CHAPTER

13

LIFE PROCESSES

We have learnt that many of the objects around us are said to be alive while many others are not alive. Then, what are the differences between these living and non living objects ? If we see a grazing cow, a running cat, a man doing work, we know that these are alive. Even while they are sleeping we know that they are alive. Why ? Because they are respiring. So, all that are alive respire while those which are not alive do not respire. We also see that a calf grows up in size with the sucking of the mother's milk. A young plant also grows in size with time. Thus, all the living things grow in size with the consumption of food. We also see a cow giving birth to a calf, a hen laying eggs which later hatch to chicken. So the living organisms reproduce their own kind to continue their race.

In earlier classes, we have learnt that the living organisms possess well organised structures. They have organs, organs have tissues, tissues have cells, cells have smaller components in them and so on.

13.1. Processes required for living

The maintenance of the functions of the body go on continuously in living organisms. Even when they are not doing any work or even when they are asleep, these function go on continuously. The processes concerned with maintenance of life are **life processes**.

The life processes of the living body need energy. This energy normally comes from outside the body of the organism in the form of food. This energy from the food from outside the body of the organism is released inside the body by a process called **nutrition.**

Food, the outside sources of energy, may occur in varied forms. These food materials need to be broken down in the body and finally converted to a uniform source of energy that can be used for the various cellular functions necessary for maintaining life. A series of chemical reactions are necessary for this. Most common chemical reactions for breaking down molecules are oxidation-reduction reactions. For this, many organisms take in oxygen from outside the body. This taking in of oxygen and breaking down of food materials inside the body for cellular need is known as **respiration**.

In most unicellular organisms, generally no specific organs or organ systems occur for taking in food, exchange of gases or removal of wastes, as the entire body surface is in contact with the environment. But, in case of multicellular organisms, most of the cells are not in direct contact with the surrounding environment. For them, various body parts have become specialised for performing these functions. These specialised structures or tissues also do the function of uptake of food and oxygen. But these are done only in the specialised parts of the body while every cell of the body needs these food and oxygen. Thus there arises a need for distribution of the food and oxygen to every cell by developing a transporting system.

When chemical reactions take place for the release of energy by using food materials and oxygen, by-products are released. Accumulation of these by-products beyond a permitted level is harmful to the body. So these are to be continuously removed from the body and discarded outside. This process is known as **excretion**. In multicellular organisms, a specialised system for excretion is present.

Now, let us discuss the various life processes, more in detail.

Let us answer these.

1. How can we know that something is alive ?
2. In which form the living organisms get energy from outside the body ?
3. What are life processes ?
4. No specific organ for gaseous exchange is needed in an unicellular organism. Why is it so ?

13.2. Nutrition

When we do some work or ride a bicycle, we are using up energy. Even when we are not doing any work or sleeping, we need energy to maintain a state of order in our body. We also need materials from outside the body in order to grow, to repair worn out tissues and also to synthesize protein and other substances needed in the body. The sources of energy and materials required come form the food we eat.

13.2.1. How do living things get their food ?

The requirement for energy and materials is common to all living organisms. But, it is fulfilled in different ways. Some organisms synthesize their food from simple inorganic components like carbon dioxide and water. These organisms, known as **autotrophs** , include green plants and some bacteria. Other organism, known as **heterotrophs,** utilise the food materials synthesized by the autotrophs. Thus, the heterotrophs depend directly or indirectly on autotrophs for their food. Heterotrophic organisms include animals, fungi and protists.

13.2.2. Autotrophic nutrition

Autotrophs take in simple substances from the outside and convert them into more complex forms of energy through a process called as **photosynthesis.** In this process, carbon dioxide (CO_2) and water (H_2O) are converted into carbohydrates with the help of the light energy absorbed by the chlorophyll pigment of the green plants. Carbohydrates are utilized for providing energy to the plant and excess carbohydrates are stored in the form of starch.

During this process, oxygen (O_2) is evolved as a byproduct, as shown below

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

The following events occur during photosynthesis:

(i) Chlorophyll of the plant traps the light energy.

(ii) Conversion of light energy to chemical energy and splitting of water molecules into hydrogen and evolution of oxygen.

(iii) Reduction of carbon dioxide to carbohydrates.

Activity 13.1.

☞ Take a potted plant with variegated leaves e.g. *Coleus* or *Croton*.

☞ Keep the plant in a dark room for three days. Pluck a leaf from the plant and keep the leaf in a dark place.

☞ Now keep the plant in sunlight for about 6 hours.

☞ Again pluck another leaf from it.

- ☞ Dip both the leaves in a beaker containing alcohol. Carefully place the above beaker in a water bath and heat till the alcohol began boil.
- ☞ Transfer the leaves in a beaker containing dilute solution of iodine for starch test.
- ☞ Take out the leaves and rinse with clean water.
- ☞ Observe the colour of the leaves.

What can you conclude from the above experiment ?

Why the first leaf does not change its colour after starch test ?

Why the second leaf shows colouration only in various places ?

13.2.3. Let us see how CO_2 and chlorophyll are necessary for photosynthesis

A transverse section of a green leaf under the microscope (Fig. 13.1.) shows the presence of many cells containing green dot like cell organelles. These dot like organelles are the chloroplast which contain chlorophyll.

How do the plants obtain carbon dioxide ?

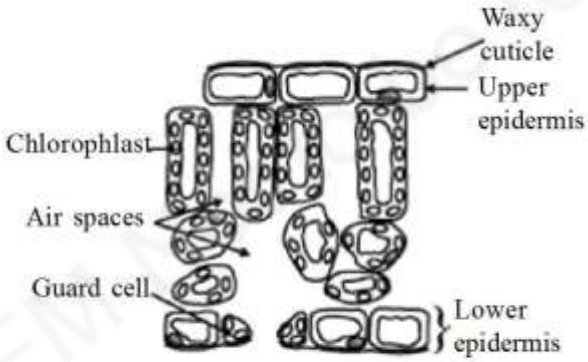


Fig. 13.1. Cross section of a leaf

The stomata are the minute openings present on the epidermis of green leaves through which gases move in or out during photosynthesis. Water is also lost in the form of water vapour through these pores. Each stoma is surrounded by two specialised, kidney shaped **guard cells**. A few cells adjacent to guard cells are modified into **subsidiary cells**.

These pores close when the plant does not need carbon dioxide for photosynthesis. The opening and closing of the stomata is brought about by the change in shape of the guard cells. The stomatal pore remains open when the guard cells swell due to the absorption of water and closed when the guard cells shrink (Fig. 13.2).

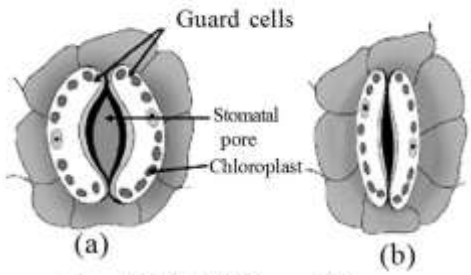


Fig. 13.2. (a) Opened stoma (b) Closed stoma

The water used during photosynthesis is absorbed from the soil by the roots of land plants . Other nutrients like nitrogen, phosphorus, magnesium and iron etc. are also absorbed from the soil. Nitrogen is absorbed from the soil in the form of inorganic nitrates or nitrites or as organic compounds prepared by bacteria.

13.2.4. Heterotrophic Nutrition

Animals are heterotrophic organisms requiring readymade organic and inorganic compounds as food. These food substances are broken down, absorbed and used as a source of materials and energy.

Types of heterotrophic nutrition

(i) Holozoic animals take in whole material and break it down inside their bodies. Protists like *Amoeba* and higher animals are important examples.

(ii) Saprozoites like roundworms and flatworms feed on soluble organic matter in solution.

(iii) Saprophytic fungi and bacteria break down the food materials outside the body and then absorb it.

(iv) Parasitic organisms obtain their food from the body of other living organisms called the host. Examples are *Cuscuta*, Ticks, Leeches, etc.

13.2.5. Nutrition in Animals

In different animals, the food and the way it is obtained are different. So the digestive system is also different in different animals. In single celled organisms, the food may be taken in by the entire body surface. But, with the increase of complexity of the organism, different parts become specialised to perfom different functions. In *Amoeba,* food is taken in by using pseudopodia which are temporary finger-like extensions of the cell surface and form a temporary food vacuole. Inside the food vacuole, complex substances are broken down into simple forms that are absorbed by the cytoplasm. The undigested material is thrown out of the body by moving to the surface.

material is thrown out of the body by moving to the surface. In *Paramoecium* which is also an unicellular organism, the cell body has a definite shape and food is taken in at a specific spot. Food is driven to this spot by the action of the moving cilia which cover the entire surface of the body.In higher animals, for example, in human beings, the alimentary canal is basically a long tube extending from the mouth to the anus. The tube has different regions specialised to perform different functions. The different types of food we eat are crushed into small fragments in the mouth with the help of teeth. During crushing, the food is also mixed with saliva secreted by the salivary glands in the mouth. This makes the crushed food particles soft and facilitate swallowing . The saliva also contains an enzyme, ptyalin (salivary amylase) which initiates the digestion of starch to make simple sugars. The lining of the alimentary canal has muscles that contract involuntarily and rhythmically to push the food down the alimentary tract. This rhythmic movement is known as **peristalsis** and occurs all along the gut.

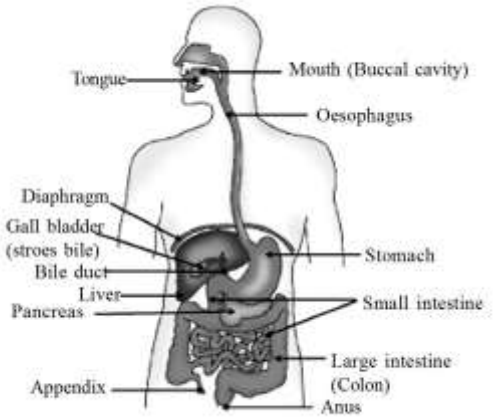


Fig.13.3. Human alimentary canal

The food from the mouth comes to the stomach passing through the oesophagus. The stomach is a large bag like organ which expands when food enters into it. The muscular walls of the stomach which also performs peristaltic movement, help in mixing the food thoroughly with digestive juices secreted by the gastric glands of the stomach. The gastric glands secrete hydrochloric acid (HCl), pepsin (a protein digesting) enzyme and mucus. The HCl creates an acidic medium which facilitates the action of the enzyme pepsin. It also kills some of the micro-organisms entering the stomach along with the food materials. The mucus in the stomach protects the inner lining of the stomach from the action of HCl.

The stomach is followed by the small intestine. The passage of food from the stomach to the small intestine is regulated by a sphincter muscle. The small intestine is the longest part of the alimentary canal which is fitted into a compact space because of extensive coiling.

The length of the small intestine varies in different animals depending on the type of food they eat. The small intestine is very long in herbivores. This facilitates digestion of the cellulose of the plants by passing the food through a long distance . The small intestine is shorter in carnivores because it is easier to digest the animal tissues.

The digestion of carbohydrates, proteins and fats are completed in the small intestine. It receives the secretion of the liver, the bile and the secretion of the pancreas, the pancreatic juice. The food coming from the stomach is acidic as it is mixed with HCl. This acidic food has to be made alkaline since the pancreatic enzymes act in an alkaline medium. This change from acidic to alkaline medium is achieved with the help of bile . Bile salts also act on large fat globules and break them down to smaller globules thus helping in the digestion of fat. It is known as emulsification of fat.

The pancreatic juice contains enzymes such as trypsin for digesting proteins, lipase for digesting emulsified fats. It also contains the enzyme amylase for the digestion of carbohydrates. The walls of the small intestine also contain glands which secrete protein, carbohydrate and fat digesting enzymes. These enzymes finally convert the proteins to amino acids, complex carbohydrates into glucose and fats to fatty acids and glycerol.

The digested food is absorbed by the wall of the small intestine. The inner lining of the small intestine is provided with numerous, small, finger like projections called **villi** which increase the surface area of absorption.

The villi are richly supplied with blood vessels. The absorbed food is transported by blood to each and every cell of the body, where it is used for obtaining energy, building up new tissues and repair of damaged tissues.

The undigested and unabsorbed food is sent to the next part of the alimentary canal, the large intestine. Here most of the water is absorbed in the blood. After this the undigested portion of the food is removed from the body through the anus. The exit of undigested waste material is regulated by a sphincter muscle of the anus.

Let us answer these.

1. What are the differences between autotrophic and heterotrophic nutritions?
2. From where plants get the raw materials required for photosynthesis?
3. What are the different types of heterotrophic nutrition ?

4. Write the role of HCl in our stomach.
5. What are the functions of digestive enzymes ?
6. How does the small intestine designed to absorb digested food ?

13.3. Respiration

Activity 13.2.

- ☞ Take a clean test tube and fill about half of it with freshly prepared lime water.
- ☞ Blow air into this lime water by using a glass tube.
- ☞ Note how long it takes for the lime water to turn milky.
- ☞ Take another test tube and fill about half of it with freshly prepared lime water as before.
- ☞ Allow air to pass through the lime water using a syringe.
- ☞ Note in this case also how long it takes for this lime water to turn milky.

What does this tell us about the amount of CO_2 in the exhaled air ?

We know that during the process of nutrition food material is taken in the body of the organism. This food material is used in cells to provide energy for various life processes. Diverse forms of organisms do this in different ways. Some use oxygen to break down glucose completely into CO_2 and water, some use other pathways that do not use oxygen. The first step of the reaction for the liberation of energy in all cases is the break down of glucose, a six carbon molecule, into a three carbon molecule called **pyruvate** (Fig. 13.4.). This process takes place in the cytoplasm. Pyruvate may further be converted into ethanol and carbon dioxide. This takes place in yeast during fermentation. Since this process takes place in the absence of oxygen, it is called **anaerobic respiration**. Pyruvate may also be broken down by using oxygen in the mitochondria. In this process, the three carbon pyruvate is broken down to give three CO_2 molecules and water. Since this process takes place in the presence of oxygen, it is called **aerobic respiration**. The release of energy in the aerobic process is greater than in anaerobic process. There is another pathway for breakdown of pyruvate. This takes place when there is lack of oxygen in the muscle cells. In this pathway the pyruvate is converted to lactic acid which is also a three carbon molecule. The accumulation of lactic acid in our muscles during sudden activity causes **cramps**.

The energy released during cellular respiration is immediately used up to synthesize a molecule called ATP. All the energy required for different life processes are supplied in the form of ATP. During the process, ATP is broken down giving rise to a fixed amount of energy. This energy can drive the endothermic reactions taking place in the cell.

Being a living organism, plants also need energy. The energy is supplied by the process of respiration. The process of aerobic respiration is similar in

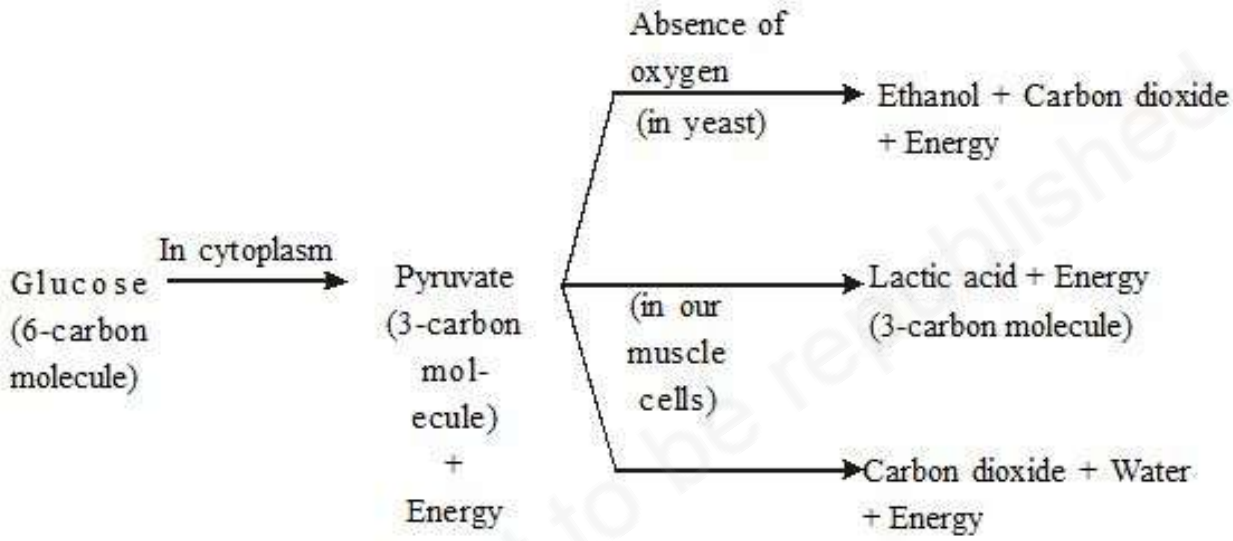


Fig. 13.4. Break down of glucose by various pathways

both plants and animals. The exchange of gases in plant takes place through the stomata and the large intercellular spaces ensure that all cells are in contact with air. The exchange of oxygen and carbon dioxide between the cells and atmosphere occurs by **diffusion**. The direction of diffusion depends upon the environmental conditions and the requirements of the plant. The CO_2 released by respiration during daytime is used up by photosynthesis, hence there is no CO_2 released but O_2 is released. At night, there is no photosynthesis, so CO_2 is eliminated as a byproduct. The unique feature in plant respiration is anaerobic respiration. This process does not occur in animals.

Various animals have developed different organs for taking in oxygen and giving out CO_2. The terresterial animals use atmospheric oxygen for breathing but the aquatic animals used oxygen dissolved in the water.

The amount of oxygen dissolved in water is very low when compared to the amount of oxygen present in the atmospheric air. So the rate of breathing in aquatic organisms is much faster than that in terrestrial animals. For breathing, fishes take in water through their mouths and force it to pass the gills where the dissolved oxygen is taken up by blood through diffusion.

Activity 13.3

- Observe some fishes in an aquarium. They open and close their mouths and gill slits or the operculum covering the gill slits also open and close. Are the timings of the opening and closing of the mouth and gill slits co-ordinated in some manner ?
- Count the number of times the fish opens and closes the mouth in a minute.
- Compare this to the number of times you breathe in and out in a minute.

Different terrestrial animals have different organs to absorb atmospheric oxygen. All these organs have a structure that increases the surface area which is in contact with the oxygen rich air. Since the exchange of oxygen and carbon dioxide has to take place across this surface, it is very fine and delicate. Moreover, in order to protect the surface, it is lodged inside the body and so there have to be a passage that will take air to this area. A mechanism to move the air in and out of this area where the oxygen is absorbed is also developed.

Human beings take in the air into the body through the nostrils. The passage is provided with fine hairs and mucus to filter the air. From the nostrils the air comes to the lungs passing through the throat. The throat is provided with rings of cartilages. These ensure that the air passage does not collapse.

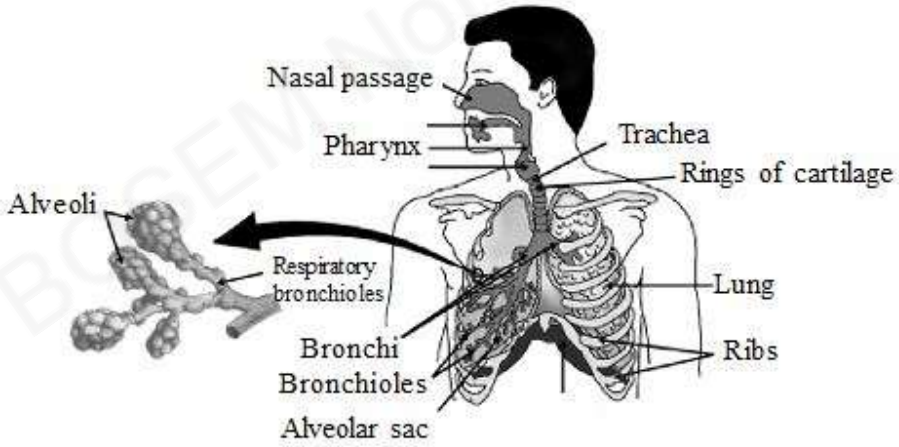


Fig.13.5. Human respiratory System

The wind pipe or air passage known as **trachea** divides into two **bronchi** leading each to each lung. In the lungs the bronchi divide into smaller branches called **bronchioles**. These bronchioles end in alveolar sac where the gaseous exchange takes place. The walls of the alveoli contain an extensive network of blood-vessels. When we breath in the ribs are lifted and the diaphragm is flattened . As a result the chest cavity becomes larger. By doing so, the air is sucked into the lungs and fills the expanded alveoli. The blood in the alveolar blood vessels absorb the oxygen from the alveolar air and the carbon dioxide in the alveolar blood vessels diffuse out in the alveolar sac. The oxygen absorbed in the alveolar blood vessels is transported to all the cells of the body. During the breathing cycle, when air is taken in and let out, the lungs always contain a residual volume of air so that there is sufficient time for oxygen to be absorbed and for the carbon dioxide to be released.

When the body size of the animal is large, the diffusion pressure alone is not sufficient for supply of oxygen to all parts of the body. In addition there are respiratory pigments in the blood which take up oxygen from the air in the lungs. In human beings, haemoglobin is the respiratory pigment. It has very high affinity for oxygen. This pigment is present in the red blood corpuscles (RBC). Carbon dioxide is more soluble in water than oxygen. So, it is mostly transported in the dissolved form in our blood.

Do you know ?

- ⇨ ***If the alveolar surface were spread out it would cover about 80m^2. What is the approximate surface area of your body ? Consider how efficient exchange of gases carried out because of the large surface area available.***
- ⇨ ***If diffusion were to move oxygen in our body, it is estimated that it would take about 3 years for a molecule of oxygen to get to our toes from our lungs. This does not happen due to the presence of haemoglobin.***

Let us answer these.

1. What advantage does a terrestrial animal get with regard to obtain oxygen during respiration over an aquatic animal ?
2. How is oxygen and carbon dioxide transported in human beings ?
3. "The human lungs are designed to have maximum surface area for exchange of gases".

   Explain.

13.4. TRANSPORTATION

Transportation in Human beings

13.4 Activity

- ☞ Visit your local health centre and find out what is the normal range of haemoglobin content in human beings.
- ☞ Is it same for children and adults ?
- ☞ Is there any difference in the haemoglobin levels for men and women ?

In previous sections, we have seen that the blood transports digested food, oxygen, carbon dioxide, waste materials, etc. in our bodies. In previous classes also we have learnt that the blood is a fluid connective tissue. Blood consists of a fluid called plasma and cells suspended in it. Plasma transports digested food materials, carbon dioxide and nitrogenous wastes in dissolved forms. Oxygen is transported by red blood corpuscles. Many other substances like salts, hormones are also transported by the blood. Thus, for transporting various substances from one part of the body to another part, there is the necessity of a pumping organ to ensure a continuous flow of blood and a network of blood vessels to reach all the tissues.

13.4.1. Heart

The heart is the pumping organ which send blood to every part of the body. The human heart is a muscular organ which is as big as our fist. Since both oxygenated and deoxygenated bloods are to be transported by the heart, it has four separate chambers to check the mixing of the two types of blood. The oxygen rich blood from the lungs comes to the left upper chamber of the heart known as the left atrium. It is a thin walled chamber. The left atrium relaxes when the blood enters into it. Then it contracts and the blood from this enters the thick walled left ventricle. When the left ventricle contracts the blood is

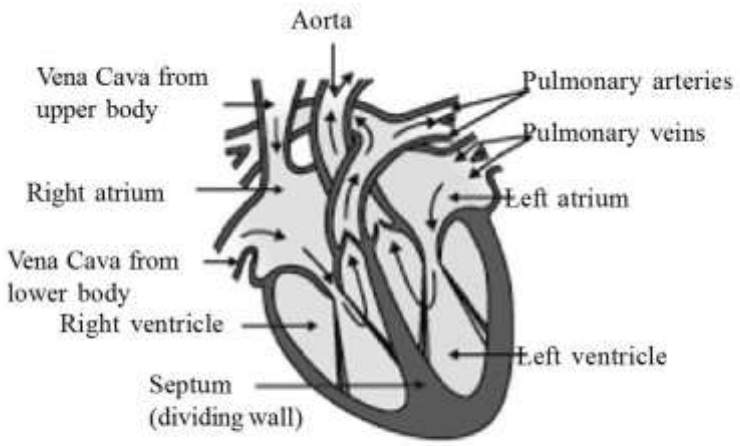


Fig.13.6. Sectional view of the human heart.

pumped out to the different parts of the body. Deoxygenated blood returning from different parts of the body enters the right atrium when it expands. As the right atrium contracts, the blood from here enters the right ventricle. When the right ventricle contracts in turn the deoxygenated blood from here is pumped to the lungs for oxygenation. The ventricles pump the blood to various organs, they have thick muscular wall while the atria have comparatively thinner walls. The back flow of the blood when the atria or ventricles contract is checked by the presence of valves.

The separation of the flow of blood in the right and left sides of the heart is useful in preventing the mixing of oxygenated and deoxygeneted blood. This complete separation of the two types of blood gives a sufficient supply of oxygenated blood in the animals that have high energy needs. Such type of heart is present in birds and mammals which constantly use energy to maintain their body temperature. Animals like amphibians and many of the reptiles have only three chambered heart in which there is mixing of oxygenated and deoxygenated blood. In these animals the body temperature depends on the temperature of the environment. In fishes also the body temperature depends on the temperature of the surrounding environment . In these animals the heart is only two chambered. The deoxygenated blood collected in the heart is pumped to the gills for oxygenation. From the gills after oxygenations the blood is supplied to different parts of the body. So the heart in fishes contains only deoxygenated blood. Thus, in these animals the blood passes only once through the heart during one cycle of flow through the body. In other higher vertebrates, the blood goes through the heart twice during each cycle. Such condition is known as double circulation.

13.4.2. Blood vessels

The blood vessels which carry blood from the heart to various organs of the body are the **arteries**. These are thick walled because they are to carry the blood emerging under high pressure from the heart. The blood vessels which collect blood from various organs and return it to the heart are the **veins**. These are thin walled because the blood passing through them are not under high pressure. They posseses valves which check the backflow of blood.

The artery divides into smaller and smaller vessels in the organs or tissues and the smallest vessels are known as **capillaries**. The capillary wall is of one-cell thickness and arranged in such a way that each and every cell is in contact with blood. Exchange of materials between the blood and surrounding

cells takes place across this thin wall. After supplying blood to the cell the capillaries join together to form veins and carry the blood from the organs or tissues and back to the heart.

13.4.3. Platelets

When there is an injury, bleeding starts. The leakage in the blood vessels would lead to a loss of pressure which would reduce the efficiency of the pumping system. To prevent it, there are platelets in the circulating blood which bring about the clotting of blood. Clotting prevents the loss of blood from the sides of injury.

13.4.4. Transportation in Plants

Plant transport systems involve the movement of raw materials from roots to the leaves for photosynthesis and synthesized food from leaves to the different parts of the plant. Movement of water and minerals is through the xylem and transport of photosynthetic products is through the phloem.

In lower plants, transport of water and other organic materials is done by different processes like simple diffusion, osmosis and active transport. Transportation of substances in algae and fungi take place across the cell membrane and within the cell cytoplasm by the above processes.

How the transportation takes place in vascular plant ? What types of forces are essential for transportation in higher plants.

In higher plants, the leaves can directly absorb carbon dioxide through diffusion for the process of photosynthesis. Other kinds of raw materials needed by the plant are taken in the form of solution through its root system. If the distance between the root system and chlorophyll containing parts are short, energy and raw materials can be easily diffused to all parts of the plant body. In trees the distance become long and simple diffusion processes is not sufficient. So a proper system of transportation is essential in such situation.

A single rye plant in four months of growth have 350 km of roots. There are approximately 13 million root tips possessing an estimate total of 14 billion root hairs.

13.4.5. Transport of water in vascular plant

The water conducting system of higher plant includes xylem tissues, like vessels and tracheids of the roots, stems and leaves are interconnected to form

a continuous system reaching all parts of the plant. The capacity of root cells to take up ions from the soil creates a difference in the concentration of these ions between the root and the soil. So, water moves from the soil into the root to stabilize this difference. Such a steady movement creates a pressure that can push the water upward. The root pressure is not enough to lift the water upto the height that we commonly see in a plant. Plants thus, have to use other strategies to overcome it.

13.5. Activity.

- ☞ Cut a leafy twig of Balsam plant (it has semitransparent stem) under water to avoid entry of airbubble through the cut end.
- ☞ Place the cut end in a beaker containing water coloured with eosin (a red dye) dissolved in it.
- ☞ After some time red lines will be seen moving upward through the stem.
- ☞ If a section of the stem is observed under microscope, only the xylem elements will be seen filled with coloured water.

In which tissues transport of water takes place ?

Can uplift of water takes place without root ?

What are the processes responsible for the uplift of water through stem ?

Water is lost in the form of water vapour from the aerial portion of the plant through the stomata of leaf. This loss of water is replaced by water from the xylem vessels in the leaf and also creates a suction which pulls water from the xylem cells of roots.

Thus the loss of water in the form of vapour from the aerial portions of the plant is called **transpiration.** It helps in the absorbtion and movement of water and minerals dissolved in it from the roots to the leaves. It also helps in temperature regulations. During night transportation of water is done by root pressure and by transpiration during daytime when the stomata are open. So transpirational pull is major driving force in the movement of water in the xylem.

13.4.6. Transport of food and other substances

The transport of soluble products of photosynthesis from the leaves and stem to the other parts of the plant through the phloem is called **translocation**. Phloem also transport amino acids and other substances. The upward and

downward translocation of food and other substances takes place through the sieve tubes with the help of companion cells of phloem tissue.

Unlike water transport, the translocation in phloem is performed by utilising energy from ATP. The transfer of substances like sucrose into the phloem tissue results in increase of osmotic pressure causing water to move into it. This pressure moves the material in the phloem tissues which have less pressure. In this way the materials are translocated by the phloem to all the parts of a plant, which need it for various activities and storage. During spring stored materials in root or stem tissue would be transported to the bud which need energy to grow.

Let us answer these.

1. Name the components of the transport system in human being. Write the functions of the components.
2. What are the advantages of separation of oxygenated and deoxygenated blood in birds and mammals ?
3. What are the components of the transport system in highly organised plants ?
4. How are water and minerals transported in plants ?
5. How is food transported in plants ?

13.5. Excretion

The removal of harmful metabolic waste from the body is known as **excretion**. The metabolic activities in the body generate nitrogenous materials. These nitrogenous wastes are harmful if accumulated in the body so these are to be removed. Different organisms use different devices for the removal of waste materials. Many unicellular animals remove these waste products by diffusion through the body surface to the surrounding water. Other multicellular organisms use specialised organs for the removal of the nitrogenous wastes.

13.5.1. Excretion in Animals

Different groups of animal have different organs for the removal of nitrogenous waste products.

Certain animals like platyhelminthes use structures called **flame cells** to remove the waste products. The Insects remove the nitrogenous waste by the help of structures called **Malpighian tubules**. The vertebrates have **kidney** for excretion. In human beings the excretory system consists of a pair of kidneys, a pair of ureters, a urinary bladder and a urethra.

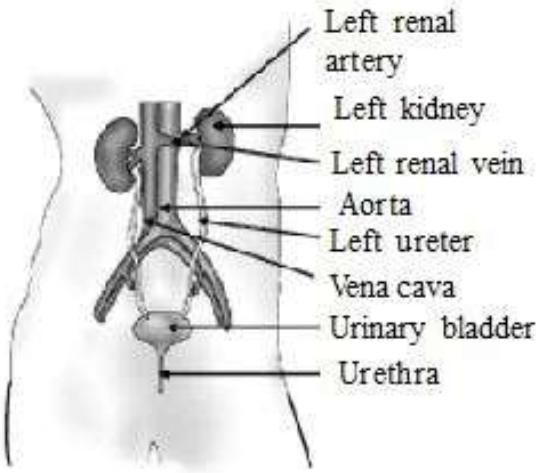


Fig. 13.7. Excretory system in human beings

Kidneys are located in the abdomen, one on either side of the backbone. Urine produced in the kidneys passes through the ureter and is stored in the urinary bladder. From the urinary bladder it is released through the urethra.

Nitrogenous waste products collected by the blood from different organs of the body are filtered in the kidney. Such compounds like urea or uric acid are removed from the blood. Like in the lungs, clusters of very thin walled blood capillaries are present in the kidney. Each capillary cluster in the kidneys is associated with the cup-shaped end of a tube that collects the filtered urine. Each kidney has large numbers of these filteration units called **nephron** packed closed together. Some substances

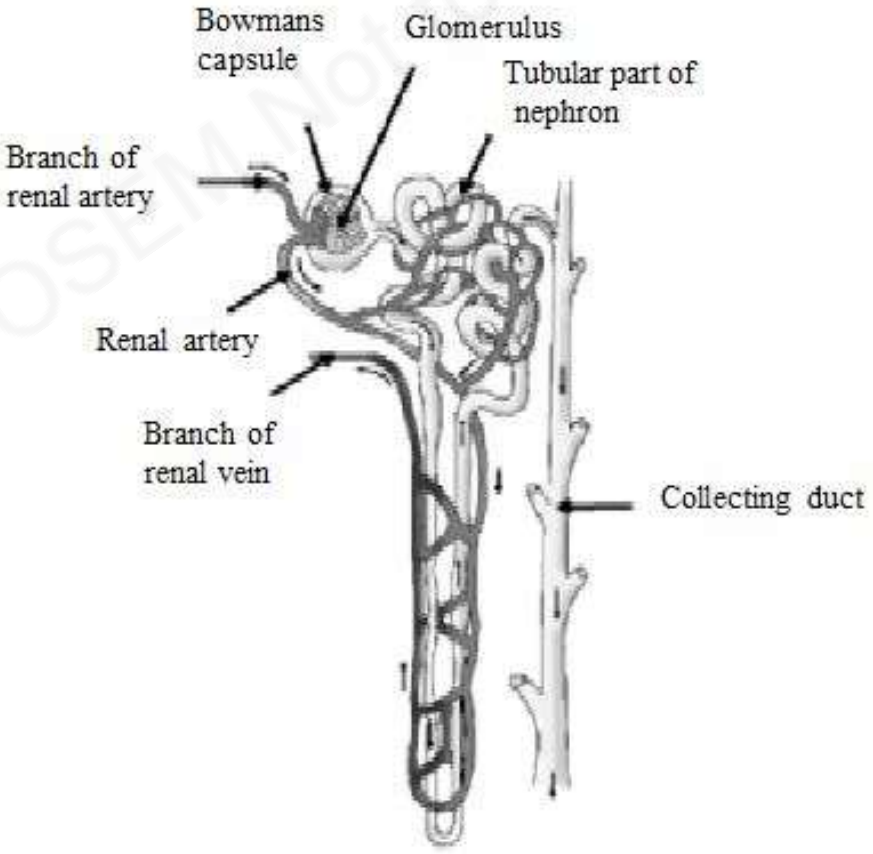


Fig. 13.8. Structure of a Nephron

like glucose, amino acids, salt and major amount of water are selectively re-absorbed as the urine flows along the tube. The urine forming in each kidney enters a long tube, the ureter, which connects the kindneys with the urinary bladder. From the urinary bladder the urine passes out of the body through the urethra.

13.5.2. Excretion in plants

Plants give out oxygen during photosynthesis and carbondioxide during respiration. Water in released as vapour during day time and in liquid form during night. Roots also exudate waste materials into the soil. All mineral salts absorbed in the form of ions are not essential in plants. The excess minerals are deposited in the leaves that fall off. Other waste products are stored as resins and gums specially in old xylem.

Let us answer these.

1. What are the methods used by plants to get rid of excretory products ?
2. Which organs are responsible for excretion in platyhelminthes and insects ?

POINTS TO REMEMBER

- ⇨ All living organisms respire.
- ⇨ The maintenance of life requires proceses like nutrition, respiration, transport of materials within the body and excretion of waste products.
- ⇨ Autotrophic nutrition involves the manufacture of complex high energy organic material from simple inorganic materials by using solar energy.
- ⇨ Heterotrophic nutrition involves the intake of complex material prepared by other organisms.
- ⇨ In human beings the food eaten is broken down by various steps along the alimentary canal and the digested food is absorbed in the small intestine to be sent to all cells in the body.
- ⇨ Respiration provides energy in the form of ATP by broken down complex organic compounds such as glucose. ATP is the source energy for other reactions in the cell.
- ⇨ Respiration may be aerobic or anaerobic. Aerobic respiration produces more energy available to the organism.

- ⇨ In human being, the transport of materials such as oxygen, carbon dioxide, food and excretory products is the function of the circulatory system. The circulatory system consists of the heart, blood and blood vessels.
- ⇨ In highly differentiated plants, transport of water, minerals, food and other materials is a function of the vascular tissues which consist of xylem and phloem.

EXERCISES

1. What is the function of xylem ?
2. Which part of the alimentary canal absorbs the digested food ?
3. In which part of the cell the three carbon compound pyruvate is broken down to give CO_2, H_2O and energy.
4. What is the function of kidney ?
5. Describe the structure and function of nephrons.
6. Describe double circulation in human being.
7. How are the alveoli designed to maximise the exchange of gases ?
8. What is the role of saliva in the digestion of food ?
9. How does the small intestine designed to absorb digested food ?
10. What are the differences between the transport of materials in xylem and phloem?
11. What are the differences between aerobic and anarobic respiration ? Name some organisms that use the anaerobic mode of respiration.
12. What are the necessary conditions for autotrophic nutrition and what are its byproducts ?
13. What would be the consequences of a deficiency of haemoglobin in our bodies ?
14. Compare the alveoli in the lungs and nephrons in the kidneys with respect to their structure and function.
15. Draw and label the sectional view of the human heart.

★★★★★★

CHAPTER 14

CONTROL AND CO-ORDINATION IN LIVING BEINGS

14.1. Co-ordination in Animals

Irritability or sensitivity is one of the characteristic features of the living organisms. The living organisms have the ability to respond to a stimulus. They respond to changes in the environment. When the temperature around us is very low we feel cold and like to use warm cloth. When a teacher teaches a lesson in the class he speaks somewhat loudly so that every student can hear him. But when a student in the class wants to say something to his friend he whispers rather than shouting loudly. A cat, on seeing a rat, moves very silently and slowly at the begining so that the rat might not see him but when nearer the cat will jump suddenly to catch the rat. It is seen that in all organisms some degree of control and internal co-ordination is necessary in order to ensure that the events of the stimulus and response bear some mutual relationship. In multicellular organisms, specialised tissues are present to perform control and co-ordination activities.

14.1.1. Nervous System

In animals, control and co-ordination activities are performed by the nervous and muscular tissues. When we touch a hot object, we will feel the heat and respond to it. Then how do we know that we are touching a hot object ? Some of the nerve cells have specialised tips which detect all the information from our environment. These receptors are usually located in our sense organs, such as the skin, the tongue, the nose, the ear and the eye. Thus, the olfactory receptors of the nose will detect smell, the gustatory receptors of the tongue will detect taste and so on.

The information received at the end of the dendritic tip of a nerve cell (Fig.14.1.) sets off a chemical reaction that creates an electrical impulse. This impulse passes from the dendrite to the cell body, then it moves along the axon to its end. At the end of the axon, the electrical impulse sets off the release of some chemicals. The chemicals cross a gap known as **synapse** and start a similar electrical impulse in a dendrite of the next neuron. A similar synapse

finally allows delivery of such impulses from neurons to other cells such as muscle cells or glands. Thus, the nervous tissue is made up of an organised network of nerve cells or neurons and is specialised for conducting information via electrical impulses from one part of the body to another.

The brain and spinal cord constitute the central nervous system.The brain is divided into three major regions, namely the fore-brain, mid-brain and hind-brain.

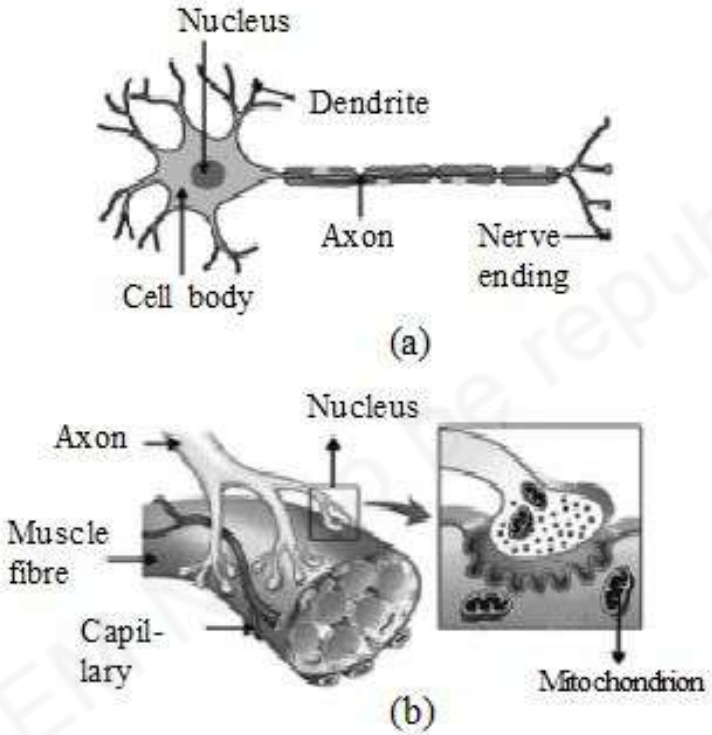


Fig. 14.1. (a) Structure of neuron (b) Neuromuscular junctions

We human beings think about our actions. Doing something like running , walking, talking, writing etc. are examples of voluntary actions which are based on deciding what to do next. For these the brain has to send messages to muscles. This is the second way in which the nervous system communicates with the muscles. There is another nervous system known as peripheral nervous system which constitutes the cranial nerves arising from the brain and spinal nerves arising from the spinal cord. The communication between the central nervous system and the other parts of the body is facilitated by the peripheral nervous system.

The main thinking part of the brain is the fore-brain. It has regions which receive sensory impulses from various receptors. The fore-brain has seperate areas specialised for smell, hearing, sight and so on.

There are seperate areas of association where the sensory information is interpreted by putting it together with information from other receptors as well as with information that is already stored in the brain. Then, a question arises on how response and the information are passed on to the motor areas which control the movement of voluntary muscles, for example the muscle of the hand or leg.

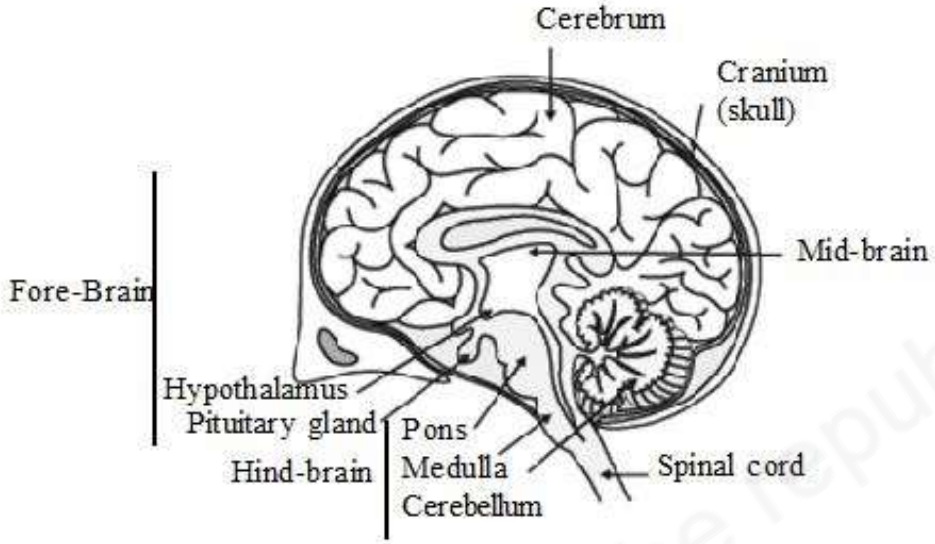


Fig. 14.2. Human brain

There are certain sensations which are different from seeing or hearing etc. for example, feeling of fullness of our stomach. The sensation of being full is because of a centre associated with hunger, which is a separate part of the fore -brain. Mid-brain is comperatively a small region. It controls the reflex movement. The change in eye pupil size and shape of the eye lens are controlled in this region of the brain.

On the other hand, there are other actions that we cannot control easily by thinking about them. For example, our mouth waters when we see food we like, our heart beat or we breathe without thinking about it. These involuntary actions are controlled by the medulla in the hind-brain.

The brain which is very important for a variety of activities, is a delicate organ and needs to be protected. It is protected by a bony box, the cranium. In between the bony covering and the brain there is a fluid filled space which provides further shock absorption. The spinal cord is lodged inside the vertebral column.

14.1.2. Reflex Action

When we walk accidentally on an inverted nail and pierces the foot we feel pain and suddenly remove our leg from it without thinking anything about it. Such an involuntary sudden action in response to something in the environment

is the **reflex action**. In another example when our hand touches a hot object or a burning charcoal, we suddenly remove the hand automatically without thinking about it. The sudden response in these pain or heat is done in such a way that the nerves that detect pain or heat are connected to the nerves that move muscles in a simpler way, the process of detecting the signal or the input and responding to it by an output action might be completed quickly. Such a connection is commonly called a **reflex arc** (Fig .14.3.). Nerves from all over the body meet in a bundle in the spinal cord on their way to the brain. Such reflex arcs are

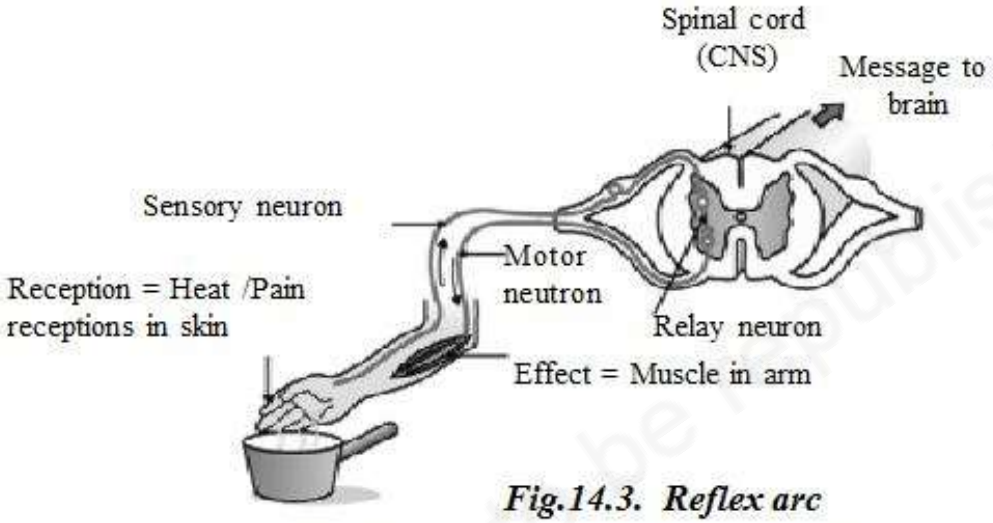


Fig.14.3. Reflex arc

formed in this spinal cord itself, although the information input also goes on to reach the brain.

14.1.3. Conditioned Reflexes

Conditioned reflexes are the acquired reflexes during the lifetime of an individual. These are not constant that they may disappear or reappear again. They depend on previous experience. They are not transmitted by heredity.

Ivan Pavlov, a Russian Physiologist, for the first time discovered the existance of conditioned reflexes.

14.1.4. Pavlov's Experiment on conditioned reflex

Pavlov conducted his experiment on a dog. He used to ring a bell every time just before the food was placed in front of the dog. The dog gradually learnt to associate the bell with food. Later when the bell was rung, the dog would salivate even though no food was placed (Fig.14.4).

14.1.5. Chemical Co-ordination – Animal hormones

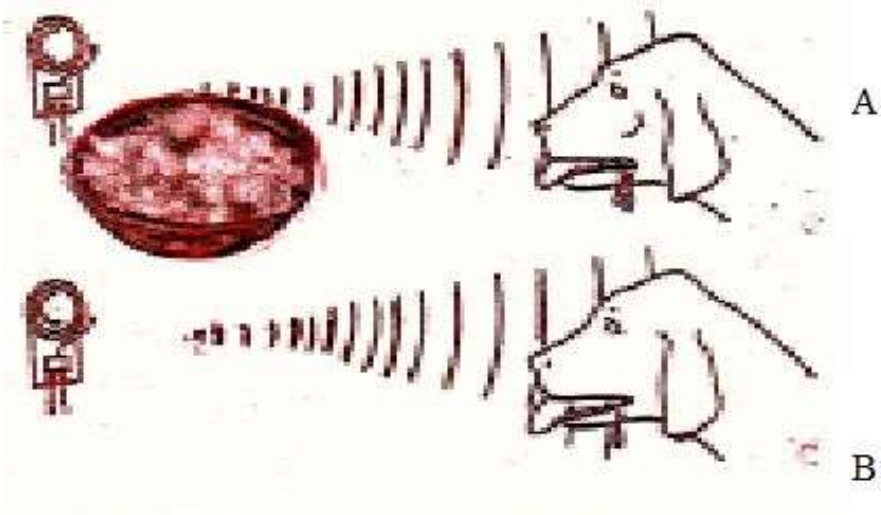


Fig.14.4. Pavlov's experiment on conditioned reflex.
A. The dog salivated at the sight of the food with a sound of a bell.
B. The dog salivated at the sound of the bell even though no food was placed.

In animals control and co-ordination is done not only by the nervous system but also by the hormones. The hormones are secreted by the endocrine glands (ductless glands) of the body (Fig. 14.5.). Different hormones perform different functions of co-ordination in the animal body. Among human beings there are very short (dwarf) individuals and sometimes extremely tall (gaint) individuals while majority are of normal size. These conditions are related with a pituitary hormone, known as growth hormone. If the secretion of this hormone is optimum during the childhood there will be normal growth of the individual. If the secretion of this hormone is less during childhood it will lead to dwarfism. If there is excessive secretion during growth period, it will result to extremely tall individual (gigantism).

Nowadays diabetes is very common among us. This is also caused due to inadequate production of a hormone known as insulin secreted by the pancreas. It maintains normal blood sugar level in the body. If there is insufficient secretion of insulin the sugar level in the blood becomes high and we suffer from diabetes.

Another example of chemical co-ordination is the role of the thyroid hormone, the thyroxin, in the growth of an individual. Nowadays we use iodised salts in our diet. Iodine is needed by the thyroid gland to make thyroixin hormone. Thyroxin regulates carbohydrates, protein and fat balance for growth. If there is deficiency of iodine in our diet there will be no synthesis of this thyroid hormone. In such a condition, one may suffer from goitre, the characteristic

symptom being a swollen neck.

Adrenaline is a hormone secreted by the adrenal gland. The action of this hormone is widespread throughout the body. It prepares the animal for situations of 'fight or flight'. It facilitates the response to sudden demands imposed by stress such as pain, shock, cold, low blood sugar, low blood pressure, anger, passsion etc. Adrenaline, being a hormone, is secreted directly into the blood and carried to different parts of the body. The target organs on which it acts include the heart. As a result the heart beats faster resulting in supply of more oxygen to the muscles. The blood supply to the digestive system and skin is reduced due to contraction of muscles around small arteries in these organs and diverted to skeletal muscles. The breathing rate also increases. As a result of these responses, the animal body is ready to face with the hard situation. Thus, this hormone participates in the a chemical control and co-ordination in our body.

You might have experienced the changes in your general appearance as well as that of your friends as you reach 10–12 years of age. These changes are

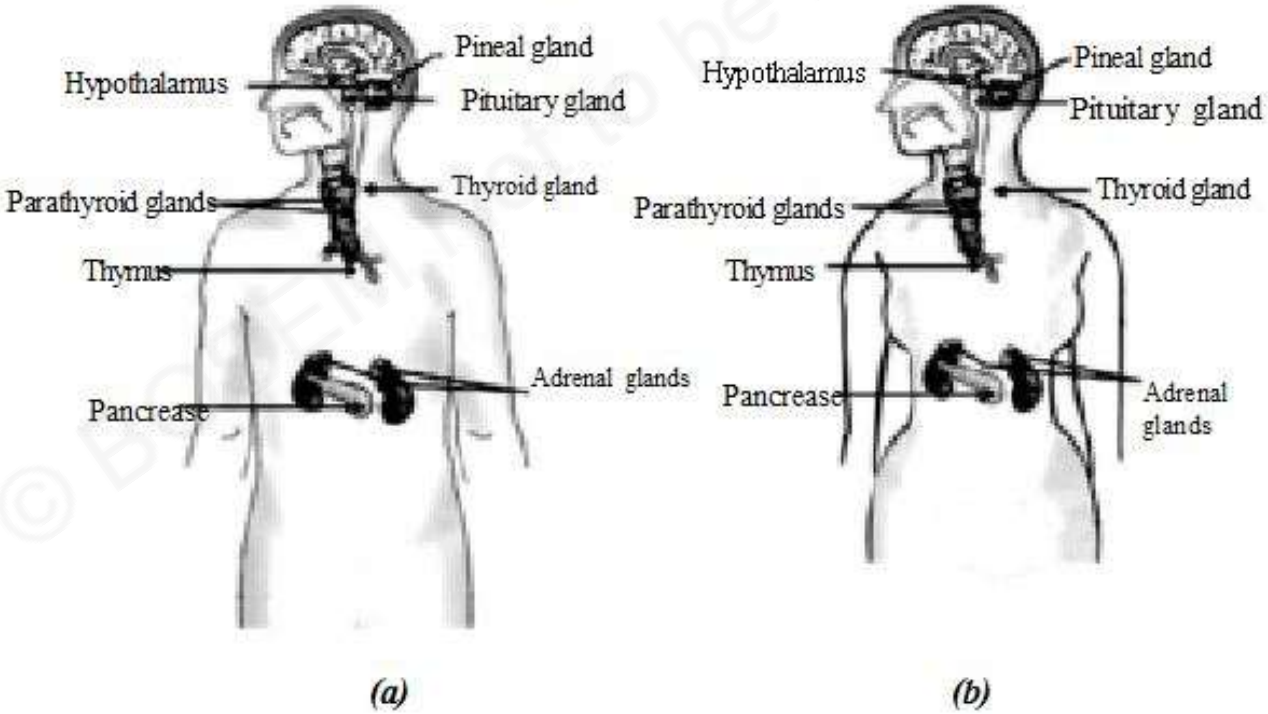


Fig .14.5. Endocrine glands in human beings (a) male, (b) female.

associated with puberty and these are resulted by the secretion of testosterone in males and oestrogen in females.

14.2. Co-odination in Plants

Let us answer these.

1. What is a reflex action ?
2. What happens at the synapse between two neurons ?
3. Why should we use iodised salt ?
4. Why are some patients of diabetes treated by giving injections of insulin ?

Nervous system is the controlling and co-ordinating unit of body activities in animals. But plants have no nervous system. Then, how do plants respond to stimuli ? When a sensitive plant (*Mimosa pudica*) leaflets are touched, they fold up and drop. In germinating seeds, the root goes down the soil and the stem comes up into the air. The response to touch is very quick in sensitive plants without involving any growth. But the directional movement of a seedling is caused by growth which shows a slow movement.

How many kinds of movements are recognized in plants ?

14.2.1. Immediate response to stimuli

The leaves in sensitive plants move in response to touch. This plant does not posses nervous tissue or muscle tissue. How does the plant feel the touch ? How do the leaves move in response?

Fig. 14.6. Sensitive Plants (Mimosa pudica)

If you touch the plant and examine the part of the plant actually moves. The movement happens to a point different from the point of touch. So, information that a touch has occured must be communicated. Unlike in animals, plants do not have specialised tissues for collection of information. Instead of specialised proteins found in animals, the plant cells change shape by changing the amount of water in them. The swelling and shrinking due to water pressure

makes a change in the shape of plant.

14.2.2. Movement due to growth

A pea plant climb itself with the help of tendrils. When a tendril comes into contect with any support, the side of the tendril in contact with the object ceases to grow as rapidly as the side of the tendril away from the object. So the tendril can encircle an object and thus clings to it. Plants can respond to stimuli and grow slowly in a particular direction. This directional growth makes a plant appears as if it is moving. **Tropism** is the movement of curvature brought about by more growth on one side and less growth on opposite side of plant organ induced by some external stimuli. Depending upon the nature of stimuli the tropism can be phototropism (light induced), geotropism (induced by gravitational force), hydrotropism (water induced), thigmotropism (touch induced) and chemotropism (chemical induced).

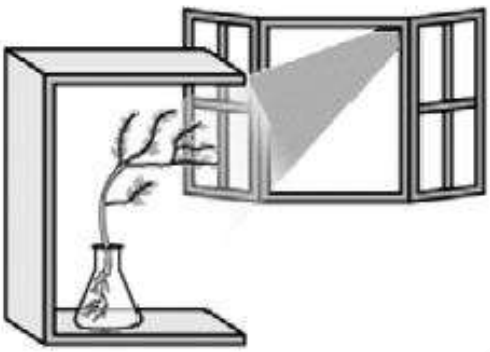


Fig.14.7. Stem is positively phototropic.

Activity 14.1.

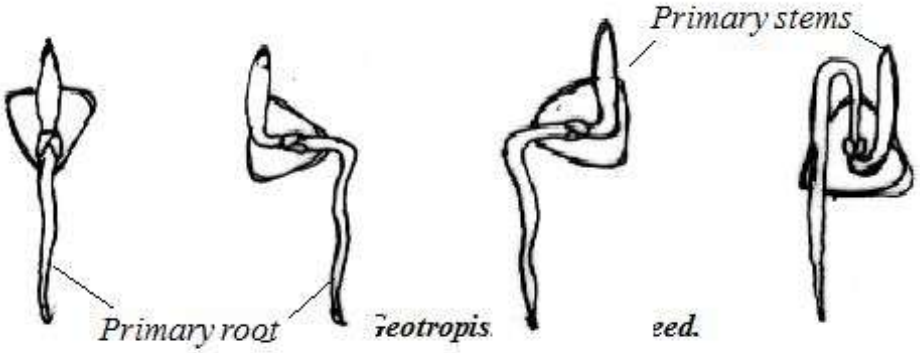
- Take a potted plant and keep the potted plant in a room near an open window.
- Observe after 2 or 3 days.
- The stem is seen bending towards the open window.

What conclusion you can draw from this activity ?

Environmental factors like light, gravity, water etc. are responsible for the directional movement in plants. In phototrophic movement shoots bend towards light while roots respond by bending away from light. So the directional or tropic movement can be either towards the stimulus or away from it.

14.2.3. Why do roots grow towards the soil ?

The tropic movements in response to gravity are called **geotropism**. In plants the primary roots grow down into the soil and are positively geotropic. On the other hand, the primary stems are negetively geotropic (Fig. 14.8.).



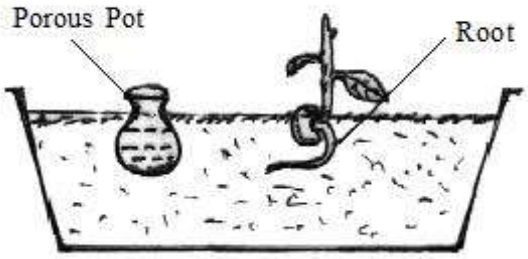


Fig. 14.9. Hydrotropism in germinating seed

Activity 14.2.

- Take a vessel nearly filled with sand.
- On one side immersed a porous pot filled with water.
- Place a germinating seed away from the porous pot in the vessel.
- Examine the germaniting seed after 4 to 5 days.

How the root elongates ?

It has been observed that roots grow vertically downwards due to gravitational pull. Then, the root bends towards the porous pot, showing a tendency to grow towards the source of moisture (Fig.14.9.). So, the root is said to be positively hydrotropic. Hydrotropism is stronger than geotropism.

One example of the chemotropism is the growth of pollen tube through stigma and style, towards ovule with the stimulus of chemical substances present in the carpel.

How the information is communicated in the body of multicellular plants? The movement in sensitive plant in response to touch is very quick, whereas growth related movements in plants are quite slow. If the response to stimuli is to be made quickly, information must be transferred very fast. It can be easily achieved by means of electrical impulses. But electrical impulses can reach only those cells that are connected by nervous tissues. Once an electrical impulse is generated in a cell and transmitted, it takes more time to reset its mechanism

before it can generate and transmit a new impulse. Moreover, cell can not continuously create and transport electrical impulses.

In multicellular organisms, the control and co-ordination is done by the release of certain chemical compounds from the stimulated cells. These compounds are detected by other cells around it by using special molecules on their surface then, they would be able to recognise information and even transmit it. This is a slow system but regardless of nervous connection. The co-ordination in growth, development and respond to environment in plant is done with the help of different compounds or plant hormones. They are synthesised at places away from where they act and simply diffuse to the area of action.

14.2.4. Plant hormones

What are plant hormones ? How do they act on plants? The growth of the stem towards light in Fig.14.7., is the action of a hormone called **Auxin**. It is synthesized at the shoot tip. Auxin diffuses towards the shade side of the stem. The higher concentration of auxin stimulates the cells to grow longer on the side of the shoot which is away from light. So, the plant bend towards light. No growth can occur in plant without auxin.

Auxins in plants are to stimulate the elongation of cells in shoot. Similarly **Gibberellins** also help in the growth of stem by inducing elongation of internodes. **Cytokinins** stimulates cell division and also cause the enlargement of cells and promote seed germination.

All the above hormones are growth promoters. But plants also need signals to stop growing. **Abscisic acid** (ABA) is a powerful growth inhibitor and can induce bud dormancy in varieties of plants. There are significant evidence to support that ABA controls geotropic response of roots.

Ethylene also acts as a plant hormone and can prevent the longitudinal elongation of stem and roots but is associated with radial enlargement of tissues. It can hasten post harvest maturation of fruits.

14.2.5. Apical dominance

It is common observation in vascular plants, specially the taller ones, that if the apical bud is intact and growing, the lateral buds remain suppressed. Removal of apical bud causes fast growth of lateral buds.

Let us observe the three potted plants (Fig. 14.10.). The first pot is

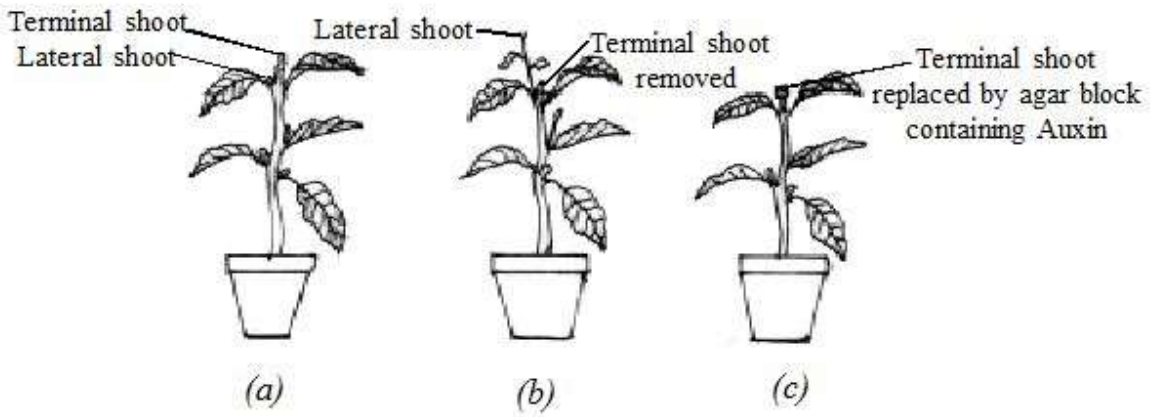


Fig.14.10. Apical dominance in Plants (a,b&c)

kept as control, so growth of lateral buds are suppress. The terminal shoot is removed from the second pot and the lateral buds commence to grow. What is the inhibitor which supresses the growth of lateral bud?

Apical dominance seems to result from the downward transport of auxin produced in the apical meristem.

In the third plotted plant terminal shoot is replaced by an agar block containing auxin showing the inhibition of lateral bud. Aplain block of agar has no such effect. What inferance can you narrate from the above observations?

Let us answer these.

1. What is the factor responsible for the movement of leaves in the sensitive plants ?
2. What are plant hormones ?
3. How do auxins promote the growth of tendril around a support ?
4. Give an example of chemotropism.

POINTS TO REMEMBER

⇨ Control and co-ordination are the functions of the hormones and nervous system in our bodies.

⇨ The responses of the nervous system can be classified as reflex action, voluntary action or involuntary action.

⇨ The nervous system uses electrical impulse to transmit messages.

- ⇨ The nervous system gets information from our sense organs and acts through our muscles.
- ⇨ Plants do not have nervous system, but some plants can response to external stimuli.
- ⇨ Stem moves upward towards light whereas root moves downward away from light.
- ⇨ Chemical co-ordination is seen in both plants and animals.
- ⇨ Hormones are organic sustances which are synthesized in minute quantities in one part of the plant body and transported to another part where they influence specific physiological processes.
- ⇨ Auxin is responsible for apical dominance in plants.

EXERCISES

1. How does phototropism occur in plants?
2. Why do roots grow towards the soil ? Explain with three points.
3. Explain the function of two growth inhibitors in plants.
4. In what way auxin is involved in the process of apical dominance ?
5. What is the name of the gap between the two neurons ?
6. What is the function of receptors in our body ? What will be the conditions if the receptor are not properly working ?
7. How do the reflex actions differ from the involuntary actions ?
8. Explain the functions of any three hormones in human being.

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CHAPTER

15

REPRODUCTION

Unlike the essential life processes such as nutrition, respiration or excretion, reproduction is not necessary to maintain the life of an individual. When an organism reproduces, it creates more individuals and a lot of its energy is spent in the process. Then, why do organisms reproduce? The organisms reproduce to maintain the continuity of their own race.

15.1. Reproduction in Plants

The origin of life is estimated to have happened over 3000 million years ago and has produced all living organisms of today by different methods of reproduction. One of the most important aspects of living organisms is their ablity to produce copies of themselves.

Two distinct methods of producing offspring are found among living organisms.

Asexual reproduction is a rapid method of increasing the number of a species without involving an union of two cells (gametes). **Sexual reproduction** is a slower method in which the union of two cells take place for the production of a new individual . Do plants and animals have similar reproductive cycles ?

15.1.1. Asexual reproduction

In asexual reproduction, the nucleus divides by mitosis, producing two daughter cells, each having the same number of chromosomes in their nuclei as the parent. **Cloning** is a term used to describe the formation of a group of organisms of the same species by asexual methods involving mitosis and vegetative or artificial propagation. The clones have identical genetic composition. This method is widely used by microorganisms, plants and lower animals.

Activity 15.1.

- Prepare a 10% sugar solution (10 g in 100 ml of water).
- Transfer 20 ml of the solution to a test tube.
- Add a pinch of yeast granules in it.
- Close the mouth of the test tube with a cotton plug.

- Keep it undirsturbed for about 2 hours in a warm place.
- Take a drop of the yeast culture from the test tube on a slide and cover it with a cover slip.
- Observe the slide under a microscope.

Write down your observations.

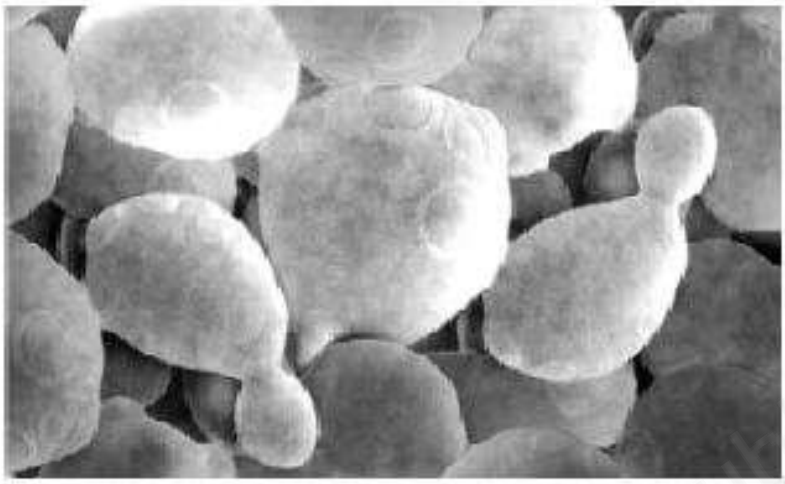


Fig . 15.1. Yeast budding

15.1.2. Budding

Yeast cell forms a small bud into which cytoplasm and a nucleus pass. The bud is much smaller than the parent cell and becomes detached (Fig. 15.1.). A multicellular organism like *Hydra* also reproduced by the formation of bud which later separates from the parent body.

15.1.3. Fragmentation

In multicellular filamentous algae like *Spirogyra*, a parent cell divides by forming a new cell wall or septum into daughter cells i.e. septation or fragmentation.

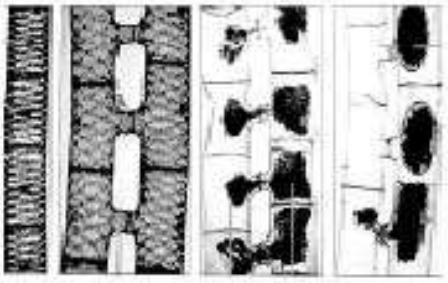


Fig. 15.2. Conjugation in Spirogyra

15.1.4. Sporulation (Spore formation)

Fungi, liverworts, mosses and ferns can produce enormous number of spores.

Spores are small bodies containing a nucleus and a small amount of cytoplasm. The spores of terrestrial organisms are usually very light and have a protective wall around them.

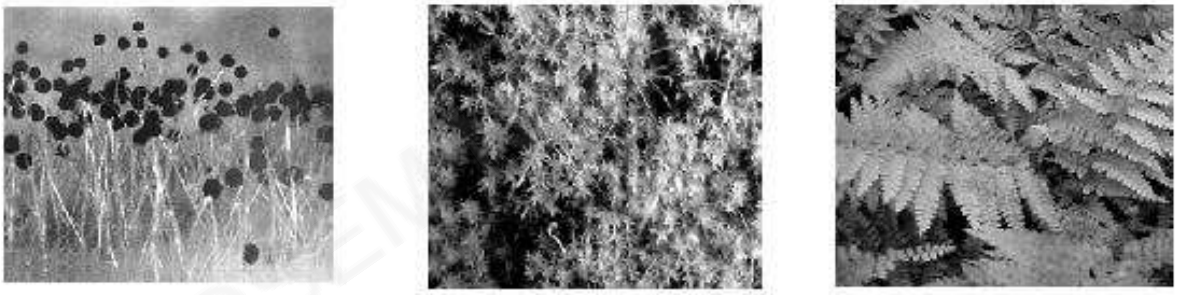
Many bacteria form a thick-walled spore inside the bacterial cell wall. This can not be considered as a reproductive mechanism for them but provides a means of survival during unfavourable conditions.

Some of the green algae and aquatic fungi form two to eight small zoospores, each with a nucleus, cytoplasm and two flagella. Swimming by means of their flagella, the spores disperse the species to new locations.

Activity 15.2.

- Keep a slice of moistened bread in a moist, warm and dark place.
- Observe the slice daily, for a week with a magnifying glass.
- Record your daily observations.

The thread like structures that developed on the bread in Activity 15.2. above are hyphae of either the bread mould (*Rhizopus*) or the pin mould (*Mucor*) from its body or mycelium. The erect hypha develops a swelling at its tip to form a sporangium. Inside the sporangium, a large number of spores are produced by mitosis and they are liberated.



(a) *(b)* *(c)*

Fig.15.3. (a) Rhizopus (b) Moss (c)Fern

The mosses, clubmosses and common ferns also produce enormous number of tiny windblown spores which serve to disperse the species to new locations.

15.1.5. Vegetative Reproduction

Vegetative reproduction is a method of asexual reproduction in which vegetative parts (root, stem, leaf and buds) can be detached from the parent plant body and developed into another complete daughter plant. This method of asexual reproduction is seen in many flowering plants like sweet potato, onion, potato, grasses, banana etc. Perennial plants which overwinter as bulbs, corms, tubers or rhizomes are vegetatively propagated plants.

This property of vegetative propagation is used artificially by the methods of layering, grafting, cutting and by artificial culture in different media. Artificial propagation is successfully performed in plants like rose, orange, grapes, sugarcane, banana, jasmine etc. Another advantage of vegetative reproduction is that the offsprings produced are genetically identical to the parent plants.

15.1.6. Micropropergation or Tissue Culture

It is a teachnique of propergation of plants from cells, tissues or organs by using the methods of tissue culture. Here the plant parts (roots, steam, leaf etc.) are cultured on a sterilized medium containing necessary nutrients. After some days a mass of undifferentiated cells known as callus is developed. By transferring the cells of callus to other media containing hormones the callus differentiated into plantlets. This method is successfully used in many economically important plants such as orchids, chrysanthemum, gladiolus etc.

The ability of a somatic cell to produce the complete organism is called cellular totipotency. It was first observed in carrot cells.

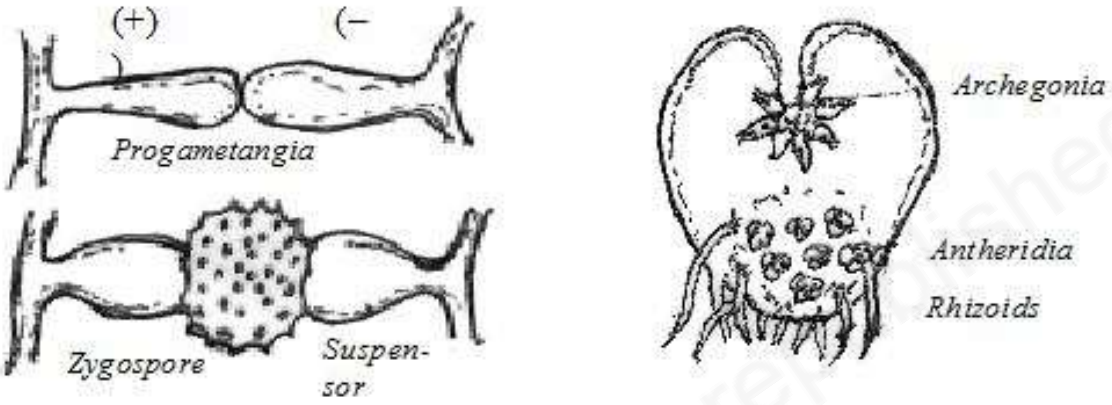
15.1.7. Parthenogenesis

Parthenogenesis is a type of asexual reproduction in which the organism is developed from unfertilized egg. This process may be natural as well as artificial. Natural parthenogenesis is found in many plants and animals.

Nonflowering plants like Spirogyra, Chara, Marsilea etc., and flowering plants like Thalictrum and certain species of Asteracae (Sunflower family) and Solanaceae (tomato family) can reproduce by parthenogenesis. In animals the process is found in Aphids or Greenfly, but they are normally reproduce by sexual reproduction.

15.1.8. Sexual reproduction in plants

Sexual reproduction occurs widely in lower plants like *Spirogyra* (through the process of conjugation , Fig.15.2.) and *Mucor* (by gametangial contact). In mosses and ferns, there is the formation of motile male gametes in the antheridium and non-motile female ova in the archegonium. It is followed by the union of male and female gametes to form zygotes and reduction division (meiosis) to form spores. What is the significance of this sexual reproduction in non-flowering plants ?



(a) Gamentangial contact *(b) Prothallus*

Fig.15.4. Sexual reproduction in (a) Mucor (b) Fern

Let us answer these .

1. Why reproduction is essential in living organisms?
2. Name the two methods of reproduction.
3. How can you differentiate budding from fragmentation ?
4. How does an organism be benefited, if it reproduce through spores?
5. Why vegetative propagation is more suitable in some types of plants?
6. What is tissue culture?

7. How will you define a callus?
8. Name two plants which can reproduce by natural parthenogenesis.
9. Give the definition of cellular totipotency.?

15.2. Sexual reproduction in flowering plants

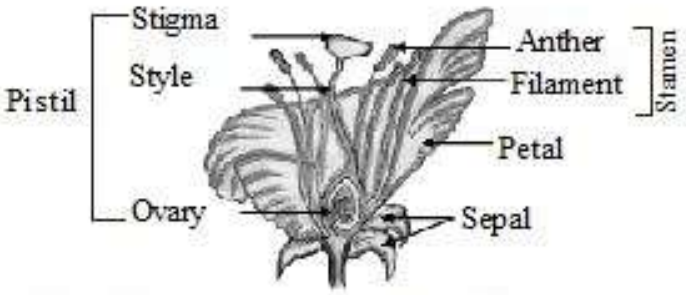


Fig. 15.5. Longitudinal section of a flower

A flower can be defined as a reproductive structure of a flowering plant. A complete flower will have four sets of floral parts. They are **Calyx** (composed of mainly green sepals), **Corolla** (composed of brighty coloured petals), **Androecium** (the male parts consisting of stamens , composed of filaments and anthers) and **Gynoecium** (the central fimal part consisting of a swollen bottom part called ovary, middle elongated part is the style and terminal part which may be sticky is the stigma).

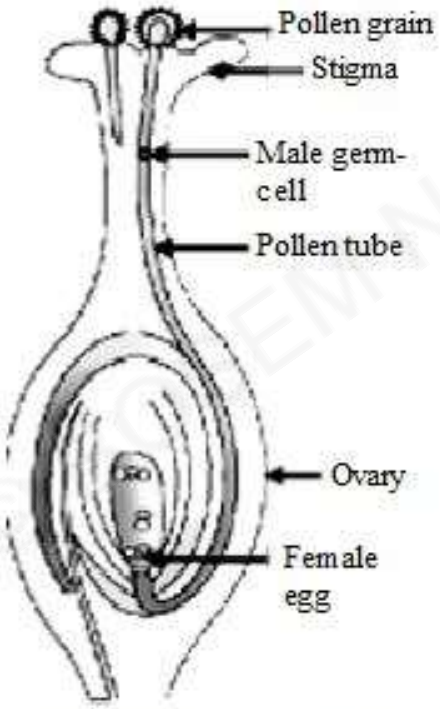


Fig.16.6. Germination of pollen on stigma

Flowers are generally bisexual in mustard, pea, china rose having both male and female floral parts. Many flowers are unisexual, (papaya, watermelon) when it contains either androecium or gynoecium. The male germ cell from the pollen, produces by the anther unites with the female gamete present in the ovule. The fusion of germ cells or fertilisation gives raise to zygote which is capable of growing into a new plant. What could be the possible functions of calyx and corolla ? Their function is mainly for protection of floral sex organs and also act as flag apparatus for insect pollination.

For the process of fertilisation the pollen grains from the anther has to be

the same flower or different flowers of the same plant, it is refered to as **self pollination**. And if the transfer takes place between two different flowers of **different plants**, the process is called as **cross pollination**. Pollination is generally done in nature by wind, water, insects and animals. Artificial pollination (Pollination by human with some intention) is widely practiced in economic plants for the production of hybrids.

After the pollen lands on a suitable stigma, the male gamate from the pollen is brought by the pollen tube grows out of the pollen grain and travels through the style to reach the ovule. The zygote resulted from the union divides several times to form an embryo within the ovule. The ovule develops a tough coat and is gradually converted into a seed. The ovary grows rapidly and ripens to form a fruit. Other floral parts like sepals, petals, stamens and style fall off. The seed contains the future plant or embryo. What are the advantages of seed formation in a plant ?

Activity 15.3.

- Soak a few seeds of pea in water and keep them overnight.
- Transfer the seeds on a wet cloth and leave them for a day under cover.
- Open the wet seeds carefully and observe the different parts.
- Try to draw the parts you have seen and compare it with Fig. 15.7.

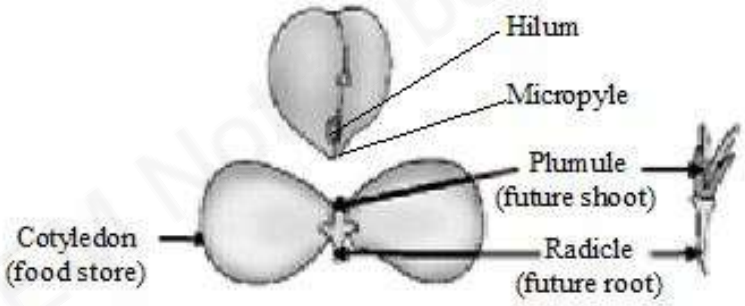


Fig.15.7. Dicotyledonous seed (gram)

15.2.1. Seed and Germination

Seed is a part of plant which contains a young plantlet in a dormant and resting condition. Can you get seeds in all the plants ? Seeds are formed within the cones of gymnosperms and inside the fruits of angiosperms, as a result of fertilization.

A seed is surrounded by a thick seed coat or testa providing protection

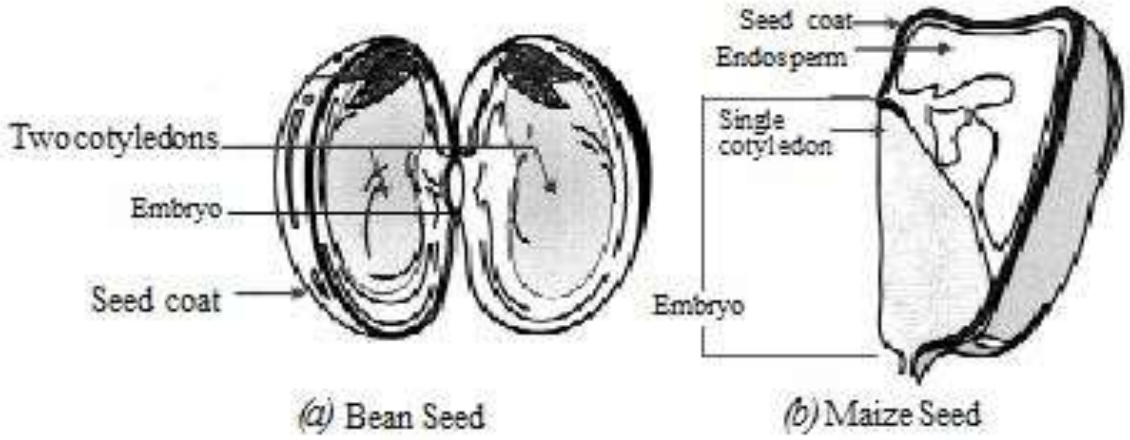


Fig. 15.8. L.S. of seeds (a) dicot and (b) monocot seeds showing em-

against dehydration. A hilum is the scar of the seed stalk. The embryo inside the seed consists of a plumule (future shoot), radicle (future root) and seed leaves or cotyledons. Monocotyledonous plants like, grasses, rice, etc. have only one cotyledon. Dicotyledonous plants have two cotyledons, i.e. pea seeds, castor seeds, etc. Endosperm is a nutritive tissue which may surround the embryo of maize, rice, castor seed etc. or it may be absorbed into the cotyledons of non-endospermous seeds of pea, bean, etc.

Seed growth or germination commences by water entering the seed through the micropyle and the testa absorb water. The testa splits and radicle emerges.

Activity 15.4.

- Soak one healthy seed of pea and another healthy seed of castor overnight with water.
- Keep them in a petridisc containing humid sand.
- Observe the seeds for a period of 5 days.
- Record your daily observations.

Compare the mode of germination in the two seeds.

Hypogeal germination occurs in maize, gram, bean, etc. when the

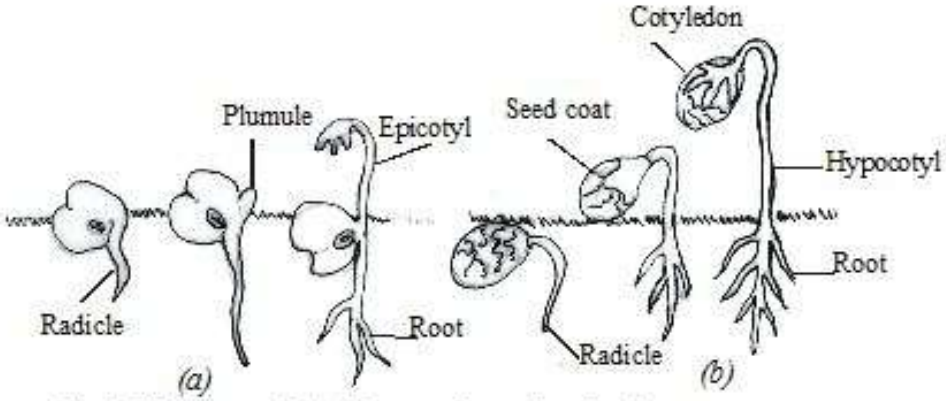


Fig.15.9. Stages of : (a) Hypogeal germination in gram (b) Epigeal germination in castor

cotyledons remain below ground and the plumule emerges (by the elongation of epicotyl).

Epigeal germination occurs in castor, sunflower, etc. when the pulmule and cotyledons emerge above ground (by the elongation of hypocotyl). The cotyledons function as leaves (Fig.15.9.).

Let us answer these.

1. How is the process of pollination different from fertilisation ?
2. Describe the parts of a dicot seed.
3. How does a seed germinates ?
4. Name the different parts of a typical flower.

15.3. Reproduction in animals

Among animals there are two types of reproduction – Asexual and sexual.

15.3.1. Asexual Reproduction

Asexual type of reproduction may be binary fission, multiple fission, regeneration and budding. **Binary fission** is seen in unicellular animals like *Amoeba*, *Leishmania*, etc. In this the single - celled body is divided into two daughter individuals (Fig.15.10).

Fig.15.10. Binary fission in Amoeba

In multiple fission, the unicellular body is divided into a number of daughter

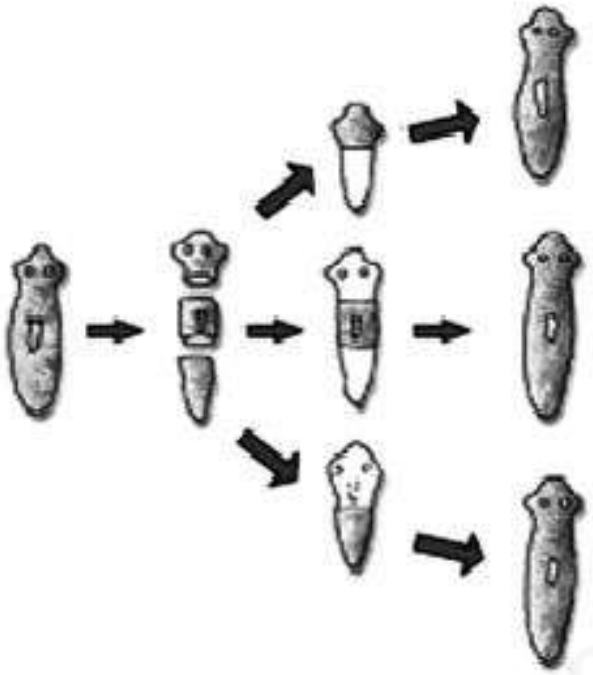


Fig.15.11. Regeneration in Planaria

cells. This type of reproductions is seen in *Plasmodium, Amoeba*, etc.. In some animals like *Hydra* and *Planaria*, if the body is cut or broken up into many pieces, many of the these pieces grow into separate individuals. This is known as **regeneration** (Fig. 15.11).

Regeneration is carried out by specialised cells. These cells divide and

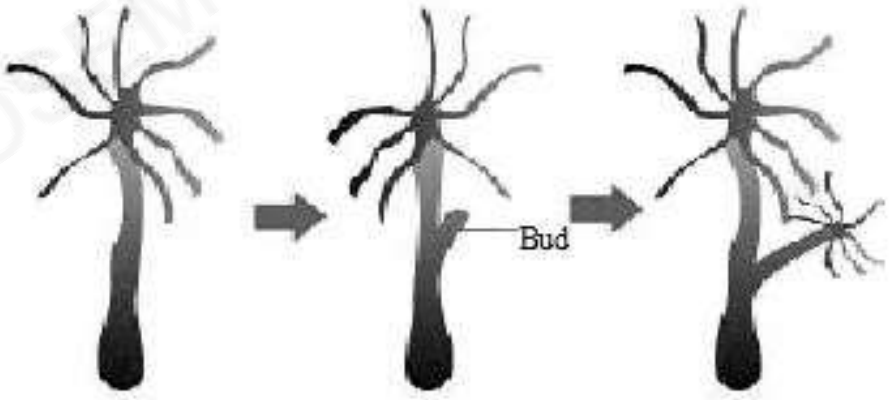


Fig.15.12. Budding in Hydra

make large number of cells, different cells give rise to various cell types and tissues. Finally they give rise to a complete individual. However regeneration is

not a normal process of reproduction. Most organisms would not normally depend on being cut up to be able to reproduce.

In some animals like *Hydra* some regenerative cells are used for reproduction in the process of budding. In such cases, a bud develops as an outgrowth due to repeated cell division at a specific site. Later these buds give rise to small individuals and when fully mature, detach from the parent body and become new individuals independently.

15.3.2. Sexual reproduction

This involves two individuals, male and female, followed by the fusion of two gametes one from male parent and other from female parent. Majority of the animals reproduce by this method.

In the sexual mode of reproduction, the germ-cells from two individuals have to meet and fuse together. This can happen by the external release of germ-cells from the bodies of individuals, as happens in fishes and amphibians; or it can happen by joining their bodies together by two individuals for internal transfer of germ cells for fusion as happens in many animals.

15.3.3. Sexual reproduction in invertibrates

In Paramecium the two partners meet with their oral grooves opposite. There is exchange of cytoplasmic and nuclear materials by breaking the surface membrane. After separation each individual divides into two by binary fission.

Hydra, Earthworm and Tapeworm are hermaphrodite animals having gonads, ovary and testes. But these animals have different devices to perform sexual reproduction with their partners. In Hydra and Tapeworm the male and the female gonads mature at different time. In earthworm sperms are exchanged between two individuals by copulation. This prevent them from self fertilization.

Sexual reproduction in insect is by copulation between a male and female partner. The fertilized eggs undergo metamorphisis to become a complete young individual.

15.3.4. Sexual reproduction in vertebrate animals

The fertilization (union of gametes) is external in fishes and amphibians. The eggs are laid in great numbers into the surrounding water. These eggs are fertilized by the sperms released over the eggs from the male. In amphibians the fertilized eggs undergo metamorphosis.

Internal fertilization is the characteristic feature of birds and mammals. In birds the fertilized zygotes are converted into eggs and the eggs are laid down. Further development of embryo takes place inside the egg. Most mammal embryos develop within the mother's uterus and are protected and nourished by embryonic membranes and a placenta. Such placental mammals are called viviparous e.g. rat, rabbit, monkey and human beings.

Let us answer these.

1. Name an animal that reproduces by budding.
2. What is meant by binary fission?

POINTS TO REMEMBER

- ⇨ Reproduction, unlike other life processes, is not essential to maintain the life of an individual organism.
- ⇨ Various organisms use different modes of reproduction depending on their body design.
- ⇨ Budding, fragmentation and sporulation are examples of asexual reproduction where new generations are created from a single individual.
- ⇨ Roots, stems and leaves of some plants develop into new plants through vegetative propargation.
- ⇨ Sexual reproduction involves two individuals for the creation of a new individual.
- ⇨ Lower plants like algae, fungi, mosses and ferns etc. also can reproduce by sexual methods.
- ⇨ Reproduction in flowering plants involves transfer of pollen grains from the anther to the stigma. This process is referred to as pollination. This is followed by fertilisation.
- ⇨ Germination is the beginning of growth and developement of the dormant embryo within the seed.
- ⇨ Hypogeal germination occurs in maize, pea and bean, whereas epigeal germination occurs in castor, sunflower, etc.
- ⇨ Micropropergation is a technique of propagation of plants from cells tissues or organs by using the methods of tissue culture.

- ⇨ Parthenogenesis is the development of ovum without fertilization into a new individual.
- ⇨ Metamorphosis is the period of rapid transformation from larval to adult form.
- ⇨ Viviparous is the method of development of embryo within the maternal organism and derive nutrition by close contact with maternal tissues, frequently by a placenta, without interposition of any egg membranes.
- ⇨ Cellular totipotency is the genetic potential of a plant cell to produce the entire plant.

EXERCISES

1. What type of asexual reproduction takes place in yeast ?
2. Name the plant which reproduces by the process of conjugation.
3. What are the advantages of sexual reproduction over asexual reproduction ?
4. Draw a labelled diagram of the longitudinal section of a typical flower.
5. Describe the two types of germination with labelled diagram.
6. How does binary fission differ from budding in animals.
7. How sexual reproduction takes place in Paramecium?
8. Give one similarity between the sexual reproduction of Hydra and Tapeworm.
9. In what way earthworm prevent itself from self fertilization?
10. What is metamorphosis ? Give two examples which shows metamorphosis.
11. How will you define a viviparous animals ? Give two examples.
12. What are the advantages of tissue culture in plant?
13. Why parthenogenesis is considered as asexual reproduction?

★★★★★★

CHAPTER

16 HEREDITY AND EVOLUTION

Living organisms produce new individuals that are similar to themselves by the process of reproduction. Generally very low degree of differences are observed in the offsprings produced through asexual reproduction. On the other hand, in case of sexually reproducing organisms, their offsprings develop traits different from those of their parents. In plants like sugarcane and bamboo, which are generally reproduce asexually, we find very little variation amongst individual plants so long as they are grown under similar conditions. But in a number of animals including human beings, which reproduce sexually, quite distinct variations are visible among different individuals (except in identical twins).

DNA (deoxyribonucleic acid), the genetic material provides instructions for making structural and functional proteins that give members of the same species similar recognisable external and internal features which are called **characters** or **traits**. A segment of DNA molecule that provides information for one trait is called the **gene** for the traits.

The genetic material sometimes changed or mutated due to certain internal or external factors. Such changes can cause the genetic material to give different instructions and lead to different kinds of traits being formed. Consequently, small differences or variations in structural and functional characters between members of the same species are observed.

All these variations in a species do not have equal chances of surviving in the environment in which they find themselves. Depending on the nature of variations, different individuals would have different kinds of advantages. Selection of variants by environmental factors forms the basis of evolutionary processes.

16.1. HEREDITY

Long before the discovery of genetic materials, biologists tried to discover rules which would explain why observable characteristics of offsprings are similar to those of their parents and even their grand parents.

A normal child bears all the basic features of a human being. However, it shows variation from their parents. Thus every person possesses certain characters which distinguish himself from others. Can you imagine how much variations exist in human population ?

(a)

(b)

Fig.16.1. (a) Free and (b) attached earlobes. The lowest part of the ear, called the earlobe, is closely atttached to the side of the head in some of us and not in others. Free and attached earlobes are two variants found in human populations.

Activity 16.1.

- Let us observe the ears of all the students in the class. Prepare a list of students having either free or attached earlobes and calculate the parcentage of students having each type of earlobe (Fig.16.1).
- Find out the earlobe types of the parents of each student in the class. Compare the earlobe type of each student with that of their parents.
- Based on this evidence, suggest a possible rule for the inheritance of earlobe types.

16.1.1. Mendel's Contributions

Of the several theories that have been formulated to explain how traits are inherited, Mendel's theory has provided the foundation upon which all later works in genetics have been built.

Gregor Johann Mendel(1822-1884)

*Gregor Johann Mendel was an Austrian monk, educated in science & mathematics at the University of Vienna. From 1858 to 1865, Mendel worked in the garden of his monastery in the town of Brünn (now Brno), breeding garden pea (**Pisum sativum**) and explaining the characters of the offsprings. This helped him to arrive at the famous laws of inheritance.*

Mendel selected the common garden pea for his exprimental work. In garden pea, he found a number of contrasting visible characters, namely, round and wrinkled seeds, tall and dwarf plants, yellow and green seeds and so on.

In garden pea flower, the petals entirely enclose the reproductive structure i.e. male/stamens(which produce pollen) and pistil/female (which produce the egg). Although insects may occasionally penetrate in the flowers, self-fertilization is the rule. In his experiments, Mendel opened the buds and removed the stamens before they are ripened. Then, by dusting the pistil with pollen grains from another plant, he performed cross pollination between them.

In one series of experiments, he selected only one pair of contrasting characters viz. tallness and dwarfness. He crossed a dwarf male plant with a tall female plant and vice versa. The results he obtained in these experiments were the same in all the cases.

Rediscovery of Mendelian principles

Mendel read out his findings before the Brünn Natural History Society in 1865 and was published in the Annual proceedings of the Brünn Natural History Society in 1866. But his findings were not accepted by other scientists of those days. He died in the year 1884. Hugo de-Vries (Holland), Carl Correns (Germany) & E Von Tschermak (Austria) rediscovered the Mendel's discovery in 1900. Mendel did not formulate any Laws of heredity. Carl Correns summerize Mendel's findings into two laws i.e. Law of segregation and Law of independent assortment.

16.1.2. Mendel's Laws of Inheritance

From the results of Mendel's experiments, Carl Correns formulated certain laws to explain the inheritance.

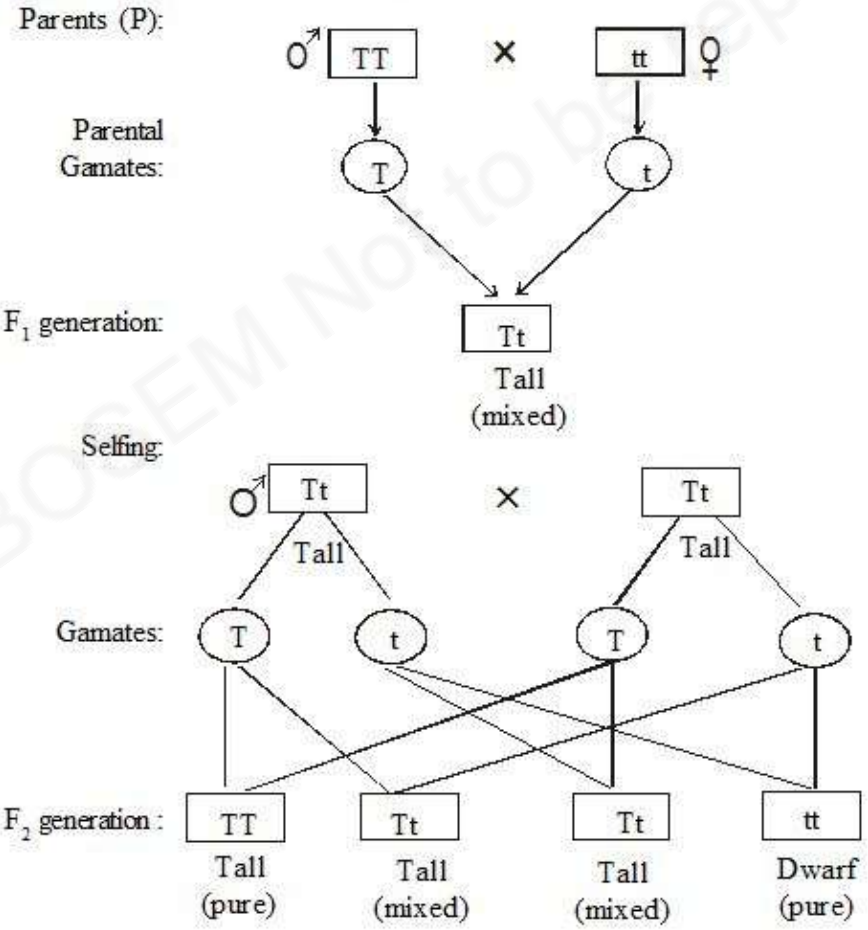
First Law / Law of segregation

Allelic genes in a hybrid do not blend or contaminate each other but segeregate & pass into different gametes. This law is derived from a Monohybrid cross.

Monohybrid Cross

In monohybrid cross only one pair of contrasting characters is taken into consideration at a time. Mendel brought about artificial crossing between a tall and a dwarf pea plant. The progeny that resulted from this cross were all tall. This means that only one of the parental traits appear in the progeny. He named this progeny as the first filial generation or F_1 generation.

Monohybrid Cross



The F_1 tall plants were left for reproduction by self pollination. The resulting seeds were collected and sown next year. They gave rise to a mixed generation of tall and dwarf plants, in the ratio of 3:1, i.e. three-fourth talls and one fourth dwarfs. This is known as the second filial generation or F_2 generation. All dwarfs of the F_2 generation bred true, producing dwarf only in third and subsequent generations. Seeds were collected separately from each F_2 tall plants and sown separately. It was seen that one-third of the tall plants bred true, while the other two third again split up in the same ratio of 3:1. The F_2 ratio is therefore 1:2:1. (one pure tall : two mixed tall : one pure dwarf). The ratio of F_2 generation (3:1) considers only its external structural forms is known as **phenotypic ratio**. Whereas the F_2 ratio of 1:2:1 is called as **genotypic ratio.**

In this experiment (Fig. 16.3), both **TT** and **Tt** are tall plants while only **tt** is a dwarf plant. In other words, a single copy of '**T**' is enough to make the plant tall while both copies have to be '**t**' for the plant to be dwarf. Traits which are transmitted unchanged in the F_1 generation, Mendel called it as **dominant**. Those which are hidden in F_1 but reappeared in F_2, he called it as **recessive**. Here tallness is dominant and dwarfness is recessive.

Second Law / Law of independent assortment

The segregation in one pair of allele is independent of the segregation in any other pair of allele. This law is derived from a dihybrid cross.

Dihybrid Cross

In dihybrid cross two pairs of contrasting characters are taken into consideration at a time. What do the progeny of a round and yellow seed with wrinkled, and green seed look like? They are all round and yellow seeds in F_1 progeny. Round and yellow seeds are thus dominent traits. But what happens when these F_1 progeny are used to generate F_2 progeny by self pollination ? From the knowledge of the previous monohybrid experiment, the expected F_2 progeny are round, yellow seeds and some wrinkled and green seeds. However, there would also be some F_2 progeny that showed new mixtures. All possible combinations took place in the following proportion i.e. 9 round, yellow; 3 round, green; 3 wrinkled, yellow and 1wrinkled, green. Thus the phenotypic ratio of F_2 generation in dihybrid cross is 9:3:3:1. What will be the genotypic ratio of F_2 generation in dihybrid cross ?

Dihybrid cross can be explained by the checkerboard method as shown below.

Parents (P) : RR YY × rr yy

(round , yellow) (wrinkled, green)

Parental gametes : RY ry

F_1 generation Rr Yy

(round, yellow)

F_1 gametes : RY Ry rY ry

F_2 generation :

Male gametes of F_1 generation

Female gametes of F_1 generation ♀ \ ♂	RY	Ry	rY	ry
RY	RRYY Round, yellow)	RR Yr Round, yellow	Rr YY Round, yellow	Rr Yy Round, yellow
Ry	RR Yy Round, yellow	RR yy Round, green	RrYy Round, yellow	Rr yy Round, green
rY	RrYY Round, yellow	Rr Yy Round, yellow	rr YY Wrinkled, yellow	rrYy Wrinkled, yellow
ry	RrYy Round, yellow	Rr yy Round, green	rr Yy Wrinkled, yellow	rr yy Wrinkled, green

The genotypic ratio of F_2 generation in dihybrid cross is 1:2:2:4:1:2:1:2:1.
i.e. 1(RRYY) :2 (RRYy) : 2(RrYY) : 4 (RrYy) : 1(RRyy) : 2(Rr yy) :1(rr YY) : 2(rr Yy) : 1(rr yy)

Thus the Round/Wrinkled traits and Yellow / Green seed traits are independently inherited.

Whether the genotypes of F_1 generation are homozygous or heterozygous can be determined by back cross or test cross.

Glossary of some genetical terms

Phenotype : Characters that we can see through naked eye, e.g. Tall & dwarf plants.

Genotype : Genetic constitution of an individual e.g. TT for tallness, and tt for dwarfness.

Allele/Allelomorph : Alternative form of the same factor/gene.

Homozygote : True breeds e.g., Tall is genotypically represented by TT.

Heterozygote: Hybrid ; Tall is represented by Tt.

Dominant : The character which appears in F_1 generation is called Dominant character.

Recessive : The other parental character which is not appear in the F_1 generation is called recessive character.

Back cross : It is a cross between F_1 offspring and one of its parents.

Test cross : A cross made between an F_1 offspring and its recessive parent.

Activity 16.2.

- ☞ Take two middle size cotton carry bags.
- ☞ Add 100 yellow pea seeds in one carry bag, representing mother's 50 sets of 'XX' chromosomes.
- ☞ Add 50 yellow and 50 green pea seed in the other bag, representing 50 sets of 'XY' chromosomes of a father.
- ☞ Take out one seed each, from each bag representing the two sex chromosomes.
- ☞ Repeat at least ten times to get ten pairs.
- ☞ Calculate the number of similar and dissimilar pairs of pea seeds.

The pair of yellow seeds will represent the number of female children and the pairs of yellow and green seeds will represent the number of male children. Write the numbers of male and female children.

Let us answer these.

1. What is a gene ?
2. Why did Mendel select garden pea for his experiments ?
3. What is the genotypic ratio of F_2 generation in a monohybrid cross ?
4. What are back cross and test cross ?
5. How many perfect pairs of chromosomes are found in the father of a girl ?

16.2. The origin of life

Darwin's theory of evolution tells us how life evolved from simple to more complex forms and Mendel's experiments give us the mechanism for the inheritance of traits from one generation to the next. But neither tells us anything about how life begin on earth in the first place.

Chemical evolution is one means of explaining the origin of life on Earth through the formation of complex organic compounds like the DNA molecule, capable of reproducing themselves. Alexander Ivanovich Oparin (1894), a biochemist, first produced an account for the chemical origin of life.

J.B.S. Haldane, a British scientist, suggested in 1929 that life might have developed from the simple inorganic molecules which were present on earth soon after it was formed. How did these organic molecules arise ?

An answer was suggested by the experiment conducted by Stanley L. Miller and Harold C.Urey in 1953. They performed a simple experiment by assembling a mixture of ammonia, methane and hydrogen sulphide all believed to be present in the atmosphere of the primitive earth, over water. This was maintained at a temperature just below 100^{o}C and electric sparks were passed through the mixture of gases to simulate lightening. At the end of the week, the mixture was analysed and was found to have acquired a mixture of amino acids, which are building blocks of protein molecules.

In the primitive condition of our planet these amino acids were converted to DNA and the nucleic acid is capable of replicating itself. Once a living organism has been formed from non- living organic compound, more living things would arise. All living organisms may have had a common ancestory in the soup of organic materials. The sea should have been the home of first life.

Let us answer these.

1. Who had first proposed the chemical origin of life ?
2. Name three gases that were present on the primitive atmosphere of the earth.

16.3. Evolution

Evolution is a process of gradual change from one form of life to another through a series of intermediate forms. In the course of this process, new forms were formed and get established along side or in the place of the original types. The evolution in living organisms is known as organic evolution.

As already stated, the first living organisms emerged over 3000 million years ago and today the earth is inhabited by more than two million different species. How these new species had evolved or how the present day plants and animals came into being ?

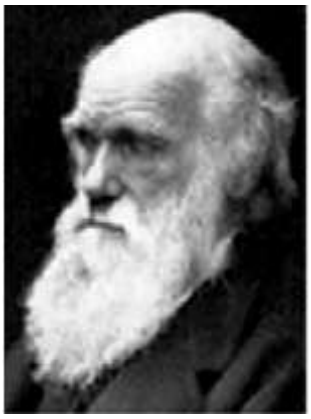
The process of changing the genetic material (DNA) has occured gradually and continuously since life started on earth. The inheritable variations had been the means of life survival when external conditions changed on earth, these variations become traits evident in different species alive on earth today.

There are three different theories to explain the course of organic evolution.

1. **Lamarckian Theory of Inheritance of Acquired Characters propounded by Jean Baptist Lamarck in 1809.**
2. **Theory of Natural Selection propounded by Charles Darwin and Affred Russel Wallace in 1858.**
3. **Mutation theory propounded by Hugo de-Vries in 1901.**

If we breed a group of mice, all these progeny will have tails. Now, if the tails of these mice are surgically removed in each generation, will these tailless mice produce a tailless progeny? Obviously not, because changes in the non-reproductive tissues can not be passed on to the DNA of the germ cells. So, the removal of the tails can not change the genes of the germ cells of the mice.

Charles Robert Darwin (1809-1882)



Charles Darwin was born on February 12, 1809 at ***Shrewsbury.*** *He was educated at Shrewsbury and later sent to Cambridge. During his three years' stay there he used to mix with the Cambridge naturalists. At the age of 22, he was entertained as a naturalist on board the Admiralty vessel, H.M.S. Beagle which sailed from the shores of England on a long five year voyage of survey (December, 27, 1831 to October 2, 1836,) in the South Atlantic and Pecific Oceans. The studies that he conducted during this five year voyage were to change forever the way we look at the variety of life on earth. But he did not know the mechanism whereby variation arose in the species. Darwin's work was published with R. Wallace's paper in the "Proceeding of the Linnean Society" in 1859, later on Darwin published his famous book "Origin of species". Darwin expired on 19 th April 1882 at the age of 73 years.*

One of the most accepted theories of organic evolution is the theory of Natural Selection proposed by Charles Darwin along the following lines.

16.3.1. Over production of offspring and a consequent struggle for existance

The multiplication of individual of a species occurs in a geometrical proportion. But a large majority of the individuals do not survive and consequently the numbers of individuals in a species remain more or less the same. The survivors in any population remain survive because of being better adapted to reach the limited resources, food etc. of the environment. These limited resources are the cause of struggle for existance.

16.3.2. Variations and their inheritance

The survivors in the struggle for existance have certain favourable variations. As a result of struggle for existance only those individuals showing variation in the right direction survive, and these variations are transmitted to the offspring. Others with unfavourable variations perish, resulting to the survival of the fittest.

16.3.3. Natural Selection

Nature or the environment selects those individuals best fitted for survival. The survival of fittest is a result of selection and prolification of only those organisms which are most suitably adapted to the environment and most successful in mating.

16.3.4. Formation of new species (Speciation)

Speciation is the evolution of a new species from the pre-existing one. A species consists of a population of organisms which are able to breed amongst themselves in the natural conditions. Whenever segments of a population are isolated geographically over a period of a number of generations the two isolated segments of the population might gather enough genetic differences to result in a lack of genetic exchange even if the original barrier is removed. In this way new species are being generated.

How will you observe the occurance of evolution in nature ?

16.3.5. Fossils

When organisms die, their bodies will decompose and be lost. But, fossils are the material remains or traces of organisms preserved inside the earth's crust. Fossilization or formation of fossils involves the conversion of an organism or its parts into a hard structure or rock. While a body or some parts of it get caught in hot mud, they will not decomposed quickly and the mud will eventually hardern and retain the impression of the body or body parts. How do we know how old the fossils are ? It is reasonable to suppose that the fossils we find closer to the surface are more recent than the fossils we find in deeper layers. Fig.16.3., shows various forms of fossils.

From the study of these fossils one can understand about the life forms of the past. It enables us to trace the origin and trend of evolution of several groups of plants and animals.

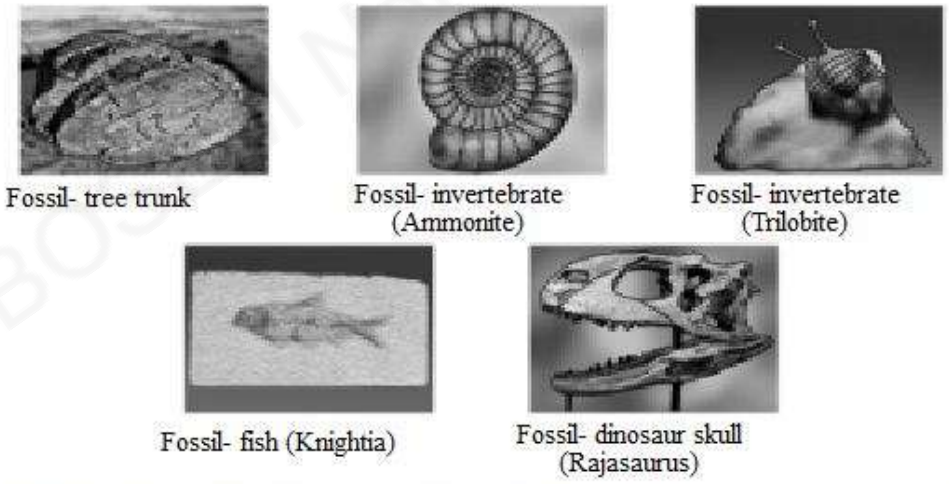
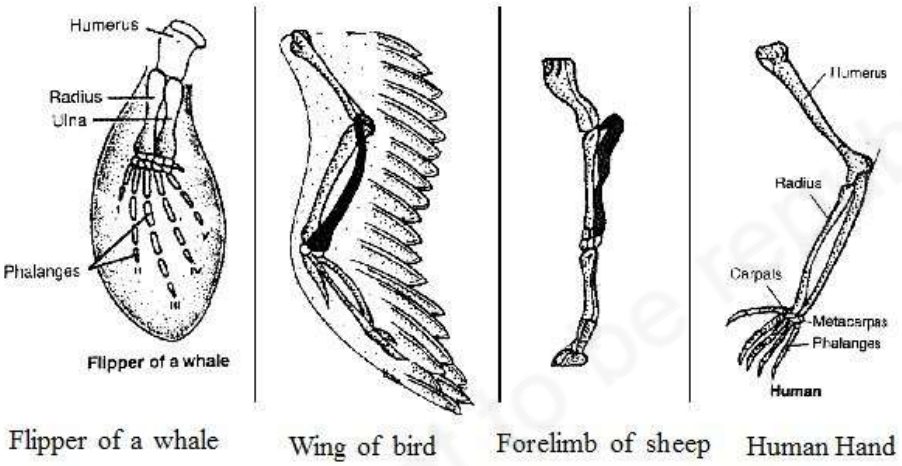


Fig.16.3. Various kind of fossils. Note the different appearances and degrees of detail and preservation.
The dinosaur skull fossil shown was found only a few years ago in the Narmada valley.

16.3.6. Homologous and Analogous Organs.

Homologous organs are those structures of organisms, which have the same embryonic origin, though they may or may not perform the same function. A front flippper of whale, a wing of bird, a forelimb of sheep, a human hand (Fig.16.4) perform different functions but they have a common origin. In plants a thorn (in *Bougainvillea*) and a tendril (in *Cucurbita*) are morphologically & functionally different, but they are homologous organs.

On the other hand wings of dragon fly, wings of eagle and wings of bat (Fig.16.5.) appear similar and perform same function but are different in their basic structure and developmental origin. So they are called analogous organs. Thorns (in *Duranta*), spines (in *Opuntia*) and prick les (in Rose) are sharped and pointed structures. Due to their difference in origin they are analogous structures.



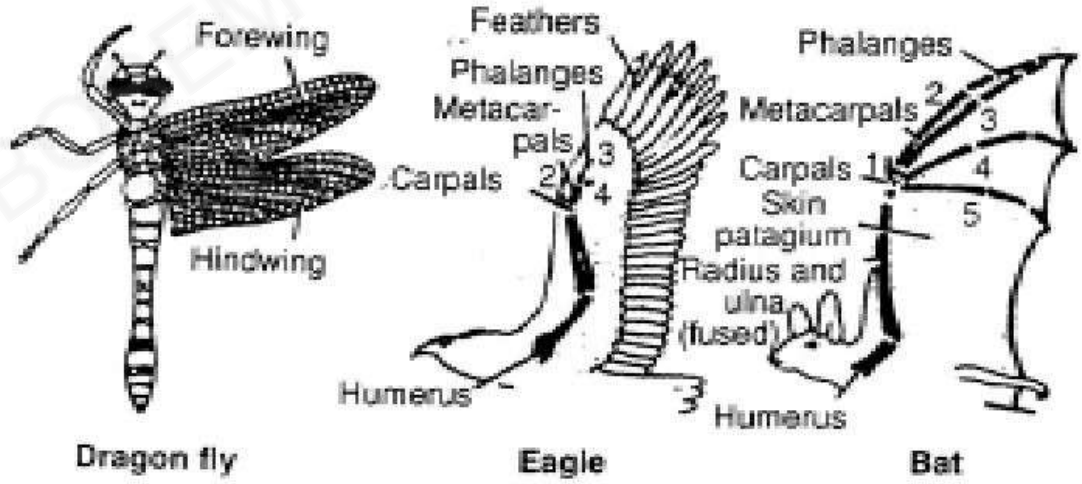


Fig.16.5. Analogous organs in animal

Homologous structures which is specialised to perfom a variety of different functions represent evolution of new forms in several directions from the common ancestral type. Whereas analogous structures does not bear close phylogenetic link but shows adaptation to perform the same function during the course of evolutionary history.

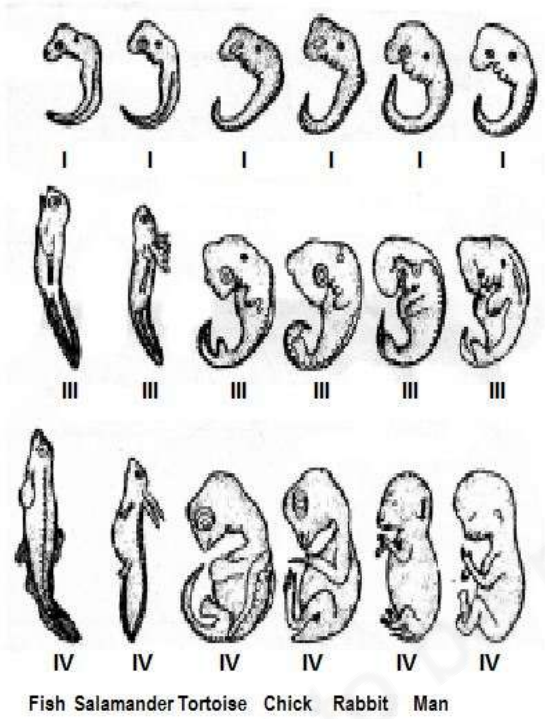


Fig.16.6. Depicting the remarkable similarlity in the early embryos of some vertebrates

16.3.7. Resemblance among vertebrate Embryos

There is a close relationship among the early embryonic stages of vertebrates. Fig.16.6. shows the embryonic development of some vertebrates.

It is difficult to differentiate a human embryo from the other vertebrate embryos of **Rabbit**, **Chick**, **Tortoise**, **Salamander** and **Fish** at their early stage of embryogenesis. There are similarities in having gill clipts, notochord, tail, rudimentary eyes and ears, limb buds, etc. The study of embryonic development among verterbrates can also give a clear idea about the evolution of different vertebrates.

Let us answer these.

1. Define organic evolution.
2. Who proposed the theory of natural selection ?
3. What are fossils ?
4. Mention two examples of analogous organs in plant.

16.4. Human evolution

More than a hundred years ago Charles Darwin suggested in his Descent of Man, a common ancestary for apes and humans based on their similarities in anatomy and behaviour. A great diversity of human form and features makes us a great confusion about the origin of human races. Human races have yellow, black and white or brown skin colour.

But all human individuals belong to a single species. It had been proved by using tools for tracing evolutionary relationship like excavating, time dating, studying fossils as well as determining DNA sequence.

The earliest member of human species, *Homo sapiens* has appeared about 300,000 years ago. Our genetic foot prints can be traced back to our African roots. From Africa they migrates slowly to West Asia, then to Central Asia, Eurasia, South Asia, East Asia, then to Indonasia and the Philippines to Australia.

There is no single line of migration. They went forwards and backwards.

In India, the earliest fossil remains of *Homo sapiens* in the form of skull and other bones was discovered in Bhimbetka near Bhopal. It is about 25 to 60 thousand years old. Like all other species in this planet, human being evolved as an accident of evolution and were trying to live their lives the best they could.

Let us answer these.

1. Trace the migratory root of human species.
2. From where the earliest fossil of human species, was discovered in India ?

POINTS TO REMEMBER

- Variations arising as a result of mutation can be inherited.
- All variations do not have equal chance of survival.
- Variations may lead to increase survival of an individual.
- Mendel selected garden pea (*Pisum sativum*) with many contrasting characters for his experiment on inheritance.
- Sexually reproducing organisms have two copies of genes for the same trait. If the copies are not identical, the trait that gets express is called the dominent trait and the other is called the recessive trait.
- Traits in one individual may be inherited separately, giving rise to new combinations of traits in the offsprings of sexually reproducing organisms.
- In dihybrid cross a trait of one pair can combine with another trait of the second pair.
- In human beings, the sex of the child depends on whether the paternal chromosome is **X** (for girls) or **Y** (for boys).
- Mendel formulated certain principles to explain the inheritance, viz. Principle of segregation and Principle of independent assortment.
- Life on earth had originated from inorganic molecules.
- Organic evolution is a process of gradual change of living organisms from simple forms to complex forms through a series of intermediate forms.
- The theory of organic evolution through natural selection was proposed by Darwin.
- Speciation may take place when variation is combined with geographical isolation.
- Evolution can be worked out by the study of not just living species, but also fossils.
- Evolution from a common ancestor can be achieved from the study of embryonic development.
- The earliest human species, *Homo sapiens* had appeared about 300,000 years ago in Africa.

EXERCISES

1. What is the Phenotypic ratio in F_2 generation of a dihybrid cross ?
2. What supportive evidence for evolution is provided by comparative embryology ?
3. What is heredity ? What are the laws of inheritance?
4. Explain the term adaptation and how it is related to evolution.
5. How does the creation of variations in a species promote survival ?
6. How do Mendel's experiments show that traits may be dominant or recessive ?
7. How is the sex of a child determined in human being ?
8. What factors could lead to the formation of a new species ?
9. How does the study of fossils provide an evidence in favour of organic evolution?
10. Explain, the theory of organic evolution proposed by Charles Darwin.
11. Explain three evidences of organic evolution.
12. Give three points of difference between homologous and analogous organs with suitable examples.
13. How does the experiment of Miller and Urey provide some support to the hypothesis of Oparin.
14. How the human beings who look so different from each other in terms of size, colour and looks said to belong in the same species ?
15. Draw neat labelled diagrams of two homologous organs in animals.

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CHAPTER

17

OUR ENVIRONMENT

Environment literally means everything in our surroundings. How do you define our environment? Our environment includes the physical (nonliving or abiotic) and biotic (living) components which influence with each other including ourself. It also provide us all the materials required for our survival and comfort. The growth of human population increases in demand for food, water, shelter, electricity, roads, automobiles and numerous other commodities. These demands exert a tremendous pressure on our natural resources and brings about undesirable changes in physical, chemical and biological characteristic of our environment. The need of the hour is to check the degradation and depletion of our precious natural resources and undesirable change of our environment without halting the process of development.

In order to control environmental degradation, the Government of India had passed the Environment (Protection) Act, 1986 to protect and improve the quality to our environment (air, water and soil).

We shall now see how the various factors of the environment interact with each other and how human activities affect their cycles.

17.1. What happen if we bury different materials in the soil?

A lot of materials in the form of solid waste and sewage (liquid form of waste) are added to the environment due to our daily activities. It is beyond the capacity of nature to degrade many of these. These materials create a great problem in our natural environment if they are not properly managed.

What happens to the waste materials that we throw away in our surrounding ? Let us perform an activity to find out the answer to these questions.

Activity 17.1.

- ☞ Collect all the solid waste materials produced in a day at your home. They include kitchen waste (mostly organic), paper, plastic, glass, leather, old and torn cloths, metals etc.
- ☞ Bury them in a pit in your garden or in a bucket or flower pot and cover with at least 15 cm of soil.

- ☞ Observe the buried materials after an interval of 15 days and keep them moist.
- ☞ What are the materials which changes their form and structure over time?
- ☞ What are the materials that remain unchanged over long periods of time ?
- ☞ Which ones change the fastest ?

The food we eat is digested by various enzymes in our body. Verious enzymatic activities are also taking place in the degradation of these waste materials. Enzymes are specific in their action, i.e. specific enzymes are needed for the breakdown of a particular substance. Organic matters are easily broken down in nature whereas many man made materials like plastics are not easily acted upon by micro-organisms. They are slowly broken down by physical processes like heat and pressure.

Substances that can be broken down naturally into harmless products are called biodegradable substances. In the above activity, how many of the substances are biodegradable ?

Substances which can not easily broken down into harmless products through biological processes, are called non-biodegradable substances.

Activity 17.2.

- ☞ Collect more information about biodegradable and non-biodegradable substances by using library or internet.
- ☞ How long are various non-biodegradable substances expected to last in our environment.
- ☞ Find out more about such materials which do not harm the environment.

Let us study some of the various waste products and their mode of disposal in various parts of Manipur.

In Fig. 17.1, we can see various forms of solid waste collected from an area of Imphal, the capital city of Manipur. Make a list of the biodegradable and non-biodegradable substances present in it. Can you expect the same type of materials in all the other areas of this state?

Fig. 17.1. Solid waste at Imphal

for effective collection and disposal of waste are very much inadequate in all towns resulting to a large proportion of these remaining uncollected. There is no specific landfill site for disposal. As a result the waste is dumped at unspecified places in unscientified manners.

The average output of waste is around 120 tones per day in Imphal city area. Most of these wastes are dumped into the Naga and Nambul rivers, while some portion are disposed at Lamphel and other law laying areas. (Fig.17.2.).

a. Naga River

b. Nambul River

c. Lamphel Area

Fig. 17.2. Solid wastes disposal

Characterisation of solid Waste materials (Imphal)

Component	Percentage
Organic Waste :	60
Paper :	10
Plastic :	05
Glass :	02
Leather :	01
Textile :	05
Rubber :	01
Wood :	05
Porcelain/Stone/Clay :	03
Metals :	01
Fine Fractions (<10 mm) :	07

Source : State of Environment Report - Manipur, 2004.

Let us answer these.

1. Why are some substances biodegradable an some non-biodegradable ?
2. Explain how biodegradable substances would affect the environment ?
3. Explain how non-biodegradable substances would affect the environment ?

17.2. Ecosystem and its components

Organisms and environment are two nonseparable factors. Organisms interact with each other and also with the physical factors that are present in the environment.

The interacting organisms in an area together with the nonliving components of the environment form an ecological system or ecosystem.

The biotic components consists of micro-organisms, plants and animals, including human being. The abiotic components comprise physical factors like temperature, rainfall, wind, soil and minerals.

In a garden you will find different plants such as grasses, trees, rose, jasmine, banana trees, etc. and animals like frogs, lizards, insects, birds etc. All these living organisms interact with each other. Their growth, reproduction and other biological activities are also affected by the nonliving components of the ecosystem. Grasslands, forests, ponds and lakes are natural ecosystems while gardens and crop-fields are man made (artificial) ecosystems. The earth is also a big ecosystem.

17.2.1. Food chains

In an ecosystem, green plants, which are known as producers trap solar energy and convert it into chemical energy. The food or chemical energy manufactured by the green plants is utilized by themselves and also by plant eating organisms or **herbivores**. Herbivores fall prey to some carnivorous animals. Thus, the food energy passes from one population to the other population, in this way a chain is established. This is known as **food chain.** (Fig.17.3.). The various steps/ levels through which the food energy passes are called **trophic levels.** (Fig. 17.4.).

Producers represent the first trophic level. Herbivores and consumers of the first order constitute the second trophic level/primary consumers. Consumers of second order or primary carnivores form the third trophic level secondary consumers. The ultimate carnivores which are not eaten by others are called top carnivores tertiary consumers . They represent the fourth trophic level.

Let us answer these.

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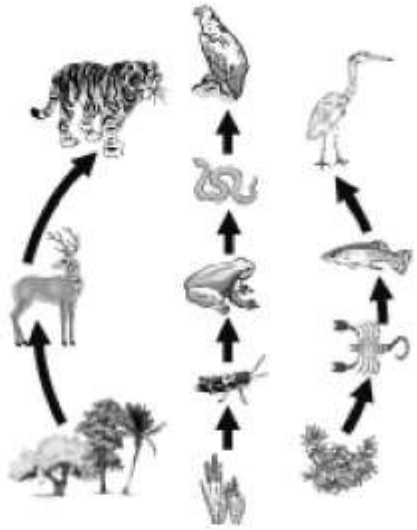

Fig. 17.3. Food chain in nature
(a) in forest
(b) in grassland and
(c) in a pond

Fig. 17.4. Trophic levels

There is another group of organisms which live on organic wastes, dead and decomposing animal bodies. Vultures, feed on dead animal body. They are called **scavengers**. Decomposers are also another category of scanvengers which live on the dead bodies of plants and animals. While scanvenging they break down the bodies and thus become agents of decay. The materials in the dead bodies are converted into organic and inorganic substances. Thus they make soil fertile and make these substances available for the producers. Men eat plant and animal parts as their food, and hence they are **omnivores**.

17.2.2. Food Webs

Food does not always pass from one population to another in a linear sequence as in a food chain. Instead several food chains are linked together in a web-like manner, thus consistituting a food web. Thus, a food web is the interlocking of different food chains by developing interconnections at various trophic levels so as to form a number of feeding interaction in a biotic community (Fig. 17.5.).

Human beings occupy the top level in any food chain. They can not be classify either as herbivores or carnivores. There are people who live on plant products only. Yet many others favour non-vegetarian food (live on animal

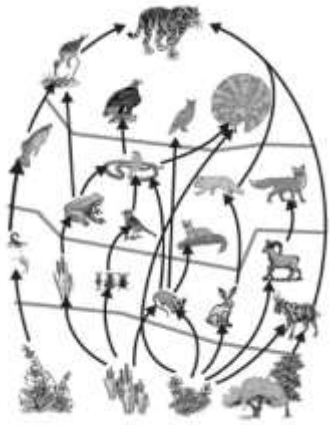

Fig.17.5. Food web

products). What about other animals like insects, rabbits, goats, cows etc. who feed grasses. Frogs and toads live on insects. Many small birds feed on insects and plants. Snakes feed on frogs, birds, rabbits etc. Elephant is a plant eater. Tiger and Lion live on other animals as their prey. In which trophic level cats and dogs are included?

Activity 17.3.

☞ Write down the common names of any five producers (green plants) you had come across in class -IX.

☞ Which animals are consumers of first order ? Give the names of any five animals.

☞ Write the names of any five animals included in the second order of consumers.

☞ Find out the names of any three top carnivores.

In the above activity you classify the plants and animals as producers and consumers of different orders. Is there any plant in the consumer's level or any animal in the producer's level ? Can you identify more plants and animals in different trophic levels ?

17.2.3. What will happen if we kill all insects ?

Give the common names of any two insects which is harmful to man and to our crop plants. Mosquito & housefly suck human blood and can spread malaria and other killer diseases. Grasshopper and thrips cause great loss to our crop plants.

In food chain of ecosystem, insects are good prey for many other animals like spiders, toads and birds. Honeybee gives us honey. During the collection of nectar, they pollinate flowers. Insects are best pollinaters and also help in the dispersal of spores. Insect larvae are used as food by animals including man. Caterpillars have medicinal values.

Let us answer these.

1. Describe the various components of an ecosystem.
2. Give the names of any three natural ecosystem.
3. How does sun act as the source of energy for all the organisations on earth?
4. How does food chain differ from food web ?
5. Give two functions of insects in our ecosystem.

17.3. How do our activities affect the environment ?

We are an integral part of the environment. Changes in the environment affect us and our activities change the environment around us. Over and above the problem of waste disposal, let us look to other problems caused by our industrial development e.g. depletion of ozone layer.

17.3.1. Ozone depletion

Ozone is a deadly poisonous gas formed by three atoms of oxygen i.e.O_3. At the higher levels of the atmosphere, ozone performs an essential function.

Ozone filters away the ultraviolet radiation from the sun and protects the earth from its harmful effect. Thus, it acts as a protective sheild.

Ozone is an unstable gas and for both its formation and destruction , UV rays are essential which comes from the sun.

The following reactions are involved

$$O_2 \xrightarrow{UV} O + O$$
$$O + O_2 \xrightarrow{UV} O_3$$
$$O_3 \xrightarrow{UV} O + O_2$$

This is a continuous process. But the amount of ozone in the atmosphere began to drop sharply since 1980s.

17.3.2. Depletion of ozone layer allows harmful ultraviolet rays to reach the part of earth

Sunburn, ageing, wrinkling of skin, cataract of eye, destruction of protein, mutation of genes leading to skin cancer or melanoma etc. are some of the effects of UV radiation to human population.

Thinning of ozone shield is caused by a number of synthetic chemicals like chloroflurocarbons (CFCs), which are used as refrigerants and in fire extinguishers. In 1987, the United Nations Environment Programme (UNEP) succeded in organising a conferance to reduce the level of CFCs to 50 p.c. by 1999. All nations of the world has agreed to phase out their CFCs emissions in the year to come.

Activity 17.4.

- ☞ Collect more information about chemicals responsible for the depletion of the ozone layer through internet or newspaper report and library.
- ☞ Find out if the regulations put in place to control the emission of these chemicals have succeeded in reducing the damage of the ozone layer.
- ☞ Is there any improvement of ozone layer in recent years ?

Let us answer these.

1. What is ozone and how does it protect the organisms on earth ?
2. How can you help in improving the depleted ozone layer ?

POINTS TO REMEMBER

- Our environment is composed of biotic and abiotic components.
- The various components of an ecosystem are interdependent.
- The producers convert sunlight to energy to make it available for consumers.
- The energy is loss when passing from one trophic level to the next, this limits the number of trophic levels in a food chain.
- The solid waste we generate may be biodegradable or non-biodegradable.
- In Manipur the facilities for effective collection and disposal of waste are very much inadequate.
- Human activities create great impact on our environment.

- Chemicals like CFCs affect ozone layer. Ozone layer protects our environment from 'UV' radiation from the Sun. This could damage the environment and causes many diseases to human being.

EXERCISES

1. What are the impacts caused on the environment by the biodegradable and non-biodegradable wastes that we generate ?
2. How can you handle the problem of solid waste in Manipur ?
3. What are the causes and effects of O_3 layer depletion ?
4. Explain the role of decomposers in an ecosystem.
5. Can you imagine, what will happen if all the insects are eliminated from our environment ?
6. Draw and lavel a food chain system showing interrelationship among the producers, primary consumers and secondary consumers.

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18 NATURAL RESOURCES

We human beings depend upon a number of things and services provided by the nature, which are known as Natural resources.Examples of the natural resources are water, air, soil, minerals, coal, petroleum, forests, crops, wild life etc.

18.1. Kinds of Natural Resourses

(i) Renewable natural resources and **(ii)** Non-renewable natural resources.

18.1.1. Renewable/Natural resources

These are inexhaustible resources and can be regenerated within a given span of time. Examples are forests, wildlife, wind energy, tidal energy, hydro power, solar energy etc.

18.1.2. Non-renewable/Natural resources

These are resources which cannot be regenerated. Examples are coal, petroleum, minerals etc. Once these reserves are exhausted, the same cannot be replenished.

Sometimes the renewable resources may become non-renewable resources when we exploit them to such extend that their rate of consumption exceeds their rate of regeneration. For example, a particular species, if it is expoited too much, its population declines to a great extent that it is not be able to sustain itself. So, it gradually becomes endengered and finally extinct.

The protection and conservation of our natural resources are very important. We should use them in a judicious manner so that it does not become exhausted. We should conserve them for use by our future generations.

18.1.3. Forest resources

Forest is one of the most important resources. About 1/3 of the earth's land surface is covered by forests. The forests not only provide us innumerable

material resources but also serve to maintain several environmental conditions which are essential for life. But, it is becoming a matter of concern that everywhere the natural forest cover has declined over the years due to human activities.

Commercial uses of forests

We get a large number of commercial goods from the forests. These include timber, firewood, pulpwood, food items, resins, gums, non-edible oils, fibres, rubbber, lac, bamboo, medicines, etc.

Ecological significance on importance of forests

It is said that the environmental services provided by a typical tree is worth more than three times its commercial value.

The ecological services provided by the forests include the following :

(i) Production of oxygen– All the green plants of the forest produce oxygen through photosynthesis which is essential for respiration of all the living organisms.

(ii) Reducing global warming : CO_2 which is the main greenhouse gas is absorbed by the forests as a raw material for photosynthesis. Thus, the forests act as an absorbant for CO_2 thereby reducing the problem of global warming caused by CO_2.

(iii) Habitat for wild life : Forests are the homes of millions of wild animals and plants.

(iv) Regulation of hydrological cycle : The forest floor absorbs most of the rainwater by slowing down the surface runoff. Such water is released slowly for recharge of springs. About 50-80% of the water vapour in the air above tropical forests comes from transpirtion by plants and helps in bringing rains.

(v) Soil conservation : The trees of the forest bind the soil particles tightly in their roots thus preventing soil erosion. They also act as wind breakers.

(vi) Pollution moderator : Forests also act as pollution moderators by absorbing many toxic gases and thus help in keeping the air pure. The forests are also reported to abosrb noise. Thus reducing noise and air pollution.

18.1.4. Deforestation

Due to rapid increase in population growth, more lands for housing and agriculture are needed. To accomodate the increasing population more houses are to be constructed leading to the requirements of more construction materials like timber, bamboos etc. More and more forest products are consumed for fire wood, charcoal etc. leading to exploitation of forests. Many tribes still follow the practice of **shifting cultivation**. They burn down the forest in different areas for cultivation. With growing civilization more lands are required for establishment of industries. Use of wood for making boxes, furnitures, railway sleepers, plywood, pulp for paper industry etc. also exert tremendous pressure on forests. Construction of hydro-electric projects, roads, big dams and mining also result in deforestation.

18.1.5. Major consequences of deforestation

Deforestation leads to many far reaching consequences, as follows :

(i) The existence of many wild life species are threatened due to the destruction of their natural habitat.

(ii) Rainfall is affected due to changes in hydrological cycle.

(iii) Problems of soil erosion and loss of soil fertility increase.

(iv) In hilly areas deforestation leads to landslides.

18.1.6. Forest conservation

Since forest cover has become decreased very fast (about 14%) it needs conservation. The following situations are ways through which conservation of forest is done.

(i) Conservation of reserve forests

These include National Parks, Sanctuaries, Sacred Groves, Biosphere Reserves and all ecologically fragile areas. No exploitation of flora and fauna can be done for commercial purpose. Cutting of trees for fuel and consumption of fodder by cattles should be prevented. For this public support is needed to fulfil the real goal of eco-development. The Chipko Movement is a very good example of public support.

Chipko Movement – A case study

About 300 year ago, a ruler in Rajasthan started to fell the 'Khejarli' trees in his state. Local women led by a Bishnoi woman, Amrita Devi, clung to the trees to prevent the felling of the trees that were the valuable resources on which they were dependent. The women were mercilessly massacred. Later the ruler knew his mistake. The story was remembered and revived in December 1972 when the illiterate tribal women in Tehri-Garhwal district of Uttrakhand commenced the movement against the felling of trees by timber contractors. The movement gathered momentum in 1978 when the women faced police firing. This movement was known as Chipko (means to embrace) Movement in memory of the Bishnoi women who had clung to their trees and given up their lives. These women had realized that their firewood and fodder resources had receded fast in the areas around their settlements due to excessive commercial timber extraction. This led to serious floods and the loss of precious soil. The movement was supported by the persons like as Sunderlal Bahuguna and Chandi Prasad Bhat who led the people's movement to prevent deforestation by timber contractors.

Chipko activists made long padyatras across the Himalayas protesting against deforestation. The movement was successful and supported by empowering local women's groups who were the most seriously affected population. The movement had proved to the world that the forests in the hills were the life supporting systems of local communities and of immense value in ecological services such as soil conservation and maintanance of the natural water regime of the whole region.

(ii) Forest plantations

Extensive planting of trees through afforestation programmes is needed to save the diminishing forest cover. For this, production or commercial forestry has been widely adopted in different regions of the world. This aims to fulfil the commercial demand, without causing destruction of the natural forests, through intensive plantation in all available spaces.

(iii) Social forestry and Agroforestry

In social forestry, the trees and shrubs are planted in unused areas like unused farmland, community land, sides of road and rail tracks, etc. This provides firewood, fodder etc. thereby reducing pressure on existing forests.

Agroforestry is a combination of agriculture and forestry technologies for integrated, diverse and productive land use system. This combines the plantation of trees and other woody perennial plants in association with agricultural crops, pastures on the same unit of land either at the same time or in time sequence.

18.1.7. Forest Conservation through Law

According to the National Forest Policy, 1952, one third of the geographical area of the country should be under forests. But, due to continuous deforestation in the country for various reasons, it is estimated that 4.238 million hacters of forest land was officially diverted to non-forest purposes betweeen 1951-52 and 1979-80. Under such condition, Government of India could enact the Forest (Conservation) Act, 1980 with a view to conserve forests.

18.1.8. Forest (Conservation) Act, 1980

Forest (Conservation) Act, 1980 was enacted with a view to check indescriminate dereservation and diversion of forest land for non-forest purposes. Under this Act, prior permission should be taken from the Central Government before any reserved forest is declared as de-reserved, or any forest land is diverted to non-forest purposes. If there is permission for diversion, compensatory afforestation should be done. Where non-forest lands are available compensatory afforestation be raised over equivalent area of non-forest lands. If non-forest lands are not available, compensatory plantations be raised over degraded forests twice in extent to the area being diverted.

The Forest (Conservation) Act, 1980 was amended in 1988. This is to incorporate stricture penal provisions against violators. Important amendments are as follows :

(i) No state government or other authority may direct that any forest land may be assigned by way of lease or otherwise to any person, corporation, agency or organisation (not owned by the government) without prior approval of the Central Government.

(ii) No forest land or any portion thereof may be cleared of trees which have grown naturally in that land or portion, for the purpose of using it for reforestation without prior approval of Central Government.

(iii) Scope of existing “non-forest purposes” has been extended to other areas as cultivation of tea, coffee, spices, rubber, palms, medicinal plants, etc.

(iv) Admissible punishment to the offender of the provision of Section 2 of the Act.

Let us answer these

1. What are renewable and non-renewable resources ?
2. How does the forest act in reducing the global warming ?
3. What are the major consequences of deforestation ?

18.2. Wildlife

All kinds of non-cultivated plants and non-domesticated animals living freely in their natural habitats far from human interference, control and dominance are known as **wildlife**. In India, a wide variety of vegetation and animals are found. It is estimated that in India there are about 350 species of mammals, 2,100 species of birds, 500 species of amphibians and reptiles and 30,000 species of invertebrates. Many of the important wildlife fauna are becoming threatened to extinction. Some of them are Indian lion (*Panthera leo persica*), Royal Bengal tiger (*Panthera Tigris*), Sangai (*Cervus eldi-eldi*) etc.

18.2.1. Why should we conserve wildlife?

Some of the important reasons for conserving wild life are as follows :

1. Ecological balance

Every animal is a link in one food chain or the other. A loss or extinction of an animal may affect the food chain. In addition to this, every animal has a specific role in an ecosystem. If the role is that of a scavenger (animal eating dead body of other animal), then in its loss, our surrounding will be filled with rotting flesh of dead animals. If it is a rat eating snake, then in the absence of the snake, the number of rats will increase so much that they may consume all our grains which may lead to famine. So, the existance of the animals are required for ecological balance.

2. Utility to man

We can get many useful materials like meat, honey, wax, silk, lac, fur, hide ornamental materials (elephant tusks, horns, mollusk shells, pearls etc.), scent (from musk-deer), timber, medicines and many other things from the animals and plants. If the wild life is conserved and propogated, we can get these materials abundantly and can be used for commercial purpose. But, killing

animals for these materials without propagating them will lead to the extinction of the animals. Their consevation and propagation is thus highly essential.

3. Helps to our survival

For the conservation of a particular animal, say tigers or lions, we are to protect or conserve the natural habitat of the animals. For their protection we should not disturb the vegetation of the area as well as the smaller animals like deer, wild boar etc. on which they eat. By doing so we will get oxygen from the plants through the process of photosynthesis and CO_2 gas also will be taken in. As a whole, the ecological balance is maintained in the area. The rainfall may not be disturbed, the climatic condition of the area will not be changed.

4. Science and Education

Animals such as frogs, rabbits, dogs, guineapigs , monkeys, etc. are used in teaching students and also by scientist to experiment in surgery and medicine.

5. Tourist attraction

Many people like to see the wild animals in their natural habitats and also at zoos. So animal lovers travel to far off countries to see the different animals. Such activity helps to increase income of the country.

6. Game value

Many people enjoy fishing and hunting (except those decleared protected) as their hobby. This is also a source of income for a country. For this the government opens their forest reserves for hunters who pay and hunt a specified number of animals and birds. At times, it is closed to allow the animals to increase their number. In this way a lot of revenue can be earned.

7. Aesthetic value

Many animals by their beauty and pattern (peacock, butterflies), majestic elegance (tiger and lions), sweet voice (cuckoo) and playful behaviour (dolphins and chimpanzees) appeal to the aesthetic sense of man and often become a subject of inspiration for painting, poetry, sculptures and writing.

18.2.2. Conservation of Wildlife

It is clear that the conservation of wild life is necessary not only for the benefit of the wildlife itself but also for our survival. The number of endangered

species of flora and fauna is increasing continuously. For this, steps have been taken up to protect and manage the wildlife of the country. Non-governmental organizations (NGO) as well as government organizations at state and central levels have been set up to protect the wildlife. Recently the subject was given top priority and a separate Ministry of Environment and Forests under the central government is entrusted with the task to environmental protection. The Department of Environment, Forests and Wildlife was set up under this Ministry with a view to bring co-ordination between states and centre and speedy implementation of the steps to be taken up for the protection and conservation of Wildlife.

Wildlife conservation can be done by

(i) protection of natural habitats through controlled, limited exploitation of species.

(ii) establishing Biosphere Reserves for plant and animal species.

(iii) improving the existing protected areas as sanctuaries, national parks etc.

(iv) imposing restrictions on export of rare plant and animal species and their products.

(v) imposing protection through legislation.

(vi) educating public for environmental protection at all levels of education.

Some of the Wild Life Acts enacted by the State and Central Government for the conservation of Wildlife are:

1. Madras Wild Elephant Preservation Act, 1873
2. All India Elephant Preservation Act, 1879
3. The Wild Birds and Animals Protection Act, 1912
4. Bengal Rhinoceros Preservation Act, 1932
5. Assam Rhinoceros Preservation Act, 1952
6. Wild Life (Protection) Act, 1972

Some Government organizations for wildlife protection

1. Indian Board for Wildlife (IBWL) , 1952
2. Indian National Man and the Biosphere committee, 1972 for Biosphere Reserve.

Some principal Non-Government Organizations

1. Bombay Natural History Society, founded in 1883.
2. Wildlife Preservation Society of India, Dehradun, founded in 1958.
3. World Wide Fund for Nature India.

Let us answer these.

1. What is meant by wildlife ?
2. How the wildlife can be conserved ?

18.3. Conservation of Coal and Petroleum

Coal and petroleum are important conventional sources of energy.These are fossil fuels and non-renewable sources of energy.

Coal was formed 255-350 million years ago in the damp, hot regions of the earth. The ancient plants growing in swamps and river banks were burried into the soil after death. Due to heat and pressure they became gradually converted into peat and coal over millions of years. Coal is the world's most abundant fossil fuel. The coal reserves are likely to last for about 200 years at the present rate of usage. But if the usage increases by 2 % per year then it will last for another 65 years only.

Coal is a prime source of industrial energy. It provides about 60% of the industrial power requirement in our country. Many thermal and superthermal power stations are located near the coal fields where the coal is burned and converted to electric power which can be used for many purposes. Sixtytwo percent of the world's electric power is generated from the burning of coal. Being a non-renewable resorce, if extracted at the present rate, it will soon become totally exausted. So, it needs conservation for the future generations.

Petroleum is found in the sedimentary rocks, containing plants and animals remains about 100 to 200 million years old. Crude petroleum is a complex mixture of alkane hydrocarbons. It is purified and refined by the process of fractional distillation. During this process different constituents separate out at different temperatures and get a large variety of products namely petroleum gas, kerosene, petrol, diesel, fuel oil, lubricating oil, paraffin, wax, plastic, etc.

It is estimated that at the present rate of usage, the world's crude oil reserves will be exhausted in just 40 years.

Since many of the petroleum products and coal are utilized for the production of electricity, the conservation of electric energy also will lead to the conservation of coal and petroleum. The following practices can be followed for the conservation of coal and petroleum.

1. To turn off light, fans and other electric appliances when not in use.
2. To arrange for getting as much heat as possible from natural sources. If it is a sunny day, we can dry our clothes in sun instead of using a drier.
3. To use solar cooker for cooking our food on sunny days which will cut down the expenses of LPG .
4. Plantations of deciduous trees and climbers at proper places outside our house. This will cut off intense heat of summer and get a cool breeze and shade. This will lead to the reduction of electrcity charges on coolers and air conditioners. The deciduous trees shed their leaves in winter so it will not obstruct sunlight during winter.
5. To drive the vehicles less, make fewer trips and to use public transportations when ever possible. If some people are to go regularly to the same place, like office going then we can share by joining a car-pool.
6. To wear adequate woolen warm clothes in winter days inside the house instead of using the heat convector.
7. To ride bicycle or just to walk down small distances instead of using car and scooter.
8. To use as far as possible renewable energy sources like solar energy, wind energy, hydro power sources etc.

18.3.1. CNG (Compressed natural gas) use as an alternative fuel for vehicles

The use of petrol and diesel as fuels of the vehicles add more and more pollutants in the environment particularly in urban areas where large number of vehicles are running. CNG , is nowadays used in place of petrol and diesel as fuel in buses and autorickshaws in the cities like Delhi. CNG use has greatly reduced the vehicular pollution.

Let us answer these.

1. About how many years more are likely to last the coal reserves of the world at the present rate of usage ?
2. What are different constituents of the petroleum separated after fractional distillation ?
3. Which fuel can be used in place of petrol and diesel to reduce pollution ?

POINTS TO REMEMBER

- The natural resources like forests, wildlife, coal, petroleum etc. need to be used in a sustainable manner.
- The environmental services provided by the forest are more than its commercial value.
- There are many far reaching consequences of deforestation.
- The fossil fuels, coal and petroleum, will ultimately be exhausted. Because of this and because their combustion pollutes our environment, we need to use these resources judiciously.

EXERCISES

1. What is meant by natural resources ?
2. What are the two kinds of natural resources ?
3. What are the ecological services provided by the forests ?
4. How the forests can be conserved ?
5. Why should we conserve wildlife ?
6. What steps can be taken up for the conservation of coal and petroleum ?

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CHAPTER 19

THE REGIONAL ENVIRONMENT

The environment of a region changes considerably due to human activities. The construction of big dams, deforestation, urbanisation or industrialization of a locality are main factors for the changes in the regional environment of the area.

19.1. Human activities and regional environment

How does the construction of a big dam affect the life of the people and the regional environment ?

19.1.1. Advantages

Big dams constructed in the river valley projects are considered to play a key role in the development process due to their multiple uses. India is known for having largest number of river valley projects. These dams take a big role in the development of the nation. The inhabitants of the area are always having big hopes on these projects as they aim at providing employment and raising the standard and quality of life. The big dams have tremendous potential for economic upliftment and growth. They can generate electricity and reduce power shortage. They provide irrigation water to cultivated lands in lower areas. They supply drinking water in remote areas. The dams also can help in checking floods and famines. These also promote navigation, fishery etc.

19.1.2. Limitations – Environmental Problems:

The environmental impacts of big-dams are numerous. Due to this, the construction of big dams very often become a subject of controversy. The impacts can be at the upstream as well as downstream levels, as follows:

(A) The upstream problems include the following:

(i) The inhabitants of the nearby area are to be displaced as the water level raises due to construction of the dam.

(ii) There is loss of forests, plants and animals.

(iii) There are changes in fisheries and the breeding grounds of the fishes.

(iv) Siltation and sedimentation of reservoirs occurs.

(v) Lost of non-forest land occurs.

(vi) There may be stagnation and water logging near the reservoir.

(vii) There may be increase in vector-borne diseases due to breeding of vectors in the expanding waterlogged areas.

(viii) Possibility of earthquakes due to reservoir induced seismicity (RIS).

(ix) There will be microclimatic change.

(B) The dowstream problems may be of the following:

(i) Micro-climatic change.

(ii) In the river, water flow will be reduced and due to this there will be silt deposition in the river.

(iii) There may be intrusion of salt water at river mouth.

(iv) The fertility of the land along the river will be reduced as the sediments carrying nutrients get deposited in the reservoir.

(v) There may be outbreak of vector-borne diseases like malaria.

Although the construction of big dams are of multiple uses for the development of the society, besides there are many serious side effects. Therefore, nowadays, as an alternative, attentions have been given to the construction of small dams or mini-hydel projects.

19.1.3. Water harvesting

Water is the most essential thing of all living organisms. We can live without food for many days. But we cannot live even for few days without water. Water is needed in our body to help in the digestion of the food we eat, to remove the waste products and also to maintain the blood pressure. It is also necessary to grow all the plants.

19.1.4. From where we get this water ?

We get water from different sources in different localities, such as tanks, rivers, lakes, wells, streams, taps etc. But the ultimate source of all these waters is rain. Nowadays we are facing shortage of drinking water in almost all the places. Even in Cherrapunji where the annual rainfall is more than 1100 cm, there is shortage of drinking water. This is due to lack of proper harvesting and proper management of the rain water.

19.1.5. Rainwater harvesting

Rainwater harvesting is done by constructing special water storage tanks, ponds, dugwells, pits, lagoons, check dams etc. Rainwater, wherever it falls is collected and pollution of this water is prevented. Harvesting of rainwater is usefull not only for the poor and scanty rainfall regions but also for the rich ones.

The average annual rainfall in India is 120 cm. In most places it is concentrated over the rainy season, from June to September. So proper arrangement for the storage of water to use in the dry season also is needed. Due to lack of proper harvesting and management of rain water, people face scarcity of water even in the areas where there is the highest annual rainfall.

Rainwater harvesting is done with the following objectives :

1. to check the surface run off loss of water.
2. to meet the increasing demands of water.
3. to avoid flooding of roads.
4. to recharge the ground water for raising the water table.
5. to supplement the groundwater supplies during lean season.

Rainwater harvesting can be done by any one of the following methods:

1. By storing in special storage tanks or reservoirs constructed above or below ground.
2. By constructing pits, dug-wells, lagoons or check- dams on small streams.
3. By recharging the ground water.

In India as a traditional practice, in the high rainfall areas the rainwater is collected from roof-tops into storage tanks. In the foot hills, water flowing from the springs are collected in the embankment type water storage. In Rajasthan people use ‘tankas’ (underground tanks) and ‘khadins’ (embankments) for rainwater harvesting.

The harvested rainwater needs proper management so that it should not be contaminated and also for safe future use.

Let us answer these.

1. What are the advantages of the construction of big dams ?
2. What are the disadvantages of the construction of big dams ?

POINTS TO REMEMBER

- The construction of big dams take a big role in the development of the nation.
- Big dams can generate electricity and also supply drinking water.
- Construction of big dams on the other hand creates many environmental problems.
- Harvesting of rainwater should be done to meet the shortage of drinking water.
- Rainwater harvesting can be done by the construction of pits, dug-wells, check dams etc.

EXERCISE

1. The construction of big dams in the river valley projects are considered to play a key role in the development process. Explain.
2. Write the environmental problems faced to the construction of big dams.
3. What are the alternative practices to the construction of big dams to avoid serious side effects?
4. What are the objectives of rainwater harvesting?
5. Write the methods that can be taken up for harvesting rainwater.

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