolphins and whales come to the surface of sea-water from time to time to breathe in air, sometimes whales release a function of water that moves upwards like a spray. This is because when a whale breathes air out of its blowhole it appears as a spray or mist, also called a spot. It can be seen from many miles away. Blowholes are surrounded by muscles that keep the holes closed when the whales or dolphins are underwater and open it when the animal is at the surface and needs to breathe.

The human cannot survive underwater because they do not possess any gills to make use of oxygen dissolved in water for breathing. When we go underwater we have to take oxygen gas cylinders for breathing.

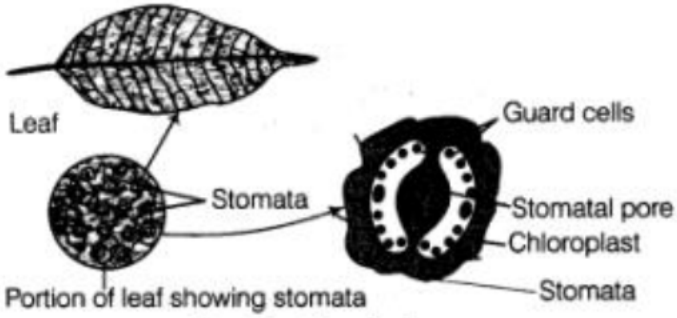
Respiration in Plants

All the organism in the world respires whether it is an animal or a plant. Plants also take in oxygen from the air and give out carbon dioxide. They also breakdown glucose into C02 and water and releases energy to perform other functions. The respiration in plants differs from the animal because in plants, respiration occurs through leaves and roots, etc. They carry out respiration independently, i.e. each plant part can independently take in oxygen from the air, utilise it to obtain energy and give out CO_2.

Respiration in Leaves

The leaves of the plants have tiny pores on their surface which are called stomata. The exchange of gases, i.e. O_2 and CO_2 in the leaves takes place through stomata during respiration. The oxygen from air enters into a leaf through stomata and reaches inside all the cells of the leaf through diffusion while CO_2 produced during respiration also diffuses from the leaf

to the atmosphere through the stomata.

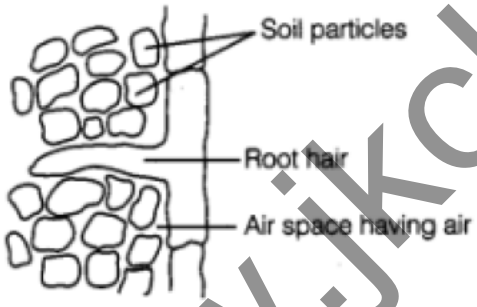


Respiration in leaves

Respiration in Roots

Root cells of the plants respire under the ground. They also need oxygen to carry out respiration and releases energy for their own use. Root cells get oxygen from the air present in the spaces between the soil particles.

Plant roots have a large number of tiny hairs on them which are called root hairs. Oxygen from the air present in soil particles diffuses into root hair and reaches to the cells of the root where it is utilised for respiration.



Respiration in plant roots

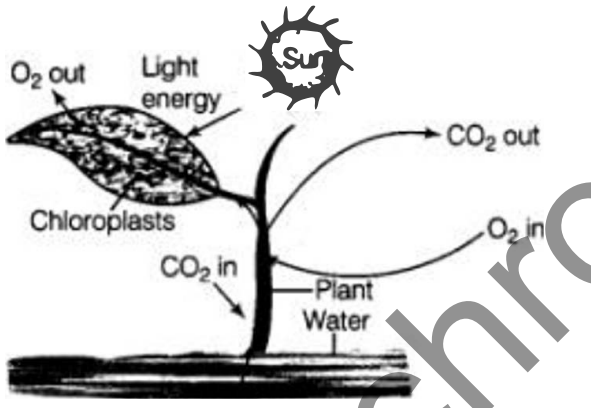
Note: If a potted plant is over watered for a long time, the plants die. This is because the water molecules fill the space between soil particles and push the air out. Due to this reason, the oxygen is not available to the roots for aerobic respiration and plants die. Due to the production of alcoholic products as a result of undergoing anaerobic respiration. It is not wise to sleep under a tree during the night because in the night, plants do not photosynthesis and plants are unable to use CO_2. So, a person will suffer from suffocation and feel the excess weight on the chest.

Exchange of Gases

The exchange of gases takes place in the plants all the time, but it is increased during day time. The leaves are more actively involved in photosynthesis during the day time in the presence of sunlight. The CO_2 released during respiration is utilised by the plant during photosynthesis to produce its food.

During photosynthesis, the O_2 is released by plants which are taken up during respiration in plants. Therefore, a balance between CO_2 and O_2 is maintained by the plants.

Respiration thus provides continuous energy to plants to perform all its functions regardless of time.



Plant showing intake and release of O_2 and CO_2 during photosynthesis and respiration

Chapter 11

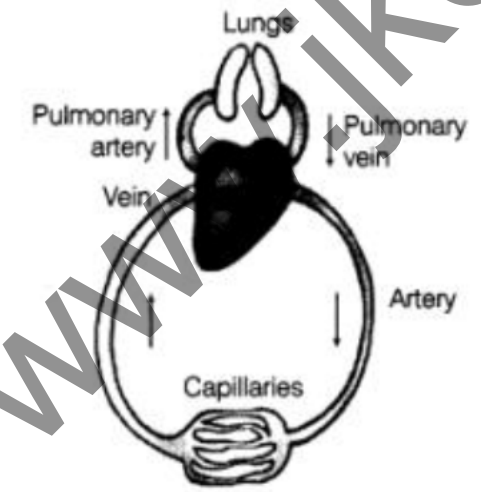
Transportation in Animals and Plants

Transport means 'to carry things from one place to another'. The body of an organism requires nutrients and oxygen to carry out various life processes. Waste products, produced due to the various functions inside the body also need to be transported and removed. Therefore, the term transport may be defined as a life process in which a material is absorbed in one part or organ of an organism and is carried to other parts in its body. In animal body, these functions are carried out by an internal transport system called as circulatory system.

Circulatory System

Circulatory system or blood circulatory system is the main transport system in human beings and animals. It makes food, water and oxygen available to every parts of the body and helps in removing waste material (urea, CO_2, etc).

The circulatory system consists of blood, blood vessels and heart.



Schematic diagram of circulation

Blood

It is a fluid tissue that flows in blood vessels. It is red in colour and it flows through a network of tubes in whole body called blood vessels. Blood is pumped to every part of the animal by heart. Blood consist of four components, i.e. plasma, Red Blood Cells (RBCs), White Blood Cells (WBCs) and platelets. Plasma is a liquid while RBCs, WBCs and platelets that float in it.

1. Plasma

It is the sticky liquid part of the blood which is pale yellow in colour. It is 90% water and 3.5% common salt. It contains dissolved substance such as digested food and waste products and carry them from one part to another part in the body.

2. Red Blood Cells (RBCs)

RBCs are red in colour due to the presence of pigment called haemoglobin. This pigment carries oxygen by binding with it. Haemoglobin is a red protein that binds with oxygen and transports oxygen to all the parts of the body and ultimately to all the cells. It is the presence of haemoglobin which makes the blood appear red. When haemoglobin binds with oxygen, it forms oxyhaemoglobin which is transported to various body parts. The carbon dioixde from the various body parts is transported back by binding again with haemoglobin. It forms carboxyhaemoglobin with C02, this C02 is expelled out from the body.

3. White Blood Cells (WBCs)

The WBCs fight against infection and protect us from diseases. WBCs eats up the germs (like bacteria) that cause disease. WBC also makes antibodies that fight against infection. The number of WBC is quite less than RBC. WBC can change their shape and move on their own. They can squeeze out of the blood vessels to reach any part of the body.

4. Platelets

Blood platelets are small, irregular, tiny fragments of special cells formed

in the bone marrow. These are colourless and help in the clotting of blood in a cut or wound. If a cut or wound is made the blood starts flowing from it, after some time the platelets plug the cut and the bleeding stops due to the formation of a dark red clot.

If the platelets are not present in the blood, the blood flow from the cut or wound will not stop causing excess loss of blood which may be fatal to a person leading to death.

Functions of Blood

Various functions of blood are

- It transports substances like digested food from the small intestine to the other parts of the body.
- It carries water to all the parts of the body.
- It carries oxygen and C02 during circulation.
- It carries waste products like urea from liver to kidney for excretion in urine.
- It protects the body from disease.

Blood Vessels

These are tubes or pipes that carry blood throughout the body. It runs between the heart and the rest of the body. There are three major types of blood vessels in the body, i.e. arteries, veins and capillaries.

1. Arteries

These carry blood from the heart to all the parts of the body. These lie quite deep under our skin and cannot be seen easily. Arteries have thick elastic walls as the blood flows at high pressure due to pumping action from the heart through arteries. No valves are present in the arteries. The main artery, i.e. aorta is connected to the left ventricle of the heart. It carries oxygenated blood from the left ventricle to all the parts of the body except the lungs. Another artery called the pulmonary artery is connected to the right ventricle of the heart and carries deoxygenated blood from the right ventricle to the lungs.

Note: The arteries normally carry oxygenated blood from the heart but one artery called pulmonary artery carries deoxygenated blood from the heart to lungs.

2. Veins

These are the blood vessels that carry blood from all the parts of the body back to the heart. These tube-like blood vessels are situated just under the skin and can easily be seen as greenish-blue tubes or lines below the skin. These carry deoxygenated blood from the body parts to the heart. Veins have thin walls and blood flows at low pressure through the veins. Therefore, veins have valves in them which allow the blood to flow in one direction and prevent the backflow of blood in veins.
Usually, veins carry deoxygenated blood but pulmonary vein that is connected to the left atrium of the heart carries oxygena ed blood from the lungs to the heart.

Differences between artery and vein

Artery	Vein
It is thick walled tube present deep under the skin	It is thin walled tubes lying just below the skin.
It cannot be seen easily.	It appears as a greenish blue line under the skin.

It does not possess valves.	It has valves which prevent the backflow of blood.
It carries oxygenated blood (except pulmonary artery).	It carries deoxygenated blood (except pulmonary vein).
Blood flows at high pressure.	Blood flows at low pressure.

Pulse Rate

To know your pulse rate, place the middle and index finger of your right hand on the inner side of your left wrist. You will feel the throbbing movement at this place. This throbbing is called the pulse the pulse is produced due to the blood flowing in the arteries.

Now count the number of beats or pulse in one minute. The number of beats per minute is called the pulse rate.
At the resting phase, a normal person has a pulse rate between 72-80 beats per minutes. Run for about 5 minutes and again measure the pulse rate, you will notice that the pulse rate per minute will be increased after running.

3. Capillaries

These are extremely thin blood vessels that connect the arteries to veins. These allow substances to pass from blood into the body cells and also from body cells into the blood. The exchange of substances like food, 02, C02, etc., between the blood and the body cells take place through the capillaries.

Oxygenated and Deoxygenated Blood

The blood that carry oxygen in it is called oxygenated blood, i.e. it is rich in oxygen. The oxygenated blood comes from the lungs, where oxygen from the fresh air gets mixed into blood and is carried towards the heart.

The blood that is rich is carbon dioxide, i.e. all oxygen has been used by tissues and organs is called deoxygenated blood. It is formed in alt the organs of the body except lungs. Oxygenated blood is bright red in colour while deoxygenated blood is darher in colour.

Blood Groups

The blood group of an individual human being always remains unchanged throughout their life. Karl Landsteiner described that human blood can be divided into four groups, i.e. A, B, AB and O. These are named on the basis of substance present in the blood (RBC). Every man has one of these four groups of blood which is inherited from parents to offspring and is never changed.

If a person gets injured and heavy blood loss occurs, there is a need to give blood of other people to the patient. The person who gives the blood is called a donor while the person who receives the blood is called the recipient.

Blood Group	Can donate blood to	Can receive blood from
A	A and AB	A and O

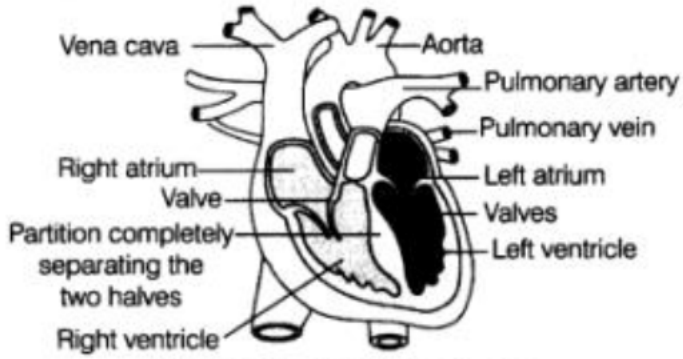
B	B and AB	B and O
AB	AB	All the group i.e., A, B, AB and O
O	All the group i.e., A, B, AB and O	O

The process of donation of blood from one person to another is called blood transfusion. Before donation, the blood group must be matched because transfusion of different groups can be dangerous. The RBCs of the patient receiving blood will stick together and may cause the death of the patient. This matching of blood group is called blood group compatibility. It can be shown as follows

Heart

The heart is an organ which beats continuously as a pump for the transport of blood carrying other substances with it, through a network of tubes or blood vessels. The heart pumps blood throughout our life without stopping

or relaxing.



Structure of human heart

Location of Heart

The heart is located in the chest cavity slightly towards the left side. It lies between the two lungs and above the diaphragm. The heart is made up of special muscles called cardiac muscles that do not fatigue and are not the solid muscle. The size of our heart is roughly equal to our left closed and is enclosed in a protective cover called pericardium fist. The heart is hollow inside.

Structure of Heart

The heart has four compartments called as chambers. The upper two chambers of heart are called atria (sing, atrium) and the lower two chambers of heart are called ventricles. On the left side of heart are left atrium and left ventricle and on the right side of the heart are right atrium and right ventricle.

The atria and ventricles are separated by valves. These are the muscular flaps that allow the blood to flow in only one direction. The right side of the heart carries deoxygenated blood while the left side of the heart carries oxygenated blood. The heart is separated by a partition called septum (from right side of the heart to the left side). This prevents mixing of oxygenated and deoxygenated blood inside the heart.

Left and Right Side of the Heart

The left and right side of the heart act as two separate pumps.

The left side of heart pumps the oxygenated blood into the whole body, while the right side of heart pumps the deoxygenated blood to the lungs. The oxygenated blood must be kept separated from deoxygenated blood to supply good amount of oxygen to the body cells for respiration and release of energy.

If the oxygenated and deoxygenated blood will mix with each other, the body cells will not be able to get enough oxygen for respiration due to which less energy will be released in the body.

Heartbeat

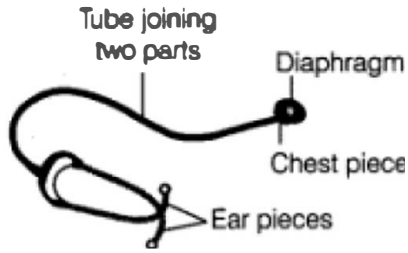
The rhythmic contraction and relaxation of heart muscles that produce a specific sound of lubb-dubb is called heartbeat. The average heartbeat of an adult person is 72-80 beats per minute at resting but the number increases during and after a physical exercise or when a person is excited. During fast beating of heart, the blood is pumped more rapidly to the organs to supply more oxygen to the body cells. It helps in rapid respiration and to produce more energy. The heartbeat is equal to the number of pulse in a minute.

Stethoscope

The heartbeat can be heard by an instrument called as stethoscope. It is used by doctor to amplify the sound of heart. It consists of

- a chest piece that carries a sensitive diaphragm
- two earpieces
- a tube joining both the parts

Doctors get to know about the condition of heart by listening to the sound through a stethoscope.



A stethoscope

You can prepare a model of the stethoscope by yourself. Take a small funnel of 6-7cm in diameter and fix a rubber tube tightly on the stem of the funnel. Stretch a rubber sheet on the mouth of the funnel. Fix t tightly with the help of rubber band. Put the open end of the tube on one of your ear. Now place the mouth of the funnel on your chest near he heart. Listen the thumping sound carefully. These sounds are the heartbeat. Count the number of beats in a minute.

Mechanism of Circulation

The contraction of two atria is immediately followed by the contraction of two ventricles which leads to the continuous flow of blood in the human body. The mechanism of circulation can be summarised as follows:

- The blood passes through the capillaries of the lungs and is mix with oxygen. This oxygena ed blood is then carried from the lungs to the left auricle by four pulmonary veins.
- The left atrium contracts and the oxygenated blood is pushed into left ventricles.
- The left ventricle pumps the blood into the biggest blood vessels of the body called aorta. It distributes oxygen-rich blood to the different parts of the body.
- The oxygenated blood is distributed to all the organs of the body through capillaries.
- The deoxygenated blood from various organs of the body enters from the capillaries to veins and then to the right atrium.
- The right atrium contracts and pushes the deoxygenated blood into right ventricles through the opened valve.
- Right ventricles pump the impure blood into pulmonary arteries that carry it to the right and left lungs for purification.

- The CO2 is released as a waste product from the lungs and again the blood absorbs oxygen and becomes oxygenated. The valves present on both sides of heart regulate the blood flow from one chamber to another.
  This cycle keeps on circulating continuously day and night, even when we sleep.

The English physician, William Harvey (AD 7578-1657), discovered the circulation of blood. The current opinion in those days was that blood oscillates in the vessels of the body. For his views, Harvey was ridiculed and was called circulator. He lost most of his patients. However, before he died, Harvey's idea about circulation was generally accepted as a biological fact.

Circulation in Sponges and Hydra

Sponges and Hydra are simple animals that do not possess any circulatory system. They live in water and therefore, the food and oxygen enter into their body along with water. The water also carries the C02 and other waste material away from the body as it moves out of their bodies.

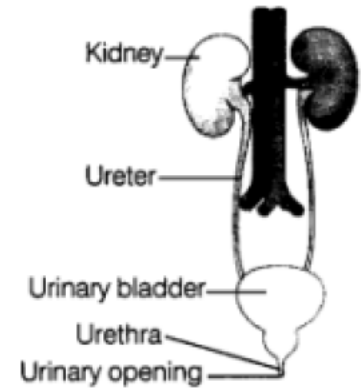
Excretion

The process of removal of waste materials produced in the cells of the living organism is called excretion. When our body uses food, water and air, it produces some by-products or unwanted substances. These are called waste materials. These waste material are toxic or poisonous and causes harm to the body. These poisonous substances if get mixed with blood may become fatal and may cause the death of an organism. Therefore, the waste material must be removed from the body so that a person may stay healthy.

These waste material produced after the various functions of body cells include CO2, urea, sweat, etc. These waste materials are removed from the body different organs of the body like lungs (CO2), kidney (urea) and sweat glands (sweat). These parts or organs of the body that are involved in the process of excretion are called excretory system.

Excretory System in Humans

Urea is the major waste product released in our body. It is produced as a waste product of the decomposition of unused food proteins in the liver. It is a poisonous substance which must be removed from the body. Urea from blood is removed by the kidney. Therefore, the kidney is the main excretory organ in our body. The urea and other unwanted salts when dissolving in water form a yellowish liquid waste called urine.



Human excretory system

It consists of 2.5% urea, 2.5% other waste salts and 95% water. An adult human being normally passes out 1-1.8 L of urine per day. The excretory system collects the urine and remove it. The excretory system of human being consists of two kidneys, two ureters, a bladder and a urethra.

Kidneys

These are called the magic filters. Kidney are bean-shaped organs present at the back of our body, just above the waist. It is brick red coloured about 4 inches long. It is richly supplied with blood vessels. Kidney can filter the unwanted substances from the blood. Each kidney consists of thousands of tiny filters called nephrons. When the blood containing urea and other waste salts pass through these nephrons, it filters the blood and removes urea and salts and urine are left in the kidney.

The urine thus formed by each of the kidney is then passed through the ureter (a tube-like structure which connects the kidney to the bladder) to urinary bladder. The urine is stored in the urinary bladder for some times and at regular intervals it, is removed through the opening at the end of the tube called urethra. The process of ejection of urine is called micturition.

The opening of urinary bladder is controlled by the ring of muscle called as bladder sphincter. When the bladder becomes full with urine this bladder sphincter opens and allows the urine to flow out.

Carbon Dioxide

It is produced as a waste product in our body cells during the process of respiration. The food is broken down during respiration to release energy and releases CO_2 as a by-product. This CO_2 is removed from our body by the lungs during exhalation. Therefore, lungs also act as the excretory organs for removing the waste product, $CO_2$from the body

Sweat

It is the liquid waste of the body that is produced by the sweat glands present in our skin. Sweat contains water, some unwanted salts and urea in a very small amount. During hot summer, we sweat a lot. This gets evaporated from our body. This helps to provide the cooling effect to the body. The two major functions of sweat are as follows

- It helps to remove excess water, salt and urea from the body.
- It helps to keep our body cool during hot summer days.

Dialysis

The normal functioning of the kidney is necessary for good health of a person. But sometime s the kidney may stop working due to infection or injury. This condition of kidney is called kidney failure which may lead to the accumulation of urea in the blood of a person. Since, urea is a toxic substance which must be removed from the blood. Such person having kidney failure cannot survive unless his blood is filtered periodically through the artificial kidney machine to remove urea. The process used for cleaning the blood of a person by separating the waste product urea from it is called dialysis.This machine removes urea and other waste the product periodically.

The long term solution for the patient suffering from kidney failure is kidney transplantation. In this method, the diseased or damaged kidney is

removed and the matching kidney is donated by a healthy person. The donated kidney is transplanted in its place by performing ^surgery.

Excretion in Animals

Like humans, animals also excrete waste products from their body. The way in which waste materials are removed from the body of the animal depends upon the availability of water. Fishes are the aquatic animals that excrete ammonia as their waste product. This ammonia is excreted in the gaseous form which directly gets dissolved in water. The land animals like lizards, birds, snakes, etc, have less water availability. These animals excrete this waste material in the form of uric acid pellets. These are white coloured semi-solid excretory products of several land animals. Urea is the excretory product of animals like human, cow, goat, etc. and is eliminated as urine.

Amoeba, Paramecium, etc., are the unicellular organisms and their excretory products are removed by diffusion from the body of the organism into the surrounding water.

Transport of Substances in Plants

Plants take up water and dissolved minerals from the soil through their roots and transport it to their leaves. The leaves use this water and mineral for synthesising their food by the process called photosynthesis.The food produced by green plants in transported back to all the parts of plant body. Therefore, it is clear that plants also need a transport system for carrying water, minerals and food through various parts of their body.

Transport of Water and Minerals

Plant root absorbs the water and mineral from the soil. The roots possess root hair which increase the surface area of the root for absorption of water and minerals nutrient that is dissolved in the water. It is moved from roots up to the stem and leaves through the tube-like tissue called as xylem.

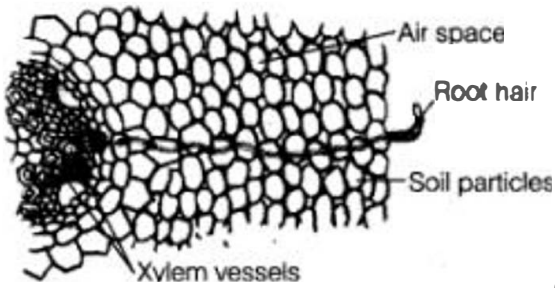
Absorption and flow of water is a continuous process through the xylem tissue. Xylem tissues are the continuous network of channels which

connect roots to the leaves through the stem and branches. It thus transports water and minerals to the leaves of the entire plant.

Transport of Food Material

The food manufactured in the leaf is transported to different parts of plants. This transportation of food material from leaves to the other parts of plants is carried out by the tissue called phloem and the process of transport of food material is called translocation. The phloem consists of vessels that are known as sieve tubes.

The xylem and phloem tissues together form the vascular bundles or conducting tissues.



Transport of water through xylem

Transpiration

The process of evaporation of water through the stomata present on the surface of leaves is called transpiration. The continuous evaporation of water from the leaves produces an upward pull, called a suction force. This force pulls the water from roots upward through the stem, branches and finally to the leaves. Though transpiration causes loss of water from the plants, still it is a necessary process for plants due to the following reasons:

- Suction pull caused due to the evaporation of water helps to draw water to a great height in tall trees.
- It produces a cooling effect on the plant and therefore, prevents the plants from the damage caused by heat of sunlight.
- It also helps in the transport of water and minerals to the leaves for performing photosynthesis in them.

The rate of transpiration increases in a hot sunny day or in moving air. This happens because the heat from sun or moving air causes evaporation of water at a faster rate from the stomata.

Increases in the rate of transpiration cause an increased rate of absorption of water through the roots. Therefore, when a potted plant is kept under the moving fan, the absorption of water through root will be increased along with the increased rate of evaporation.

Chapter 12

Reproduction in Plants

All the living organisms including plants and animals have the capability to produce new individuals during their lifespan. This process of producing a new organism from the existing organism (or the parent) of the same species is called reproduction. The new individuals produced, are the copies of their parents. The process of reproduction is one of the important life processes and is essential for the continuity of the species.

Thus, reproduction makes the life continuous which is not only essential for the survival of an organism but it is also very necessary for the perpetuation and preservation of the species because it increases the number of members of a species.

Modes of Reproduction

The various parts of a plant such as roots stem and leaves each with a specific function is called vegetative parts. After a certain period of growth, plants bear flowers. These flowers develop into fruits and seeds.

The parts of a plant that participate in the process of sexual reproduction are called reproductive parts or organs. In plants, the reproductive parts are a flower which may have the male or female part or both the parts on the same flower.

Different organisms reproduce in a different way. In plants, there are two different methods of reproduction:

1. Asexual reproduction
2. Sexual reproduction

The term 'sexual' means involving the fusion of sex cells or gametes while 'asexual' means without involving the fusion of gametes.

Asexual Reproduction

The process in which only one parent is involved in the production of new individuals of the same kind is called asexual reproduction. In plants, asexual reproduction results in the formation of offsprings or new plants without seeds or spores.

Asexual reproduction in plants occurs through the following methods:

1. Vegetative propagation
2. Budding
3. Fragmentation
4. Spore formation

1. Vegetative Propagation

It is the formation of new plants from vegetative units o bud, stem, etc. These vegetative units are called propagules. Vegetative reproduction may take place using various plant parts as given below:

(i) Vegetative Reproduction by Stem

The stems or branches of the plant normally bear buds in the axils. The buds that are present in the axil (i.e. the point of attachment of leaf at the node) develops into the shoot. Th se are called vegetative buds.

The vegetative buds can give rise to a new plant. These buds consist of a short stem around which immature overlapping leaves are folded. These can produce a new plant by vegetative propagation.

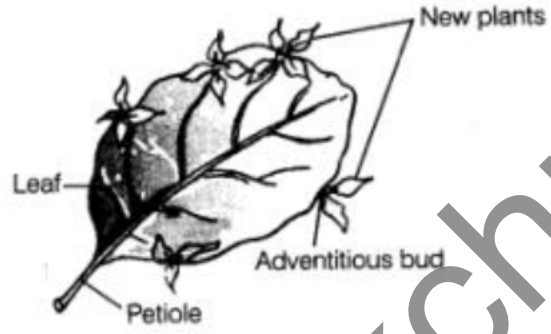
Methods to Vegetative Reproduction by Stem

(i) New plants are obtained from the stem by the cutting method. In this method, the small part of stem is removed by making a cut with a sharp knife. The stem cutting must have some buds on it. Now the lower end of stem cutting is buried in the moist soil. The upper part of cutting having bud on it, is kept above the soil. After few days, this cutting develops new roots. The bud grows and produces a shoot
(i.e. branches with leaves). Thus, a new plant is produced which is exactly

similar to the parent plant, e.g. rose, champa, grapes, sugarcane, banana, cactus, etc.

(ii) Another method of vegetative reproduction in stem is by layering. In this method, a mature branch of parent plant is bent down and covered with soil. The tip of the plant is kept above the ground. The root develops from the branches and grows into a new plant. Layering method is usually done in the plants that have long and slender branches, e.g. jasmine.

(iii) Grafting is also a method of vegetative reproduction in stems, where new plants of desired qualities is developed from two different plants. The part that has shoot part is called scion and part having root is called stock. Scion is attached to the stock which provides support and basic requirement for the development of plant, e.g. apple, mango, rose, etc.



Vegetative propagation in leaf of *Bryophyllum*

(ii) Vegetative Reproduction by Leaves

When the leaf of some plants are hurried into the moist soil, the cut edges or margins of leaves develop a new plants that resemble to the parent, e.g. Bryopbyllum or sprout leaf plant.

(iii) Vegetative Reproduction by Roots and Bulbs

In some plants like sweet potato, dahlia, etc, a new plant develops through their roots and bulbs.

Note: Plants like cacti produces new plants when their parts get detached from the main plant body. Each detached part can grow into a new plant.

Advantages of Vegetative Propagation

- Plants produced with vegetative reproduction takes less time to grow and bear flower and fruits earlier than those produced from seeds.
- The new plants are the exact copies of parent plant because they are produced from a single parent.

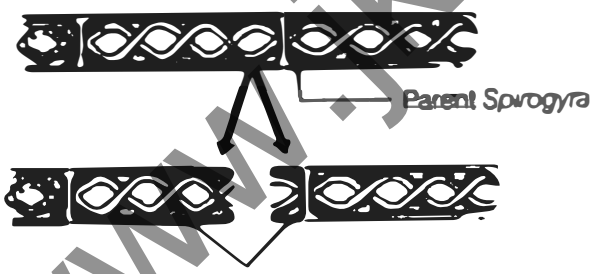
2. Budding

In this process, a daughter individual is formed from a small projection on parent body called a bud. Most of the fungi-like, yeast reproduce by budding.

Yeast grow and multiply in every few hours, if provided with sufficient nutrients and favourable condition.

3. Fragmentation

Some algae (Spirogyra) that are present in waterbodies reproduce by fragmentation. In this- method, he body of the parent breaks into small pieces called fragments and each fragment grows up to become a new plant. Fragmentation of parent body occurs when they are matured.

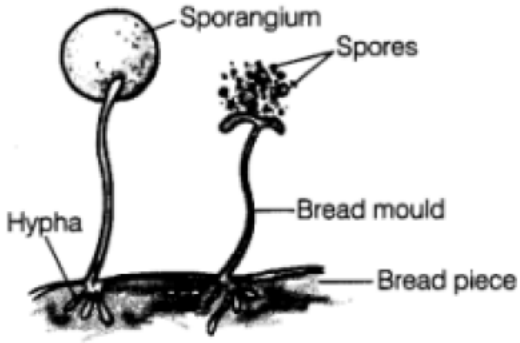


Fragmentation in algae (*Spirogyra*)

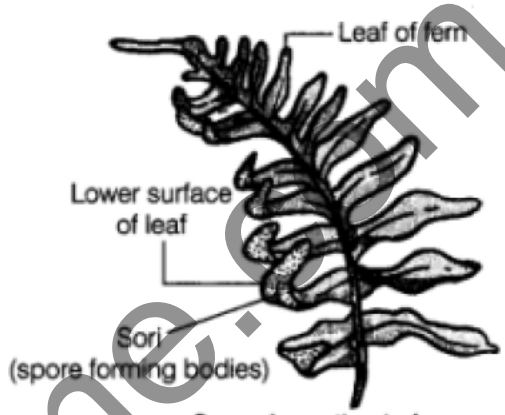
If water and nutrient are available, the algae will grow and multiply rapidly by fragmentation. If this process continues, it will cover a large area in a very short period of time.

4. Spore Formation

Some fungus like bread mould reproduces asexually by spore formation. Spores (present in the air) are the small spherical bodies, having a thick protective wall that protects them from unfavourable conditions. When favourable conditions arrive the spores burst and germinate to develop into new plants.



Reproduction in bread mould by spore formation



Spore formation in fern

Spore formation

Spores are very light asexually reproducing bodies which can be carried over a long distance by air or wind. Some other plants like mosses and ferns also reproduce by spore formation in the underside of their leaves.

Sexual Reproduction

Flowers are the reproductive part of a plant. They help the plants in sexual reproduction and producing fruits and seeds. In sexual reproduction, a male cell is produced by the male part of a flower which fuses with a female cell produced by the female part of the flower. These cells are called gametes, which when combined form a zygote by the process called fertilisation.

Parts of a Flower

The main parts of a flower are

(i) Sepals These are the green leaf-like outermost circle of the flower. All the sepals are together referred to as calyx. The function of the calyx is to protect the flower when it is in bud form.

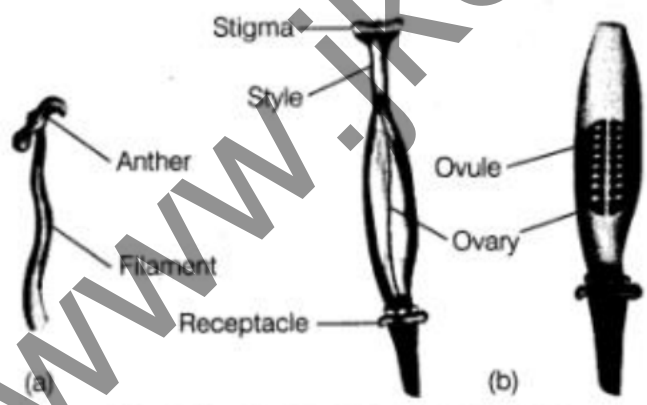
(ii) Petals These are the colourful and most attractive part of the flower. These lie inside the sepals. All the petals are together referred to as corolla. These are scented and attract insects for pollination.

(iii) Stamen It is a male reproductive organ of a plant. These are the little stalks with swollen top and lies inside the ring of petals. The stamen is made up of two parts, i.e. filament and another. The stalk of stamen is called filament and the swollen top of stamen is called anther.

The anther contains the pollen grain which have male gamete in it. Pollen grains are exposed when the anther ripens and splits. These appear as the yellow powder like substance which is sticky in nature. Flowers usually have a number of stamens in it.

(iv) Pistil It is the female reproductive part of a flower that lies in the centre of a flower. These are a flask-shaped structure which is made up of three parts, i.e. stigma, style and ovary.

The top part of the pistil is called stigma. It receives the pollen grains from the anther during pollination. The middle part of the pistil is tube-like structure called style which connects stigma to the ovary.



Reproductive parts of a flower:
(a) Stamen and (b) Pistil

The swollen bottom part at the base of pistil is called ovary. The ovary makes ovules and stores them. These ovules contain the female sex cells also called an egg cell. It is the female gamete of flower. Pistil is also

called as carpel. The pistil is surrounded by several stamens.
The base of the flower on which all the parts of the flower are attached is called receptacle.

Types of Flower

On the basis of the type of reproductive organs present in a flower, the flowers are of following types:

(i) Unisexual flower: The flower which contains only one reproductive organ (i.e. either male or female) are called unisexual flowers. These are also called as an incomplete flower, e.g. papaya, watermelon, corn, cucumber, etc.

(ii) Bisexual flower: The flower that contains both reproductive parts (i.e. male and female) in a single flower are called a bisexual flower. These are also termed as hermaphrodites or complete flower, e.g. rose, mustard, Hibiscus, etc.

Function of a Flower

The function of a flower is to make male and female gametes and also to ensure that fertilisation would take place for the seed formation. During sexual reproduction male and female gametes fuse to form the zygote.

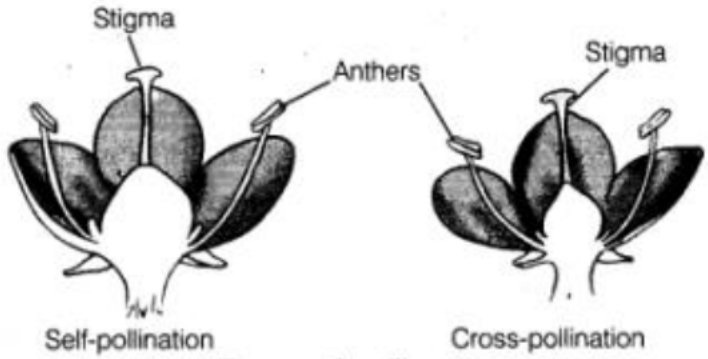
Pollination

The transfer of pollen grains from the anther of a stamen to the stigma of a pistil is called pollination. Pollination takes place in two different ways:

(i) Self-pollination: When the pollen grain from the anther of one flower reaches to the stigma of the same ‘ flower, it is called self-pollination. Self-pollination generally occurs in a bisexual flower.

(ii) Cross-pollination: When the pollen grains from the anther of a flower or of a plant are transferred to the stigma of a flower of the same plant or that of a different plant of the same kind the process is called cross-pollination. This transfer to another plant is mediated by insects, wind,

water, animals, birds, etc.



Types of pollination

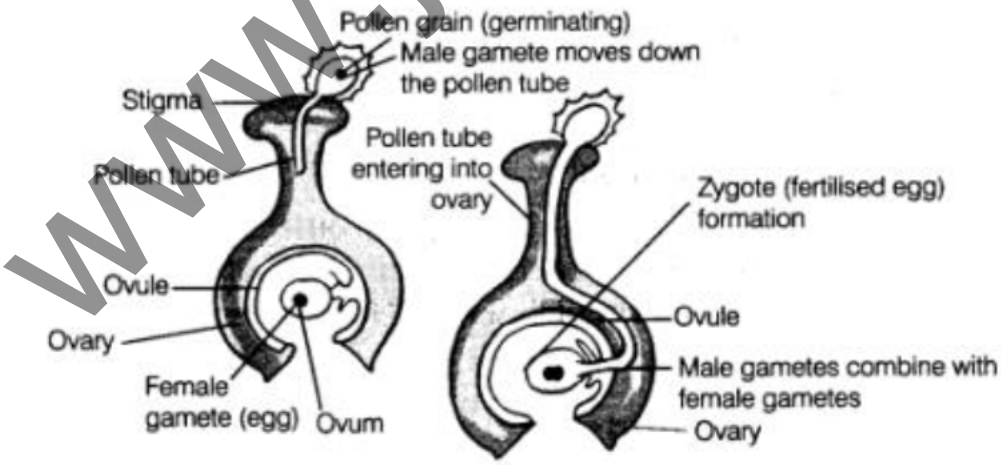
Agents of Pollination

The process of pollination is carried out by some external agencies like wind, water, insects, birds, etc. These are called agents of pollination.

Fertilisation

The process in which the male gamete fuses with the female gamete to form a new cell (called zygote) is called fertilisation.

When the pollens are deposited on the stigma of the pistol, it begins to germinate. After some time, a long pollen tube is developed from the pollen grain which passes through the style towards the female gametes in the ovary. The male gametes move down the pollen tube and the tube enters the ovule present inside the ovary.



The process of zygote formation: fertilisation

The tip of pollen tube bursts and the male gamete comes out of the pollen tube. Inside the ovary, the male gametes fuse with the female gametes present in the ovule to form a fertilised egg cell which is called zygote. The zygote develops into an embryo which is a part of a seed that develops into a new plant.

Fruit and Seed Formation

After the fertilisation, the ovary grows into the fruit and the ovule develops into the seeds. The outer parts of the flower, i.e. petals, sepals and stamen become dry and fall off. Stigma and style also fall off leaving ovary on the receptacle. The zygote inside the ovary gets its food from the ovule and grows by cell division to form an embryo. Parts of the ovule develop into the seed covering or seed coat.

Fruits are the ripened ovary of a flower. Which protect the seed. Some fruits are fleshy and juicy, e.g. mango, apple and orange, while some are hard like almonds and walnuts.

Seed Dispersal

Seeds are developed from the ovule. Seeds contain an embryo enclosed in a protective seed coat. Plants produce a large number of seeds. When these seeds fall down, they start growing. If a large number of seeds falls on the same place, they will not get enough space for water and light, and will not develop into a healthy plant. Thus, the seeds are moved away by some external agencies to far off places.

The process by which the seeds are scattered to different places (far and wide from their parents) is called dispersal. The seeds and fruits are dispersed away through various agencies like wind, water, birds and some animals. Sometime seed dispersal takes place naturally by the explosion or bursting of fruits.

Seed Dispersing Agents

Wind, water, animals, birds and humans are the dispersing agents of seeds. These are described below:

Dispersal by Wind or Air

The seeds that are very light and have wing or hair-like structure on them, are easily carried away by the blowing wind, e.g. seeds of maple, drumstick have wings, seeds of Madar or oak have hairs on them, cottonseed also possess hairs on them, while seeds of grasses, orchids, begonia are very small and light. These seeds can be easily carried away by the wind and dispersed away from their natural habitat.

Dispersal by Water

The seeds of some plants that have an outer fibrous or spongy covering are dispersed through water. They have the ability to float in the water and drift along with its flow, e.g. seeds of water lily, lotus, chestnut (singhara) and coconut are dispersed through water. The coconut fruits have a fibrous outer coat which enables them to float in water and carried away by flowing water to far off places.

Dispersal by Birds

The birds eat fruits along with the seeds. These seeds have hard outer covering. The seeds are dispersed to some other place through the bird's faeces. The digestive enzymes present in the digestive system of birds helps in dissolving the hard seed coat and when they are released or excreted along with the faeces, they germinate, e.g. neem seeds are dispersed by the bird's faeces.

Dispersal by Animals

Some seeds have hooks or spines which get attached to the fur or body of the grazing animals. When these animals move to a distant place, the seeds get dispersed (while animal rub their body surface), e.g. fruit of Xantbium and Urena plants are covered by numerous hooks which attach to the animal's fur and are dispersed with them. Along with the fruits, the seeds also get dispersed.

Dispersal by Explosion or Bursting of Fruits

Sometimes fruits mature and a strain is produced in their walls. This produces a sudden jerk causing fruits to break open, thus allowing the

seeds to scatter far away from their parent plants. Due to the explosion of fruit, the seeds are thrown away from the plant with a great force in all direction, e.g. castor plant burst suddenly with a jerk and scatter the seeds far away from the parent plant. Similarly, fruit of balsam is also dispersed through the explosion mechanism.

Benefits of Seed Dispersals

- Seed dispersal avoids overcrowding of young plants around their parent plants.
- It helps in preventing competition between the plants and its own seedlings for sunlight, water and minerals.
- One of the benefits of seed dispersal is that it enables the plant to grow into new habitats for wider distribution and provides them with a better chance of survival.

Germination of Seed

A seed contains a plant embryo in a resting state which begin to grow only under favourable conditions. The process by which seeds begin to grow is called seed germination. It is the growth of a plant from its seed. When the seed germinates, the seed coat splits and a tiny root called radicle grows downward and shoot called plumule starts growing upwards. This produces seedling of the plant.

The seedling grows faster and ultimately forms a new plant. When the plant starts maturing, it bears flower which again produces seed and fruits. This cycle continues to produce more offsprings for the preservation of a species.

Chapter 13

Motion and Time

In our daily life routine, we usually see some objects at rest and others in motion like birds fly, fish swimming, planets moving around the sun, etc., are all in motion. When an object changes its position with time, we often perceive an object to be in motion, e.g. when the position of a car changes with time, we say that the car is moving or the car is in motion.

Types of Motion

The motion of all the objects are not of the same type. There are four different types of motion shown by the different objects.

Rectilinear motion: The motion possessed by the body moving along a straight line path, is called rectilinear motion,
e.g. the motion of a train on a straight bridge.

Circular motion: The motion possessed by a body when it moves along a circular path, is called circular motion,
e.g. the motion of a child in a merry-go-round, motion of the earth around the sun in a circular orbit.

Rotational motion: The motion possessed by a body when it spins about a fixed axis, is called rotational motion,
e.g. the motion of the earth about its axis, spinning top, the motion of blades of a fan.

Periodic motion: The motion which repeats itself after regular intervals of time, is called periodic motion,
e.g. the motion of the swing, to and fro motion of a simple pendulum.

Slow or Fast Motion

An object which takes a long time to cover a certain distance is known as

slow while the other object which takes shorter time to cover the same distance is known as fast, e.g. if your school is at a distance of 5 km from your home and you want to go to school by bicycle, then it may take about 25 min to reach the school and if you go to school by school bus, then the same distance can be covered only in 10 min.
It means that a bicycle takes a longer time than the bus.
Thus, the most convenient way to determine which of the two objects is moving faster is to compare the distance moved by them in a unit time which is known as speed.

Speed

The distance travelled by an object per unit time (either in one hour, in one minute or in one second) is known as speed of the object. A slow moving object is said to have a low speed and a fast moving object is said to have high speed. So, if we know the distance covered by two buses in one hour, then we can answer which one is slower. Therefore, the formula for calculating the speed of an object can be given by

Speed = $\frac{Distance travelled}{Time taken}$

e.g. If a car travels a distance of 100 km in 2 h, then the speed of this car is given by

Speed = $\frac{100 km}{2 h}$ = 50 km/h

It shows that the car will travel a distance of 50 km in 1 h. It does not matter if a car seldom moves with a constant speed for one hour as it starts moving slowly and then picks up speed. So, when we say that the car is moving with a speed of 50 km/h, then we do not bother whether the car has been moving with a constant speed or not during that hour. Therefore, the speed calculated here is the average speed of the car.

Non-Uniform and Uniform Motions

In everyday life, we seldom find objects moving with a constant speed over long distances or for iong durations of time. If the speed of an object moving along a straight line beeps changing, its motion is said to be non-uniform motion.
On the other hand, an object moving along a straight line with a constant

speed is said to be in uniform motion. In this case, the average speed is the same as the actual speed.

Units of Speed

The unit of speed depends upon the unit of distance and the unit of time used.

- The metre is the standard unit of distance and second is the standard unit of time. So, the standard unit of speed is metre per second (m/s).
- The large values of speed are expressed in kilometre per hour (km/h) and in this case, the distance travelled is measured in terms of kilometre and time taken is measured in an hour.
- The small values of speed are expressed in centimetre per second (cm/s) and in this case, the distance travelled is measured in terms of centimetre and time taken is measured in second.

If we have to compare the speeds of a number of objects, then we must express the speeds of all those objects in the same unit.

Measurement of Time

A duration or moment in which things occur is known as time. With the help of clocks and watches, we generally
measure time. It is very difficult to think that how did the people in ancient time measure times as they did not have clocks or watches.

In order to measure the time, ancient people used some natural events which repeated regularly after fix time intervals, e.g. they found that the sun rises every day in the morning. So, the time between one sunrise and the next I was known as a day. In a similar manner, time from one full moon to the next full moon was. called a month.

A year was fixed as the time taken by the earth to complete one revolution of the sun.
Many time measuring devices were used in different parts of the world

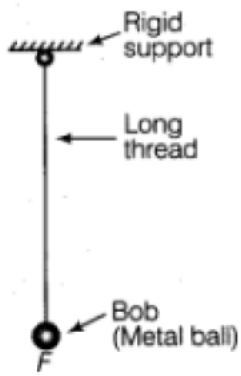
before the pendulum clocks became popular. Sundials water clocks and sand clocks are some examples of such devices.

Note

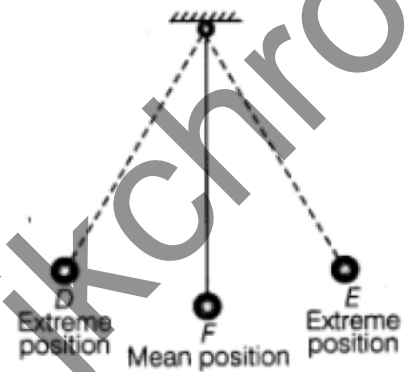
(i) A sundial measures time by the position of the shadow cast by the sun.
(ii) The device which uses the flow of sand from one glass bulb to another in order to measure time is known as a sand clock
(iii) A device which uses the rate at which water drip from one vessel to another measure time interval is known as a water clock

Simple Pendulum

A simple pendulum consists of a small metal ball called bob which is suspended by a long thread from rigid support such that bob is free to swing back and forth. The to and fro motion of a simple pendulum is an example of periodic or oscillatory motion. Galileo was the first person to study the motion of a pendulum.



Simple pendulum



Motion of a simple pendulum

A pendulum completes every swing or every oscillation in exactly the same time provided its length should be kept constant. The pendulum is said to have completed one oscillation when its bob starting from its mean position F, moves to D, to E and back to F. The pendulum also completes one oscillation when its bob moves from one extreme position D to the other extreme position E and come back to D. So, the time taken by the pendulum to complete one oscillation is called its time period. The time period of a pendulum depends on its length. The length of a pendulum is the length of thread from the point of suspension to the centre of the bob.

Note: Galileo experimented with various pendulums to verify his observation. He found that a pendulum of a given length tabes always the same time to complete one oscillation. This observation led to the development of pendulum clocks. Winding clocks and wristwatches were refinements of the pendulum clocks.

Units of Time

Second is the basic unit (or standard unit) of measuring time and it is represented by symbol s. The larger units of time are minute and hour.
i.e. 1 h = 60 min and 1 min = 60 s
Different units of time are used depending on the need, e.g. in order to express the longer time interval, the bigger units of time are used, i.e. day, month and year.
i.e. 1 day = 24 h, 1 month = 30 days and 1 year = 12 months

Note: Nowadays, most clocks or watches have an electric circuit with one or more cells. These clocks are called quartz clocks. The time measured by quartz clocks is much more accurate than that by the clocks available earlier.

Measuring Speed

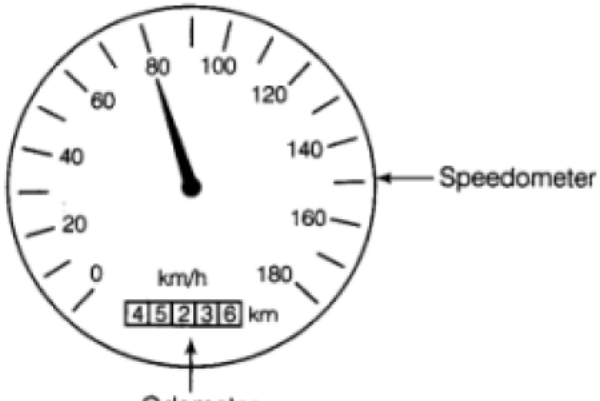
We have learnt how to measure distance and time, we can calculate the speed of an object. Now, we should learn how to measure the speed by doing an activity.

Speedometer and Odometer

The speedometer is an instrument on a vehicle's dashboard which indicates the speed of the vehicle when it is moving. This instrument tells us the speed of a running vehicle at that instant of time in kilometre per hour.

e.g. A panel of instruments fitted on the top of a scooter or a motorcycle. In the same way, metres can be seen on the dashboard of cars, buses and other vehicles in addition to the speedometer, there is another instrument in a vehicle called odometer. An instrument which is used for measuring

the distance travelled by a vehicle is known as an odometer. This instrument measures the distance in kilometres. Usually, a small rectangular window within speedometer dial with the symbol km (as shown in the figure) gives the (metre) odometer reading.



Speedometer and odometer

Graphical Representation of Motion

By drawing the distance-time graph, the motion of an object can be represented in diagram form. A distance-time graph represents how the distance travelled by a moving object changes with time.

Method to Draw Distance-time Graph

To draw a distance-time graph, use a graph paper. For drawing the distance-time graph for a moving object, we require the readings of distances travelled by the object and the corresponding time values which have been obtained experimentally.

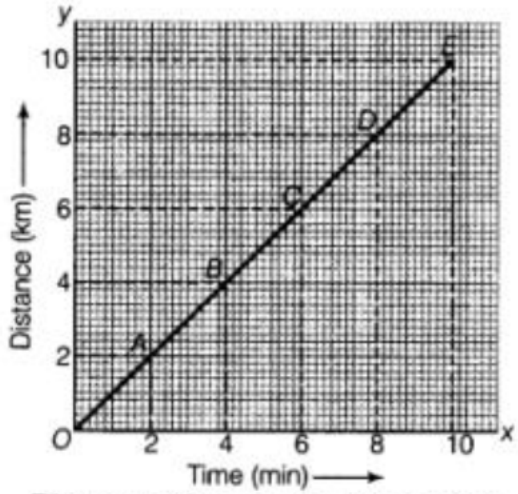
The distances travelled by car at various times are shown below:

Distance(km)	0	2	4	6	8	10
Time (min)	0	2	4	6	8	10

- Firstly, we take the graph paper and draw a horizontal line OX (x-axis) and a vertical line OY (y-axis) at right angles to each other.
- Now, write time (min) on x-axis and distance (km) on the y-axis and also put arrows with them.
- In this problem, we have only small time values (0, 2, 4, 6, 8 and 10 min) to represent. So, the scale to be used for showing time can be 2 min = 2 cm. Here, we mark the time values 0, 2, 4, 6, 8 and 10 on the line OX as shown in the figure given as alongside.
- Again, the distance values given in this problem are small (0, 2, 4, 6, 8 and 10 km). So, the scale to be used for representing distance values on the graph can be 2 km = 2 cm. We now mark the distance values 0, 2, 4, 6, 8 and 10 on the line OY (see figure).
- We can see in the graph that the first reading given in this problem is time = 0 and distance = 0. The point O (called origin) represents the 0 (zero) values both for time and distance. Therefore, at point O on graph paper, time is 0 and distance is also 0. The second reading is time = 2 min and distance = 2 km.
- Now, the vertical line above the 2 min mark on the graph paper and horizontal line on the right side of 2 km mark on graph paper cross at point A (see figure). So, we put a pencil dot at point A.
- In the same way, the third, fourth, fifth and sixth readings of time and the corresponding readings of distance will give us points B, C, D and E on the graph paper which are marked as pencil dots (see figure).
- After joining the point O and the dots at point A, B, C, D and E with a pencil line, we will get a straight line graph OE (see figure). So, this is the required distance-time graph for the motion of the car.

Since the distance-time graph for the motion of the car is a straight line, so from here we can conclude that the car is moving with a constant speed (or

uniform speed).

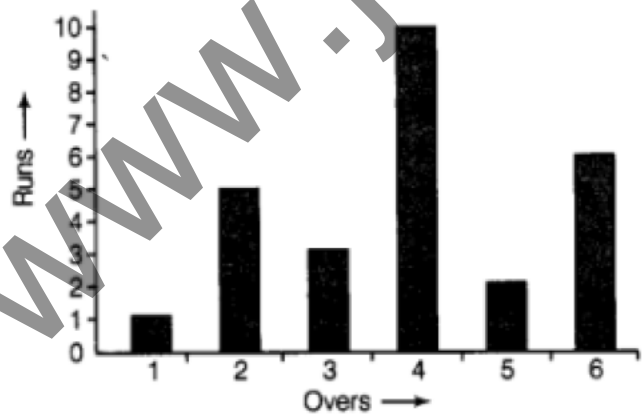


Distance-time graph of the car

Other Types of Graph

We generally see while reading newspapers, magazine, etc., that the present information is represented in various forms of graphs in order to make it interesting. These graphs generally bar graphs and pie chart as shown in the figure.

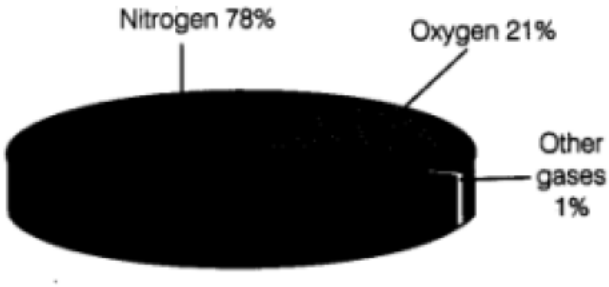
A diagram which shows information as thin rectangles (known as bars) of different heights is known as a bar graph. In this graph, the position and heights of the bars represent the values of the variable quantity about which information is being given.



A bar graph showing in the runs scored in six overs of a cricket match

A kind of graph or diagram which shows the percentage composition of

something in the form of slices of a circle (the whole circle representing 100 per cent), is known as a pie chart.



A pie chart showing the composition of air

Chapter 14

Electric Current and Its Effects

The most convenient source of energy is electricity. Electricity has a very important role because it is used to run many electrical appliances like an electric bulb, television, a stereo system, refrigerator, washing machine, computers, etc., and we cannot think our life without making use of electricity.

Electricity is produced at power stations from where it is brought to our homes through the thin wire and electric poles networks or underground cables (or wires). Here, we can define the electric current as of the flow of electricity through a conductor (wires, cables).

Actually, in everyday life, the word electricity and electric current are used in the same sense. There is another source of electricity, i.e. electric cell or battery. Now, in order to obtain electricity from a cell or battery, we have to connect it into a circuit. So, let us study about the electric circuit.

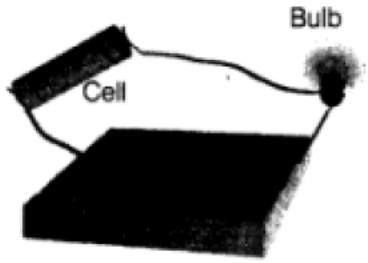
Electric Circuits

A continuous conducting path (consisting of wires, bulb, switch, etc.) between the two terminals of a cell or battery along with an electric current flows, is known as an electric circuit.

e.g. take a cell having a positive terminal (+) and a negative terminal (-). Now try to connect the positive terminal of the cell to one end of the switch with a piece of copper wire and other ends of the switch to one end of bulb holder with another piece of copper wire.

The negative terminal of the cell is connected directly to the other end of the bulb holder with a wire (as shown in the figure), so this kind of setup is

known as an electric circuit.



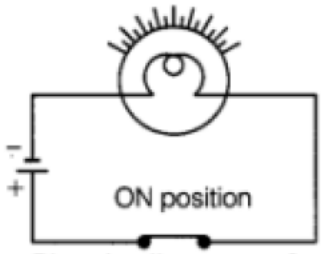
An electric circuit

Circuit Diagram

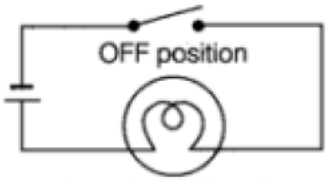
A circuit diagram tells us how the various components in an electric circuit have been connected by using the electrical symbols of the components.

(i) When the bulb glows In an electric circuit when the switch is closed, then the switch is said to be in the ON position. And when the switch in a circuit is open, then the switch is said to be in the OFF position. So, in an electric circuit, a bulb lights up only when the switch is in the ON position and at that time, we can say that the electric circuit is complete because the current flows throughout the circuit instantly (as shown in the figure) electric circuit

(ii) When the bulb does not glow While checking the circuit notice that sometimes the bulb does not glow even when the switch is in the ON position. This condition can occur only if the bulb gets fused, i.e. its filament breaks. It is a difficult and time-consuming job to draw the electric circuit by making the actual drawings of cell, battery, switch, bulb, etc.



Circuit diagram of electric circuit



Another circuit diagram

So, the scientists have devised a very easy way to represent the component of an electric circuit (cell, battery, switch, bulb, etc.) with the help of symbols, which are easy to draw.

Some of the commonly used symbols for electric components are shown here:

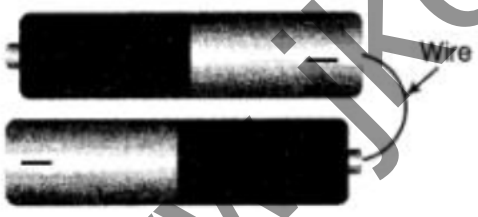
Electric component	Symbol
Electric cell	
Electric bulb	
Switch in ON position	
Switch in OFF position	
Battery	
Wire	

Electric Cell and Battery

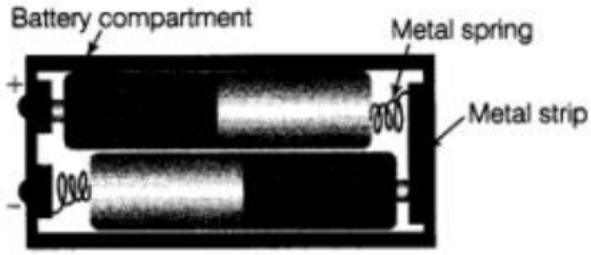
The common source of electricity to run the number of devices, e.g. torches, radio, electric clocks and watches, toys, etc., is an electric cell, but sometimes a single cell is not sufficient to run many devices as they require high voltage to run all these appliances. The cell provides much less electricity as compared to that provided by the electric supply line, e.g. in the case, a single electric cell which provides only 1.5 V of electricity, whereas electricity from the power station is supplied to our home at very high voltage of 220 V.

Combination of Electric Cells

Since the higher voltage can be obtained by combining a number of cells in series. So, when the positive terminal of one cell is joined with the negative terminal of the other cell, then the cells are said to be joined in series (as shown in figure given below). So, a battery can be defined as the group of cells joined together in the series, e.g. in a torch, the cells are placed one after the other. But in many devices, cells are not placed one after the other, e.g. in a TV remote control, the two cells are placed side by side (or parallel to each other) instead of single one. So, two or more cells connected in side by side manner are said to be joined in parallel. This combination is also known as battery.



A battery of two cells



Connecting two cells together to make battery

If we combine two cells by keeping the positive terminal of one cell in contact with the positive terminal of the other cell or negative terminal of one cell in contact with the negative terminal of the other cell, then the battery obtained will not work.

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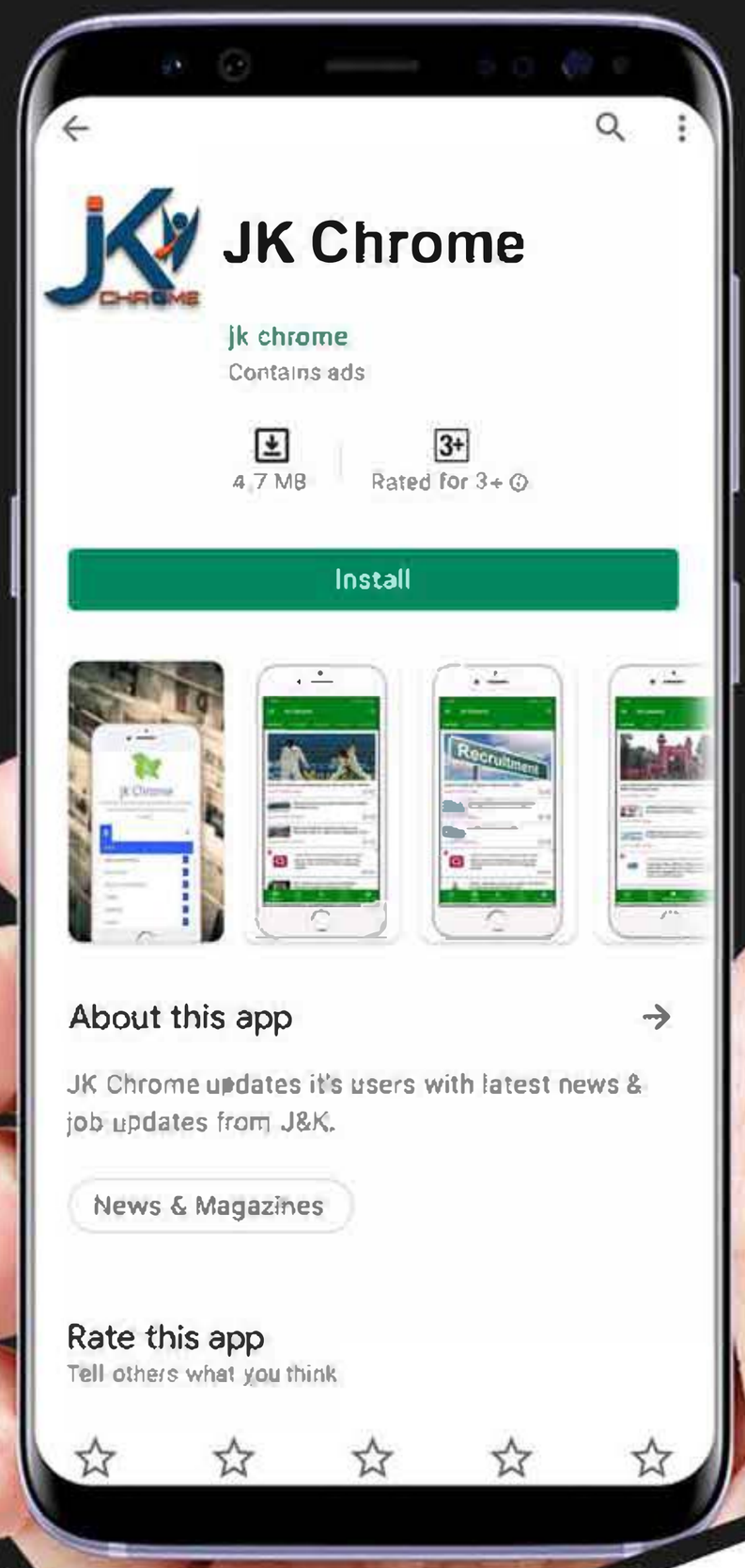

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The batteries which are used in cars, buses, trucks, inverters, etc., are also made of cells. There is a special feature of car battery is that its cells can be recharged. Ordinary cells, however, cannot be recharged.

Connection of Cells/Battery

'+' and '-' symbols are printed in the battery in order to have an exact placement of the cells in their respective battery compartment.

- The switch or key can be placed anywhere in the circuit.
- The circuit is complete and it is said to be closed only when the switch is ON.
- The circuit is incomplete and it is said to be open, only when the switch is OFF.

There is a thin wire in the bulb, called filament which glows when an electric current passes through it. So, if the bulb gets fused, then its filament gets broken.

Note: Never touch a lighted electric bulb connected to the mains as it may be very hot and can damage your hands.

Heating Effect of Electric Current

Production of heat in an electric device due to the flow of electric current is called the heating effect of electric current. We have seen an electric heater used for cooking, an electric bulb or room heater. So, when these appliances are switched ON after connecting to the electric supply, then their elements become red hot and release the heat. This happens due to the heating effect of electric current.

The degree to which a material opposes the passage of current through itself is known as its resistance. Actually, when an electric current passes through a high resistance wire, the electric energy gets converted into heat energy and this heat energy heats up the wire.

Element

All electrical heating devices consist of a coil of wire called an element.

When these appliances are switched ON after connecting to the electric supply, then their elements become red hot and release the heat. There are some electric appliances such as immersion heaters, hotplates, irons, geysers, electric kettles, hair dryers, etc., which have elements inside them.

Factors on Which the Heating Effect of Current Depends

There are two factors on which the heating effect of current depends:

(i) Resistance of wire: Greater the resistance of a wire, greater will be the heat produced in it by a given
current, e.g. if we choose two wires, one of copper and other is nichrome of equal length and equal thickness and pass them the equal amount of current through them for the same duration, then we will notice that nichrome wire will become hotter in comparison to the copper wire. It is due to the reason that the resistance of nichrome wire is more than that of the copper wire.

That is why the nichrome wire is used to make heating elements of electric heating appliances such as electric room heater, electric iron, etc. The resistance of a wire depends on the material of the wire, length of wire and thickness of the wire.

(ii) Magnitude of current passed through a given wire: If the magnitude of current passed through a given wire is greater, then the heat produced in it will also be greater, e.g. if a normal amount of current flows through the copper wires of household electric wiring, then the wires do not become much hot but if a large current flows in the same wiring accidentally, then the wires become extremely hot and a fire may be started.

Applications of the Heating Effect of Current

Some of the important applications of heating effect of electric current are

- For the production of light, the heating effect of electric current is utilised in the electric bulbs.
- For the working of electrical heating appliances such as water heater, electric room heater, electric iron, etc., the heating effect of electric current is utilised.

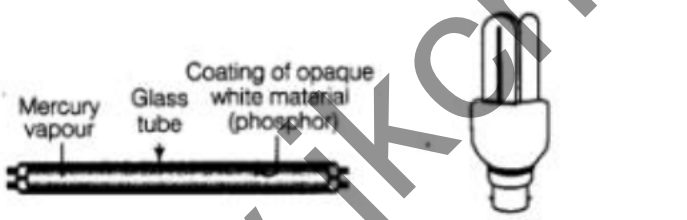
- The heating effect of electric current is utilised in a safety device called 'electric fuse'.

Glowing filament of an electric bulb

Compact Fluorescent Lamps (CFLs)

An electric bulb is basically used for producing light but it also releases the heat which is not desirable because a major part of the electricity consumed by the filament of a bulb is converted into heat and results in the wastage of electricity. So, this wastage can be decreased by using fluorescent tube light or CFLs (as shown in the figure) in place of the bulbs.

However, before purchasing bulbs, tubes orCFL's we should look for the ISI marl? (ISI- Bureau of Indian standard). It is because the ISI mark ensures that the appliance is safe and wastage of energy is minimum.

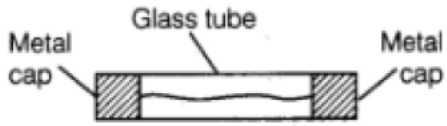


Fluorescent tubelight Compact Fluorescent Lamp (CFL)

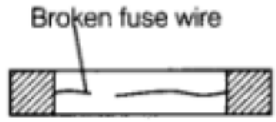
Electric Fuse

A safety device which works on the heating effect of current and prevents electric fires or damage to electrical appliances due to excessive flow of current is known as the fuse. This safety device consists of a short length of a thin wire of tin plated copper having a low melting point and this wire has a much greater resistance than the rest of the electric wiring in the house.

So, due to this, if the current in the electric wiring suddenly increases too much, then the fuse wire gets heated, then it melts and breaks the circuit which means that the current flowing in the household circuit will stop. This prevents fire in the house and also the damage of various electrical appliances like refrigerator, fans, tube lights, TV, etc. When a fuse gets blown (breaks), a new fuse has to be fitted in its place in order to restore the electricity supply in the household circuit.



The fuse used in an electrical appliance



This is blown up fuse

Note: We should not use a thick wire as a fuse wire because it will have low resistance and thus it will not get heated to its melting point ' when a large current passes through it.

Cause of Large Current Flow in Household Electric Wiring

An extremely large current can flow in the household electric wiring circuits under two circumstances overloading and short circuit. We might have read reports in the newspaper about fires caused by short circuits and overloading. Now, let's study these two terms.

Overloading

It is a situation when too many electrical appliances are connected to a single socket, they draw an extremely large amount of current from the household circuit. The flow of large current due to overloading may heat the copper wires of household wiring to a very high temperature and fire may be started.

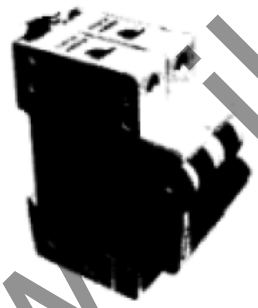
Short Circuit

Electric current is supplied by household through two insulated wires

which run together and reach each and every electrical appliances. One insulated wire is called live wire and the other insulated wire is called neutral wire and both these wires are necessary for the working of an electrical appliance (say an electric iron).

So, if in case the plastic insulation of the live wire and the neutral wire gets worn due to wear and tear, then the two naked wires touch each other. So, this touching of live wire and neutral wire directly is known as a short circuit. Due to which a large current flows through the household wiring and this large' current may heat the wires to a dangerously high temperature and a fire may be started.
Note: Always use proper fuses which have been specified for particular applications carrying ISI mark Never use just any wire or strip of metal in place of a fuse.

Miniature Circuit Breakers (MCBs)
This ore increasingly being used these days in place of fuses. MCB does not work on the heating effect of current as it works on the magnetic effect of current. These switches outomaticoUy turn OFF when the current in a circuit exceeds the safe limit. We turn them ON and the circuit ¡s once again completed.



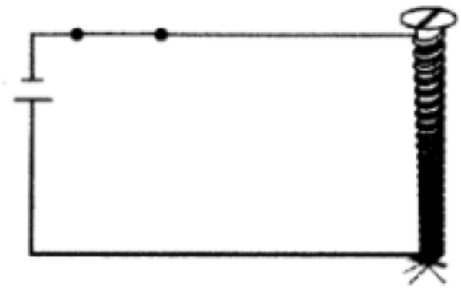
Miniature Circuit Breaker (MCB)

Magnetic Effect of Electric Current
If the electric current passes through a wire, then the current carrying wire behaves like a magnet. This phenomenon is known as the magnetic effect of current. It was discovered by a scientist Hans Christian Oersted who found that when an electric current is passed in a wire, then the compass needle placed near it got deflected from its usual North-South position.

A straight wire carrying an electric current produces a magnetic effect. The magnetic effect is increased only if we use a long coil of wire instead of a straight wire. Even further the magnetic effect is increased if the coil of wire is wound around an iron rod and then current is passed through it.

Electromagnets

It is a magnet made by using electric current. An electromagnet works on the magnetic effect of current. An electromagnet consists of a coil of insulated wire wrapped around a piece of iron which is magnetised only when an electric current is passed through the coil.



An electromagnet

This magnet consists of a long coil of insulated copper wire wound around an iron rod and when the two ends of the coil get connected to a cell, then a current passes through the coil and produces a magnetic effect. The magnetic effect magnetises the iron rod. In this way, the iron rod becomes an electromagnet. The magnetism of an electromagnet remains as long as the current is flowing in its coil. So, if we switch OFF the current in the coil, then all the magnetism of the iron rod disappear and it will no longer behave like a magnet.

There are two factors through which an electromagnet can be made stronger, i.e.

- By increasing the amount of current used in the coil.
- By increasing the number of turns forming the coil.

Uses of Electromagnets

- These magnets are used in electrical appliances such as an electric bell, electric fan, electric motor.

- These magnets have their utilisation in electric generators where the very strong magnetic field is required.
- For deflecting electron beam of the picture tube of TV electromagnets are used.
- For the magnetic separation of iron ores from the earthly substances, electromagnets are used.
- For preparing strong permanent magnets, electromagnets are used.

Advantages of Electromagnets over Permanent Magnets

An electromagnet is a temporary form of the magnet because its magnetism is only for the duration of current flowing in its coil. Actually, an electromagnet is better than a permanent magnet in many respects. There are some of the advantages of the electromagnets over the permanent magnets which are stated as follows:

- The magnetism of an electromagnet can be switched ON or switched OFF as desired. While it is not possible with a permanent magnet.
- By increasing the number of turns in the coil and by increasing the current passing through the coil an electromagnet can be made very strong. On the other hand, a permanent magnet cannot be made so strong.

Electric Bell

An electric bell works on the magnetic effect of current. It has an electromagnet in it. Let us study its construction and working as well.

Construction of Electric Bell

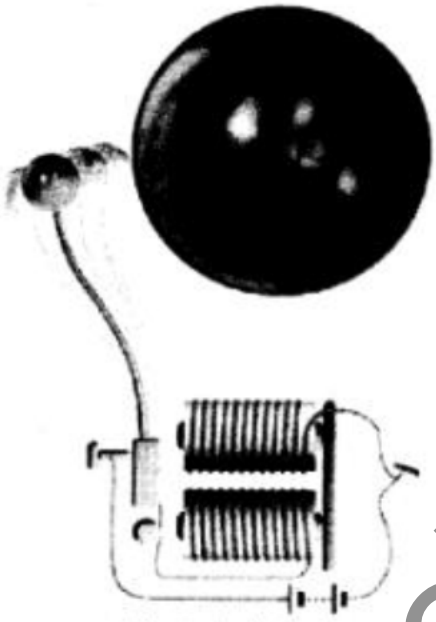
The electric bell has a U-shaped electromagnet. There is a small iron bar called armature which is h^d in front of the poles of the electromagnet. The lower end of the iron bar is attached to a flat spring and the flat spring is itself fixed to a metal bracket. The upper end of the iron bar has a clapper attach to it. A metal gong is fixed near the clapper.

Working of Electric Bell

In order to ring the bell, first of all, we press the push button switch in order to ring the bell. So, when we press the switch, then the electric

circuit of the bell is completed and a current passes through the coil of the electromagnet and it gets magnetised. The electromagnet attracts the iron armature towards itself.

So, as the armature moves towards the poles of the electromagnet, the clapper attached to it strikes the gong and produces a ringing sound. It implies that the bell rings.



Electric bell

When the armature moves towards the magnet, its contact with the contact screw is broken. Due to this, the electric circuit breaks and no current flows in the electromagnet coil. The electromagnet loses its magnetism for a moment and the armature is no longer attracted by it. The flat spring brings back the iron armature to its original position and the clapper also moves away from the gong.

As soon as the armature comes back and touches the contact screw the circuit is completed and current starts flowing in the electromagnet coil again. The electromagnet attracts the iron armature once again and the clapper strikes the gong again producing a ringing sound.

So, this process of 'make and break' of the electric circuit continues as long as we are pressing the switch. Due to this, the armature vibrates forwards and backwards rapidly each time making the clapper strike the gong. Thus, the clapper strikes the gong rapidly producing an almost continuous sound.

Chapter 15

Light

In this world, we usually see a variety of objects. Sometimes, we are unable to see anything in a dark room but on lighting up the room, we are able to see the things in the room. Since, it is an obvious question arising that what makes thing visible.

So, its answer is light. Light is a form of energy which enables us to see objects from where it comes or reflected. We can detect light with our eyes.

Light Travelling along a Straight Line

By seeing the phenomena around us like a beam of sunlight enters a room through a narrow opening or a hole and beams of light coming out from the headlamps of cars, scooters, engines, torch, etc.
From the above examples, we can conclude that light travels along a straight line.

Reflection of Light

There are some certain situations in which a mirror or shiny surfaces like stainless steel plate, shining steel spoon act as a mirror, can change the direction of light that falls on it. So, this process of change in direction of light by a mirror is called a reflection of light. The surface of the water can also act as a mirror and can also change the path of light and that is why we see the reflection of trees or buildings in the water.

Image of An Object

Generally, when we look into a mirror, then we see our face. Actually, what we see in the mirror it is exactly a reflection of our face, hence it is known as an image of our face. In this case, our face is the object and what we see in the mirror is its image. The image of our face seen in the mirror is formed where light rays, after reflection from the mirror, seems to

originate from. The image of our face appears to be situated behind the mirror.

There are two types of images:

Real image: It is an image which can be obtained on a screen, e.g. the image formed on a cinema screen. When the light rays coming from an object actually meet at a point after reflection from the mirror, then it results in the formation of a real image.

Virtual image: It is an image which cannot be obtained on a screen, e.g. image formed by a plane mirror. When the light rays coming from an object appear to meet after reflection from the mirror, then it results in the formation of virtual image. It is not possible to form a virtual image on the screen because light rays actually do not pass the screen or cannot be received on a screen.

Characteristics of the Images Formed by a Plane Mirror

Now, we will describe the various characteristics of the images formed in a plane mirror by taking the example of the image of the candle.

(i) When we see the mirror, the image of candle appears to be formed behind the mirror.

(ii) Now, put a vertical screen behind the plane mirror (where the image of candle appears to be situated), then we will notice that the image of candle cannot be formed on the screen. Even if the screen is placed in front of the plane mirror, then the image of candle cannot be formed on the screen. Since, the image of candle formed in the plane mirror cannot be formed on a screen, which means that the image of candle in the plane mirror is a virtual image.

(iii) If we see the figure, then we will find that the length and breadth of the image of the candle and its flame to be the same as that of the original candle and its flame. The image of candle in the plane mirror is of the same size as the original candle.

(iv) Also if we see the figure, then we will find that the candle has a flame at the top and the image of candle also has a flame at the top. So, the top of the candle remains at the top in the image. In the same way, the bottom of candle remains at the bottom in an image. Such an image is called an erect image (or upright image). Therefore, the image formed by a plane mirror is erect.

Side Inversion (Right ⇔ Left)

When we see our image in a plane mirror, is it exactly like us? There is an interesting difference between us and our image. Let us find out this difference with the help of an example.

If we stand in front of a plane mirror and lift our right hand, then we see our image lift its left hand. And if we lift our left hand, then the image appears to lift its right hand.

This means that the right side of our body becomes the left side in the image while the left side of our body becomes the right side of the image. It appears as if our image has been 'reversed side ways' with respect to your body. The effect of reversing the sides of an object and its image is called lateral inversion.

So, we say that image formed in a plane mirror is laterally inverted.
So, we can understand why the word AMBULANCE is written as 3DMAJU9MA. When a driver of a vehicle ahead of an ambulance look in his/her rear view mirror, then he/she can read AMBULANCE written on it and give way to it. So, it is the duty of everyone of us to allow an ambulance to pass without blocking its way.

Spherical Mirrors

All the mirrors are not straight like plane mirror as some of the mirrors are curved mirror. There is a common example of a curved mirror, i.e. spherical mirror. A mirror whose reflecting surface is the part of a hollow sphere of glass is known as a spherical mirror.

Image Formed by Spherical Mirror

It is a fact that spherical mirrors form images of the objects placed in front of them. So, these images are formed, when light rays coming from the object fall on the mirror, get reflected and converge or diverge. We can use a spoon in order to understand the image formation by a spherical mirror.

The inside surface of a hollow sphere of glass is bent in or concave but the outside surface is bulging out or convex. So, the spherical mirrors are of two types:

- Concave mirror
- Convex mirror

e.g. A shining steel spoon represents both a convex mirror as well as a concave mirror. As the front side (or inner side) of a spoon is bent inward, so the front side of a shining spoon represents a concave mirror while the back side (or outer side) of a spoon is bulging outward, so the back side of a shining spoon represents a convex mirror as shown in figure.

Concave Mirror (Converging Mirror)

The mirror whose reflecting surface is concave (and polished surface is convex) is called a concave mirror.

The concave mirror reflects the parallel rays of light in such a way that after reflection, all the rays converge (or meet) at one point called focus in front of the mirror. Since a concave mirror converges a beam of parallel light rays. Therefore, a concave mirror is also known as a converging

mirror.

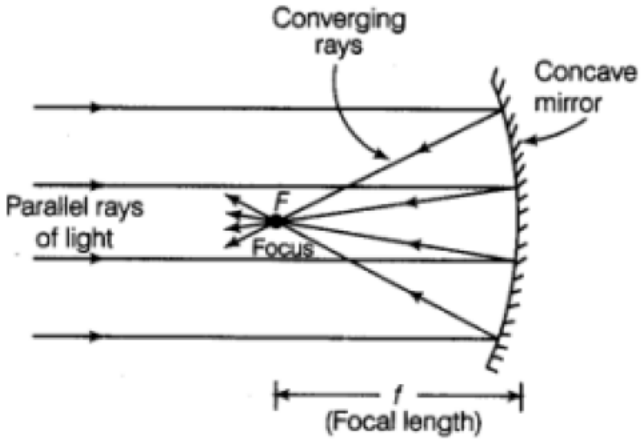


Image Formed by a Concave Mirror When the Object is Far Off

A concave mirror forms a real image of the sun. We can understand the formation of the image by a concave mirror when the object is far off by an activity.

Therefore, we can conclude that the image formed by a concave mirror is much smaller than the object (highly diminished) and real because it can be obtained on a sheet of paper (which is a kind of screen).
So, when an object is placed at a far off distance front a concave mirror, then image formed by a concave mirror is

- real
- inverted
- much smaller than the object.

Image Formed by a Concave Mirror When the Object is Placed Close to Concave Mirror

Let us perform an activity to understand the formation of image by a concave mirror when the object is placed close to the concave mirror.

Since the image can be observed only by looking into the concave mirror and cannot be formed on the screen, therefore, the image is virtual. If we look at the image in the concave mirror, we find it to be the same side up as the candle, so the image is erect. And if we compare the size of the

candle and its image, then we will find that the image is larger than the candle. Therefore, the image is larger than the object (enlarged or magnified).

Hence, we can conclude that when an object is placed close to a concave mirror, the image formed by the concave mirror is

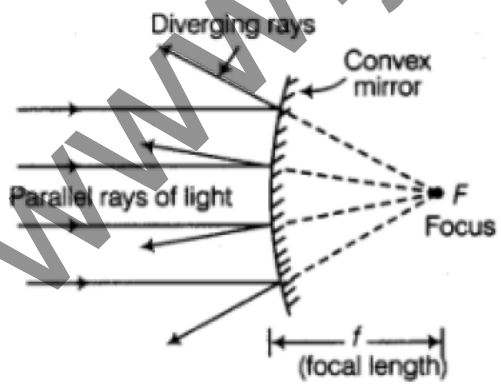
- virtual
- erect
- larger than the object (enlarged or magnified).

Uses of Concave Mirrors

- To see the large image of teeth of a patient, concave mirrors are used by the dentist.
- In torches, headlights of vehicles and searchlights to get a strong, straight beam of light, etc., concave mirrors are used as reflectors.
- To see a large image of the face, then concave mirrors are used as shaving mirrors.

Convex Mirror (Diverging Mirror)

The mirror whose reflecting surface is bulging or convex (polished surface is concave) is called the convex mirror. After reflection from the convex mirror, the parallel rays of light are spreading out. When the parallel rays of light spread out, we can say that the rays of light are diverging.



A convex mirror diverges a beam of parallel rays of light

Now, we can say that a beam of parallel light rays diverges (spreads out)

after reflection from a convex mirror.
Since a convex mirror diverges a beam of parallel light rays, therefore, it is also known as a diverging mirror.

Image Formed By a Convex Mirror

Let us perform an activity to understand the formation of an image by a convex mirror.
The image of the candle can be seen only by looking into the convex mirror and cannot be formed on a screen. It is a virtual image. If we look at the image in the convex mirror, we will find that it is the same side up as the candle. So, the image is erect. And if we compare the size of the candle and its image, the image appears to be smaller. Therefore, the image is smaller in size than the object (or diminished). Even if we change the distance of candle (object) from the convex mirror, we will notice that in every case, the image of the candle formed by the convex mirror remains virtual, erect and smaller in size than the candle.
So, we can conclude that whatever be the distance of the object from a convex mirror, the image formed by a convex mirror is always

- virtual
- erect and
- smaller than the object (or diminished).

Uses of Convex Mirrors

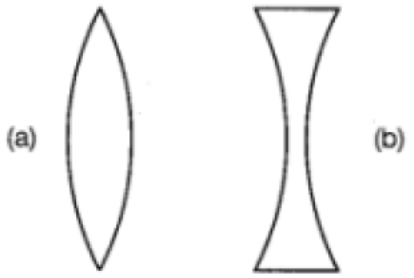
- To see the traffic at the rear side or backside on the road, convex mirrors are used as rear view mirrors or side view mirrors in vehicles such as cars, scooters, buses, etc.
- Big convex mirrors are used as shop security mirrors. By installing a convex mirror in the shop, the shop owner can keep an eye on the customers.

Image Formed by Lenses

Since a lens is a piece of transparent glass bound by the two spherical surfaces. Lenses are transparent so that light can pass through lenses.
Lenses are of two types:

- Convex lens
- Concave lens

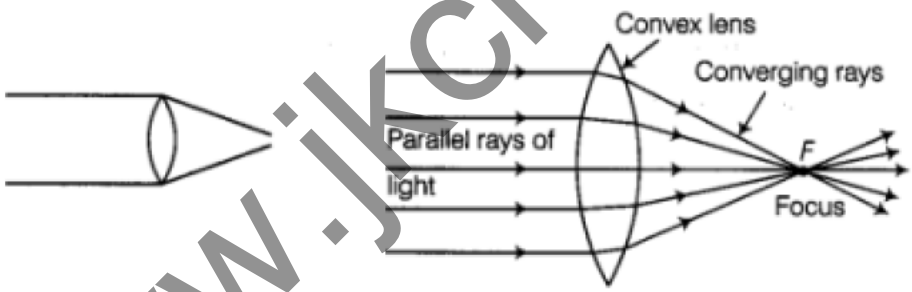
Get some lens and try to touch them, we will find that some are thicker in the middle than at the edges and some are thinner in the middle than at the edge.



(a) A convex lens (b) A concave lens

Convex Lens (Converging Lens)

The convex lens is the lens which is thicker in the middle than at the edges. A beam of parallel rays of light falls on a convex lens from the left side. After passing through the convex lens, the beam of parallel rays of light converges at a point as shown in the figure given below. Hence, a convex lens is a converging lens.



A convex lens converges a beam of parallel rays of light

Image Formed by a Convex Lens

The nature and size of the image formed by a convex lens depend on the distance of the object from the convex lens.

Thus, we can conclude that when an object is placed at a far off distance from a convex lens, then the image formed by the convex lens is real, inverted and much smaller than the object (or highly diminished).

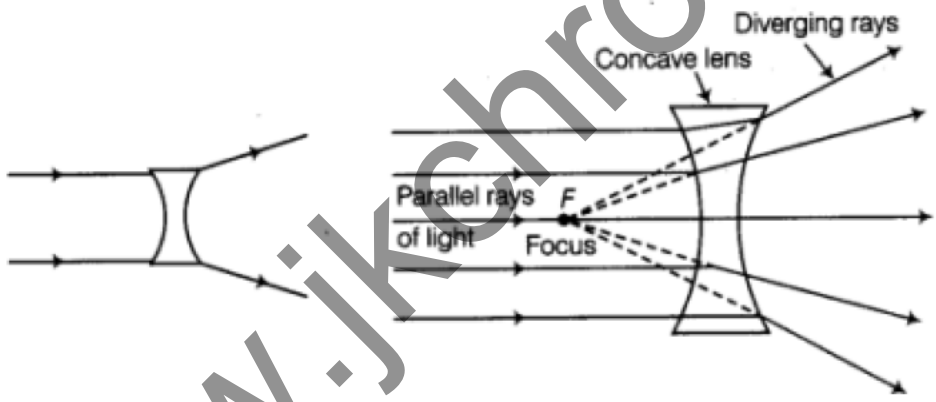
Now, change the distance of the candle from the lens and try to obtain the image of the candle flame every time on the screen by moving it. So, is it possible to get in any position of the object for which image was erect and, magnified? Yes, it is possible when the candle is placed very close to the convex lens.

Uses of Convex Lenses

- Convex lenses are used as a magnifying glass.
- In the manufacturing of spectacles, camera, microscope, telescope and binoculars, convex lenses are used.

Concave Lens (Diverging Lens)

A concave lens is a lens which is thinner in the middle than at the edge. A parallel beam of light falls on a concave lens as shown in the figure. After passing through the concave lens, the rays of light are diverging (or spreading out).



A concave lens diverges a beam of parallel rays of light

Since a concave lens diverges light rays falling on it, therefore, it is also called a diverging lens.

Image Formed by a Concave Lens

In the case of a convex lens, we have studied that the nature of image formed depends on the distance of the object from the convex lens. But, this is not followed in the case of a concave lens.

Let us perform an activity to understand the formation of an image by a concave lens.

Uses of Concave Lenses

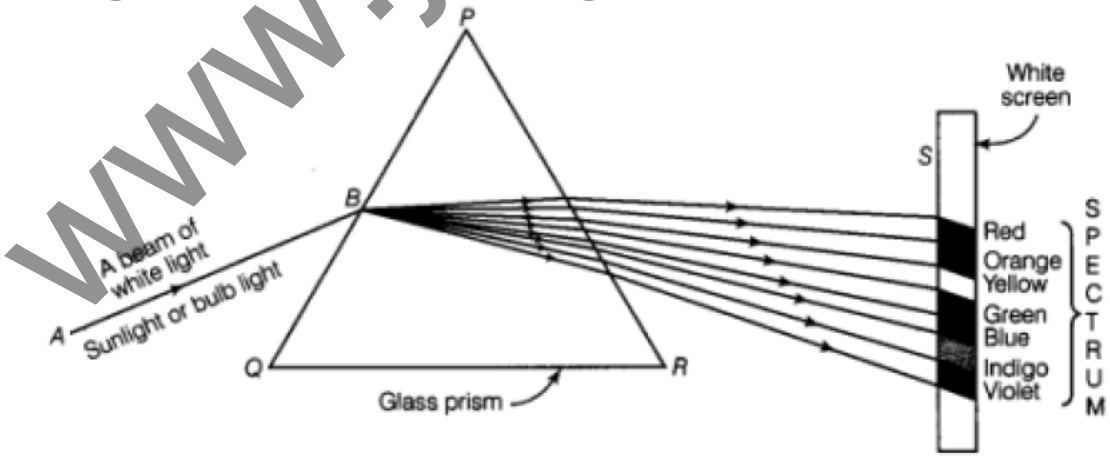
- In order to see the image of the person standing outside, concave lenses are used in the peepholes in the door of hotel rooms.
- Concave lenses are used in making spectacles.

Sunlight: White or Coloured

We might have noticed a rainbow which usually appears after the rain when the sun is low in the sky. An arc of seven colours seen in the sky is known as the rainbow. The seven colours of a rainbow are red, orange, yellow, green, blue, indigo and violet. We might also have seen that when we blow soap bubbles, they appear colourful. Similarly, when light is reflecting from the surface of a Compact Disc (CD), we can see many colours. The rainbow is produced by the dispersion of sunlight by tiny raindrops suspended in the atmosphere.

Dispersion of Light

In the year 1665, Newton discovered by his experiments with glass prisms that white light (like sunlight) consists of a mixture of lights of seven colours. Newton found that if a beam of white light is passed through a glass prism, then the white light splits to form a band of seven colours on a white screen. The band of seven colours formed on a white screen, when a beam of white light is passed through a glass prism, is known as a spectrum of white light. The seven colours of the spectrum are Red, Orange, Yellow, Green, Blue, Indigo and Violet.



A glass prism splits white light into seven colours

So, dispersion of light is the phenomenon of splitting up of white light into seven colours on passing through a transparent medium like a glass prism. The formation of a spectrum of seven colours indicates that white light is a mixture of seven colours. White light can be sunlight. So, now we can say that sunlight consists of seven colours.

We can mix these colours to get white light. This can be done by using Newton's disc, let us try this.

Chapter 16

Water: A Precious Resource

Water is one of the most common and useful substances around us. Water is essential for the existence of all forms of life.
After knowing the importance of water, awareness is being created by different organisations of the world. 22nd March is celebrated as World Water Day to attract the attention of everybody towards the importance of conserving water. The year 2003 was recognised as 'International year of freshwater'.

By doing such activities, we spread the message of conservation of natural resources of water and make people understand that there will be no life without water on the earth. We also believe that "if you have water, you can think of the future". Before we discuss why water is getting scarce, we must know how much water is available for use on our planet.

Water Available for Use

If we take a picture of earth from outer space, it appears blue because of presence of water in the form of sea and ocean. About 71% of surface of the earth is covered with water. Of the total water present on earth, 97.4% is in the seas and oceans but it is not fit for human consumption.
Freshwater in a usable form is present in just a small fraction of all water present on the earth.
Most of us assume that there is plenty of water all over the earth. But infact this all water is not suitable for human consumption, not even fit for plants and other forms of life.

Different Forms of Water

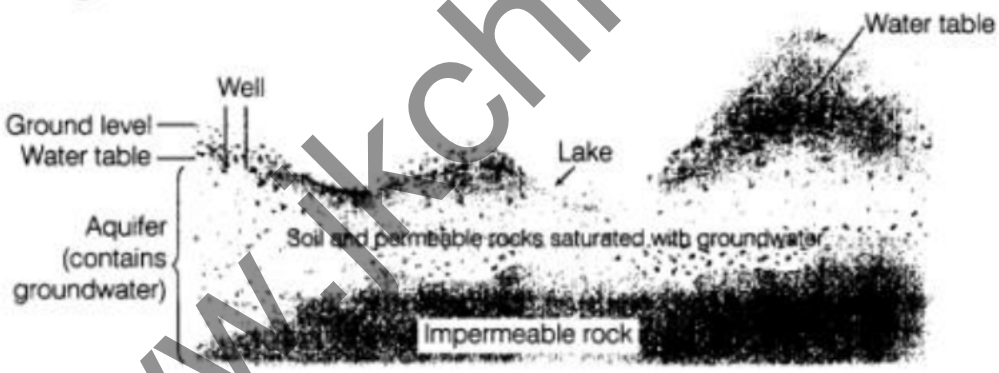
Water exists in three forms. These three forms of water are as follows:

- **Snow or ice (solid)** exists on the earth in the form of ice caps at the poles of the earth, glaciers and snow covered mountains. These are the main sources of water on earth.
- **Water (liquid)** is present in oceans, lakes, rivers and even underground water in the earth's upper layers.
- **Clouds (gas)** are found in the form of water vapour present in the atmosphere. On condensation, it turns into droplets and precipitates on earth's surface in the form of rain.

The continuous recycling of these forms of water takes place and the amount of water on the earth is maintained of constant. Most of the urban areas have a system of water supply whereas underdeveloped/undeveloped areas depend on resources like rivers, lakes, ponds, handpumps, etc.

Groundwater as an Important Source of Water

The wells, tubewells and handpumps are the main sources of water for many people. The water in these sources is the groundwater. It is the upper level of underground water which occupies all the spaces in the soil and rocks and form a water table as shown in the figure below:



Water table, groundwater and aquifer below the surface of earth

The upper limit of groundwater is called water table. It represents the depth of water filled area at a given place. The water table rises and falls depending upon the amount of rainwater that seeps into the groundwater and how much groundwater is drawn out for irrigation and industry. The seeping down of rainwater into the groundwater is called infiltration. The groundwater thus gets recharged by this process.

At some places, the groundwater is stored between layers of hard rock below the water table. This is aquifer which contains the groundwater usable by tubewells and handpumps. These sources however, have limited sources of water and may get exhausted if used excessively.

Depletion of Water Table

Water drawn from underground water gets replenished by seepage of rainwater. The water table does not get affected as long as we draw the same amount of water as is replenished by natural resources like rain.

However, there is a number of factors which cause depletion of water table at a very fast rate which is really a matter of concern for every one of us. Increase in population, industrial and agricultural activities are some common factors affecting water table. Scanty rainfall, deforestation and decrease in the effective area for seepage of water may also deplete the water table.

Increasing Population

As our population increases, we need more water for drinking, washing, cooking and cleaning. We also need more number of houses, offices, shops and roads. This means more construction work and construction itself uses lots of water itself. Most of the time, it is the groundwater. Besides this, there is less open area which can seep in the rain water into the ground.

So, rise in population also increases use of water. This results in depletion of groundwater level to alarmingly low levels (in many cities).

Increased Industrialisation

Water is used by all industries. Almost everything that we use needs water somewhere in its production process. The number of industries is increasing continuously. Most of the water used in the industries is drawn from groundwater. This results in depletion of water.

Agricultural Activities

More food is needed to meet the requirement as there is an increase in

population. This puts more pressure to the agriculture practices. In our country, farmers depend on rain, canal water or groundwater for irrigation. Canals are found only at a few places. Since rain is often erratic, canals also suffer frequently from lack of water. Therefore, farmers have to use groundwater for irrigation. This results in depletion of groundwater.

Deforestation

Large scale deforestation has occurred to accommodate the growing population to grow food for them and to provide space for industries. Overgrazing by our animals has also destroyed large amount of vegetation. The green coverage of vegetation slows down the flow of water on land and increases the absorption of water by the soil. Cutting down of trees and vegetation, therefore interferes with the natural processes by which seepage takes place and the groundwater is recharged and causes depletion of water.

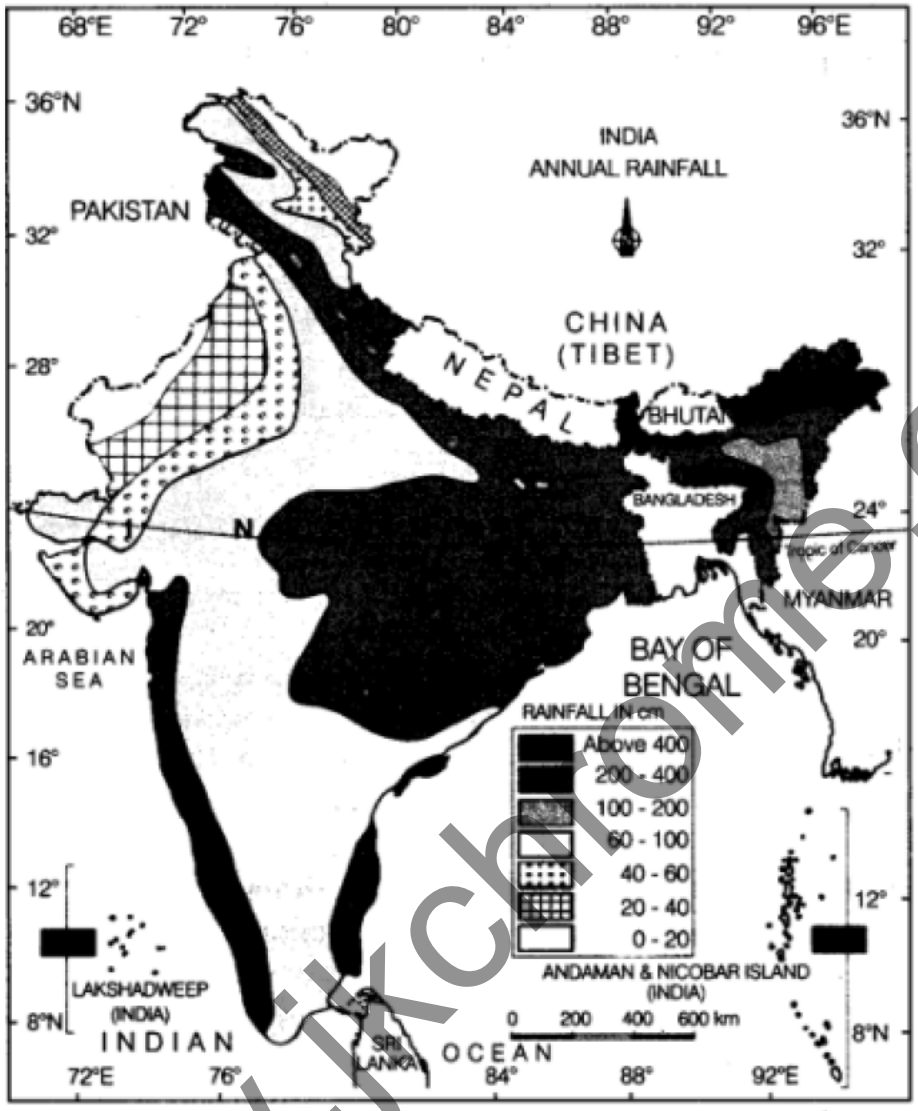
Distribution of Water

The distribution of water over the globe is quite uneven due to the number of factors. Some places have a good amount of rain. On the other hand, these are deserts which have scanty rainfall. Some regions have excessive rains which cause floods while some others have very little rainfall which causes drought. India is a vast country and the rainfall is not the same everywhere. Therefore, some regions in our country may have floods while others may suffer from droughts at the same time.

Water Resources in India

India receives a lot of precipitation (rain and snow) in comparison to the rest of the world. The average annual precipitation in India is 1170 mm as compared to the world's average of 700 mm. The rain map of India

showing average rainfall in the different parts of our country.



Rain map of India

Note:

1. Government of India, Copyright 2007.
2. Based upon Survey of India map with the permission of the Surveyor General of India.
3. The territorial waters of India extend into the sea to a distance of twelve nautical miles measured from the appropriate baseline.
4. The external boundaries and coastlines of India agree with the Record/Master Copy certified by Survey of India.

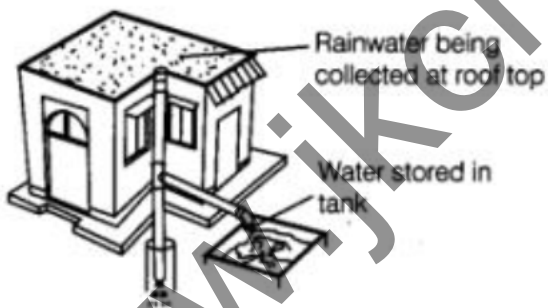
Water Management

It is the activity of planning, developing, distribution and managing the optimum use of water resources. It is a subset of water cycle management. Water supply pipes leaking and a lot of water gushing out of the pipes are the wastage of water. It is the responsibility of the civic authorities to prevent such wastage of precious water. Mismanagement or wastage may also take place at the level of individuals also. All of us knowingly or unknowingly waste water, we should also take care for it. Some of the steps which can be taken for the proper management of water are given below:

1. Rainwater harvesting
2. Bawris
3. Drip irrigation

1. Rainwater Harvesting

Most of the rainwater just flows away. This can be skillfully used to recharge the groundwater. The modern buildings of schools, offices, homes can install a rainwater harvesting system, so as to store rainwater in their own premises for future use.



Rainwater harvesting helps in raising the groundwater level

A Case Study

Bhujpur in the Kutch area of Gujarat has a very erratic rainfall. The only source of freshwater lies underground because rivers in this area do not have water throughout the year. Over the years, demand for water has grown. As a result, the water table has gone down alarmingly.

In 1989, the villagers along with a non-governmental organisation, decided

to harvest rainwater.
Eighteen chech-dams were built on Ruhmavati river and its tributaries where water percolates through the soil and recharge the aquifers. ^ According to farmers, the wells have water now and the water that flowed into the sea and was wasted has become available for irrigation.

2. Bawris

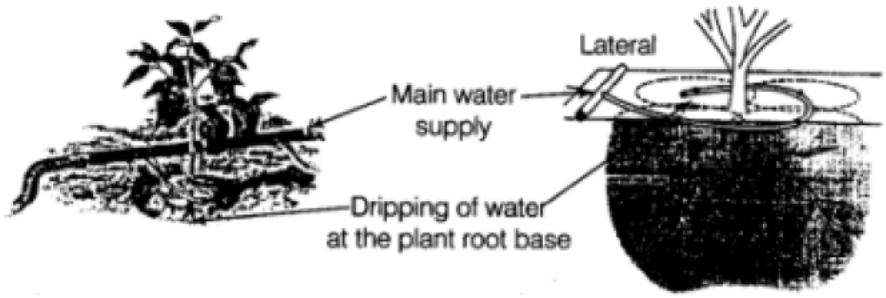
The bawris is age old method of collecting water. These structures are still found in old buildings, palaces and forts. With time, the bawris fell into disuse and garbage started piling in these reservoirs. However, because of the acute shortage of water, the bawris are being revived. Today the situation is that inspite of scanty rains those places are managing their water needs well.

Bawris stores rainwater and recharges groundwater

3. Drip Irrigation

It is a method of watering plants by use of narrow tubings which deliver water directly to the base of a plant. This minimises wastage of water. The

mechanism of drip irrigation is shown in the figure given below:



Drip irrigation

Role for Saving Water

You can be a leader to show people about water management skills. If any pipeline and tap water is leaking there, immediately report to authorities like 'JAL BOARD' (in Delhi) to prevent water loss. Educate people about water wise habits which can be developed gradually and will last life long once developed.

Water-wise Habits

- Turn off the tap while brushing, shaving and washing hand. Open when need. This will check the excess flow of water into drains.
- Use mug and water in the bucket for bathing instead of using showers.
- Mop the floor instead of washing.
- Irrigate potted plants with used water for washing rice and dal in the kitchen while cooking.
- Check no tap or pipe is leaking.

Effect of Water Scarcity on Plants

We grow many plants in pots in our homes. These are called potted plants. The potted plants are watered regularly. If the potted plants are not watered even for a few days, the plants will 'wilt' (become limp) and ultimately 'dry up'. If potted plants are not given water for a considerable time, they will die. Thus, sufficient water is essential for maintaining the life of plants. Plants need water to obtain nutrients from the soil and to

make food by the process of photosynthesis.
The various effects of water scarcity on plants are

- Water scarcity will affect nutrient uptake from soil by the plants.
- The rate of photosynthesis will decline, so oxygen evolved will be less.
- Rate of transpiration will also decline, so water vapours released in the atmosphere by transpiration will be less, it will disturb the water cycle.

So, in brief, we can say the shortage of water will lead to a shortage of food, shortage of oxygen and shortage of rain also.

Chapter 17

Forests: Our Lifeline

In ancient times, we used to live in forests. It met all our requirements for leading a normal life at that time. Now-a-days, we live in cities and towns far off from forests, so we really do not know the importance of forests in our life. It is a natural renewable resource a habitat (home) to many forms of wildlife like bear, bison, jackal, deer, porcupine, elephant, etc.

Many trees like sal, teak, semal, Sheesham, neem, Palash, fig, khair, amla, bamboo, kachnar and many others are also found in the forests. The forest also contains insects, butterflies, honeybees and birds which help in palliation in the flowering plants of the forest in pollination.

Structure of a Forest

The plants (trees, shrubs and herbs) make different layers in the forest which are described below:

1. Canopy

The uppermost branches and leaves of tall trees which act as a roof over the forest ground is called canopy. It is the highest layer of vegetation in the forest. The branch part of a tree above the stem is known as the crown of the tree.

2. Understorey

The different horizontal layers formed due to different types of crowns in the forest is called understorey. The constituents of understorey can be

described as follows:

Different layers of plants in forest

(i) Top layer It constitutes the gaint and tall trees followed by shrubs and tall grasses.
(ii) Shrub layer It has many shrubs and bushes of approximately 1-2 metres of height from the forest floor. It makes dense layer at some places of forest where enough sunlight is present.
(iii) Herb layer Just below the shrub layer occurs the herb layer of plants. It is the lowest layer of vegetation in the forest (having leafy plants). Most of the plants in herb layer have short lifespan.
(iv) Forest floor Plants found here are as small as mosses, liverworts, lichens. It has many kinds of insects, worms, toad stool, etc. Most of the forest floor is covered with dead and decaying plant matter, and animal waste.

Components of the Forest

The living organisms found in the forest are plants, animals, decomposers and scavengers. The non-living environment of the forest provides nutrients, water and carbon dioxide for the growth of the plants.

1. Plants

Green plants are living organisms also called autotrophs as they produce food by photosynthesis (by absorbing nutrients water from soil, CO_2 from air and sunlight as energy source). They provide food to all living organisms which live in the forest. They are called producers (of food).

2. Animals

Forests have many animals and they are called consumers (of food). The animals which eat only plants/their parts are called herbivores (herb eating) whereas flesh-eating animals are called carnivores. All animals are called heterotrophs because they depend on other organisms for food.

3. Decomposers

Mostly these organisms are microorganisms like bacteria and fungi. They feed on dead plants and animals and thus are called saprotrophs. These organisms are also called decomposers as they breakdown dead parts of plants and dead bodies of animals into simple substances. They play a very important role in sustaining the forests.

4. Scavengers

Those animals which eat dead animals are called scavengers, e.g. vultures, crows, jackals, hyena, some insects (ants, beetles, termites, woodlice, maggots, millipedes and earthworms), etc. Scavengers are the cleaning agents of our environment. But these are not decomposers as they do not breakdown complex dead organic matter into simple ones.

Importance of Forests

The forests provide us with a large number of products. They also purify air and water quality and maintain soil moisture and climate. So, they are called lifeline.

1. Forests Provide Many Useful Products

The various things which are obtained from the forests are called forest products. Forests give us a large number of useful products. Some of the important products which we get from the forests are wood, honey, gum, sealing wax (or lac), catechu (kattha), fruits, oils, spices, natural rubber, cork, dyes, medicinal plants and fodder for cattle. Perhaps the most important product obtained from forests is the wood (which is obtained by cutting down the forest trees). The wood obtained from forests is used for a large number of purposes in our day-to-day life.

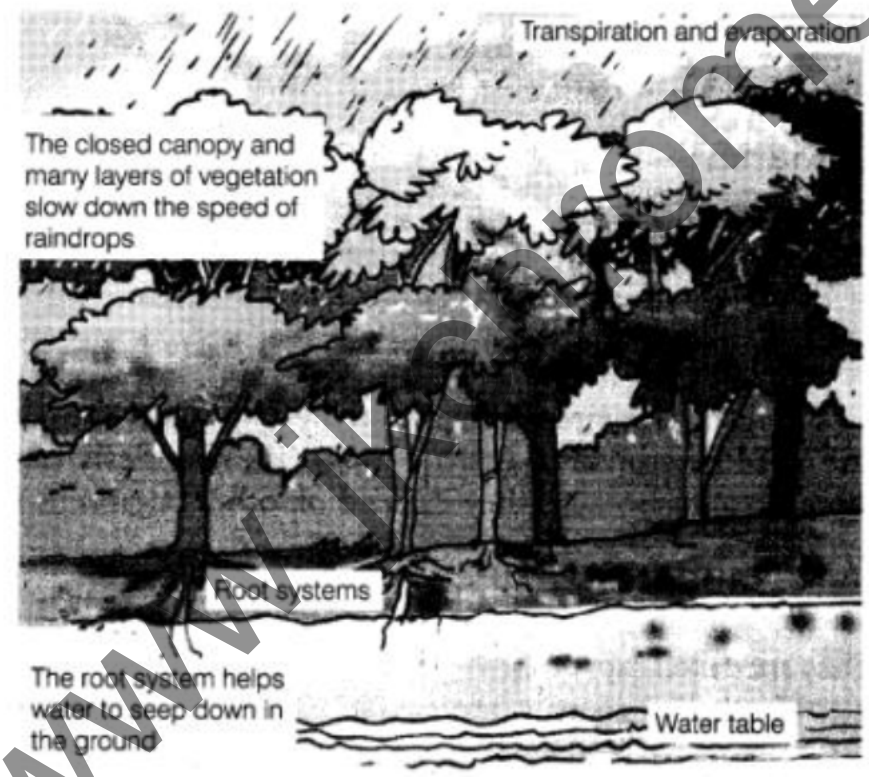
2. Forests Maintain Balance between Oxygen and Carbon Dioxide

Plants in the forest release oxygen during photosynthesis. This provides all animals including us with oxygen to breathe and helps to maintain the ratio of oxygen to carbon dioxide in the atmosphere. That is why, forests are called green lungs.

If the amount of carbon dioxide increases in the atmosphere, it would result in an increase in earth's temperature. Plants in the forest intake carbon dioxide from the atmosphere during photosynthesis. Hence, they help to maintain the right amount of carbon dioxide in the atmosphere.

3. Forests Maintain Water Cycle

The forest trees suck water from the soil through their roots and release water vapour into the air through transpiration. This water vapour helps in the formation of clouds and bring rain on the earth. Thus, forests bring sufficient rainfall on the earth. In fact, about half the rain which falls in forest areas comes from the transpiration of forest trees themselves. In this way, forests help in maintaining a perfect water cycle in nature and meet our freshwater requirements.



Rainwater drips from the trees and seeps into the ground

4. Forests Prevent Occurrence of Flood

The forest acts as a natural absorber of rainwater and allows it to seep. It helps to maintain the water table throughout the year. Forests not only help

in controlling floods but also help to maintain the flow of water in the streams so that we get a steady supply of water.

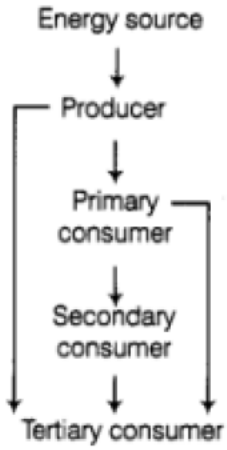
On the other hand, if trees are not present, rain hits the ground directly and may flood the area around it. Heavy rain may also damage the soil. Roots of trees normally bind the soil together, but in their absence, the soil is washed away or eroded.
The different kinds of plants grow together in the forest making different levels of layers and habitat for wild animals. In the absence of plants/trees, the soil will not hold water which will cause flood and erosion.

5. Forests Provide Habitat for Wildlife
The different types of vegetation present in a forest provide food and shelter to animals, birds and insects which live in the forest. This makes a food chain.

Food chain
Food chain can be defined as a sequence of living organisms in which one organism feeds on another.
A typical chain in grassland is: grass → deer → lion
A typical food chain in a pond is: algae → small fish → large fish

Flow of Energy in a Food Chain
The sun is the ultimate source of energy for everything on the planet. Green plants or producers are able to harness the energy of the sun to make food. In a food Flow ener0y in food chain chain, energy from plants (producers) is passed on from one organism to another. From the producers, the energy goes to primary consumers (herbivores) and is then passed on to secondary consumers (carnivores). Thus, producers are

always at the beginning of the food chain.



Flow of energy in food chain

Dynamic Living Entity

By harbouring greater variety of plants, the forest provides great opportunities of food and habitat for the herbivores. Larger number of herbivores means increased availability of food for a variety of carnivores. The wide variety of animals helps the forest to regenerate and grow. Decomposers help in maintaining the supply of nutrients to the growing plants in the forest. Therefore, the forest is a dynamic living entity. There is a continuous interaction between soil, water, air, plants and animals in a forest.

6. Forests can Regenerate on their Own

The dead parts of trees and plants, dead animals and animal wastes (like animal dung or droppings) keep on collecting on the forest floor. Decomposers (fungi and bacteria) degrade them into simple organic substances which are usable by plants in the form of humus. The hummus makes the forest soil fertile by providing the nutrients. The animals, birds of forests, wind and water disperse the seeds of trees and plants on the forest soil. These seeds obtain nutrients from the soil and germinate to form seedlings and ultimately grow to form the forest vegetation.

Forest Conservation

Paper is made from wood pulp that is produced from the wood of forest trees. So, to make paper, many trees have to be cut down from the forests.

If all of us keep on collecting old newspapers, magazines, books, notebooks, etc., and send them to paper mills for recycling through a junk dealer (kabaddi wala), we will be able to save many forest trees from being cut down.
Some of the other ways to conserve forests are also given below:

- Excessive cutting down of forest trees should not be allowed by the government to conserve forests.
- More trees should be planted in the forest in place of cut down trees to conserve forests.
- Paper products such as old newspapers, magazines, books, notebooks, etc., should be recycled to conserve forests.

A large number of forest trees are being cut down every day to meet the various demands of the increasing population. This is called deforestation. Following are the consequence if forests disappear:

- Increase of the earth's temperature If there are no trees and plants, their will be no photosynthesis. So, no C02 of the atmosphere will be used. This will increase the level of C02, resulting in the increase of earth's temperature.
- No food and shelter to wildlife In the absence of trees, plants and animals will not get food and shelter. So, this will disrupt the whole cycle of life and gradually life might disappear from the land area of the earth.
- There will be more floods The trees plant roots help in holding the soil during rains and also soil is able to hold water. In the absence of trees, the soil will not hold water which will cause floods.
- Deforestation endanger the environment The continuous deforestation is threatening the different form of life including human beings. So, there is necessity to think and set to conserve forests. Natural calamities like floods, cyclones, hail forms are more in the absence of trees and forest. People become homeless when such disaster occurs.

Chapter 18

Waste Water Story

Water is an elixir of life. We all use water and in that process of using, we make it dirty. The water rich in a lather, mixed with oil and other pollutants that go down the drains from sinks, showers, toilets, laundries is dirty. It is called wastewater.

We use water every day for drinking, bathing, washing clothes, cooking food, washing utensils, flushing toilets, mopping the floors, etc. We cannot think of our life without water. We use lots of water daily which is passed on to the drainage system every day.

Water, Our Lifeline

Water is needed by all forms of life. Clean water is a basic need of human beings. Unfortunately, clean water is not available to a large segment of human populations.

The water which is unfit for human consumption becomes the source of many water-borne diseases which ultimately lead to loss (of human life. It is estimated that one billion human beings do not get safe drinking water. So, realising the urgency we celebrate 22nd March as World Water Day to bring awareness amongst people for safe water, fit for human consumption.

Thus, the water is cleaned by removing pollutants before it enters a waterbody or is reused. This process of wastewater treatment is commonly known as sewage treatment which takes place in several steps as discussed later.

On the World Water Day, i.e. 22 March 2005, the General Assembly of the United Nations proclaimed the period 2005-2015 as the International Decade for action on Water for Life. All efforts made during this decade

aim to reduce by half the number of people who do not have access to safe drinking water.

Sewage

It is wastewater released by homes, industries agricultural fields and other human activities. It also includes rainwater that has run down the street during a storm or heavy rain and it is liquid waste. Most of its water has dissolved and suspended impurities called contaminants.

Composition of Sewage

The following components make the sewage:

- The organic impurities present in sewage are human faeces, animal wastes (like animal dung), urea (as urine), oil, fruits and vegetable wastes, pesticides, herbicides, etc.
- The inorganic impurities present in sewage are nitrates, phosphates and metals.
- The nutrients present in sewage are nitrogen and phosphorus.
- The bacteria present in sewage include those bacteria which cause water-borne diseases such as cholera and typhoid.
- The other microbes present in sewage are Protozoa which cause a water-borne disease called dysentery.

Water Freshens Up: An Eventful Journey

In a house (a public building) generally, there are two sets of pipes, i.e. one set of pipes brings clean drinking water into the house and the other set of pipes takes away wastewater (sewage) from houses. For proper sanitation, a well-maintained sewage system is required.

Sewerage System

The pipes which carry away wastewater or sewage from houses and other buildings are buried under the ground. An underground pipe which carries away dirty drainage water and waste matter is called sewer. The provision of drainage at a place by laying sewers under the ground is called sewerage. Actually, sewerage is an underground network of

interconnected pipes called sewers that carries the sewage from the place where it is produced to the sewage treatment plants, where it is processed.

Manholes

A manhole is a covered vertical hole in the ground, pavement or road, above the underground sewer pipeline through which a worker can go down up to the sewer pipes for inspection, cleaning, etc. Manholes are provided at every 50-60 m distance in the main sewer pipeline. Manholes are also provided at the junction of two or more sewers and at points where there is a change in the direction of the sewer line.

Treatment of Polluted Water

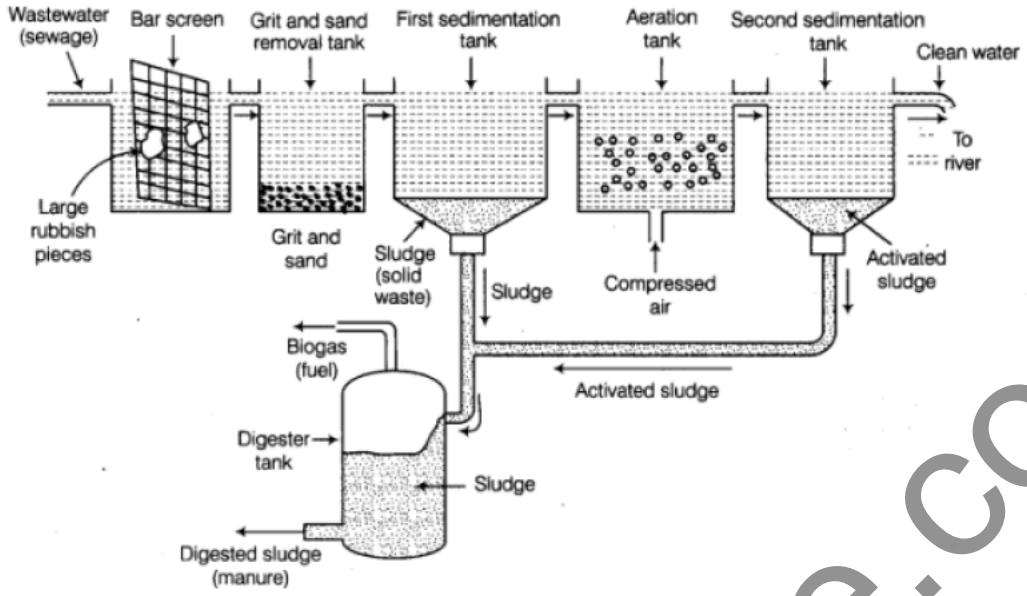
Perform the following activity. It will help you to understand the processes that take place at the wastewater treatment plant.

Wastewater Treatment Plant (WWTP)

A place where wastewater or sewage from houses and other buildings is brought for processing is called wastewater treatment plant.
Treatment of wastewater involves physical, biological and chemical processes depending on the nature of contaminants.

1. Physical Process (Screening)

The bar screens first remove the large rubbish objects like rags, sticks, cans, polybags, napkins, sanitary towels, etc., from the wastewater.



Wastewater treatment plant

After passing through the bar screen, wastewater is taken to a tank called grit and sand removal tanks. In this, sand and grit settle down slowly at the bottom of the tank as water passes slowly through this tank. The settled sand and impurities are removed from the tanks from time to time.

2. Biological Process

The first sedimentation tank is sloped towards the centre. Solid like faeces settle at the bottom and is called sludge which is removed by a scraper. Oils and grease float at the surface of the water are removed by a skimmer. The biogas produced (by anaerobic bacteria) in the process can be used as fuel or can be used to produce electricity. Here, water gets cleared of rubbage, oil, grease, etc and we get clarified water which is sent to aeration tank now. In the aeration tank, the watery waste already contains bacteria (aerobic) in it. The compressed air bubbles are passed through this waste to provide 02 to the bacteria to increase bacterial activity which ultimately digests human waste, food waste, soaps and other unwanted and harmful matter still remaining in the wastewater leaving behind fairly pure water.

3. Chemical Process

The water after aeration tank is allowed to stand in a second sedimentation tank. Here, the microbes present get settled at the bottom at the tank in the

form of activated sludge which is about 97% water. At this stage, water has very low level of organic matter suspended matter and does not contain many harmful things. It is safe for human consumption but is disinfected by chlorine or ozone before distributing it.

Become an Active Citizen

Waste generation is a natural part of human activity but we can limit the type of waste and quantity of waste produced. Often we have been repelled by an offensive smell. The sight of open drains is disgusting. The situation worsens in the rainy season when the drains start overflowing. We have to wade through the mud pools on the roads. Most unhygienic and unsanitary conditions prevail. Flies, mosquitoes and other insects breed in it.

We should be an enlightened citizen and approach the municipality or the gram panchayat. We should also insist that open drains should be covered. If the sewage of any particular house makes the neighbourhood dirty. We should request them to be more considerate about other's health.

Note: We should plant Eucalyptus trees all along sewage ponds. These trees absorb all surplus wastewater rapidly and release pure water vapour into the atmosphere.

Better House Keeping Practices

We must minimise and manage waste at our houses before its disposal in the following manner:

- Cooking oil and fats should not be thrown down the drain. They can harden and block the pipes. In an open drain, the fats clog the soil pores reducing its effectiveness in filtering water. Throw oil and fats in the dustbin.
- Used tea leaves, solid food remains, soft toys, cotton, sanitary towels, etc., should also be thrown in the dustbin. These wastes choke the drains. They do not allow the free flow of oxygen. This hampers the degradation process.

- The chemicals like paints, solvents, insecticides, medicines and motor oils should not be thrown in drains as they kill helpful microbes which digest the organic waste.

Sanitation and Disease

Contaminated water and poor sanitation practices are the major causes of the number of infectious diseases in our country. Safe sewage disposal facilities are still not available at many cities and villages in India. So, people go to open places and defecate. This causes the increase in insect-vector population which transmit diseases like cholera, typhoid, meningitis, etc.

Untreated human excreta is a health hazard which causes soil pollution and water pollution also. The river water and groundwater are sources of water for drinking for many people. So, the contaminated water can spread many diseases especially water-borne.

Vermi-processing Toilets

In the vermi-processing toilets, human excreta is treated by earthworms in a pit. The earthworms usually eat up all organic matter present in human excrete and turn it into compost. These are tow water use toilets for the safe processing of human.

Alternate Arrangement for Sewage Disposal

Low cost outside the sewage disposal system has been developed to take care of places where there is no sewage system, e.g. rural areas, isolated buildings. These are described below:

(i) Septic tanks: Septic tank is a low-cost onsite sewage disposal system. Septic tanks are suitable where there is no sewerage made. These tanks need cleaning every four to six months.

A septic tank usually consists of a big, covered underground tank made of concrete having an inlet pipe at one end and on outlet pipe at the other end. The toilet seat is connected to the inlet pipe of the septic tank. The human excreta from the toilet seat enters into the septic tank through the inlet

pipe. The solid part of excreta keeps on collecting at the bottom of the septic tank in the form of a sludge whereas watery waste remains above it.

The anaerobic bacteria breakdown most of the solid organic matter present in human excreta due to which the volume of solid waste is reduced too much. The digested solid waste keeps on depositing at the bottom of septic tank. The watery waste is also cleaned by anaerobic bacteria. The excess water goes out of the septic tank through the outlet pipe and get absorbed in soil.

(ii) Composting pits: These are self-sustained human waste disposal units which is not connected to a sewer line or a septic tank. A composting toilet breaks down and dehydrates human waste to compost.

(iii) Chemical toilets: These toilets have limited storage capacity for human waste and need to be emptied periodically. These are the toilets which use chemically treated reservoir located just below the toilet seats. The chemicals reduce the foul smell coming out of human excrete and carry out partial disinfection of human waste.

Sanitation at Public Places

In our country, fairs are organised periodically. A large number of people participate in them. In the same way, railway stations, bus depots, airports, hospitals are very busy places. Thousands of people visit them daily which generate large amount of waste. It must be disposed of properly otherwise epidemics could break out. The government has laid down certain standards of sanitation but unfortunately, they are not strictly enforced. We should not scatter litter anywhere. If there is no dustbin in sight, we should carry the litter at home and throw it in the dustbin.

Conclusion

We all have a role to play in keeping our environment clean and healthy. We must realise our responsibility in maintaining the water sources in a healthy state. Adopting good sanitation practices should be our way of life. As an agent of change your individual initiative will make a great

difference. Influence others with your energy ideas and optimum, A lot con be done if people work together. There is great power in collective action.

As an active citizen, we have many responsibilities regarding sanitation. These can be listed as follows:

- To ensure that our surroundings are clean.
- To ensure that the sewerage system in our house is properly managed.
- If any leakage or an open drain in the sewerage system is present, then it should be reported to the municipality or the gram panchayats to insist that the open drain must be covered properly and several air and water-borne diseases can be prevented.

Note: Mahatma Gandhi said, 'No one needs to wait for anyone else to adopt a humane and enlightened course of action'.

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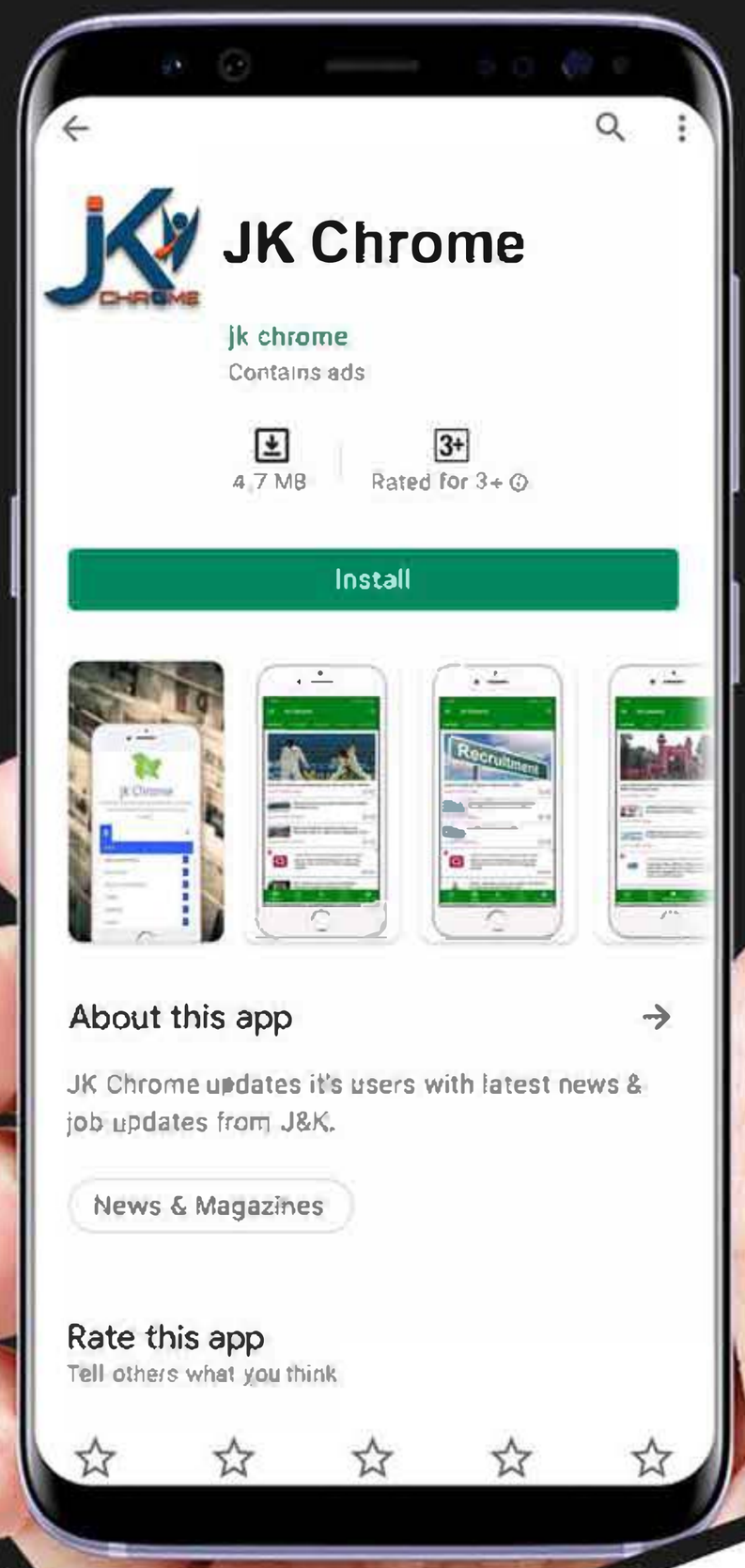

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