

## **LESSON 1**

### **NUTRITION**

Human body remains balanced and unhampered due to simultaneous biochemical processes taking place inside the body. Energy is essential for all these processes. Food is essential for the formation of cells, tissue and other organs and for growth and repairing of the body. Organisms need food to accomplish all the life processes taking place inside our body. Acquiring energy and collection of different essential components takes place through nutrition. Green plants produce their own food by photosynthesis, acquire different nutrients from the surroundings. But animals and other organisms are dependant on the plants for their food directly or indirectly. They eat food prepared by plants or stored or on other animals. Food initially found in complex form. This complex food is simplified and made available in different organs. Simplified food releases energy by oxidation process. Release of energy from food is a destructive process. This is an example of **catabolism**. Similarly formation of useful components for the growth of body from the food is a constructive process which is called as **anabolism**. Both catabolism and anabolism together form **metabolism**. Metabolism always takes place inside the living body. Therefore metabolism plays important role in maintaining our body active and healthy. So it is clear that food is essential for living organisms.

**Types of food-** Depending upon chemical structure, function and production of energy, food is classified into six main types.

**Carbohydrate:-** Sugars and Starch are main carbohydrates of food that we eat. Potato, rice and bread contains a lot of starch. Sugar and jaggery contains sucrose, fruit juice and vegetable contains more of glucose. We acquire energy easily from carbohydrate. Glucose ( $C_6H_{12}O_6$ ) contains carbon, hydrogen and oxygen. During cellular respiration, oxidation of glucose takes place and  $CO_2$ ,  $H_2O$  and energy is produced. One gram of glucose releases approximately 16 Kilo Joules (KJ) of energy.

**Proteins:** We get animal proteins mainly from fish, meat, egg albumen, cheese and milk and plant proteins from pulses and soyabean etc. Protein food is essential for growth of the body and formation of new cells. Proteins are made of amino acids present in sequence. Proteins after synthesis change into Amino acids and reach various various cells and specific organelles.

**Fats/Lipids:** Meat, milk, cheese, butter, egg yolk, oil and ghee contain fats or lipids. Lipids play important role in the formation of plasma membrane. Lipids are stored in the body as fats. When required it is oxidised by cellular respiration and it provides energy to the body. A layer of fat is present below the skin. As it is bad conductor of heat, fat helps to keep our body warm.

**Minerals:** Different types of minerals such as iron, calcium, iodine, phosphorous, sodium and potassium etc are required for our body



**(2) Saprophytic Nutrition:** Heterotrophs which obtain their nutrition from dead, decayed and decomposed plants and animals body are known as saprophytes. Saprophytes secrete digestive juices out to change the complex food into simple as they cannot intake the complex food directly. Later they absorb this simplified food which can be utilized for building their body. This type of nutrition is observed in some fungi like mushroom, yeast & bacteria etc.

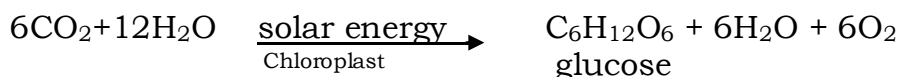
**(3) Parasitic Nutrition:** The organisms live inside or outside of other living plants or animals (host) and collect food from them for their nutrition are called as parasites. Parasites collect simplified food directly from their host. This is called as parasitic nutrition. Parasites take shelter in the host body and harm it. Plants like **Loranthus, cuscuta, Reflesia** etc and animals like plasmodium, Louse, Leech, hook worm etc are few examples of parasites. Some parasites live inside the host body and called as endoparasite (e.g. Plasmodium). Parasites live outside the body of the host are called as ectoparasite (e.g. Louse).

**(4) Symbiotic Nutrition:** Sometimes totally two different species of animals or plants and animals or animals and microbes or plants and microbes live together. This is known as symbiosis. They do not harm each other rather they exchange their food. This is known as symbiotic nutrition. For example Escherichia coli bacteria lives inside our intestine as symbiotic organism provides us vitamin B<sub>12</sub> (Cyanocobalamin) produced by its body, in exchange it takes simplified food from our intestine as their food. Another example is contribution of symbiotic bacteria in nitrogen fixation.

Basing on food habits, animals are classified into 3 main groups:

- Herbivore: Those take plant and plant product as food
- Carnivore: These take other animals & animal products.
- Omnivore: Those eat all eatable substance without any discrimination of food.

**Photosynthesis:** Green plants prepare their food by a process called photosynthesis. They release O<sub>2</sub> in the atmosphere by this process. All living beings depend upon food produced by this process. Robert Hill made research on photosynthesis and showed in 1937 that in photosynthesis, 6CO<sub>2</sub> molecule react chemically with 12H<sub>2</sub>O molecules to produce one glucose molecule. As a result of this chemical reaction, 6H<sub>2</sub>O Molecule and 6O<sub>2</sub> molecules are released with glucose molecule.

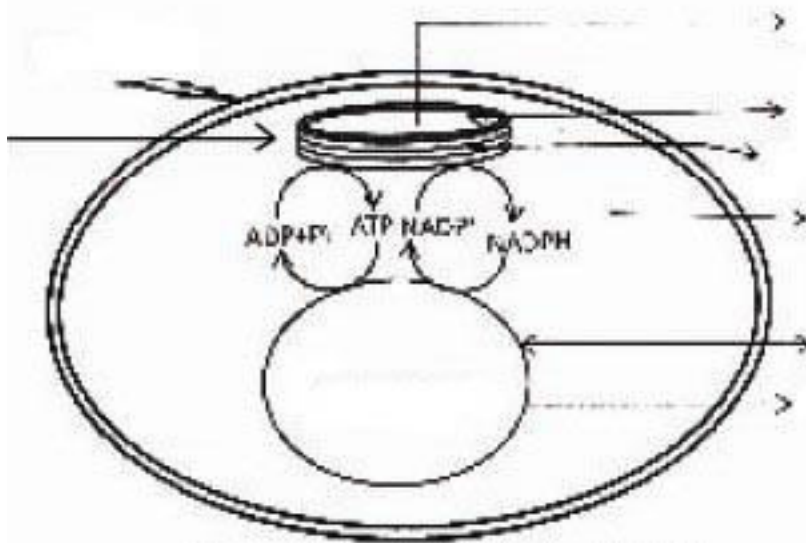


F.F Blackman, (1866-1947) a scientist from England divided photosynthesis into two processes.

- (1) Light reaction or photochemical Reaction
- (2) Dark reaction or Biochemical Reaction.

Both these process take place in green leaves in presence of chloroplast pigments. Inside the chloroplast a number of small, flat coins like structure called Thylakoids present in stacks. These stacks of thylakoid are called as Grana. Granas are interconnected with each other by fine membrane called thylakoid membrane. Chloroplast contains a jelly like aqueous fluid called Stroma. **Light reaction takes place in thylakoid membrane** and **Dark reaction takes place in stroma of chloroplast**. Each thylakoid memberane contains chlorophyll and other light absorbing molecules.

**Light Reaction:** Chlorophyll, water and light are the essential components for this process. Chlorophyll molecules absorb visible rays of sunlight and makes one chlorophyll molecule more energetic through energy flow and creates excitation.



### CHLOROPLAST AND CALVIN CYCLE

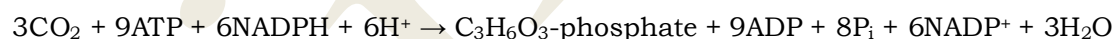
One electron comes out of this excited chlorophyll and flows through thylakoid membrane; as a result hydrogen ion flows into the thylakoid. At last it reaches at a low energetic oxidized co-enzyme  $\text{NADP}^+$  (Nicotinamid Adenine Dinucleotide Phosphate) and reduces it ( $\text{NADPH}$ ). Hence, low energetic  $\text{NADP}^+$  changes in to high energetic  $\text{NADPH}$ . During flow of electron, hydrogen ion present in the thylakoid, comes out of it. As a result, a low energetic molecule  $\text{ADP}$  (Adinosine Diphosphate) changes in to high energetic  $\text{ATP}$  (Adenosine Triphosphate) molecule with the help of  $\text{ATP}$  synthase enzyme. Both  $\text{ATP}$  and  $\text{NADPH}$  combine together form assimilatory power. These two products act as reactants in chemical reactions take place during Dark reaction of photosynthesis and give to  $\text{ADP}$  and  $\text{NADP}^+$  as output. Reduced chlorophyll molecule that donates electron acquired one electron and return back to the ground state. This electron is made available by the decomposition of  $\text{H}_2\text{O}$  ( $\text{H-OH}$ ) molecule and dioxide molecule ( $\text{O}_2$ ) is released as waste molecule.



NADP plays an important role in photosynthesis. It remains as co-factor with an enzyme called ferredoxin NADP Reductase (Fd-NADP) which is taking part in this process. It absorbs two highly energetic electrons flowing during photosynthesis and reduces to form high energetic NADPH. Hence in this process, light energy is stored in the form of chemical energy.

**Dark Reaction:** Dark reaction is also called as enzyme reaction. As this process was discovered by Melvin Calvin so it is called as Calvin cycle. Photosynthetic energy accumulated in light reaction is used in dark reaction; change CO<sub>2</sub> into glucose (carbohydrate). Hence, dark reaction begins immediately after the light reaction and continues along with light reaction. A number of enzymes participate in this process. Enzyme is a biocatalyst. It speeds up various chemical reactions (processes) without changing itself. Among these enzymes RuBisCo is an important enzyme. At first the enzyme RuBisCo captures CO<sub>2</sub> from the atmosphere gradually changes in to glucose. Later on glucose changes to starch and stored in spongy parenchyma of the leaf. The stored starch changes/converts back into glucose and flows to different parts of the plant through phloem whenever required by a plant.

As energy is essential for dark reaction, it continues along with light reaction mostly in the same speed. So in absence of sunlight when light reaction stops, after a short while dark reaction also stops itself. But exception is found in some desert or xerophytic plants. These plants have their stomata open during night and absorb CO<sub>2</sub> from atmosphere and store it as organic compounds inside the cells of the leaves. During day time they keep their stomata closed in order to conserve water even though sunlight is present. But after the formation of chemical energy in light reaction, they take out CO<sub>2</sub> from the stored organic compounds to produce glucose.



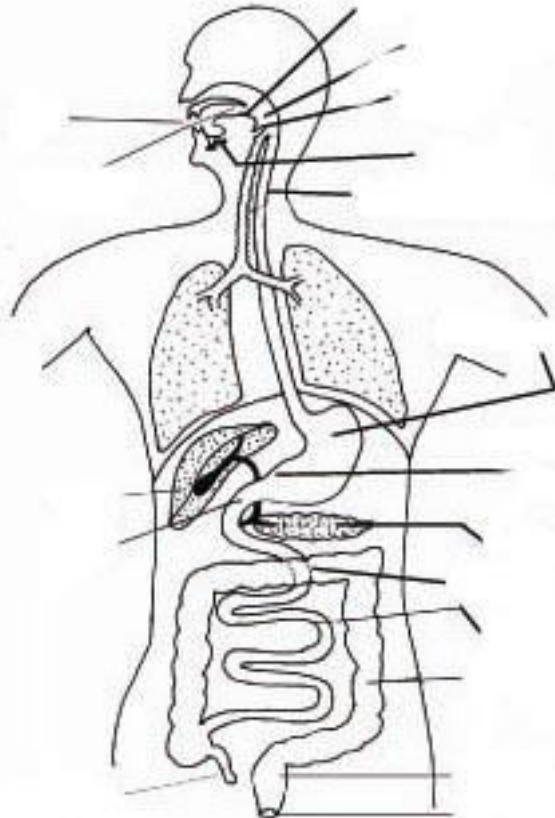
Starting from the absorption of light, till the formation of glucose, all chemical reactions take place in four steps-

- (1) Absorption of light by chlorophyll of chloroplast and giving out of electron after it is formed during this process (Energy transfer in antenna chlorophyll and transfer of electrons).
- (2) Change of light energy to chemical energy by flow of electron.
- (3) Hydrolysis is of water molecule (H<sub>2</sub>O) to form hydrogen ion and oxygen O<sub>2</sub>. (electron transport chain and ATP synthesis)
- (4) CO<sub>2</sub> changes to glucose by using chemical energy (Carbon fixation and export of stable products)

(Calvin cycle begins from Ribulose Biphosphate or RuBP and ends there only. As a result  $\text{CO}_2$  changes to form glucose by this process. Each RuBP molecule absorbs one  $\text{CO}_2$  molecule and bifurcates later on to form two phosphoglyceric acids (PGA). In this way 6RuBP combines with  $6\text{CO}_2$  and form 12PGA with the help of RuBisCo. Out of 12PGA, two PGA produce one glucose molecule, and rest 10PGA recycle to form 6RuBP molecule.

## **DIGESTIVE SYSTEM OF A MAN (ALIMENTARY CANAL AND DIGESTIVE GLANDS)**

Man eats food whichever is eatable without discrimination. Food that we eat does not directly used by the cells. Complex food is simplified in the alimentary canal and changed to absorbable food. The simplification of complex food into simple is called as digestion. After digestion the body absorbs essential nutrients and unwanted waste materials are discarded out of the body as stool.



### **(1) Alimentary canal and digestive glands:**

Alimentary canal begins with mouth and ends at anus. In an adult its length is 6 to 9 meters. Basing on structure and function of alimentary canal it is divided into different parts such as Mouth or Buccal Cavity, Pharynx, Oesophagus, stomach, small intestine, large intestine, rectum and anus. Alimentary canal looks like a long tube. Its walls are made up of circular and longitudinal muscles. By the contraction and relaxation of these two types of muscles food pulp moves from pharynx to anus. This kind of movement of alimentary canal is called as peristalsis.

## **(2) Mouth and Buccal Cavity:**

The mouth is the first part of the gastrointestinal tract and is equipped with several structures that begin the first processes of digestion.<sup>[3]</sup> These include salivary glands, teeth and the tongue. The mouth consists of two regions, the vestibule and the oral cavity proper. The vestibule is the area between the teeth, lips and cheeks,<sup>[4]</sup> and the rest is the oral cavity proper.

Mouth is surrounded by upper and lower lips. Inside the mouth is the buccal cavity or oral cavity. Cheeks are present on both sides of the oral cavity; palate present of the upper part whereas tongue is in lower part of the cavity. 32 teeth (16 in each jaw) found on both jaws. There are four types of teeth found depending upon the type of food we eat. Four incisors, two canines, four premolars and 6 molars are present on each jaw. Tongue helps to take food near the teeth for chewing, identify the taste of food, besides help in speech. Tongue can identify various taste like sour, bitter, salt and sweet as it has taste buds. There are three pairs of main salivary glands and between 800 and 1,000 minor salivary glands, all of which mainly serve the digestive process, and also play an important role in the maintenance of dental health and general mouth lubrication, without which speech would be impossible.<sup>[5]</sup> The main glands are all exocrine glands, secreting via ducts. All of these glands terminate in the mouth. Saliva functions initially in the digestive system to moisten and soften food into the formation of a bolus. The bolus is further helped by the lubrication provided by the saliva in its passage from the mouth into the oesophagus. Also of importance is the presence in saliva of the digestive enzymes **Ptyalin**. This digestive enzyme starts to work on the starch in carbohydrates, breaking it down into the simple sugars of maltose and dextrose that can be further broken down in the small intestine. Saliva in the mouth can account for 30% of this initial starch digestion.

**(3) Pharynx and oesophagus:** Pharynx is present just below the buccal cavity. Two doors are present at its end. One door extends to trachea and another extends to oesophagus. Epiglottis, is a flap that is made of elastic cartilage and attached to the entrance of the larynx to move food into food channel and air into trachea. Swallowing of food is voluntary action but after entering into oesophogus it's transportation becomes involuntary action. Length of oesophagus is about 22 to 25 cm; and joins with the stomach. No change of food occurs in oesophagus.

**(4) Stomach:** Stomach is present at the left side of abdominal cavity. Its upper part is wider than the lower part. Upper wider part is known as cardiac stomach as found near the heart and its lower part towards duodenum is called as pyloric stomach. Ring like muscles are present at end of pyloric stomach called as pyloric sphincter muscles. By the contraction and expansion of these muscles half or semi digested food enter in to the intestine in smaller quantities. A number of gastric glands present in the inner walls of the stomach which secrete gastric juices and HCL. Pepsin, an enzyme present in gastric juice simplifies protein food in to protease and peptone in acidic medium. HCL kills harmful bacteria present in food.

**(5) Small and Large intestine:** From the stomach food enters into duodenum, the first part of small intestine, as liquid pulp known as chyme. Pancreatic juice secreted from pancreas and bile juice from the liver enters into the duodenum mixes with the food. No enzyme is present in the bile juice but it does emulsification of fatty foods. Pancreatic juice contains various types of enzymes and alkaline like sodium hydrogen carbonate. This alkaline pancreatic juice neutralises acidic chyme (food) that is churned out by stomach. As a result different enzymes present in pancreatic juice change food to simpler form.

**SIMPLIFICATION OF COMPLEX FOOD INTO SIMPLER PARTICLES AFTER DIGESTION**

FOOD	ENZYMES	DIGESTIBLE SIMPLE FOOD PARTICLES
CARBOHYDRATES	AMYLASE	SUCROSE, FRUCTOSE GALACTOSE
PROTEINS	PROTEASE	AMINO ACID
FATS AND LIPIDS	LIPASE	FATTY ACIDS, GLYCEROL

Next part of duodenum is jejunum and the last part is ileum. In this part of small intestine digestion process is completed and simplified food is absorbed. Numerous finger-like projections called villi present in the ileum walls of small intestine which increases the surface area for absorption. The villi are richly supplied with blood vessels which take the absorbed food to liver. From liver it reaches each and every part of the body, where it is utilized for obtaining energy, building new tissues and the repair of old tissues. Utilization of food by our body is called assimilation.

After assimilation of food in small intestine the undigested food reaches to large intestine where more villi absorb water some food particles from this material. Some symbiotic bacteria present in the large intestine change food into stool and also collect food for them. Stool remains for sometime inside the rectum and by peristalsis process stool is discarded out of the body. The exit of this waste material is regulated by the anal sphincter.

Enzyme that digest meat, why is it not digest our stomach?

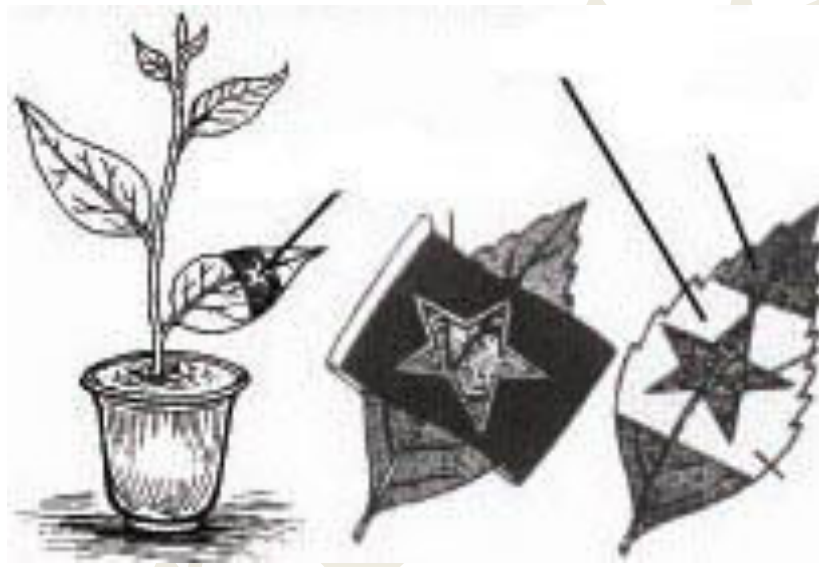
- (1) Protease – a type of enzyme that digest protein are secreted in inactive stage. It becomes active in acidic medium of stomach. When food reaches in the stomach, secretion of enzyme is accelerated.
- (2) Many mucus glands are present inside our stomach secretes mucus which is alkaline in nature hence protects stomach both from acid environment and enzymes.
- (3) As the cells of stomach are closely packed, pepsin cannot enter into stomach wall and does not harm tissues.
- (4) The cells of the stomach are regenerated in every 2 to 3 days. For this reason pepsin enzyme cannot digest the walls of stomach.



### ACTIVITY NO 1

Take a potted plant and cover a part of its leaf with a black paper or cello tape. Now keep the potted plant in sunlight for 2-3 hours. Now pluck the leaf and dip in boiling spirit or alcohol till all the green pigment of the leaf (chlorophyll) is removed and leaf becomes colourless. Now carefully wash the leaf in running water. Dip the leaf in dilute solution of iodine for few minutes and match the leaf with picture –

1. Do you find any change in the leaf? If yes, explain the reason behind it.
2. Whether the change has taken place in every part of the leaf?
3. What difference did you find between the covered part and uncovered part of the leaf?
4. As per your opinion, what role does light play in photosynthesis?

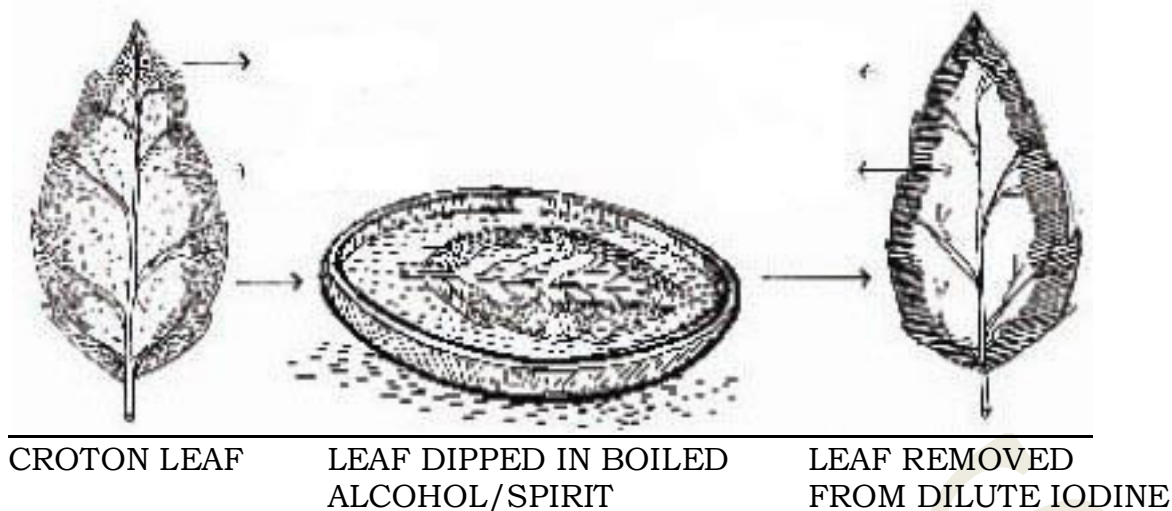


IMPORTANCE OF CHLOROPHYLL IN PHOTOSYNTHESIS

### ACTIVITY NO 2

Take a beaker and fill with water. Now put a branch of variegated leaves like money plant or croton. Now keep the beaker in sunlight for 2-3 hours. Pluck a leaf from that branch and put it on tracing paper and draw the places where you see green pigments. Now keep it into the beaker containing boiling alcohol or spirit for sometimes till all the green pigment of the leaf is removed and becomes colourless. Now wash the leaf in water. Later dip it into the dilute solution of iodine. Now observe it

1. Did you find the equal colour change in every part of the leaf?
2. What colour difference did you find if you keep the leaf on the previously drawn paper?
3. Whether did you find any change in the place where there was no green pigment.
4. As per your opinion, what role does chlorophyll play in photosynthesis?



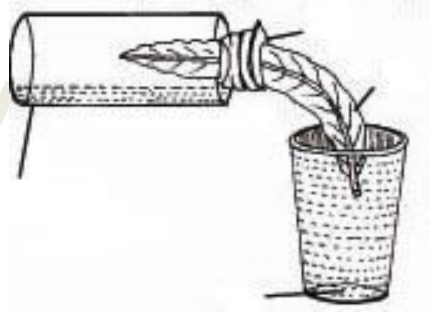
PICTURE SHOWING PRESENCE OF CHLOROPHYLL IS ESSENTIAL FOR PHOTOSYNTHESIS.

### ACTIVITY NO 3

Take a bottle pegged with a cork. Cut the cork into two pieces. Put some caustic potash into the bottle and place the leaf in between the cut cork and peg the cork into the bottle. Seal the cork and opening of the bottle with wax such that no air can pass into the bottle. Now place the stalk of the leaf into a glass filled with water put the glass in the sunlight for 2-3 hours.

Now take out the leaf from bottle and keep it into the beaker containing boiling alcohol or spirit for sometimes till all the green pigment of the leaf is removed and becomes colourless. Now wash the leaf in water. Later dip it into the dilute solution of iodine. Now observe it

1. Whether the colour of entire leaf is changed?
2. Whether there is any change occur in the leaf present inside the bottle?
3. As per your opinion, what role does  $\text{CO}_2$  play in photosynthesis?



### ACTIVITY NO 4

Saliva of man contains an enzyme called Ptyalin. It converts complex carbohydrates of our food into simpler form. The following experiment is shown how it happens.

Rinse your mouth with water and rub a piece of green chili on your tongue in such a way that you feel the hotness of chili. Saliva will pour in the oral

cavity. Collect about 5ml of saliva using a test tube. Now divide the collected saliva into two test tubes and name it as A and B. Mix 5ml of 1% dilute Starch or the starch collected at your home after the rice is cooked.

1. Now add 3-4 drops of dilute iodine in Test Tube A. You will find that the colour of the starch in test tube A change into Blue.
2. Now add 3-4 drops of dilute iodine in Test Tube B but after keeping it for 20-30 minute. What did you observe? Is the colour of Test Tube B change into blue? If not explain the reason.

### **WHAT YOU HAVE LEARNT**

1. Food is necessary for growth and building of body, tissues, obtaining energy and for various processes.
2. Food is classified into 6 types – Carbohydrates, proteins, fats and lipids, minerals, vitamins and water.
3. Organisms which prepare their own food are known as autotrophs. All green plants, blue green algae and chemosynthetic bacteria are known as autotrophs.
4. Organisms which depend on others for their food are known as heterotrophs.
5. Heterotrophs are of four types – Holozoic, Parasitic, Saprophytic and Symbiotic
6. The process of preparation of Carbohydrates by green plants in presence of water, sunlight, and carbon dioxide is called photosynthesis.
7. Photosynthesis is of two types – light reaction and dark reaction
8. The solar energy of the sun is converted into chemical energy by trapping the sunlight by chlorophyll of plants. Decomposition of water molecules take place, as a result oxygen is given out into the atmosphere.
9. In dark reaction, Glucose (sugar) is formed using  $\text{CO}_2$  and light energy.
10. The alimentary canal of a human being begin with mouth and ends in anus. It is about 6-9 meters long.
11. Basing on structure and function of alimentary canal it is divided into different parts such as Mouth or Buccal Cavity, Pharynx, Oesophagus, stomach, small intestine, large intestine, rectum and anus.
12. Complex food is simplified by the enzymes present in Oral Cavity, Stomach and Small intestine.
13. Digested food or chyme is assimilated by villi present in the walls of small intestine.
14. After assimilation of food in small intestine, remaining food goes into large intestine where further absorption of water and some food particles takes place.
15. The various enzymes and gastric juices take part in the process of digestion of food are released by pancreas, stomach and salivary glands.

## EXERCISE

### ANSWER THE FOLLOWING QUESTIONS

1. What is photosynthesis? Explain how this process occurs in green plants.
2. Write the types of food found along with examples.
3. What do you mean by Heterotrophic Nutrition? Write various types of heterotrophs.
4. Write the various parts of alimentary canal. How food changes in the mouth?
5. Write structure and function of stomach.
6. Write the names and functions of various glands related to alimentary canal.
7. **Write a short note on the following –**
  - a. What is autotrophic nutrition?
  - b. How many types of teeth are present in our mouth? What are they?
  - c. Name the different taste a tongue can identify? Write the other functions of tongue.
  - d. Write the changes takes place on food in stomach.
  - e. Where does food go from stomach? After assimilation, where does rest of the food go?
  - f. What is light reaction?
  - g. Explain the role of RuBP in photosynthesis?

### 8. Fill in the blanks

- a. The upper part of the stomach is known as Cardiac stomach, whereas the lower part is known as \_\_\_\_\_
- b. Loranthus and cuscuta are \_\_\_\_\_ plants.
- c. \_\_\_\_\_ enzyme is present in Saliva.
- d. \_\_\_\_\_ of larynx moves food into food channel and air into trachea.
- e. Bile \_\_\_\_\_ the fatty foods.

### 9. Choose the correct answer

- a. Which of the following is not required for light reaction of photosynthesis?  
i) Light ii) Water iii) Carbon dioxide iv) green leaves(Chlorophyll)
- b. How many CO<sub>2</sub> molecules are required to prepare one Glucose in dark reaction.  
i) 3            ii) 4            iii) 6            iv) 12
- c. Where do the Electron from Thylakoid membrane reach?  
i) ADP        ii) NADPH        iii) NADP<sup>+</sup>        iv) ATP
- d) Who classified the photosynthesis into Light and Dark reaction?  
i) Blockman        ii) Hill and Calvin        iii) Hill        iv) Calvin
- e) At what time does the Desert plants take CO<sub>2</sub> from atmosphere.  
i) morning        ii) after noon        iv) night        iv) always

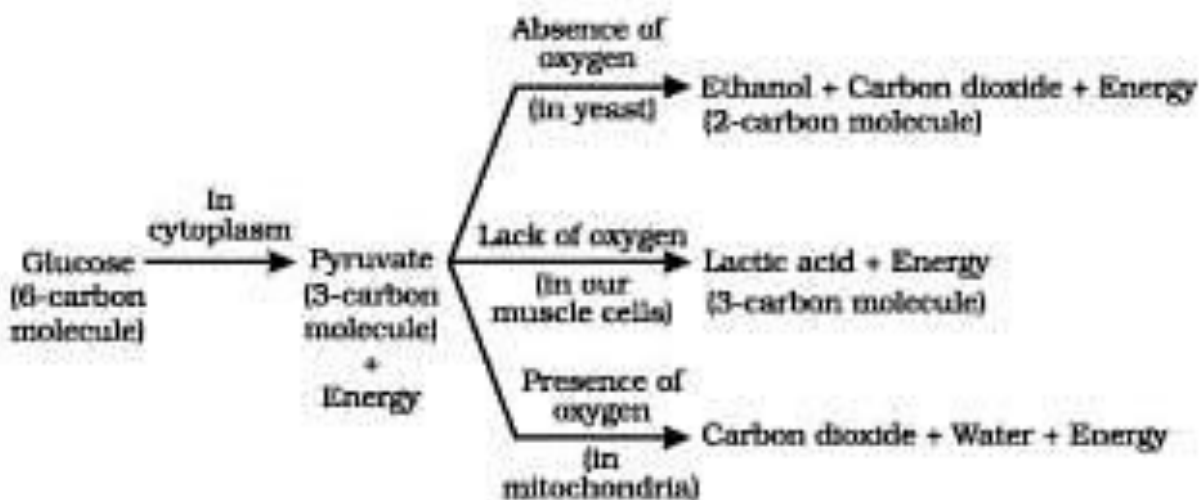
## LESSON - 2 RESPIRATORY SYSTEM

We have discussed nutrition in organisms in the last section. The food material taken in during the process of nutrition is used in cells to provide energy for various life processes. The process in which energy is released from nutrition is known as Respiration.

Generally Oxygen is essential for respiration. But diverse organisms do this process in different ways – some use oxygen to break-down glucose completely into carbon dioxide and water, some use other pathways that do not involve oxygen. In all cases, the first step is the break-down of glucose, a six-carbon molecule with a chemical formula of  $C_6H_{12}O_6$ , into Carbon dioxide ( $CO_2$ ) and water ( $H_2O$ ). Energy is released in this process. Hence respiration is a catabolic process. It takes place in cytoplasm of cell where glucose molecule breakdown into two atoms of pyruvic acid, each containing three-carbon molecules. From pyruvic acid, Carbon dioxide ( $CO_2$ ), water ( $H_2O$ ) and energy is released in presence of Oxygen. Whereas in the absence of Oxygen, other products and energy is formed like Ethanol and Carbon dioxide is formed in yeast during fermentation, and lactic acid is formed in mitochondria of muscles cells.

### TYPES OF RESPIRATION

Respiration that takes place in presence of  $O_2$  is called aerobic respiration and that takes place in the absence of  $O_2$  is known as Anaerobic respiration.



*Break-down of glucose by various pathways.*

## **SPECIALITY OF RESPIRATION –**

- i. In the 1<sup>st</sup> step, of respiration one 6-Carbon glucose molecule changes to two 3-carbon pyruvate molecule (Pyruvic acid). Breaking down of glucose molecule is called Glycolysis, takes place in cytoplasm of the cell.
- ii. In absence of O<sub>2</sub>, 3-carbon pyruvate molecule break in to ethanol/alcohol (2-carbon molecule) and CO<sub>2</sub> gas is produced. Generally, this process takes place in yeast. This is an anaerobic respiration as it takes place in the absence of oxygen. It also known as alcoholic fermentation.
- iii. In the presence of O<sub>2</sub>, CO<sub>2</sub> molecule is formed from one pyruvate molecule along with water, and energy is released. The release of energy is a lot greater than alcoholic fermentation or anaerobic respiration.
- iv. Sometimes in our muscle cells in absence of oxygen, pyruvate molecule breaks to form 3-Carbon molecule lactic acid. This is called as Lactic Acid fermentation. This build-up of lactic acid in our muscles during sudden activity causes cramps.
- i. In aerobic respiration, 38 ATP molecules are formed from one glucose molecule, whereas in anaerobic respiration (both alcoholic fermentation and Lactic acid) two ATP molecules are formed.

The energy released during cellular respiration is immediately used to synthesise a molecule called ATP which is used to fuel all other activities in the cell. In these processes, ATP is broken down giving rise to a fixed amount of energy which can drive the endothermic reactions taking place in the cell.

In aerobic respiration, citric acid and later other various acids are formed from pyruvate in a cyclic manner due to the presence of number of enzymes and co-enzymes in mitochondria of a cell.

Scientist “SIR Hans Krebs” made research in this process and discovered this method. So this **citric acid cycle** is also called as Krebs cycle. He received Nobel prize in 1953. This cycle is also called as citric acid cycle.

### **Aerobic respiration**

1. Oxygen is essential
2. More energy 38 ATP is produced
3. CO<sub>2</sub> and H<sub>2</sub>O is released
4. Complete oxidation of glucose Molecule takes place

### **Anaerobic respiration**

Oxygen is not required  
less energy 2 ATP molecule produce ethanol, alcohol/lactic acid is formed.  
incomplete oxidation of glucose molecule takes place

Concentration of O<sub>2</sub>, CO<sub>2</sub>, amount of food elements, temperature, and presence of enzymes in the cell are the few factors that regulate the respiration process.

### **REPIRATION IN PLANTS –**

Stomata present in leaves of the plants. It functions like door for incoming and outgoing gas and water vapours from the cell. Exchange of CO<sub>2</sub> and O<sub>2</sub> gas takes place through this way. During photosynthesis (takes place in day) plants absorb CO<sub>2</sub> from atmosphere, enters through stomata. But in respiration system, O<sub>2</sub> is used and CO<sub>2</sub> is released, which instead of releasing outside could have been used inside the cell. Plants do not have any particular part or organ to allow oxygen to enter; hence oxygen passes from one cell to another through diffusion. In dorsiventral leaves such as Mango Jackfruit, stomata are present in the upper side (dorsal side) whereas in Isobilateral leaves like Paddy and Wheat, stomata is present on both dorsal and ventral side.

The opening and closing of stomata depends on light and temperature.

### **RESPIRATION IN ANIMALS**

Animals have evolved different organs for the uptake of oxygen from the environment and for getting rid of the carbon dioxide produced. Terrestrial animals can breathe the oxygen in the atmosphere, but animals that live in water need to use the oxygen dissolved in water through diffusion method. Protozoa, Porifera and Hydra variety of animals do not have special organs for respiration. So they absorb dissolved oxygen directly from the water by diffusion process. Earthworm, Frog and Leech respire through skin. The atmospheric oxygen get dissolve in the wet skin of these animals and diffuse.

Frogs respire through oral cavity and Lungs but during hibernation, it respire through skin. Insects like cockroach respire through spiracles. Crabs, Prawns, Snails and mollusks respire through gills. But these gills are different from the gills of the fish. Respiration in animals such as snakes, pigeons, ducks, bats and human etc. is done by lungs. Tortoise, Crocodile, Whale though live in water, they respire through lungs only. Tadpoles (larvae of a frog), fish breathe through gills.

### **BIOLOGICAL OXIDATION.**

Oxygen helps in combustion. We know by combustion heat energy is produced. The type of combustion process take place in human body is called biological oxidation. Various enzymes are required for this process. These enzymes are found in cytoplasm and mitochondria of the cell. These enzymes help in producing energy from food by bio-chemical process. This energy is stored in form of ATP (Adenosine Triphosphate). Hence inside the cell, ATP acts as energy currency and mitochondria functions as powerhouse of the cell.

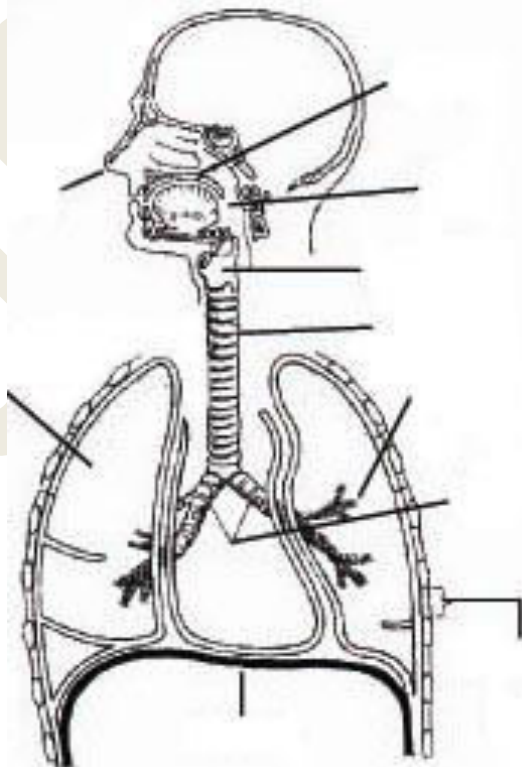
Energy produced in respiration is used for synthesis of ATP molecule. When ADP (adenosine diphosphate) combines with one phosphate molecule (Pi), form ATP molecule. ( $ADP + P_i \xrightarrow{\text{ENERGY}} ATP$ ) ATP molecules take part in different process of chemical process of cells. Endothermic processes in the cell then use this ATP to drive the reactions. When the terminal phosphate linkage in ATP is broken using water, the energy equivalent to 30.5 kJ/mol is released. ATP is used in all the processes such as contraction of muscles, synthesis of proteins and transmission of nerve impulses.

The difference between the respiration of plant and animal is that exchange of  $O_2$  and  $CO_2$  gas takes place through stomata in plants whereas diverse organisms have different organs for respiration.

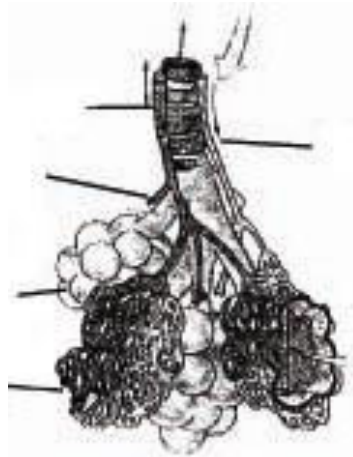
### **HUMAN RESPIRATORY SYSTEM -**

Different parts of the respiratory system of the human body are in chronological order beginning from nostrils, nasal cavity, pharynx, trachea, bronchioles, and ends in lungs.

**NOSTRILS** - Two nostrils present at beginning of the nasal cavity just above the mouth. Nasal chamber starts here. The front part of the two nostrils are made up of cartilage.







**NASAL CAVITY** – the first part of the respiratory tract is the nasal cavity. Air enters into the nasal cavity through external nostrils. The posterior end of the Nasal cavity opens into pharynx. The function of the nasal cavity is to warm, moisturize, and filter air entering the body before it reaches the lungs. Hairs and mucus lining the nasal cavity help to trap dust, mold, pollen and other environmental contaminants (micro organisms) before they can reach the inner portions of the body. Air exiting the body through the nose returns moisture and heat to the nasal cavity before being exhaled into the environment.

**PHARYNX** – The pharynx, also known as the throat, is a muscular funnel/tube that extends from the posterior end of the nasal cavity to the superior end of the [esophagus](#) (food pipe) and trachea. The pharynx is divided into 3 regions: the nasopharynx, oropharynx, and laryngopharynx. The [nasopharynx](#) is the superior region of the pharynx found in the posterior of the nasal cavity. Inhaled air from the nasal cavity passes into the nasopharynx and descends through the oropharynx, located in the posterior of the oral cavity. Air inhaled through the oral cavity enters the pharynx at the [oropharynx](#). The inhaled air then descends into the [laryngopharynx](#), where it is diverted into the opening of the larynx by the epiglottis. The [epiglottis](#) is a flap of elastic cartilage that acts as a switch between the trachea and the esophagus. On the posterior wall of the pharynx, a pair of Tonsils found and is a part of Lymphoid system.

Food channel (alimentary canal) and trachea begins from the posterior end of the pharynx. The opening of trachea is known as glottis whereas the opening of food pipe is known as gullet. The opening of trachea is guarded by a flap of elastic cartilage that acts as a switch between trachea and the food pipe is called as epiglottis. The epiglottis ensures that air passes into the trachea by covering the opening to the esophagus. During the process of swallowing, the epiglottis moves to cover the trachea to ensure that food enters the esophagus and to prevent choking.

**TRACHEA** – at the beginning of trachea, larynx is present. It has fine thread like vocal cord, by the vibration of the vocal cords, sound is produced. After Larynx, trachea divides into two parts and form Bronchi which enters to lobes of lungs of its own side. Later each Bronchus branches and splits into number of fine branches to form bronchioles. Each Bronchiole opens into small room like air cavities called Alveoli.

Each lung is surrounded by a pleural cavity. Pleural cavity is made up of exterior and interior pleural membrane. The inner Pleural membrane lines lungs whereas the outer pleural membrane covers the thoracic walls and diaphragm. The pleural cavity, which is the potential space between the two layers, contains only a thin film of fluid which keeps membrane wet. The pressure of this cavity remains 3-4 mm Hg less than that of lungs. It helps to filling the air inside the alveoli during inspiration.

**LUNGS** – there are two lungs present in the Thoracic Cavity. They are right and left lung. These are soft like sponge. Lungs are covered by plural membrane. Pulmonary artery carries deoxygenated blood (carbo-oxygenated blood) from heart into lungs whereas oxygenated blood from lungs is carried back into the heart through pulmonary vein.

## **RESPIRATION**

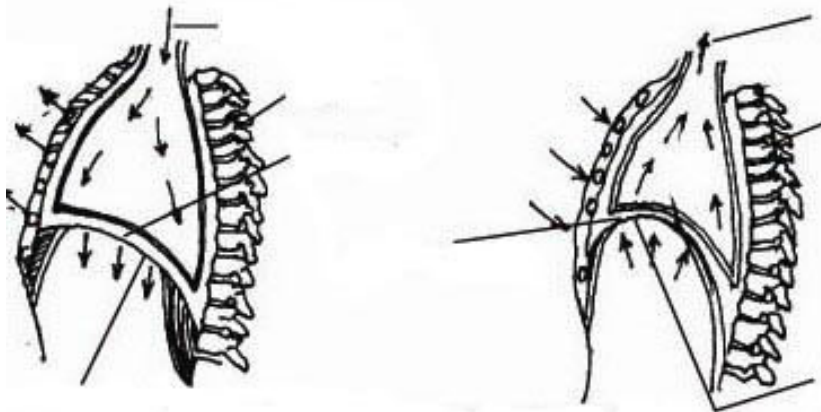
Respiration process takes place in 3 steps

1. VENTILATION
2. EXCHANGE OF GASES
3. TRANSPORTATION OF GAS

### **1. VENTILATION**

Ventilation is a two step process, moving of air into the lungs is called Inspiration and exit of air from lungs is called Expiration. This inspiration and expiration in healthy person is about 15-20 times per min.

Lungs are located in the thoracic cavity. It is an air tight chamber. Its front part is covered by Sternum and back side by vertebral column. Both the sides are covered by rib bones and inter costal muscles and Diaphragm is present at the bottom. Diaphragm is a tomb shaped muscle sector. This diaphragm separates the thoracic cavity from abdominal cavity.



- a. **INSPIRATION** – during respiration, inter-coastal muscles, diaphragm and abdominal muscles takes active part. During inspiration inter-coastal muscles contract and abdominal muscles relax. As a result tomb shaped diaphragm becomes straight or plain and rib bones come forward. During this process the size of the thoracic cavity increased to 20% and the volume of the thoracic cavity increase causing decrease in pressure in lungs in comparison to the atmospheric pressure. So the air enters from the high pressure area of the atmosphere to the low pressure area, the lungs. Hence, in air following the pressure gradient and passively filling the lungs at rest. As the lungs fill with air, the pressure within the lungs rises until it matches the atmospheric pressure. The inspiration is an active process.
- b. **EXPIRATION** – expiration is a relaxing process. During expiration or exhalation diaphragm and inter coastal muscles relax with contraction of abdominal muscles. Rib bones and diaphragm returns back to its normal position. Diaphragm comes back to its original position as a result i.e. a dome shape, as a result the volume of the thorax reduces and increase the pressure within the thoracic cavity creates pressure on lungs. This resulting in the exhalation of air until the pressures inside the lungs and outside of the body become equal. At this point, the elastic nature of the lungs causes them to recoil back to their resting volume, restoring the negative pressure gradient present during inhalation.

## **2. GASEOUS EXCHANGE.**

External respiration is the exchange of gases between the air filling the alveoli and the blood in the capillaries surrounding the walls of the alveoli. Air entering the lungs from the atmosphere has a higher partial pressure of oxygen and a lower partial pressure of carbon dioxide than does the blood in the capillaries. The difference in partial pressures causes the gases to diffuse passively along their pressure gradients from high to low pressure through the simple squamous epithelium lining of the alveoli. The net result of external respiration is the movement of oxygen from the air into the blood and the movement of carbon dioxide from the blood into the air. The oxygen can then be transported to the body's tissues while carbon dioxide is released into the atmosphere during exhalation.

Internal respiration is the exchange of gases between the blood in capillaries and the tissues of the body. Capillary blood has a higher partial pressure of oxygen and a lower partial pressure of carbon dioxide than the tissues through which it passes. The difference in partial pressures leads to the diffusion of gases along their pressure gradients from high to low pressure through the endothelium lining of the capillaries. The net result of internal respiration is the diffusion of oxygen into the tissues and the diffusion of carbon dioxide into the blood.

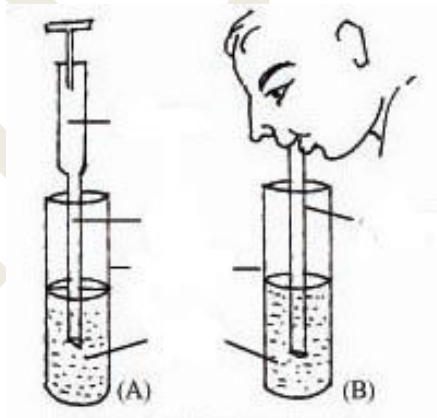
### 3. GAS TRANSPORTATION

The 2 major respiratory gases, oxygen and carbon dioxide, are transported through the body in the blood. Blood plasma has the ability to transport some dissolved oxygen and carbon dioxide, but most of the gases transported in the blood are bonded to transport molecules. Hemoglobin is an important transport molecule found in red blood cells that carries almost 99% of the oxygen in the blood. Hemoglobin when associates with oxygen changes into oxyhemoglobin. Oxyhemoglobin is carried to every tissue of body through blood. In the tissues, oxyhemoglobin dissociates into oxygen and hemoglobin. This oxygen enters into the tissues and carbon dioxides enter into blood. This exchange of gases in tissues also takes place through diffusion process. The carbon dioxide released from tissues carried by blood into the lungs and through diffusion

#### WORK FOR YOU – 1

Take some freshly prepared lime water in a test tube B. Blow air through this lime water. Note how long it takes for the lime water to turn milky. Use a syringe or *pichkari* to pass air through some fresh lime water taken in another test tube A. Note how long it takes for this lime water to turn milky. What does this tell us about the amount of carbon dioxide in the air that we breathe out?

1. Find out whether the time taken to turn lime water milky by test tube B and test tube A is equal or not.
2. Find out whether carbon dioxide present in the air blown into the test tube. Discuss.



#### WORK FOR YOU – 2

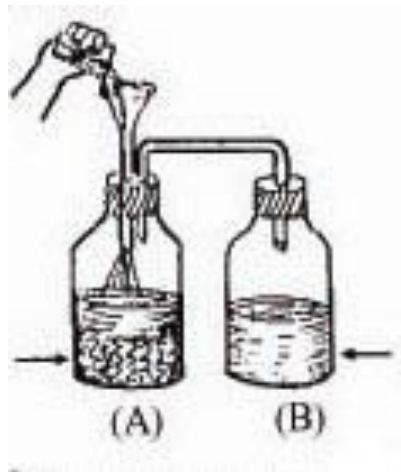
Take some fruit juice or sugar solution and add some yeast to this. Take this mixture in a test tube fitted with a one-holed cork. Fit the cork with a bent glass tube. Dip the free end of the glass tube into a test tube containing freshly prepared lime water. What change is observed in the lime water and how long does it take for this change to occur? What does this tell us about the products of fermentation?

### WORK FOR YOU – 3

Take a bottle and put some sprouted seeds in it. Now close the bottle and keep for one night. Now open it and put a lighted match stick into its neck. What did you observe?

### WORK FOR YOU – 4

Take a bottle containing sprouted seeds and label it as A. Make two holes on the lid of the bottle. Insert a funnel in one hole and take one thin pipe whose one end is inserted in bottle A and the other end into the bottle B which contains freshly prepared lime water. Now slowly pour some water into bottle A through its funnel. Now collect the gas evolved in bottle A in to bottle B. Write what you have observed and explain the same to your class teacher?



### WORK FOR YOU – 5

Observe fish in an aquarium. They open and close their mouths and the gill-slits (or the operculum which covers the gill-slits) behind their eyes also open and close. Observe it for sometimes.

Are the timings of the opening and closing of the mouth and gill-slits coordinated in some manner? Count the number of times the fish opens and closes its mouth in a minute. Compare this to the number of times you breathe in and out in a minute. Hence fish breathe through their gills. The dissolved oxygen of water is carried by the blood.

### WHAT YOU HAVE LEARNT

1. The process in which energy is released from nutrition is known as Respiration.
2. Respiration is a catabolic process.
3. ATP acts as energy currency and mitochondria functions as powerhouse of the cell.
4. Respiration that takes place in presence of  $O_2$  is called aerobic respiration and that takes place in the absence of  $O_2$  is known as anaerobic respiration.

5. Alcoholic fermentation takes place in yeast, bacteria etc.
6. In plants, gaseous exchange takes place through stomata.
7. Oxygen enters into the plant body through diffusion process.
8. Respiration in organisms takes place through gills, skin or lungs.
9. More energy (38 ATP) is released in aerobic respiration.
10. This build-up of lactic acid in our muscles during sudden activity causes cramps.
11. Scientist "SIR Hans Krebs" received Nobel prize in 1953 for his research in Respiratory skills discovery of "Citric acid cycle."
12. The "Citric acid cycle" is also known as Krebs cycle.
13. Concentration of O<sub>2</sub>, CO<sub>2</sub>, amount of food elements, temperature, and presence of enzymes in the cell are the few factors that regulate the respiration process.
14. Nostrils, nasal cavity, pharynx, trachea, bronchioles, and lungs are the important organs of respiratory system besides other organs involved in respiration.
15. The three steps of respiration are ventilation, exchange of gases and transportation of gases.

### **EXERCISE**

#### **ANSWER THE FOLLOWING QUESTIONS**

1. Draw a neat diagram of respiratory system of human and label it.
2. Draw a diagram showing the breakdown of glucose by various pathways in different types of respiration.
3. Write how ventilation and gas transportation takes place.
4. Write in short
  - a. How respiration occurs in fish and frog?
  - b. Define Plant's respiration process.
  - c. Write factors that regulate respiration.
  - d. What is biological oxidation?
5. Fill in the blanks using first relation.
  - a. Food pipe : gullet : : nasal cavity : \_\_\_\_\_
  - b. Yeast : alcoholic fermentation : : muscles : \_\_\_\_\_
  - c. Fish : gills : : snake : \_\_\_\_\_
  - d. Larynx : sound control : : epiglottis : \_\_\_\_\_
  - e. Power house : Mitochondria : : energy currency : \_\_\_\_\_
6. Fill in the blanks by choosing best option given below
  - a. Formula of Glucose \_\_\_\_\_. (C<sub>6</sub>H<sub>24</sub>O<sub>12</sub>, C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>, CHO, C<sub>6</sub>H<sub>8</sub>O<sub>6</sub>)
  - b. Glucose breaks down in to two molecules of \_\_\_\_\_ carbon molecule pyruvic acid. (5, 4, 3, 2)
  - c. \_\_\_\_\_ is the powerhouse of the cell. (ribosomes, mitochondria)
  - d. Gaseous exchange takes place through \_\_\_\_\_ of the leaves.  
(stomata, chlorophyll, vein, mitochondria)
  - e. \_\_\_\_\_ respire through skin during hibernation.  
(frog, whale, fish, snake)
  - f. \_\_\_\_\_ fermentation takes place in yeast.  
(fats, alcoholic, minerals, vitamins)
  - g. Vibration of vocal cords produces \_\_\_\_\_. (energy, sound, blood, acid)
  - h. The inspiration and expiration in healthy person is about \_\_\_\_\_ times per minute. ( 15 to 20, 21 to 40, 41 to 50, 90 to 120)

## **LESSON - 3**

### **TRANSPORTATION AND CIRCULATION**

All living organisms require oxygen beside food, multi-cellular organisms acquire food, water and oxygen by different organs of the body. Green plants absorb water, various nutrients, oxygen and CO<sub>2</sub> from the environment. The collected substances are transported from one part of the body to other by transportation and circulatory system. So that each cell of the body can get required food, water and oxygen thereby become capable of performing various life processes.

#### **TRANSPORTATION IN PLANTS –**

Water and water soluble nutrients are absorbed by the root and transported to stem leaves flowers etc. Root has root hairs. The ionic concentration of all the cells of the root hair in contact with the soil and the ionic concentration of the soil are different. To maintain equality in ionic concentration of soil and root hair, ions from the soil enter to the root hair by active absorption. Along with the ions, water also enters into the cells. Later this absorbed water is carried to the different parts of the plant by water **conducting tissue xylem** through diffusion process. Xylem tissue looks like fine tubule or pipe. Xylem extends starting from the roots of the plant to the tip. Water has soluble nutrients. Water is transported to the different parts of the plant body through xylem.

Leaves are called the kitchen of plants. Leaves produce carbohydrate, by the process called photosynthesis in presence of chlorophyll of chloroplast is soluble in water. This dissolved carbohydrates are carried to the different part of the plant body by a food conducting tissue (vascular tissue) called phloem tissue through a mechanism called translocation. The transportation of food, water and minerals to various parts of plant is known as transport of nutrients.

#### **Types of transportation and different theories –**

According to the requirement of plants, there are 3 types of theories, they are as follows – Upward transportation, Downward transportation and lateral transportation. In upward transportation water and nutrients transported from bottom parts of the plants to upward. In downward/lateral transportation food produced in the leaves is transported to the different parts of the body.

Now the question is how water is transported up to the tip of the plant in tall trees such as Sal, coconut, and palm etc.? the answer is based on three theories, like Capillary attraction, Root Pressure and Cohesion theory

- a. **Capillary Attraction** – if a capillary tube is dipped into the water, water rises in the capillary tube due to the capillary attraction pressure of tube and surface tension of water. However the rise of water depends on the

diameter of the tube Smaller the diameter of the tube greater the height of water.

Xylem is just like a capillary tube and water rises upward due to capillary attraction. In a xylem tube, having diameter of 1/100mm, water rises up to 3m high due to capillary attraction. The diameter of few xylem tissues is 0.001mm and water rises up to 10m only not more.

Capillary attraction is possible in small trees of less height but this theory is not sufficient to explain water transportation in tall trees.

- b. **Root Pressure** – if the stem of a plant is cut half way, it is observed that liquid substances come out of the plant. It happens due to root pressure. If a Manometer is fitted in that cut portion then pressure created from the root/the root pressure can be measured. If root pressure is essential for upward movement of water, then root pressure should be more in tall trees but it is not so. Besides, when transpiration is more, water transportation also becomes more. At the same time the root pressure seems to be less. From all these point, we can say that the root pressure does not play an important role in water transportation.
- c. **Cohesion theory** – Absorption of water occurs mainly by transpiration process. Due to transpiration, lot of water loss takes place from leaves and other aerial parts of the plant. Due to water loss, diffusion pressure on the leaf surface is reduced. So water moves from veins and vein-lets to leaf surface. As a result, diffusion pressure in veins and vein-lets also reduces. In order to maintain the water level, water from xylem vessels of the stem move to leaf surface, veins and veinlets of the leaf.

To make the flow of water inside the xylem vessels constant, water is absorbed from the root and move up to the stem. Hence, the conduction/flow of water takes place from root to the leaf is due to the transpiration pull of the leaf surface. This flow of water is known as transpiration stream.

This water flow does not discontinue so easily due to the following reasons.

1. The cohesive force between water molecules of the xylem vessels is quite high.
2. The adhesive force between water molecules and xylem walls, where water molecules always adhere to the xylem walls. Once adhered cannot be separated easily.

Not a single theory mentioned above is sufficient to describe the transportation process in plants. Hence we can conclude that the capillary attraction, root



pressure, cohesive and adhesive forces together help the plant to conduction of water and nutrients.

### **EXPERIMENT TO DEMONSTRATE WATER TRANSPORTATION IN PLANTS –**

Apparatus required – Conical flask, red ink or saffron colour, water, Balsam tree.

**Experiment** – Fill half of the conical flask with water and add three drops of red ink in the water. See that the colour of the water changes to red. Uproot a Balsam plant carefully from the soil along with the root and now wash the root and put the plant straight in the conical flask. Make arrangement such that the plant remain straight inside the flask and root should be dipped inside the red water. Observe this after one hour.

**Observation** – the stem, veins and veinules of the leaf of Balsam plant look red.

**Inference** – the red coloured water of the conical flask is absorbed by the root and transported through stem and veins and veinlets of the leaf. From this, it is proved that water transportation occurs in plants.

### **TRANSPIRATION**

The loss of water in the form of vapour from the aerial parts of the plant is known as transpiration. More or less transpiration process continuously takes place in plants.

Due to transpiration pull, the water and minerals from the soil enters into the root and transported to the tip of the plant, it controls the temperature in plants. Stomata, Cuticle and Lenticel of the plant take active part in transpiration. About 90% of the water vapour of atmosphere is released by plants through stomata. Increase in rate of transpiration increases the rate of absorption.

### **TRANSPORTATION SYSTEM IN HUMAN BODY.**

By digestion process, we assimilate food and water. We collect oxygen by respiration. Our body has special organs to carry out these activities. Lungs collect oxygen, digested food is absorbed in small intestine. Collected oxygen, assimilated food and water, hormones secreted by endocrine glands and waste products like urea and other substances are transported from one part of the body to other by the transportation system. (We have already discussed about blood in Tissue System chapter of Class IX, Biology (pg 42-43))

### **BLOOD CIRCULATION**

In our body, circulation of blood takes place by tube like structure called blood vessels. They are one way transportation system of the body. It is calculated that about 96,000 to 1,60,000 km long tube is spread throughout our body. Blood vessels are of three types such as Arteries, Veins and Capillaries. Heart acts like a pump which works continuously without any stop for circulation of

blood in to the arteries and veins. The contraction of heart exerts pressure, as a result blood flows through arteries and capillaries and reach in every cell of the body. Cells absorb oxygen, nutrients and other substances from blood as per need. Oxygen and food after being used by the cell, CO<sub>2</sub> and different waste products come out of the cell which is collected by venous capillaries and later on veinules and at last goes to veins. The blood goes to the heart by contraction and expansion of muscles of the veins. Besides, a special type valve present in the vein which restricts blood from returning back into the vein. Blood circulation in the human body was first discovered by a British Doctor William Harbey (1578-1657). In any human body, blood flows in one direction. The oxygenated blood from the heart to various parts of the body through arteries and deoxygenated blood returns back into the heart through another direction through veins, this flow of blood inside the blood vessels is known as closed blood circulation.

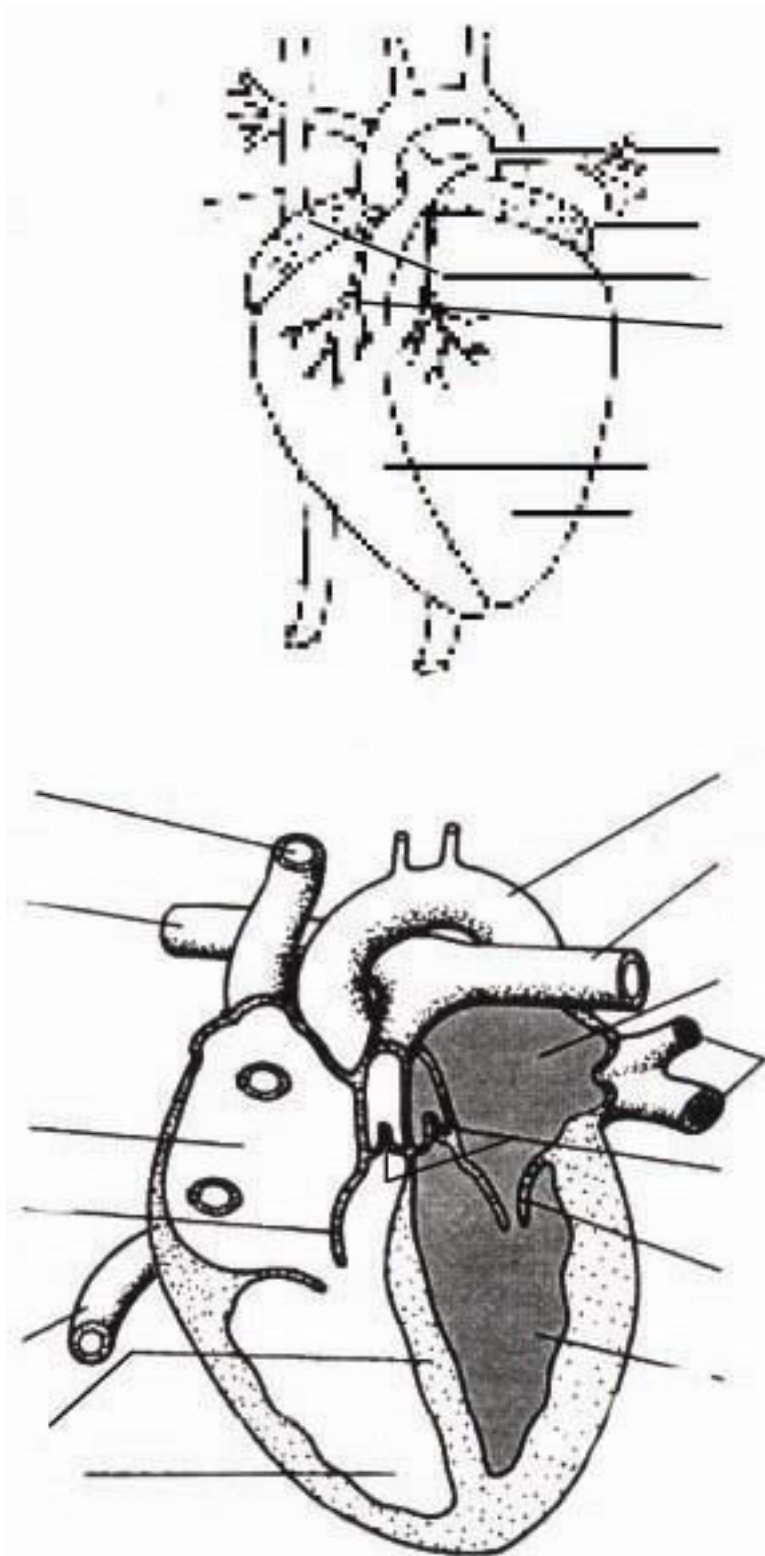
## **HEART**

Heart is located in the middle of the thoracic cavity in between two lungs just above the diaphragm, a little towards the left. In adult humans, the length of the heart is about 15cm and the breadth is about 10cm. It weighs 132 to 140 gms. It is brownish red in colour. Heart has four chambers. Upper two chambers are known atria or auricles (left atrium and right atrium, plural-atria) and lower two chambers are called ventricles (left and right ventricle). The right atrium receives deoxygenated blood from two large blood vessels, superior vena cava and inferior vena cava and pulmonary artery arises from right ventricle carries deoxygenated blood to lungs for oxygenation. The left atrium receives oxygenated blood from Pulmonary vein and Aorta arises from left ventricle carries oxygenated blood to supply it to all parts of the body.

Two or three thin leaf-like flaps acts like doors present between the auricle and ventricular aperture and ventricle and blood vessels, are known as cusps. The valve in between right atrium and right ventricle (right atrio-ventricular valve) is tricuspid valve whereas bicuspid valve is present in between left atrium and left ventricle (left atrio-ventricular valve). Three pocket shaped semilunar valves present between the ventricles and blood vessels. The cusps between the auricles and ventricles open towards ventricles whereas the valves between ventricles and blood vessels open towards blood vessels. Hence blood flows in one direction only. Back flow of blood or return of blood does not take place once the valves or cusps are closed. Out of four chambers of the heart, left ventricle is most active and has thick muscular walls because on contraction of it, the oxygenated blood goes to different parts of the body through Aorta. The deoxygenated blood goes to lungs through pulmonary artery for oxygenation when the right ventricle contracts.

Cardiac muscles are different from other muscles of the body. From the birth till death these muscles expand and contract continuously which is popularly known as heart beat. The rate of heart beat in a healthy person is 72 times per

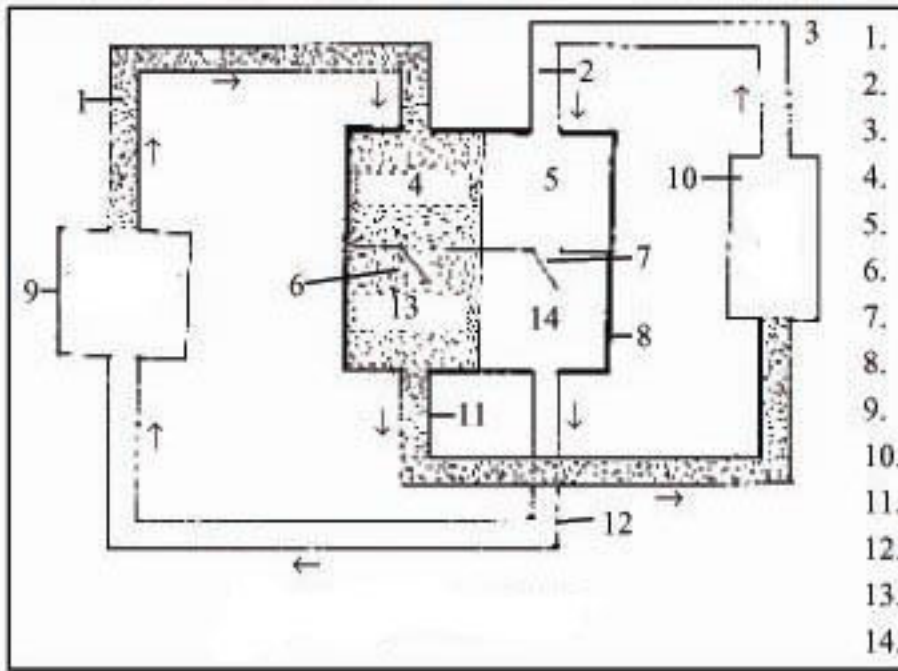
minute. Blood is supplied to the muscles of the heart by coronary artery and coronary veins.



As humans, other mammals and birds have 4 chambered heart, therefore the oxygenated and deoxygenated (carboxygenated) blood never mix. Oxygenated

blood flows through left atrium and ventricle and deoxygenated blood through right atrium and ventricle. Blood flows twice in the heart (1.the short pulmonary (lung) circulation and 2.the long systemic (general body)) before it completes one full round or it reaches any part of the body. For this reason the blood circulation in human body is also called “double circulation”.

Diagram –



**BLOOD CIRCULATION IN FISH**

Fish has two chambered heart i.e. one auricle and one ventricle only. The deoxygenated blood from different parts of the body poured into the heart and carried to the gills for purification. Blood mixes with dissolved oxygen of water and supplied to the different parts of the body. As blood passed through heart only once, hence blood circulation in fish is known as single circulation.

Frog and other amphibians have three chambered heart, two atria (auricles) and one ventricle. Right auricle receives impure blood (deoxygenated blood) and left auricle receives oxygenate or pure blood. When both auricles or atria contract, pure and impure blood pour into ventricle where they get mixed. This mixed blood carried by artery to the different parts of the body. The rate of metabolism in both frog and other amphibians is slow, hence they need less energy. So the requirement of oxygen is also less for these amphibians.

**BLOOD PRESSURE**

Blood flows in arteries due to contraction and expansion of the heart. When heart contracts, the blood flows in to the arteries. As a result blood exerts pressure on the wall of arteries. During expansion or resting stage, some blood

remains in arteries and the blood exerts less pressure on the walls of arteries. The force that blood exerts against the wall of a vessel is called blood pressure. This pressure is much greater in arteries than in veins. The pressure of blood inside the artery during ventricular systole (contraction) is called systolic pressure and pressure in artery during ventricular diastole (relaxation) is called diastolic pressure. The normal systolic pressure of a healthy human is about 120 mm of Hg and diastolic pressure is 80 mm of Hg. Blood pressure is measured by Sphygmomanometer. Blood pressure increases if the pressure on arteries increases. This increase in pressure is known as Hypertension. Sometimes Arteries rupture due to high blood pressure.

$$\text{Blood Pressure} = \frac{\text{SYSTOLIC PRESSURE}}{\text{DIASTOLIC PRESSURE}} = \frac{120}{80} \text{ mm Hg}$$

## **BLOOD CLOTTING**

### **How does blood clotting takes place?**

Among various functions of blood, blood clotting one of the important functions. If an injury or cut occurs in any part of the body, blood escapes from it. After sometimes blood clots and flow of blood stops. The different proteins present in blood plasma helps to clotting of blood. Blood clotting is also known as coagulation.

The injured tissue cells and the disintegrated platelets at the site of the wound come in contact with the air and formation of a lipoprotein called thromboplastin takes place on wound. The thromboplastin acts as an enzyme and with the help of calcium ion  $\text{Ca}^{++}$  present in the plasma, it converts a substance prothrombin (inactive) of the plasma, into thrombin (active). Thrombin in the presence of calcium ions, reacts with the soluble fibrinogen of the plasma to convert it into insoluble fibrin. Fibrin is a solid substance that forms threads. These microscopic threads of fibrin are sticky and form a network (mesh) at the wound. Blood cells are trapped in the network of the fibrin; the network then shrinks and squeezes out the rest of the plasma which is in the form of a clear liquid, the serum. The solid mass of which is left behind is called a clot (or thrombus).

### **Blood clotting in Brief-**

In presence of Thromboplastin released from the injured tissue cells and the disintegrated platelets at the site of the wound, the following steps takes place

- a. Prothrombin  $\xrightarrow{\text{calcium}}$  Thrombin
- b. Fibrinogen  $\xrightarrow{\text{Thrombin}}$  Fibrin
- c. Fibrin net and blood cell and platelets -----> thin network/mesh formed and flow of blood stops.

Normally blood clot does not take place in veins and arteries because thromboplastin is not released unless there is any injury or cut. Heparin, a

kind of protein present in the blood does not allow blood to clot. Like Heparin, Hirudin present in saliva of leech also does not allow blood to clot. Similarly salts like Sodium Oxalate and Potassium Oxalate does not allow blood clotting.

### **BLOOD GROUP -**

Each individual has a particular blood group. This concept of blood grouping was discovered for the 1<sup>st</sup> time by Karl Landsteiner (1868-1943) and for this he received Nobel Prize in the year 1930.

He showed that a special protein is present in the external surface of RBC. The protein present on the surface of RBC is called antigen which are of two types A and B. Similarly two complementary proteins called antibody present in plasma. The specialty of antigen and antibody is that a particular antibody can recognize the antigen specially meant for it.

### **ABO blood group system**

Considering the presence of antigen on the surface of RBC and antibody in plasma in human, four blood groups are identified and they are A, B, AB, & O.

### **BLOOD GROUP**

<b>Sl no</b>	<b>Group</b>	<b>Antigen Protein in RBC</b>	<b>Antibody Protein in plasma</b>	<b>Can donate blood to Which blood group</b>
1.	A	A	b(Anti B)	A & AB
2.	B	B	a(Anti A)	B & AB
3.	AB	Both A & B	Absent	Universal acceptor or recipient can receive blood from all the blood groups but can donate only AB.
4.	O	Absent	Both a(Anti A) & b(Anti B)	Universal donor can donate blood to all groups but receive only from 'O' blood group.

Antigen - A & B ; Antibody - a & b

## WHAT YOU HAVE LEARNT

1. Absorbed food, water and other substance in an organism is carried from one place of the body to other is known as transportation or circulation.
2. Water is carried to different parts of the plant through conducting tissue, xylem vessels by diffusion process.
3. The dissolved carbohydrates are carried to different parts of the plant body by a food conducting tissue (vascular tissue) known as phloem.
4. Capillary attraction, root pressure, cohesive and adhesive forces together help the plants to conduct water and nutrients.
5. The loss of water in the form of vapour from the aerial parts of the plant is known as transpiration.
6. Blood is the circulating fluid in human body.
7. When blood escapes from an injury or cut, the different proteins present in blood plasma helps to clotting of blood. Blood clotting is also known as coagulation.
8. According to ABO system, the human blood is classified into four types – A, B, AB and O.
9. Arteries carry oxygenated blood to different parts of the body from heart whereas veins collect deoxygenated or impure blood from various parts of the body and pour into heart.
10. For circulation of blood, heart acts like a pump, functions continuously.
11. Heart of a human body is four chambered.
12. In humans, the oxygenated blood and the deoxygenated blood never mix.
13. Blood circulation of humans is known as double circulation.

## EXERCISE

- 1) Describe the internal structure of human heart.
- 2) What is a blood vessel? Differentiate between artery and vein.
- 3) How is blood clots, explain?
- 4) Describe the location and external structure of human heart.
- 5) Enumerate the role of capillary attraction, root pressure, and cohesive and adhesive forces in conduction of water in plants.
- 6) Describe an experiment showing the conduction or transportation water in plants.
- 7) Draw a neat diagram of internal structure of human heart and label it.
- 8) Define the following
  - i) Double circulation
  - ii) Cohesive force
  - iii) Vein and artery
  - iv) Blood group
  - v) Capillary attraction
- 9) Short answer type
  - a) How is water conducted in plants due to capillary attraction?
  - b) How is blood group decided in humans?
  - c) Describe the position/location of ventricles and valves (cusps) of human heart.
  - d) Which factors help the conduction/transportation of water from root to tip of the plant?
  - e) What role does root pressure play in transportation of water in plants?
- 10) Fill in the blanks
  - a) \_\_\_\_\_ tissues help in conduction of carbohydrates stored in leaves.
  - b) A person who can donate blood to every one called \_\_\_\_\_
  - c) The valves present between left auricle and left ventricle is \_\_\_\_\_
  - d) \_\_\_\_\_ tissue conducts water to different parts of the plant body.
  - e) Transpiration pull controls the \_\_\_\_\_ of the plants.

## LESSON 4

### Excretion

Biochemical processes occur continuously inside different cells of the body. Proper food and enzymes are required for all these processes which we get from the food and oxygen we take. (You have already read about Food and Nutrition chapter). The unwanted waste products released by our body after different metabolic activities are harmful for our body. So a special system present inside the body to drain out these waste products and keep the internal environment of our body clean and unpolluted. As a result, maintains the balance of different biochemical activities taking place in the cell, and our body remains healthy. The biological process involved in the removal of these harmful metabolic wastes from the body is called excretion. By excretory system waste materials such as ammonia, urea, uric acid and other nitrogenous wastes etc are discarded and keep balance of water and mineral contents of the body.

In the body, ammonia is released by the metabolism of proteins. Ammonia is a gaseous substance which is water soluble. Soluble ammonia is harmful for the body. Aquatic animals remove ammonia produced in their body directly to the surrounding water by diffusion method. But this facility is not found in terrestrial animals. So they expel ammonia produced in their body by converting it into urea and uric acid. Man and other mammals, amphibians like frogs, and fish like sharks etc release urea from their body whereas birds, reptiles and insects release uric acid from their body.

#### **Excretion in Animals:**

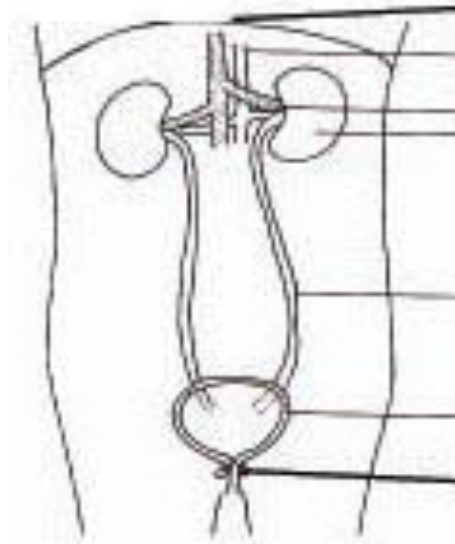
In the liver of vertebrates, ammonia combines chemically with  $\text{CO}_2$  to form urea ( $\text{NH}_2\text{-CO-NH}_2$ ). Urea is soluble in water, so it mixes with the blood and carried to kidney. In the kidney, urea is separated from blood and dissolved in water, which is released from the body as urine.

In insects and reptiles, form uric acid from ammonia. Uric acid is mostly insoluble in water. So after urine is formed, uric acid is separated easily from the solution. Water present in the solution goes back to the blood by reabsorption. So organisms like insects, birds and reptiles etc do not lose excess water in excretion process. Uric acid is released along with stool.

Different animals show difference in structure, kind and functioning of excretory organs. Unicellular organisms like Amoeba remove their waste by plasma network or extending the contractile vacuole. Lower animals like sponge and hydra do not have any excretory organ. In flat worms, **flame cells** are the excretory organs. Nephridia are the excretory organs in earthworm and leech. Insects such as grasshopper excrete by **malpighian tubule**. Vertebrates have specialised excretory organs to perform the function; among these organs kidney and skin are important.



## Excretory system in Man:

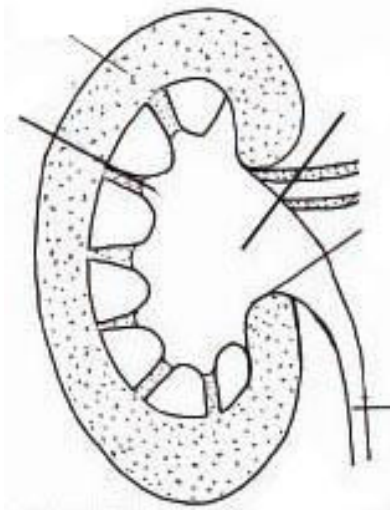


Excretory system of man consists of organ like kidney, ureter and urinary bladder etc.

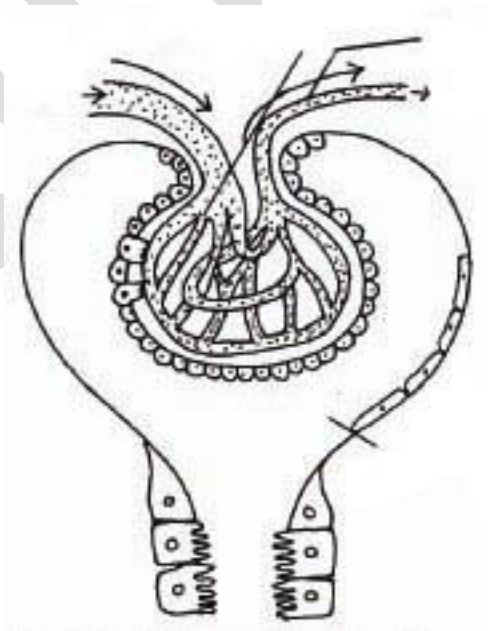
**Kidney:** Two kidneys are present in human body inside the abdominal cavity just below the diaphragm on either side of the vertebral column. Kidneys are bean shaped. In a healthy person length of kidney is about 10 to 12 cm breadth 5 to 7 cm and thickness about 3cm. The depressed part the kidney is called hilum. Renal vein and renal artery enters in to the kidneys at hilum whereas a tube, ureter, arises from the hilum and connect behind the urinary bladder in the lower part of the abdomen. The urine produced in the kidneys constantly flows through the ureters and collects in urinary bladder. The urine is intermittently emptied from the urinary bladder to the outside of the body through the urethra. The openings of the ureters are somewhat projecting and act like valves to prevent the backflow of urine when the bladder contracts to pass out the urine. A sphincter (circular muscles) guards the opening of the bladder into the urethra and relaxes only at the time of urination under an impulse from the brain.

**Structure of kidney:** Inside each kidney there are more than 10 lakhs of very fine tubules like structures known as Renal tubule or uriniferous tubule or Nephrons. These are the structural and functional units of kidney. One end of each renal tubule is cup shaped. This cup shaped end face towards outside of kidney. This cup is called as Bowman's capsules named after William Bowman (1816-1892). A pair of renal arteries branch off from the dorsal aorta to enter the respective kidneys. Each renal artery branches and rebranches several times to give rise to arterioles; each such arteriole enters a Bowman's capsule under the name of **afferent arteriole** (afferent: to bring to). This afferent arteriole breaks into a number of capillaries which form a knot-like mass closely fitting inside the Bowman's Capsule. These capillaries reunite to form

**efferent arteriole** (efferent : to carry away). The bunch of capillaries formed in Bowman's capsule from afferent and efferent arterioles is known as **glomerulus**. Blood enters to glomerulus through afferent arteriole and goes out through efferent arteriole. This system is very useful for filtration of blood.



Both, Bowman's capsule and glomerulus together form Malpighian body or Renal corpuscle-named after Marcelo Malpighii (1628-1694). The proximal part of renal tubule after Bowman's capsule remains coiled inside the kidney and the distal part (end part) enters into the collecting duct. The collecting duct receives the contents of many kidney tubules and pours it as urine in the pelvis of the ureter. One ureter emerge from each kidney and opens into the urinary bladder located in the lower abdomen. Urine is collected in urinary bladder and released out through urethra during urination.



### **Function of Glomerulus :-**

Blood filtration occurs inside the glomerulus. Through the fine pores inside the glomerulus corpuscles of the blood and protein, and some other large molecules cannot be filtered. So besides these mostly all other components of blood are filtered through glomerulus and come into the nephron. The components those enter into the nephron are water, glucose, amino acid, urea, uric acid, creatinine, sodium, potassium and chloride etc.

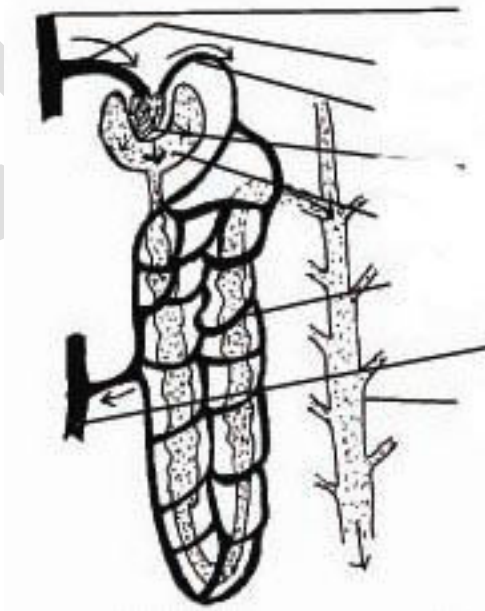
Glucose and amino acids are very much useful for our body, so instead of released out these are again reabsorbed into the capillaries surrounding the nephron. These blood capillaries join together to form renal vein.

Substances released out through urine mainly water, uria, some amount of uric acid, different mineral salts such as sodium chloride and potassium chloride etc. Due to the presence of a colouring pigment **urochrome**, the urine of a healthy person looks yellow.

Urine of healthy person does not contain glucose, protein or any blood cells. If any of these are found in the urine or change in colour of the urine is observed, that indicates person is suffering from some disease.

### **Other function of kidney**

Other functions of kidney are - it controls water and mineral contents of the body. It keeps balance of the substance which control acidic and basic ratio of blood. It controls blood pressure of our body. Kidney secretes hormone named **erythropoietin** which helps in the formation of RBC. Besides these, kidneys play an important role in maintaining the homeostatic condition (steady state) of the body (maintaining the balance of internal body environment) through processes such as filtration, reabsorption, secretion and excretion.



### **Other Excretory organs of the body:**

Some of the waste products are released from the body through the skin as sweat. Formation of sweat is main function of the skin; sweat glands present in the skin helps in formation of sweat. Mineral salts and some urea is absorbed from the blood and released out of the body as sweat. Evaporation of sweat keeps the body cool. Liver, part of digestive system helps to release some waste products. Metabolic waste products such as remains of medicines that we take, excess vitamins, pigments formed by disintegrated RBC etc. enter in to digestive canal along with bile juice and later discarded from the body with faeces. Besides this during expiration, CO<sub>2</sub> and water vapour produced in the body is expelled from the lungs.

### **Excretion in Plants:**

Plants do not have special respiratory organs like animals. Byproducts produced by different metabolic activities are stored in some special parts of the plant body. Tanin, resin, gums, latex are few examples of plant excretion. Tartaric acid present in tamarind, citric acid in lemon, quinine of chinchona plant and alkaloid named nikotene present in tobacco leaves are some other examples. These products are useful to us. They cause no harm to plant body, hence there is no necessary to have special excretory organ in plants. Stomata in plants not only perform respiration also works like an excretory organ. Plants adopt different methods to remain free from waste products. Excess water from the plant body is released out by transpiration process. In many plants waste products are collected in the vacuoles inside the cell. In some plants waste is collected in leaves and later on it dries falls. Waste products like resin and tanin is stored in the old xylem tissues.

### **WHAT YOU HAVE LEARNT**

1. The biological process involved in the removal of these harmful metabolic wastes from the body is called excretion.
2. In the liver of vertebrates, ammonia combines chemically with CO<sub>2</sub> to form urea (NH<sub>2</sub>-CO-NH<sub>2</sub>).
3. Organisms like birds, reptiles and insects form uric acid from ammonia.
4. Unicellular organisms like Amoeba remove their waste by plasma network or extending the contractile vacuole. Lower animals like sponge and hydra do not have any excretory organ. In flat worms, flame cells are the excretory organs. Nephridia are the excretory organs in earthworm and leech. Insects such as grasshopper excrete by malpighian tubule.
5. Kidney is the main excretory organ of human body.
6. More than ten lakh nephrons present in each kidney.
7. A cup shaped Bowman's capsule is present at one end of the nephron and other end enters into the collecting duct.
8. Gomerulus is found in every Bowman's capsule.
9. Filtration of blood takes place in Glomerulus.
10. Water, uria, some amount of uric acid, creatinine, different mineral salts such as sodium chloride and potassium chloride etc. present in urine.
11. Besides kidney, liver and skin also helps in excretion of waste products.

## EXERCISE

1. What is excretion? Write structure and location of kidney?
2. Write about the structure and function of the kidney?
3. Explain excretion process in plants.
4. Write the various waste products released from our body after metabolic processes take place. In what form these wastes are changed and discarded by vertebrates?
5. Draw a neat diagram of excretory system of humans and label it.
6. Draw and label the longitudinal section of a kidney.
7. Draw and explain the structure of Glomerulus.
8. Short answer type
  - a. How kidney maintains the internal environment of the body?
  - b. What is excretory system?
  - c. Where is urea formed in vertebrates? Write the important organs of excretory system?
  - d. Why urine is yellow in colour? What factors of urine tell you that a person is suffering disease?
9. Fill in the blanks
  - a. Birds and reptiles expel their waste after converting ammonia into \_\_\_\_\_.
  - b. \_\_\_\_\_ are the thin thread like tubules found in kidney.
  - c. \_\_\_\_\_ is the excretory organ of flat worms.
  - d. Malpighian tubules is the excretory organ found in \_\_\_\_\_
  - e. In humans, \_\_\_\_\_ organ helps in converting ammonia into urea.
  - f. Kidney secretes \_\_\_\_\_ hormone, which helps in the formation of RBC.
  - g. Water animals expel ammonia formed in their body by \_\_\_\_\_ process.
  - h. Nikotene present in tobacco leaves is \_\_\_\_\_
  - i. \_\_\_\_\_ acid is present tamarind.
  - j. Wastes like raisin and \_\_\_\_\_ stored in old xylem tissues.

## **LESSON 5**

### **CONTROL AND CO-ORDINATION**

Growth and development of an organism and all the organic processes occur in controlled and coordinated manner. Besides this, each organism show internal and external response according to the stimulus of the environment for its existence. For this control and co-ordination among different process, action and reaction is essential. In plants, it takes place by chemical methods. But control and co-ordination in animals takes place both by chemical and neurological method.

#### **CONTROL AND CO-ORDINATION IN PLANTS –**

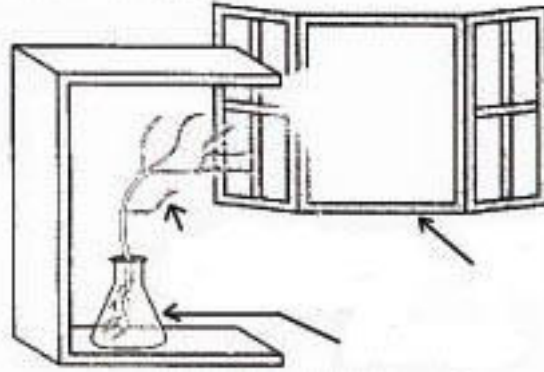
In plants, Control and co-ordination of various organic processes is done by chemical methods by hormones.

**Plant Hormones :** Hormones are organic substances and perform various functions in low concentration and volume. The place of their formation and function differs. Hormones have capability of controlling different functions. Even type of hormone control many functions. Example Auxin controls different functions such as growth of the cell, growth of the stem, formation of fruits and flowering etc. Hormones present in plants are called as **phytohormones**. Phytohormones are mainly of five type such as Auxin, Gibberlin, Cytokinin, Ethylene and Absicissic acid.

**CONTROL BY PHYTOHORMONES –** External stimuli such as light, gravitational force, water etc create reaction in tips of stem, leaves and roots. As a result hormone is secreted from that place. This hormone controls growth and development of plant body, such as growth of stem, leaf, root and flowering process. It also controls phototropism, geotropism, Nastic movement, stomatal movement and ripening of fruits. Besides this we know that plant's flowering process depends upon the duration of light, is called **photoperiodism**. It is found from the research that when plants get required duration of photoperiod, a hormone called Florigen which induces flowing process is manufactured in leaves. This hormone is transported to the tip of the plant where it helps in flowering process. Along with hormones, a special pigment called **phytochrome** is present in plants. Both Florigen and Phytochrome controls flowering process in plants.

**EXPERIMENT – 1 :** *Fill a conical flask with water. Cover the neck of the flask with a wire mesh. Keep two or three freshly germinated bean seeds on the wire mesh. Take a cardboard box which is open from one side. Keep the flask in the box in such a manner that the open side of the box faces light coming from a window. After two or three days, you will notice that the shoots bend towards light and roots away from light. Now turn the flask so that the shoots are away from light and the roots towards light. Leave it undisturbed in this condition for a few days. Have the old parts of the shoot and root changed direction? Are there differences in the direction of the new growth? What can we conclude from this activity?*

When the exposed part of the germinated seed receives light, auxin is synthesized at the tip. This auxin flows in the opposite direction while the light comes in a specific direction. With the increase in auxin, the number of cells also increases. As a result the side that remains towards darkness grows more than the side towards light and becomes longer. Hence the plant gradually bends towards the light.



**FUNCTION OF PHYTOHORMONE** : Phytohormones has two functions besides control of different organic processes of the plant body and co-ordinate them. The two functions are such as control of growth and control of movement.

#### **CONTROL OF GROWTH –**

Among the phytohormones, Auxins, Gibberellins and Cytokinins etc control growth of the plant. Gibberellins, like Auxin help in growth of the branches and stems whereas cytokinins help in increasing the rate of cell division. Generally cytokinins are found the regions where rapid cell division occurs. Growth controlling hormones present more in tips of stems and roots and in tender fruits and flowers, and the functioning capability of these hormones depends on its quantity. The rapid growth and division of cells occurs comparatively more in the tips of roots and stem, as cell growing hormones found more in these regions. As we move down from top to bottom of the plant the quantity of the hormones decreases as a result growth also reduces.

An indicator is essential to differentiate between the growth promoter or growth inhibitor hormones. The above mentioned phytohormones help in growth of the plants but some hormones inhibit the growth of the plants, are known as growth retardants. These hormones generally reduce the growth of plants. **Abscissic acid and Ethylene** is growth retardants. It helps in the falling of flowers, fruits, leaves and also accelerates senescence (aging). The amount of growth retardant hormones increase before the ripening of fruits, flowers and falling of leaves takes place.

The function of all the hormones mentioned above is properly controlled and co-ordinated. As a result proper growth of the plant is possible.

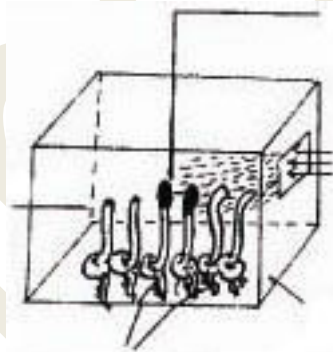
**CONTROL OF MOVEMENT** – Hormones affected by the external stimuli, control the movement of the plants. These external factors are light and gravitational force. Various types of movements are seen due to these external stimuli or factors. It is known as tropism or tropic movement. Phototropism and Geotropism is an example of this movement.

**Phototropism** – Phototropism is the special feature in plants. The stem of the plant moves towards the light which called positive phototropism while the root moves in the opposite direction of light called negative phototropism.

### **EXPERIMENT – 2 (on phototropism)**

Keep some freshly germinated bean seeds having hypocotyle in a box such that one side of the box is open through which light enters. Cover hypocotyles of some of the bean seeds with black paper caps and cut the upper portion of the and cut the upper portion of the hypocotyle of some bean seeds and leave the rest of seeds as it is.

Observe these seeds after 3 to 4 days. The seeds whose tips were cut and some covered by black paper caps are remain straight whereas the rest of the seeds, the stem bends towards the direction from which light entering. If we remove black paper caps from the seeds, they also slowly bend towards light.

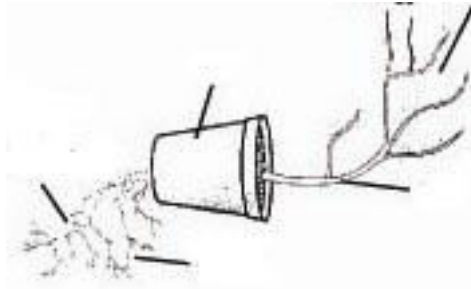


**INFERENCE** – the seeds could not get light as the tip portion is cut or covered by black paper caps. On the other hand the undisturbed germinated seeds get light on their tips hence they bend towards the light. So from this it is concluded that some chemical changes occur at the tip of the Hypocotyle due the external stimulation by light. As a result Hypocotyle bend towards light. This experiment was first carried out by Charles Darwin.

**GEOTROPISM** – the gravitational force of the earth attracts the objects towards its centre. This force affects the plants or some of its parts to move into the soil or ground called **Geotropism**. Due to gravitational force, the roots of the plants are attracted towards the centre of the earth. This is called positive of Geotropism and the stem of the plant move towards opposite direction called negative geotropism. If a growing plant is kept



parallel to the ground, after some days, a change is observed in its growth. Stem moves towards light and roots move in opposite direction of light into the ground.



How does this tropic movement take place in plants? Hormones move inside the plant body, if the plant is kept parallel, concentration of hormone increases in the lower part of the stem and growth rate becomes more whereas the concentration of hormones is less at upper part of the stem, hence less growth. Due to this dissimilarities in growth of the stem, the stem moves upwards.

But the growth of the root is just opposite by the affect hormones, the part of the root where the concentration of hormone is less, growth rate is more whereas the part where the concentration of hormone is more, growth rate is less. As a result roots grow in opposite of stem growth. For this reason, roots bend towards ground.

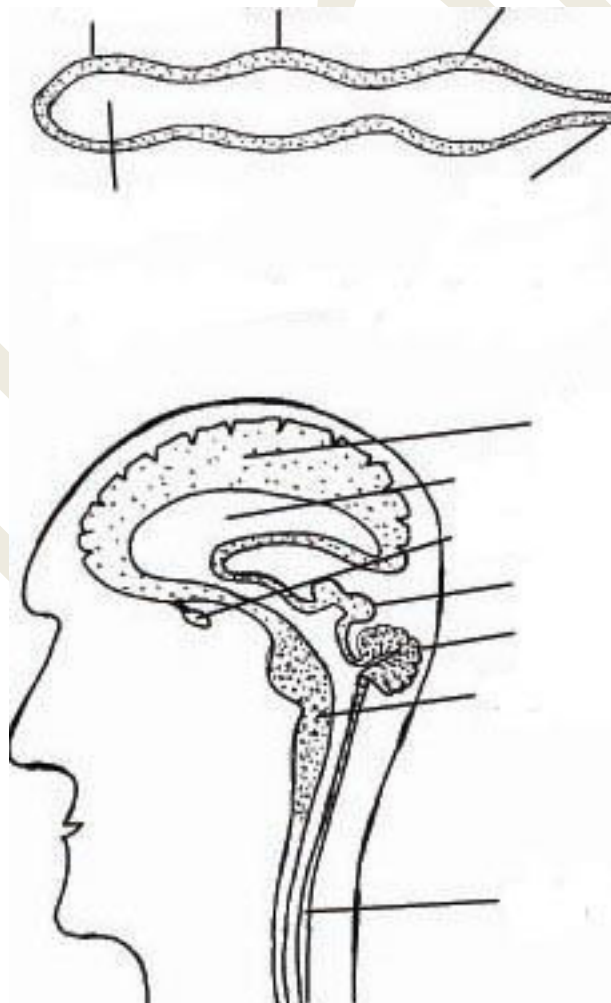
External stimuli such as light, gravitational forces, water and chemical substances create secretion or response at the tip of the stem, roots or leaves. Hence the hormone secretion increases at that place and are controlled by hormones only. In order to respond the external stimuli, the various parts of the plant move towards or opposite side of the stimulation. In this way control and coordination of organic processes in plants is carried out by chemical methods with the help of hormones.

Unlike normal stimulation movement of plants, a special movement is observed in some plants. When we touch a branch or leaf of Touch-me-not plant, then leaves move (droop) in response to touch. Why it happens? Leaves respond to the touch, hence droop. This sort of movement in touch-me-not plant is known as Nastic movement and is a special example of response to touch. Generally this type of movement in plants is possible due to external stimuli. Phototropism and geotropism are dependent upon the growth of the plant but Nastic movement does not depend upon the growth. It commonly occurs due to the rapid chemical changes occur inside the plant cell.

## **CONTROL AND COORDINATION IN HUMAN:-**

We know that, we are attracted by the sweet smell of Jasmines but go away from foul smell of decomposed body. We like to see a beautiful flower or pictures but we automatically shut eyelids to protect ourselves when an insect comes towards our eyes. All these functions are carried out by nerve and sensory organs of the body. Nerves and sensory organs together constitute the nervous system. The nervous system gives the knowledge of everything happening in and around our surroundings. Animals adapt themselves in order to adjust according to the environment. Hence nervous system controls and coordinates the function of all organs or organ systems.

Food intake or eating is the most important work for the animals but differentiating between eatable and non eatable is more important. Hence in the organic evolution, the important part of the nervous system lies near the mouth. The tube like nerve is seen on the dorsal part of all vertebrates during the embryonic stage. The front part of this tube swells and forms brain and posterior part of the tube changes to spinal cord.



## BRAIN

FOREBRAIN	MIDBRAIN	HINDBRAIN
1. Olfactory lobe 2. Cerebral Hemisphere 3. Diencephalon	Corpora quadrigemina	1. Cerebellum 2. Medulla oblongata

### HUMAN NERVOUS SYSTEM

Human nervous system can be divided into three parts –

1. Central Nervous system
2. Peripheral Nervous system
3. Autonomic Nervous system

Central nervous system includes brain and spinal cord. Peripheral Nervous system includes cranial nerves emerging from brain, and spinal nerves from spinal cord. Autonomic nervous system plays an important role in controlling all involuntary actions of the body.

### BRAIN

Brain is the most important organ of our body. So it is protected inside a strong and hard skull (cranium). The brain is protected by three membranous coverings called **meninges** which continue backwards on spinal cord. The inside of the brain is hollow, called ventricles of the brain. The space between the covering membranes and central space (ventricles) is filled with a watery fluid called **cerebrospinal fluid**.

This protects the brain from atmospheric pressure. Brain gets food and oxygen through this fluid and waste materials released from brain is expelled. In a new born baby, the weight of the brain is about 400gm whereas the weight of an adult brain is about 1500gms. It is the most active part of our body. Here, various types of metabolic activities occur all the time. For this reason, about 750 ml of blood is circulated into the brain in every minute.

### DIFFERENT PARTS OF THE BRAIN AND THEIR FUNCTIONS

Brain is divided into 3 parts – Forebrain, Midbrain and Hindbrain.

The Forebrain contains Olfactory lobe, cerebrum (cerebral hemispheres) and diencephalon.

The Midbrain contains corpora quadrigemina

The Hind brain contains Cerebellum and Medulla Oblangata

**FORE BRAIN**-the Olfactory lobe present in the forebrain is very feeble in man. This why the olfactory power of man is very weak but in dogs, cats and tiger etc olfactory lobe is well developed. So they have very strong olfactory power. **Cerebrum** is the largest part of the brain and it is equally divided into two halves (left right lobe) called cerebral hemisphere. Its dorsal part or the outer surface is highly convoluted with ridges and grooves. Our memory depends upon number of these convolutions. It helps to relays the external

stimuli such as temperature, pain, pressure and touch and show the immediate reaction. This part of the brain controls and helps to hear and think over an incidence and exhibiting ones sentiments in words. **Pineal gland is present on the dorsal wall of the diencephalon and Hypothalamus is present in the ventral side of it.** Hypothalamus functions mainly as **thermoregulatory** centre, regulation of water balance, and carbohydrate and fat metabolism. It also controls heart beat, blood pressure, sleep, feelings of pleasure, sex, fear, anger, hunger and thirst etc.

**MID BRAIN** – Midbrain lies behind the diencephalon and above the hind brain. It consists of dorsal part or roof called **corpora quadrigemina** and ventral part or floor called **cerebral peduncle**. Corpora quadrigemina consists of rounded elevations called superior and inferior **colliculi**. Superior 2 elevations (colliculi) serve as visual reflex centres and inferior 2 elevations function as auditory reflex centre. The cerebral peduncle is regarded as centres for the integration of impulses necessary for the performance of skilled muscular movement.

**HIND BRAIN** – Hind brain is the second largest part of the brain. Front part of it is cerebellum and lower part is pons and medulla oblongata. Hind brain maintains the balance and equilibrium of the body. If we lose balance of our body for any reason like lift one leg or hit an object, it helps to control the body balance. Medulla oblongata controls the functions like blood pressure, sneezing, coughing, vomiting and swallowing of the food.

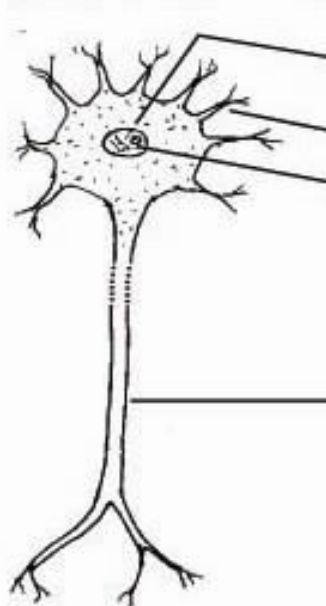
**SPINAL CORD** – spinal cord is a cylindrical mass of nerve tissue, extends from the Medulla oblongata of the brain runs down through Foramen Magnum (hole in skull) almost the whole length of the backbone or vertebral column to end at the second lumbar vertebra and lies within the neural canal of the vertebrae, becoming narrower gradually. Spinal cord protected is present vertically inside the neural canal or vertebral column safely. This is hollow and its length is about 45cm. Like brain, spinal cord is also covered by Meninges and cerebro-spinal fluid flows inside and outside the spinal cord. Spinal cord functions in two ways – (i) Messages (impulses) collected from different parts of the body, is carried to the brain and the orders (responses) from the brain reaches to effector organ through spinal cord. (ii) Spinal cord mainly controls the reflex activities. Example - withdrawal of hand or any part of the body when pricked, quick closing of the eyelids when an object suddenly approaches the eye or when a strong beam of light is flashed across.

**PERIPHERAL NERVOUS SYSTEM-** Peripheral nervous system constitutes two types of nerves, cranial nerves and spinal nerves emerge out from the central nervous system. Cranial nerves and spinal nerves further branches and re-branches. There are 12 pairs of cranial nerves in man which arise from brain and 31 pairs of spinal nerves arising from spinal cord. The nerves of our body collect stimulus from the receptor organs of our body, such as eyes, nose, ear, tongue and skin are called sensory nerves. The

nerves which carry the order from the brain and spinal cord and reaches to muscle or glands are called as motor nerves.

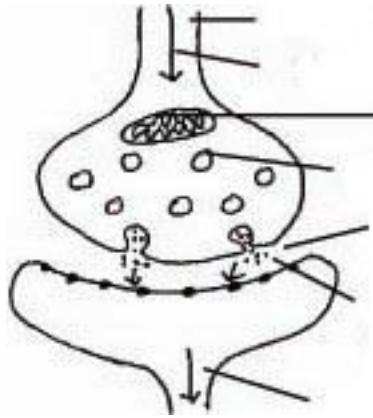
**AUTONOMIC NERVOUS SYSTEM** – we do a lot of work as per our necessity, like eating, drinking, dancing, running, studying etc. These functions which are regulated by the direction of the brain called as voluntary action. Whereas certain functions carried in our body are without our knowledge like respiration, heartbeat, excretion, food digestion, blood circulation and secretion from the glands. All these actions which are carried out automatically inside our body are called as involuntary actions. All the involuntary actions of our body is controlled and regulated by autonomic nervous system. Autonomic nervous system connected with spinal cord.

**NEURON** – the brain, spinal cord, cranial nerves and spinal nerves etc, made up of a number of neurons or nerve cells, hence neuron is the structural and functional unit of our nervous system. Like other cells, nerve cell has a nucleus and cytoplasm but **centrosome** is absent as nerve cells have lost the ability to divide. The part where nucleus is present is called **cell body**. At one side of each nerve cell, a number of small branched cytoplasmic projections or fibre like structure called **Dendrite**. Just at the opposite side of the dendrite a long out growth emerges from the cell body called **Axon**. Axon ends or terminals are closely placed near the dendrites of another one or more neurons but are not connected. Such gaps in between are called synaptic clefts or **synapse**. Cell division does not occur in matured neuron as the centrosome, an essential organelle for cell division, is absent in cytoplasm.



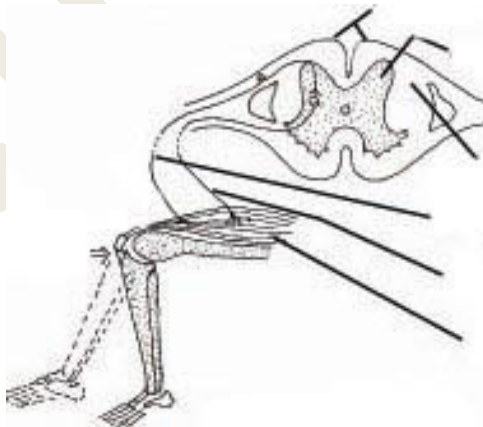
**FUNCTIONING OF NERVOUS SYSTEM** – Sensory organs like eyes, ears, nose, tongue and skin called receptor organs. Dendrites of neuron present near the eyes receive the message that we see with our eyes and send it to Brain. Similarly the sound produced in the surrounding is observed by the dendrite of sensory nerve present inside the ears. The dendrite of sensory nerves present in tongue differentiates the taste such as sour, sweet and bitter. The nerve impulses collected by the dendrites, transmitted through

the axon by electro-chemical process and reach at synapse. When message reached at the end of the axon, a chemical substance named **Acetylcholine** is secreted. **Acetylcholine is a neurotransmitter**. It creates a new electrochemical nerve impulse in the dendrite of next nerve cell. In this way, message is transmitted very swiftly from one neuron to another neuron and at last reaches brain.



## REFLEX ACTION

Brain is the main organ of our nervous system. All actions and reactions of the body are transmitted to the brain. Brain controls and maintain co-ordination in between all the organs of the body. But sometimes certain important functions are regulated by spinal cord without the knowledge of the brain. Spontaneous and automatic functions are carried away by brain or spinal cord is called as Reflex Action. E.g. secretion of saliva by tongue, when we smell the delicious food, automatically takes place. We lift our hand to kill a mosquito when it bites. Eye automatically blinks whenever an object suddenly comes in front it.



Three nerves are involved in a simple reflex action which is carried out by our body and these three nerves are **spinal cord, a sensory nerve and a motor nerve**. Sensory nerve receives nerve impulses from the receptor carries to the spinal cord. Spinal cord receives message and orders or response impulse, is immediately flashed 'like a reflection' to the effector organ through motor nerve. In this process, only one sensor nerve and one motor nerve is involved, hence called **Monosynaptic Reflex**. In our body,

sensory nerve, spinal cord and motor nerve are placed in such a manner forming a geometrical arc **called reflex arc**. Here it may be mentioned that a Russian Scientist named Ivon P. Pavlov experimented on reflex action. (He received Nobel Prize in 1904 for his contribution related to digestion process.) In his experiment, he used serve food to a dog after the bell rings. Ringing of Bell and food intake by the dog was carried out nearly at the same time every day. After continuing this experiment for few days, he rang the bell but did not serve food to the dog. He observed that the moment the bell rings, the secretion of saliva in dog takes place, even though food is not supplied. From this he proved that secretion of saliva is regulated by the reflex action of the nervous system.

## **CHEMICAL COORDINATION**

The chemical co-ordination of our body is carried out mainly by hormones. Two types of glands present in our body; such as Exocrine and Endocrine glands. Salivary glands, liver etc. are the exocrine glands. Enzymes and some other substances are secreted by these glands. Secreted substances come out of the glands through the ducts. Enzymes do not change after taking part in chemical reaction and these enzymes can be used again and again.

### **ENDOCRINE GLANDS**

**Pituitary glands, thyroid glands, parathyroid glands, adrenal glands etc are** Endocrine glands of our body. These are called as **ductless glands**. From these glands hormones are secreted. As these glands ductless, their secretions are poured directly into the blood and not through any special duct. These hormones are carried to all parts by the blood, but their effect is produced in one or more specific parts (target organ or cells) only. Hormone is spoiled when the function is over. Unlike enzymes, hormone cannot be used again and again.

### **ENDOCRINE GLANDS**

- 1.From this hormone is secreted
- 2.Secreted hormones mix directly with the blood.

e.g. Pituitary gland, thyroid gland etc

### **ENZYME**

- 1.Enzymes are secreted from exocrine glands
  - 2.After chemical reaction no change occurs in the structure of the enzyme.
  - 3.Hence these are used again and again.
- e.g. Tyaline present in Saliva

### **EXOCRINE GLAND**

From here enzymes and other Substances are secreted  
Secreted substances come out glands through ducts

E.g. Salivary gland, liver etc.

### **HORMONES**

hormones are secreted from endocrine glands  
when a targeted function is over hormone is spoiled. It functions only once.  
E.g Hormone Thyroxin secreted from thyroid gland.

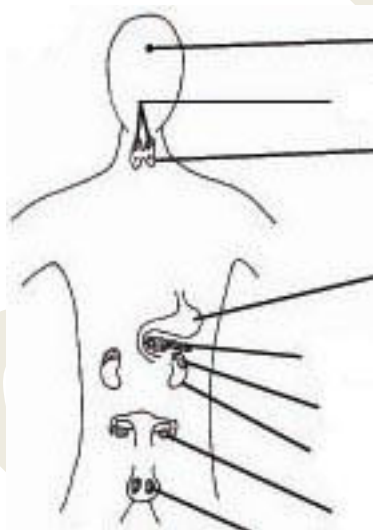
## **COORDINATION METHOD**

In our body, for the control of different organ system and to maintain co-ordination among them, two types of methods are found (1) Nerve Method

(2) chemical Method. In nerve method message is transmitted by electro-chemical method through nerve cell. In chemical method, different hormones are secreted from endocrine glands transmit messages. So in nerves method, functions take place very rapidly whereas functions take place slowly by chemical method.

## **ENDOCRINE SYSTEM**

All the endocrine glands of our body together constitute endocrine system. Nervous system and endocrine system function together maintaining coordination with each other. Hence it is known as Neuro-endocrine system. The location and function of various endocrine glands and hormones secreted by them is discussed below.



Hypothalamus, Pituitary gland, Pinnial gland, thyroid gland, Parathyroid gland and Adrenal gland, Pancreas, Testis, Ovary, Placenta.

### **HYPOTHALMUS**

Hypothalamus is present below the thalamus of the forebrain and above pituitary gland. From the hypothalamus, some releasing hormones and inhibiting hormones are secreted. These hormones control the secretion capability of Pituitary gland.

### **PITUITARY GLAND**

Pituitary gland is connected with the hypothalamus by a small stalk. This gland is made up of two separate parts such as **Adenohypophysis and Neurohypophysis.**



## **NAMES AND FUNCTIONS OF THE HORMONES SECRETED FROM ADENOHYPHYSIS.**

1. Growth Hormone (GH) – this controls the growth of the body. If the secretion of the hormone is less in childhood stage then the individual becomes dwarf. This called Dwarfism. But if its secretion is more, excess growth takes place and individual attains the height of 8 to 9 ft. it is called as Gigantism.
2. Prolactin (PRL) – this has effect on mammary gland of the mother. As a result, milk is formed and secreted for the baby.
3. Follicle Stimulating Hormone (FSH) – this hormone helps in the forming of ovarian follicles and estrogen secretion in females and in males, spermatogenesis.
4. Luteinising Hormone (LH)- this helps in ovulation and also helps to release ovum from ovary and secretion of progesterone in females, in males, secretion of testosterone.
5. Thyroid Stimulating Hormone (TSH) this controls the secretion of thyroxin hormone from thyroid gland.
6. ADNOCORTICOTROPIC HORMONE (ACTH) – this hormone controls the secretion process of adrenal gland.

## **HORMONES SECRETED FROM NEUROHYPHYSIS –**

1. **Oxytocin** – we cannot be ejaculated from cow as and when we milking a cow. But when the calf sucks for some time then milk comes out. When the calf sucks, **oxytocin** hormone is secreted from pituitary gland and milk is released. Other function of oxytocin, it stimulates the vigorous contractions the muscles during the child birth. The body of calf comes out by the contraction of uterus.
2. **Vasopressin or Anti Diuretic Hormone (ADH)** – by the effect of Vasopressin water is reabsorbed again from the nephron/urinary tubule. For this reason, the other name of this hormone is **anti diuretic hormone**. If for any reason less amount of Vasopressin is secreted from pituitary gland then an individual urinate about 20 litres per day. This state is called as **Diabetes Insipidus**. It is different from Diabetes Mellitus.

## **Pineal Gland –**

It is present at the roof of the forebrain. It is very small in size and weights about 150 mg., secretes a hormone named Mellatonin. It affects puberty, ovulation and sleep. This works like biological clock of the body.

## **Thyroid Gland –**

It is present at the bottom portion of the neck on both the sides of Trachea just at the back of Larynx. It secretes mainly thyroxin hormone. This enhances the oxygen utilization capability of different cells of the body. As a result, more energy is produced in our body. This also helps in the metamorphosis of tadpole, larva of frog.

If we put some thyroxin hormone in the water where tadpole larvae are present, Metamorphosis takes place quickly and within few days they developed into full fledged frog. By its deficiency metamorphosis of tadpole larva is obstructed.

### **Parathyroid Gland :**

Above the thyroid gland four numbers of parathyroid glands are present which are very small in size. From this gland parathormone is secreted. It helps to keep the quantity of **Calcium and Phosphorous** constant in the blood.

### **Adrenal Gland –**

In our body, two adrenal glands found just above of two kidneys. A number of hormones are secreted from this gland. Among these adrenal is important. This hormone is secreted during emergency situation of the body such as when hurt suddenly (sudden hurt), fear, tiredness and excitement. So this gland is called as emergency gland.

### **Pancreas –**

Pancreas is present just below the stomach inside the duodenal loop of the body. It is a mixed gland i.e. duct as well as ductless gland, because both enzymes and hormones are secreted from this. The part of the pancreas that secretes hormone is called **Islets of Langerhans**. Three different types of secretory cells called **alpha, beta and delta or x, B, and O** cells are present in islets. Hormone secreted from alpha cell is **glucogen, from beta cell is insulin and delta cell is called somatostatin**. Insulin checks rise of sugar level in blood. Deficiency of insulin cause increase in glucose in blood and cause **diabetes mellitus**.

### **Testis –**

In our body, two testes are present inside two scrotal sacs. A male hormone, **Testosterone** is secreted from the cells of **leydig**, present in testis. During puberty, due to the effect of testosterone male secondary sexual characters like distribution of body hair, beard, moustaches and matured voice etc are observed. Testosterone also helps in **Spermatogenesis**. **Deficiency of this hormone causes Impotency in male.**

### **Ovary –**

A paired of ovaries lie in lower or pelvis region of abdominal cavity of a female body. Two hormones estrogen and progesterone are secreted by the ovaries. By the effect of estrogen hormone, in the girl's body, secondary sexual characters are observed. After ovulation, progesterone hormone is secreted from the ovary. It plays a very important role during pregnancy, hence known as pregnancy hormone.

### **Placenta –**

Placenta is a physiological connection between developing embryo and maternal tissue. It develops partly from maternal and partly from foetal tissue. It is a temporary endocrine gland. Among the hormones secreted

from the ovary, **Chorionic Gonadotropic Hormone – CGH** is important. This hormone comes out of the body in pregnant women along with urine. So doctors could know the pregnancy by testing urine. So it is a pregnancy test.

### **Control of Hormonal Secretion –**

The external environment of our body is always changing. But by **homeostasis system**, the internal environment of the body always remains constant. As the endocrine glands work in co-ordination with each other, hence homeostasis mechanism is possible. For E.g. the moment thyroxin hormone level is decreased in the blood, the message reach up to hypothalamus. The thyroxin releasing hormone is immediately secreted and effects thyroid stimulating hormone of pituitary gland to secrete thyroxin hormone from thyroid gland. When thyroxin hormone in blood becomes normal, secretion from hypothalamus is automatically ceases. This hormone secretion system of our body is called **feedback control**. The timing and amount of hormone released are regulated by feedback mechanisms.

### **WHAT YOU HAVE LEARNT –**

1. Growth and development of an organism and all the organic processes occur in controlled and coordinated manner.
2. In plants, control and coordination of various organic processes are done by hormones by chemical method.
3. Hormones are organic substances and perform various functions in low concentration and volume.
4. Hormones found in plants are known as Phytohormones.
5. A particular hormone has the capability to control various functions.
6. Phytohormones are mainly of five type such as Auxin, Gibberllin, Cytokinin, Ethylene and Absicissic acid.
7. Phytohormones in plants, control phototropism and geotropism besides growth and development.
8. Ethylene and Absicissic acid acts as growth retarding hormones.
9. In plants, hormones influenced by external stimuli control the various movements.
10. Phototropism is the basic character of the stem whereas as roots show geotropism in plants.
11. The nervous system and endocrine system controls and coordinates the various part of human body.
12. Nervous system constitutes – central nervous system, peripheral nervous system and autonomous nervous system.
13. Central nervous system includes brain and spinal cord and the cranial nervous arising from brain and spinal nerves arising from spinal cord form peripheral nervous system.
14. Brain has three parts – fore brain, mid brain and hind brain.
15. Neuron is the structural and functional unit of our nervous system.
16. At one side of each nerve cell, a number of small branched cytoplasmic projections or fibre like structure called **Dendrite**. Just at the opposite side of the dendrite a long out growth emerges from the cell body called **Axon**.
17. Axon ends or terminals are closely placed near the dendrites of another one or more neurons but are not connected. Such gaps in between are called synaptic clefts or **synapse**.

18. The functions like respiration, heartbeat, excretion, food digestion, blood circulation and secretion from the glands are carried out automatically inside our body are called as involuntary actions. All the involuntary actions of our body is controlled and regulated by autonomic nervous system.
19. Spontaneous and automatic functions are carried away by brain or spinal cord is called as Reflex Action.
20. Two types of glands present in our body; such as Exocrine and Endocrine glands. Exocrine glands have ducts secrete enzymes and other substances whereas endocrine glands are ductless glands secrete hormones.
21. Hypothalamus present in the lower side of fore brain controls the secretion of the Pituitary gland.
22. Adenohypophysis and Neurohypophysis of pituitary gland secretes 6 hormones and 2 hormones respectively.
23. Thyroid gland is present at the bottom portion of the neck on both the sides of Trachea just at the back of Larynx. It secretes mainly thyroxin hormone.
24. In our body, two adrenal glands found just above of two kidneys. A number of hormones are secreted from this gland. Among these adrenal is important.
25. The part of the pancreas that secrets hormone is called Islets of Langerhans. Insulin is secreted from Beta cells.
26. A male hormone, **Testosterone** is secreted from the cells of leydig, present in testis.
27. Two hormones estrogen and progesterone are secreted by the ovaries.
28. After ovulation, progesterone hormone is secreted from the ovary. It plays a very important role during pregnancy, hence known as pregnancy hormone.
29. Placenta is a temporary endocrine gland. Secretion of a hormone called Chorionic Gonadotropic Hormone – CGH takes place here.
30. The hormone secretion system of our body is called feedback control.

### EXERCISE

1. What are phytohormones? Describe the types and functions of these hormones?
2. What is an external stimulus? Explain geotropism in plants caused due to it.
3. Explain the effect of auxin on plants by an experiment?
4. Give a account of different parts of the brain and their functions?
5. What is reflex action? Explain monosynaptic reflex action carried out in our body.
6. Explain the structure and function of a nerve cell or neuron.
7. Answer shortly -
  - a) What is synapse?
  - b) Write the function of vasopressin?
  - c) Where are islets of langerhans present? Write the names of its cells and their function?
  - d) Differentiate between exocrine and endocrine gland?
8. Write short notes on –
  - a) Hormones
  - b) Dwarfism and gigantism
  - c) Dendrite and axon
  - d) Diabetes mellitus
  - e) Function of auxin.
9. Answer in one sentence.
  - a) What is the function of acetylcholine?
  - b) Why is adrenal gland called as emergency gland?
  - c) What is the function of Estrogen?

- d) Why pancreas is called as mixed gland?  
 e) Which type of movement is observed in touch-me-not plants?
10. Fill in the blanks
- a) In plants falling of fruits, flowers and aging is accelerated and controlled by \_\_\_\_\_.
- b) Hormone is formed at the \_\_\_\_\_ of the stem.
- c) \_\_\_\_\_ part of the brain is responsible for memory.
- d) \_\_\_\_\_ of the brain is responsible for controlling the balance of our body.
- e) Important functions of the body occur without the knowledge of the brain is called \_\_\_\_\_.
- f) Cell division does not occur in nerve cells as it has no \_\_\_\_\_.
11. Choose the correct answer –
- a. How many pairs of cranial nerves are there in our body.  
 i)15                    ii)12,    iii)11,                    iv)10
- b. Which is the external coating spinal cord  
 i)Durameter    ii) meninges    iii)pericardium    iv)piyameter
- c. What is the other name of vasopressin?  
 i)PRL    ii)ADH    iii)ACTH    iv)TSH
- d. Which of the following is not phytohormone?  
 i)Ethylene    ii)Cytokinin    iii)Gibberelin    iv) Acetylcolin
- e. Which type of movement is observed in roots of plants?  
 a)+ive phototropism    b) -ive geotropism  
 c)+ive geotropism    d) nastic movement
12. Related words –
- a. Dwarfism : Growth hormone :: Metamorphosis : Thyroxine  
 b. Ovary : Estrogen :: Testis : Testosterone  
 c. Falling of flower : Ethylene :: flowering : auxin  
 d. Pregnant hormone : Progesterone :: pregnancy test hormone : Chorionic Gonadotropic hormone (CGH)
13. What is the number of corpora quadrigemina  
 i)1    ii) 2    iii) 3    iv) 4
14. Which of the following is present at the back of the cerebellum  
 i) Olfactory lobe                    iii) corpora quadrigemina  
 ii) Medulla oblongata            iv) cerebral hemisphere
15. Which of the following is developed in cats and dogs  
 i) Cerebellum                    iii) cerebral hemisphere  
 ii) Developed brain                iv) olfactory lobe
16. Which is the largest part of the brain.  
 i) Olfactory lobe                    iii) cerebral hemisphere  
 ii) Diencephalon                    iv) olfactory lobe
17. Which of the following controls sneezing, coughing etc  
 i) Medulla oblongata            iii) fore brain  
 ii) Olfactory lobe                    iv) cerebellum
18. Which of the following controls vision reflex.  
 i) Corpora quadrigemina            iii)olfactory lobe  
 ii) Diencephalon                    iv)forebrain

## LESSON 6

### REPRODUCTION

Reproduction is a special characteristic feature of living organism. By this process they produce offsprings exactly identical to them and continue their generation. Reproduction is not important for a man or any other organism for living. But for the existence of particular species and for the continuation of the generation for years together, reproduction is indispensable. Therefore this process plays pivotal role in continuation of generation of any species.

Reproduction is of two types - Asexual Reproduction and Sexual Reproduction. Some species reproduce through asexual reproduction, whereas some other species by sexual method. Few species reproduce both by sexual and asexual method. Besides this, many plants reproduce by vegetative reproduction or propagation to increase their number.

**Asexual Reproduction** – Asexual reproduction method is generally found in some lower plants and animals including microbes. In this process mother cell or parent cell divides, so that daughter cell or daughter offsprings are formed. This occurs by mitosis or amitosis. Asexual reproduction process found in multicellular organism is something different from this simple division process. But these organisms do not have reproductive cells.

**Sexual Reproduction** – Organisms that reproduce by sexual reproduction have two types of cells in their body. Such as 1. Somatic cells 2. Germ cells. Chromosomes of somatic cells are in paired or even numbers i.e. is divisible by 2. All the organisms belong to a particular species (such as in all the human beings) and any organism of that species (e.g. any human being), the number of chromosomes are same except gametes. Hence the number of chromosomes remain unchanged in organisms belong to this species. For example in man chromosome number is 46 (forty six) and in maize it is 20. This number is called as diploid number and this is represented as  $2n$  number. By the division of somatic cells, growth and repairing of the body is carried out. This takes place by mitosis cell division. Chromosome numbers in daughter cells formed by this process remain unchanged i.e. similar to the chromosome number of the mother cell.

Reproductive organs such as testes in male and primordial germ cells of ovary in females, and in flowering plants, pollen mother cells of androecium and megaspore mother cell of carpel (gynoecium) have  $2n$  number of chromosomes. Gametes are formed from these cells. A special type of cell division, Meiosis occurs while gamet formation by a process called **gametogenesis**. Hence chromosome number becomes half in gametes (sperm of the male and ovum of female, in pollen grains and ovary of a flower). This half number of chromosome is called as haploid number and it is represented as “ $n$ ” number. (for example in man  $n$  is equal to 23 and in maize it is 10). When a male gamet and a female gamet unite i.e. fertilization occur, zygote is formed where  $n$  number chromosomes present in male and female gametes unite, to  $2n$  number of chromosomes or diploid is restored.

Sexual reproduction is found in living kingdom much before. The structure, shape, size, behavior and use of male and female gametes differ. If both male

and female gametes are similar these are called **isogametes** and the union of similar gametes is called isogamy whereas dissimilar gametes are called Anisogametes and their union is called Anisogamy or **Heterogamy**. Generally in lower organisms like algae, fungi and some protozoa these two types of reproductions observed. In rest of the plants and animals, a special type of Heterogamy is observed, called **Oogamy**. In all the cases male gamete is smaller in size, motile (movable) and also active. But female gamete is larger in size, inactive and non motile. Examples of male gamete are sperm and pollen grains and that of female gamete is ovum and ovary.

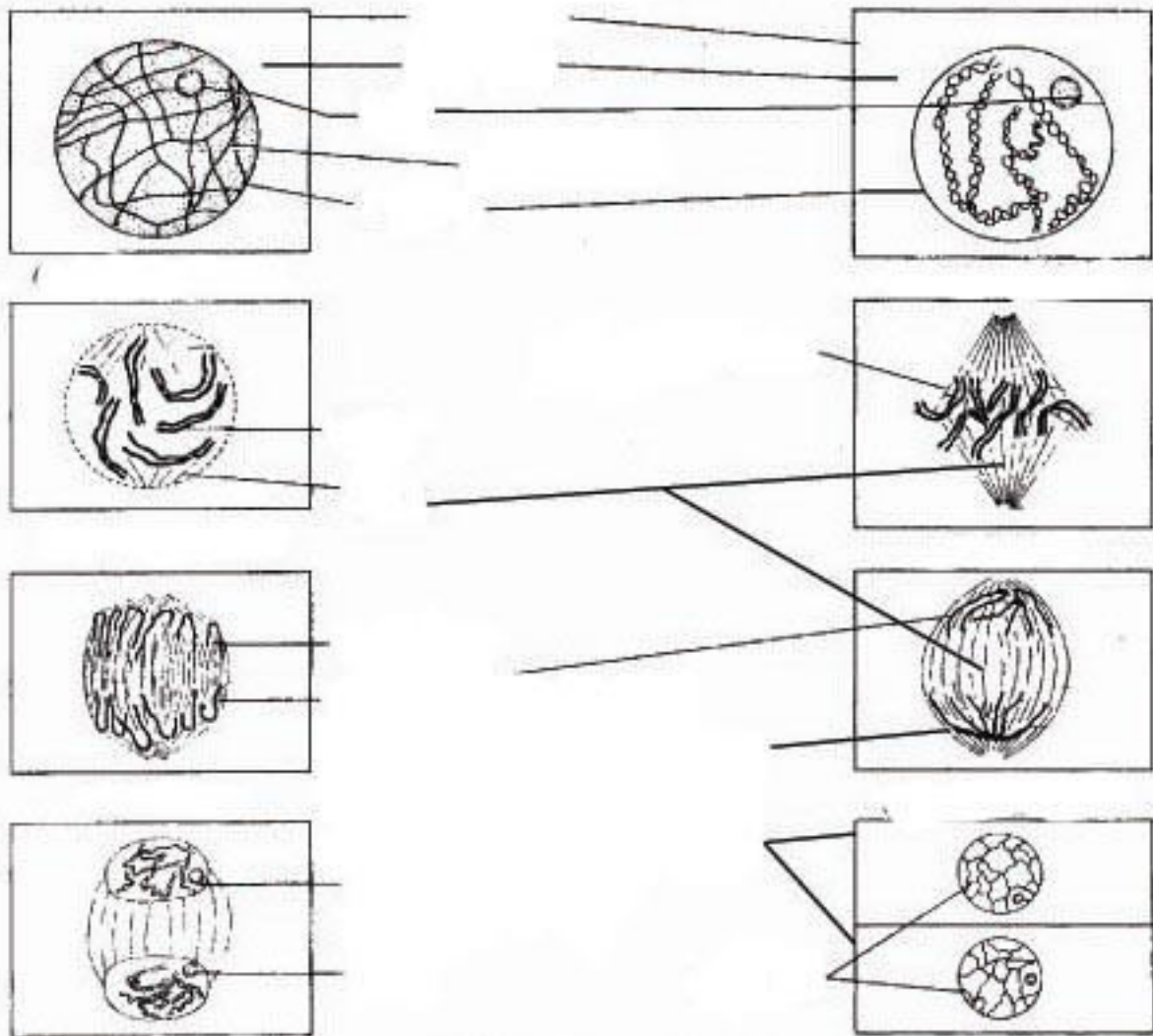
The basic principle of sexual reproduction is union of male gamete with female gamete. The zygote formed from this union is first cell of the organism for next generation. Zygote further divides by mitosis cell division, and cell number increases. Change in size, shape and function in cell takes place and various functions such cell movement occurs, hence a new organism is formed. This process continues generation after generation. The organism dies, but the species remain alive. Besides this, new and different characters found in offsprings are due to sexual reproduction.

**CELL DIVISION** : Two type of cell divisions are observed in living organisms - Mitosis and Meiosis (reproduction division). Mitosis occurs in somatic cells and primordial germ cells (1<sup>st</sup> step of gametogenesis) where as meiosis is meant for gamete formation. This occurs at the last stage of gametogenesis.

### **MITOSIS –**

In an organism, mitosis occurs in two stages. In the first stage division of nucleus takes place, called **Karyokinesis**. In the next stage division of cytoplasm takes place which is known as **Cytokinesis**. Two identical daughter cells are formed from the mother cell. Karyokinesis of mitosis is a complex process occurs in four main phases and each of these phases merges into the next phase thereby making it a continuous process. The four phases are Prophase, Metaphase, Anaphase and Telophase.

- 1. PROPHASE** – chromatin reticulum are formed at the beginning of prophase. In due course of time, the chromosomes in Chromatin reticulum become short and thick are clearly visible inside the nucleus in a particular number. Towards the end of prophase chromosomes are observed to be divided longitudinally (length wise), but remain attached to each other at a point called centromere. Gradually nucleus and nucleolus disappears. Centrosome (in animal) of the cell divides into two parts and each part move towards opposite pole. Spindle fibres begin to form near the two poles of the cell. Though centrosome is not present in plant cells, still cell division occurs normally.



**2. METAPHASE-** in metaphase, duplicated chromosomes arrange on the equatorial plane. Spindle fibres of the pole extend gradually and attached to each centromere.

**3. ANAPHASE** – in anaphase, each centromere divides, spindle fibres are contracted, so that chromatid of each chromosome move towards opposite pole. During this each chromatid (new chromosome) becomes 'V' shaped or conical while moving towards their respective poles.

**4. TELOPHASE-** in telophase, daughter chromosomes settle at both the poles. Gradually each chromatid or the daughter chromosome lengthens, becomes thinner and turns into a network of chromatin threads. Nuclear membrane reappears. Nucleolus reappears in each daughter nucleus.

**CYTOKINESIS** – In case of a plant mother cell, a cell plate is laid down in the cytoplasm at the equatorial plane which grows from centre to the periphery. Gradually the cell plate becomes prominent and divides this mother cell into two daughter cells identical to parent cell. In animal cell, cell plate is not formed in the parent cell, a deep furrow appears in the cell membrane in the middle, which deepens and finally splits the cytoplasm into two, thus providing two new cells.



## **MEIOSIS –**

By meiosis four (4) daughter cells are formed from one mother cell. Each daughter cell carries half number of chromosome in comparison to mother cell. For this reason this division is also known as Reduction division. This is meant for the formation of gametes.

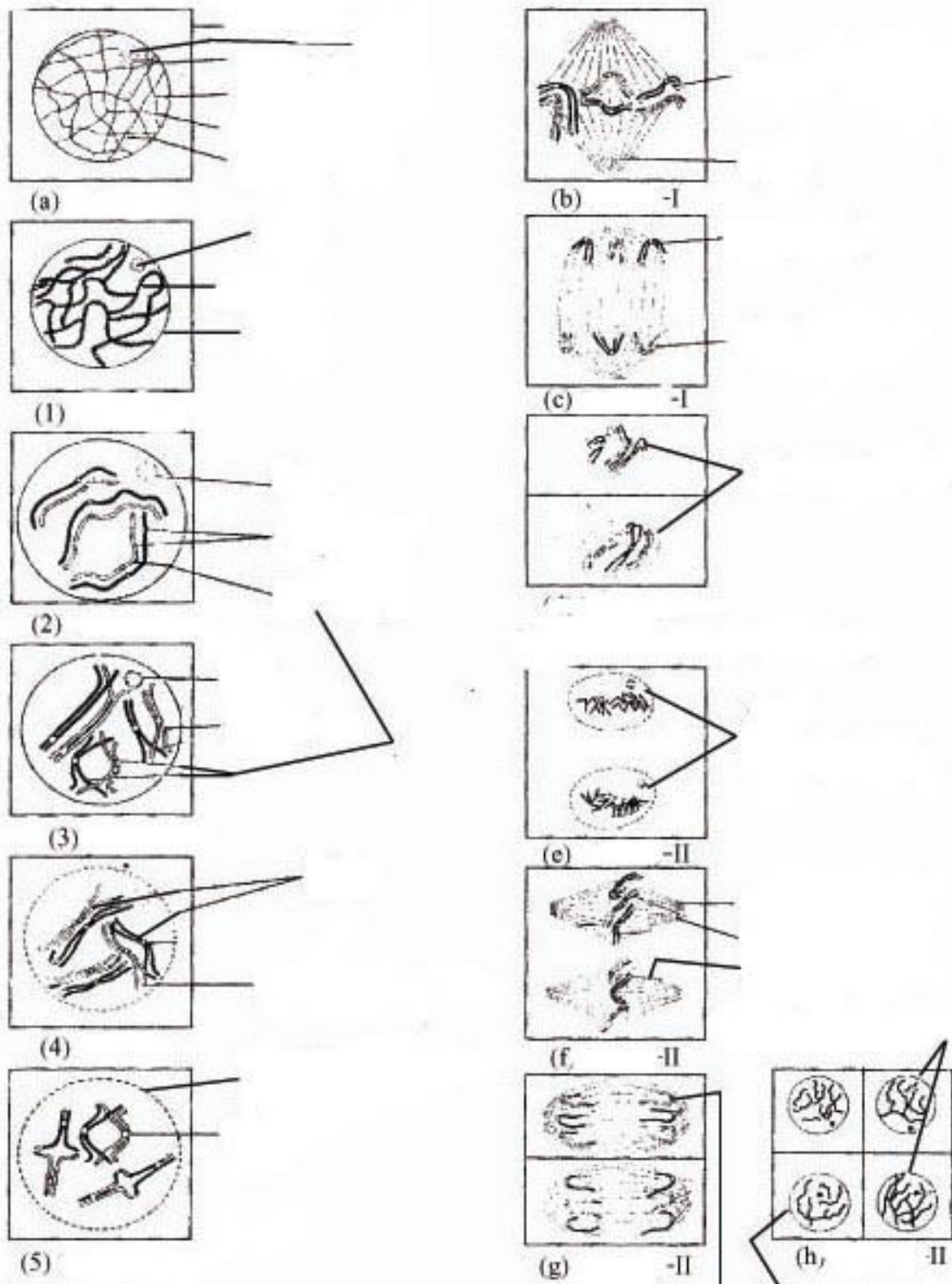
Meiosis is completed in two divisions - Meiosis I where Reduction division takes place i.e. chromosomes become half (haploid) and Meiosis II where mitotic division takes place in new daughter cells. As a result four daughter cells are formed carrying haploid number of chromosomes.

### **MEIOSIS-I**

Like mitosis, meiosis-I cell division can be studied in four stages, such as Prophase – I, Metaphase –I, Anaphase – I and Telophase – I.

**A)Prophase-I** prophase-I is comparatively long and complex. It has 5 subphases. These are – Leptotene, Zygotene, Pachytene, Diplotene and Diakinesis.

- i. Leptotene – chromosomes become visible in this phase. Though chromosomes are divided longitudinally before, these are visible as single units.
- ii. Zygotene – in zygotene, homologous (similar) chromosomes from both the parents are attracted towards each other, and lie in pairs lengthwise or longitudinally. This process of association is called **synapsis**. Each synapsed chromosome pair is called bivalent
- iii. Pachytene – during this stage, chromosomes become shorter and thicker. Each chromosome longitudinally consists of two chromatids or bivalent. Hence paired chromosomes (bivalent), now clearly appears as tetrads (4 chromatids).
- iv. Deplotene – in deplotene chromosomes (each having two chromatids) begins to separate. They remain attached to each other only at certain points and rest of the places they are separate. The place they remain attach is called as **Chiasma**. In paired chromosomes, exchange of genetic material takes place in between non sister chromatids of homologous chromosomes, at chiasmata points. This process is called as **crossing over**.
- v. Diakinesis: During diakinesis chromosomes become condensed. As they are shorter spherical, look much clear. In this substage chromosomes look like coins. Nuclear membrane and nucleolus disappear at this stage.



**B) Metaphase-I:** Like metaphase of mitosis, chromosomes in meiosis align on the equatorial plane, spindle fibres are connected to the centromeres.

**C) Anaphase-I:** Each chromosome of the paired chromosomes with their two chromatids move towards opposite poles. Centromere does not divide. This is the reason why chromosome number becomes half. During this phase chromosomes attain 'V' shape.

**C) Telophase-I:** Half numbered chromosomes present at opposite poles form nucleus. First nucleolus and then nuclear membrane reappears. Chromosomes, gradually lengthens and become not visible. During this stage cytoplasm is divided into two parts and the cell divides into two daughter cells.

**Meiosis-II:**

After first division, immediately 2nd division begins it is similar to mitosis. It has four stages i.e. Prophase-II, Metaphase-II, Anaphase-II and Telophase-II. Similar to mitosis each daughter cell forms two identical cells. In this way in meiosis four daughter cells, are formed from one mother cell, consisting haploid (n) chromosomes. For example in Meiosis, the cell having 20 chromosomes, form four daughter cells each having 10 chromosomes.

**Difference between mitosis and Meiosis.**

Mitosis	Meiosis
i) This takes place in somatic cells, primordial germ cells, pollen mother cells and megaspore mother cells.	This is meant for gamete formation. Hence it take place in the last stage of gamotogenesis in germ cell.
ii) Chromosome number in mother and daughter cell remain same.	Chromosome number in daughter become half the mother cell.
(iii) In this stage each chromosome divides independently i.e never depend on other chromosome. No exchange of genetic material takes place.	In the beginning stage of this division homologous chromosomes are formed and exchange of genetic material takes place called crossing over.
(iv) In anaphase of mitosis centromere divides and chromatids move towards opposite poles.	In Anaphase-I of Meiosis-I, centromere never divide hence the entire chromosome move towards the opposite pole.
(v) Two daughter cells are formed from a mother cell.	Four daughter cells are formed from a mother cell.

The word Mitosis originated from Mitos mean thread. Walther Flemming, while studying the cell division observed the Chromosome network where the chromosomes look like thread. As "Mitos are visible" he named the cell division as Mitosis. Whereas Meiosis is derived from a word Mieron; meaning "to reduce". As the number of chromosomes become half or diminishes, this type cell division is called Meiosis.

In Mitosis, the most important thing happens is the equal distribution of DNA of mother cell among the two daughter cells. Hence Mitosis is also called "Equatorial Division". Similarly in Meiosis, the 2n number of chromosomes reduces to n. Hence it is known as "Reductional Division"

**Mitosis = Equational Division**

**Meiosis = Reductional Division**

## **Reproduction in plants :-**

Plants reproduce both by asexual and sexual methods.

Asexual method in plants are (i) fission (ii) Budding (iii) sporulation and (iv) vegetative propagation

### **(i) Fission:**

Bacteria and many unicellular organisms like algae reproduce by fission. In this process the nucleus and the cytoplasm of the cell body of an organism divide into two parts. So that two daughter cells or organism are formed. It is called Binary Fission. The number of protozoa increases through binary fission only. Some algae such as Spirogyra divides into more than two parts and each part develop to new individual organism. This is called multiple fission.

### **(ii) Budding:**

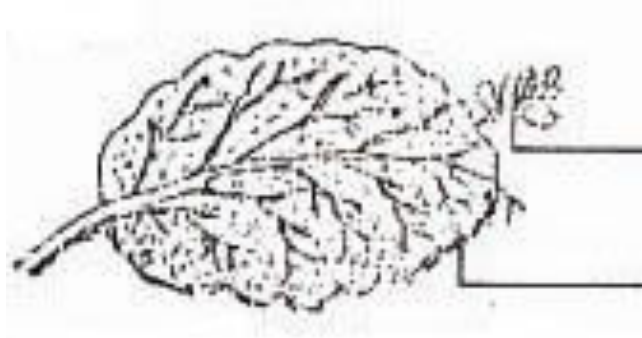
Yeast, a fungi usually reproduce by budding. The daughter cell develops like a bud from the mother cell. This bud gets separated from the mother cell and grows into new yeast cell. This process is called budding.

### **(iii) Sporulation:**

Usually non flowering plants reproduce by sporulation. Fungi like mushroom and mold reproduce by this process. Numerous black coloured spores are found in fungi. These spores once matured, are released from the spore cavity (cyst) and float in air or water. Spores germinate to form new plant once they get favourable conditions. This process of germination is called sporulation. An Algae like Ulothrix form 4 to 8 or even more motile spores called zoospores. These zoospores release from the mother cell and settle in the proper environment and germinate to form plant. Fungi like Mucor also reproduce by sporulation. Fungi like Penicilium reproduce by non motile spores called Conidia. Fungi like Pythium reproduce by motile or non motile spores that is either zoospore or conidia depending up on the environment. Excess wet environment suitable for zoospore whereas dry environment is suitable for Conidia.

Spores are very small light and cannot be seen by the naked eye. They are carried to distant places by wind and water and germinate to a new plant once they get favourable conditions or environment.

### **(iv) Vegetative propagation:**



Many species of plants reproduce through their vegetative propagation. Vegetative propagation is the formation of new plants from vegetative parts of

the plant like leaf, branch or stem etc. Many plants like sugarcane, banana and rose plant easily reproduce through this process. The marginal notches of the Bryophyllum leaf when come in contact with the wet soil, produce a new plant. New plants or creepers grow from their roots in plants like sweet potato, Dahlia etc. Plants like Banana, Onion, Garlic, Turmeric etc grow from underground stem. All these are the few examples of vegetative propagation.

Most of the time vegetative propagation is very useful for agriculture. Plants produced by vegetative propagation bear flowers and fruits more rapidly than the plants develop by seeds. Plants like Banana, Rose, Jasmine etc. reproduced through this method only. Other advantage of vegetative propagation is, since the plants produced this method are genetically identical to the parent plant and show genetic uniformity. The following are the various types of vegetative propagation:

**(a) Fragmentation:**

Algae like Spyrogyra and some non flowering plants, thallus breaks into many fragments, and each part develop into a new plant. This process is called fragmentation.

**(b) Cutting:**

The stems of the Croton and Money plant etc are cut in to small pieces and their lower ends pegged in to the soil. After few days new plants grow from the cut stem. This process is called cutting.

**(c) Grafting:**

In this process, the upper portion of plant is cut and the root system is remain intact is called **stock**. Whereas the scion, the shoot system of another plant is employed to stock and the union is plastered with grafting clay. The wrapped portion should be kept wet by watering it regularly. After some days, the joined portion gets united and a new plant grows from there. The new plant carries all the characteristics of the stock. The new plant develop from seed bearing plants show variation in characteristics whereas new plant grown by grafting method does not carry any new characteristics or variations. Various methods of grafting are implemented in plants like Rose, Mango and Lemon etc to propagate the number. The following are the various types of grafting -

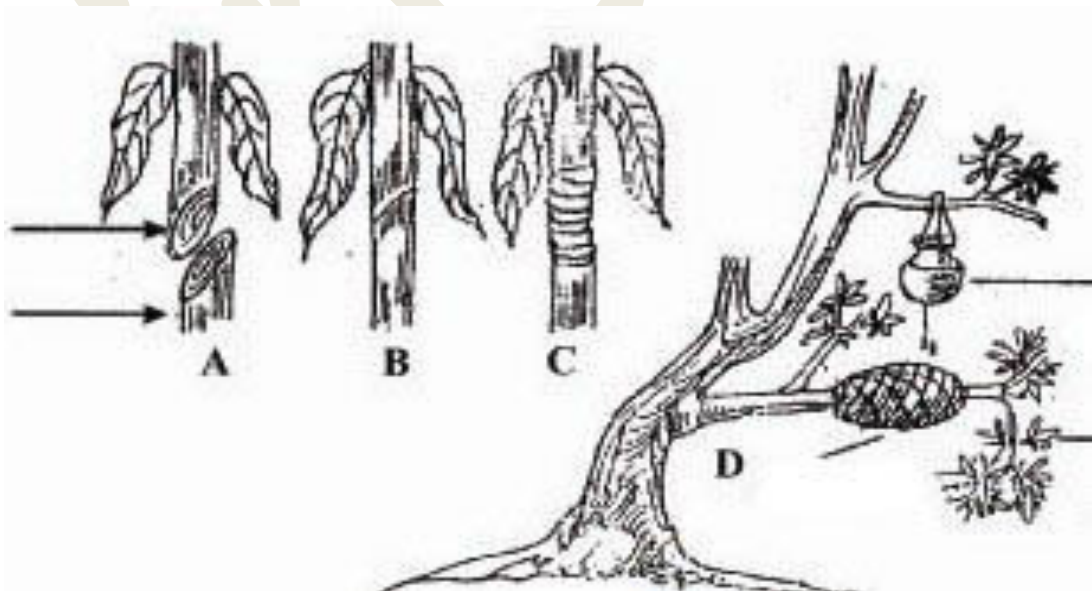
**Layering**

To produce new plants in very short time, farmers mostly use this method. In this method, a basal branch is defoliated by removing the bark of any part of a branch, bend the defoliated branch and peg into the wet soil and keep it wet for some days. Gradually roots develop from this pegged down portion. Now cut this portion from it mother plant. The new plantlet is sown separately and grow into a new plant.



### **Gootee**

In plants like guava, rose, blackberry, lemon, orange and croton, grafting is done by this method. For this, long ring of bark is removed from basal region of healthy and woody branch. It is covered by a thick plaster of grafting clay (grafting clay is a mixture of cowdung, finely cut hay and clay). The portion covered with grafting clay is covered with a gunny bandage or polythene. In order to stop grafting clay become dry, it should be kept wet by watering it. For watering, keep a water filled pot with a hole at the bottom just above the plaster so that water dropping from pot keeps the plaster wet. After some day root come out from it and develop inside the grafting clay. Now cut the branch below the bandage and used for planting. This process of propagation of plants is called Gootee or air layering. Now a days, various types of grafting processes are used for plant propagation.



### **Some special types of reproduction:**

#### **(i) Parthenogenesis:**

Sometimes Ovary develops into fruit without fertilization, is known as Parthenogenesis. Parthenogenesis is found in non flowering plants like algae and ferns and flowering plants like guava, grapes and banana. The fruits

developed by parthenogenesis are seedless. These seedless fruit are known as parthenocarpic fruit.

This type of reproduction is regularly found in honey bee, aphids and some other animals. Male honeybee (drones) and females aphids develop from unfertilized eggs.

### **(ii) Tissue Culture:**

This method includes propagation of plants by culturing and developing tissues by culture medium and forming a large number of tissues from one tissue, from where a large number of plantlets are formed, called tissue culture. Initially, the culturing of tissues results in formation of an undifferentiated mass of cells, called **callus**. Later Callus is shifted to a nutrient medium containing specific hormones for development and differentiation. Plantlets are produced by replantation of callus. These plantlets are allowed to grow under controlled environment in order to obtain a large number of plants. This process is also known as **in vitro micropropagation**. Tissue culture technique is useful in obtaining healthy, virus free, disease free plantlets for creating forests, afforestation and in micropropagation of orchids etc.

### **Sexual reproduction in flowering plants:**

In angiosperms, reproductive organs are present inside the flower. The various parts of the flower are calyx, corolla, androecium, gynoecium. Stamen (male) and carpel (female) are the reproductive part of the flower. Gametes are present in this part.

Some plants have flowers containing either of sex i.e. male or female like in pumpkin and papaya called unisexual plants. Whereas plants like Hibiscus (china rose) and mustard, flowers have both male and female sex organs called bisexual plants.

### **Pollination**

Before fertilization, pollen grains from anther are carried through external agents like wind, water etc and falls on stigma. This is called pollination. Sometimes, the transfer of pollen grains from the anther of a flower to the stigma of the same flower and fertilizes the ovum, called self pollination. But in most of the plants, the pollen grain of one species falls on the stigma of the another flower of same species through external agents such as insects, birds, wind and water and fertilization takes place. This is called cross pollination.

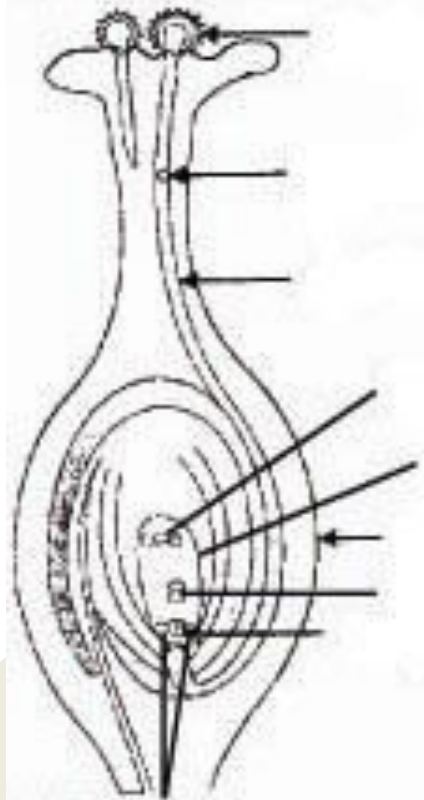
In the stigma, a sticky substance is formed by the combination of glucose, organic acid in other substances. Pollen grains fall on stigma and settle to the sticky substance and later germinate.

What happens after this? Let us first know about the Gynoecium and Ovary.

### **Gynoecium and Ovary**

Gynoecium has three parts - the swollen last part is ovary, middle is style and upper most part is stigma. Ovule is a small structure attached to the placenta by means of stalk called funicle. The body of the ovule consists of a mass of parenchymatous cells named **necellus**. One or two coverings called

integument surround nucellus. The integuments leave a narrow pore or passage at one end of the ovule. It is known as **micropyle**. The place of origin of integument usually lies at the opposite end, called **chalaza**. **Embryo sac** is embedded in the micropylar half of the nucellus. An egg cell is present at the anterior part of the embryo sac, two **synergids** or helping cells present either side of the egg cell. Three **antipodal cells** present at the stalk. In the middle of the embryo sac, the cell contains two polar nuclei lie adjacent to each other have large nucleoli. These two polar nuclei fuse together to form **secondary nucleus** just before fertilization.



### **Fertilization:**

When the pollen grain falls on the stigma, the outer covering of it ruptures. Pollen grain comes in contact with the sticky substance on the stigma and remain attach there. The inner layer of the pollen grain changes into tube like structure and germinates. This tube grows into style and move towards embryo sac. This is called as pollen tube. At the time of germination, pollen produces vegetative cell and generative cell by mitosis cell division. The generative cell further undergoes mitosis division and produces two male gametes. Inside the pollen tube, two male gametes, one tube nucleus is present along with some cytoplasm. Gradually pollen tube enters in to the embryo sac present the ovary through micropyle. The pollen tube breaks open to release its contents. The two male gametes enter into embryo sac. Out of the two male gametes one fuses with egg or female gamete to perform generative fertilization or syngamy and forms zygote from where the embryo develops.

The second male gamete fuses with secondary nucleus to form endosperm nucleus. This fertilization is called vegetative fertilization as endosperm is a nutritive tissue formed to nourish the growing embryo. The tube nucleus



present inside the pollen tube is destroyed after the two male gametes are released into the embryo sac. The fusion of male and female gametes is called **fertilization**. Generally double fertilization occurs in flowering plants (angiosperms). In angiosperms the pollen tube bursts open in one of the two synergids to release the two male gametes. One male gamete fuses with the egg or oosphere to form a diploid zygote. It is called generative fertilization. The second male gamete descends down and fuses with the diploid secondary nucleus of the central cell to form endosperm nucleus. It is known as vegetative fertilization. The chromosome number in zygote is  $2n$  or diploid whereas in endosperm nucleus, it is  $3n$  or triploid. This process of fertilization in angiosperms or flowering plants is known as **double fertilization**. This is a specialization in flowering plants. After fertilization, the zygote divides several times and forms embryo. Embryo develops into a seed when it is covered by hard seed coat. Ovary grows with the development of seed and changes into fruit. The calyx and corolla etc. dry up and wither away.

### **Did you ever see any part of the flower in the flower?**

Embryo or future plant is present inside the seed. Embryo, when given suitable environmental conditions, germinates into seedling which later forms a new plant. This process of seed germination to form a plant is called seed germination.

### **Reproduction in animals:**

Some animals reproduce either by asexual or sexual method while few animals reproduce by both methods. Two common methods of asexual reproduction found in animals are fission and budding.

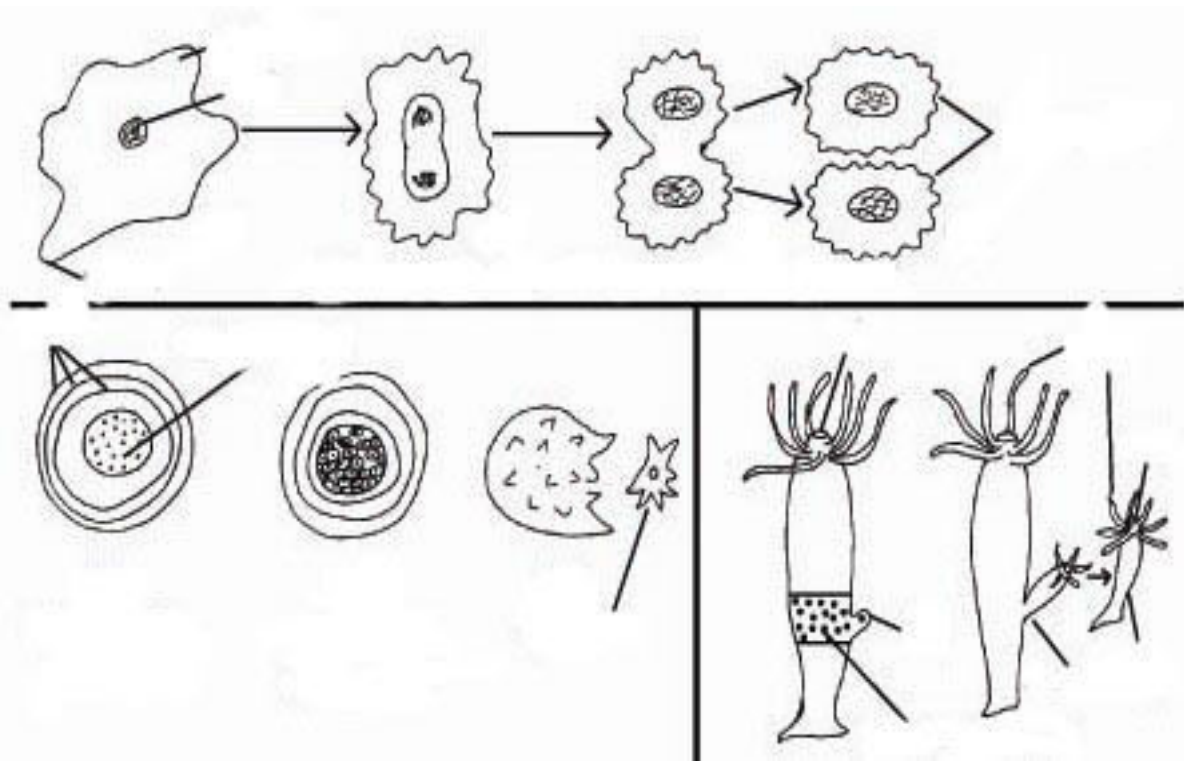
#### **(a) Fission:**

Fission is the simplest way of reproduction. It is of two types - (a) Binary fission and (b) Multiple fission

#### **(a) Binary fission:**

Animals like Amoeba, Paramecium, Euglena reproduce by this method. By this process two daughter cells are formed from mother cell. Example Amoeba lives in fresh water. In favourable environmental conditions (temperature should be  $25^{\circ}\text{C}$  and availability of sufficient food) amoeba grows. After attaining sufficient growth, it withdraws the pseudopodia, so the shape of amoeba becomes nearly round. It does not take food and gets ready for cell division. By mitotic cell division from one mother amoeba two daughter amoebae are formed. Pseudopodia are formed in daughter amoeba. They start collecting food from the environment with the help of pseudopodia and live normally and independently. It takes 30 minutes to complete this process. Amoeba that divides by this simple binary fission method does not have senescence (aging) and there is no natural death. From this point of view we can say that amoeba is immortal.

Paramecium and Euglena also reproduce by binary fission. In Paramecium, the division of cells occurs transversely hence it is called as Transverse Binary Fission. The plane of division passes along the longitudinal axis of the animal like Euglena. Hence the reproduction is known as Longitudinal Binary Fission.



### **Multiple Fission:**

Under unfavourable conditions i.e. when the pond water where amoeba lives dries up during Summer or water changes to ice due to excess cold, Amoeba withdraws its pseudopodia and secretes a three layered thick covering – the **cyst wall** around itself. During this stage, the metabolic activity ceases. Nucleus divides several times forming 500-600 nuclei. Each nucleus is surrounded by some cytoplasm. The tiny amoebae formed by this process are known as amoebulae. In the beginning of rainy season, on return of favourable conditions the cyst wall comes in contact with water, ruptures to release amoebulae in the surrounding medium to grow up into many amoebae. After this, pseudopodia form in amoeba and collect food from the environment and live normal life. The process of multiple fission in amoeba is known as **sporulation**. **Plasmodium**, malaria parasite, causes disease like malaria in human body also reproduces by multiple fission.

When infected mosquito bites, the sporogony of plasmodium enters into the blood and reaches liver cells. After entering the liver cell it reproduces by multiple fission. This type of multiple fission is called as **schizogony**.

### **Budding:**

Some unicellular animals and multi cellular animals such as sponge and hydra reproduce asexually by budding process. Budding is of two types – (i) External budding (ii) Internal budding

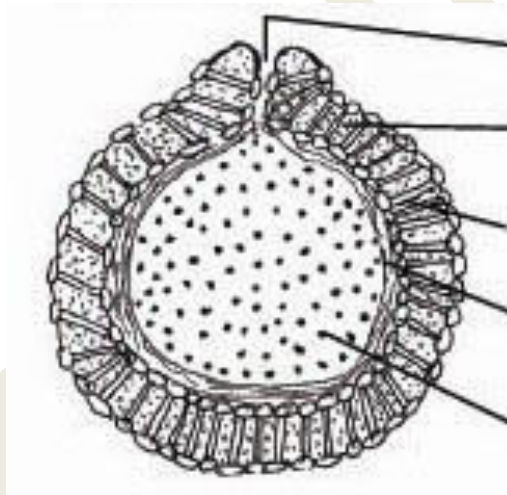
#### **i) External Budding:**

A healthy and matured hydra reproduces by budding under the favourable conditions and availability sufficient food. In the beginning, cells of a particular type group together in the middle of the hydra body and form a small outgrowth or protuberance called bud. This is called as budding zone. Gradually the bud grows in size, the coelenteron of hydra enters into bud. A

star shaped mouth is present at the anterior part of the bud and tentacles are formed around the mouth. Now it looks like a small hydra. Though the daughter hydra remain attached to mother body, it collects food with the help of tentacles. As soon as the daughter hydra grows fully, the base of it get contracted and split away from the mother hydra and collect food from the environment and take up an independent existence. This process takes 48 to 96 hours.

### **ii) Internal Budding**

Under unfavourable conditions and non availability of sufficient food, sponge prepares Gemmules (internal buds). In this process, at the very beginning cells of special type group together and enclosed by a hard protective coat and change into a gemmule. It remains open to outside through a hole called micropyle. In favourable climatic conditions, the cells inside the gammule comes out through micropyle and forms new sponge.



**Sponge Gemmule**

### **Regeneration:**

Regeneration is not reproduction process but it is considered as an independent arrangement found in some animals. Cut or fragmented or broken part of an organism regenerate to formation of new individual animal. If body of hydra is cut into pieces, each cut part develops into a new hydra. It can be noticed that a special type of cell called **Totipotent Cells** present in these organisms. These cells help in production of various other cells and tissues which help in growth of the organism. As a result the fragmented or broken parts grow into a new organism.

## **Human Reproduction:**

(i) Human beings belong to the class Mammalia. Both male and female play important role in reproduction which helps in increase in population and continuity of human species. They have separate responsibility in formation of offsprings. Hence male and female individuals are differentiated externally and this phenomenon is known as sexual dimorphism. We have discussed about **adolescence** in Class IX. During this period, young male and female individuals show various changes in secondary sex characters like change in body structure, functional and sentimental changes etc. Growth of beard and moustache in male and development of mammary glands in female, change in voice etc is seen along with the development of reproductive organs in both the sex, hence both attain the puberty and capable of reproducing their offspring.

## **Gametogenesis:**

By gamatogenesis sperms in testis and ova in ovary are formed. The process of the formation of sperm is called **spermatogenesis** and process of formation of ova is called **oogenesis**. (We know that during gamatogenesis, by meiosis cell division, sperm and ovum are formed and  $2n$  (diploid) number of chromosome of the somatic cell reduces to  $n$  (haploid) number of chromosome in gametes.)

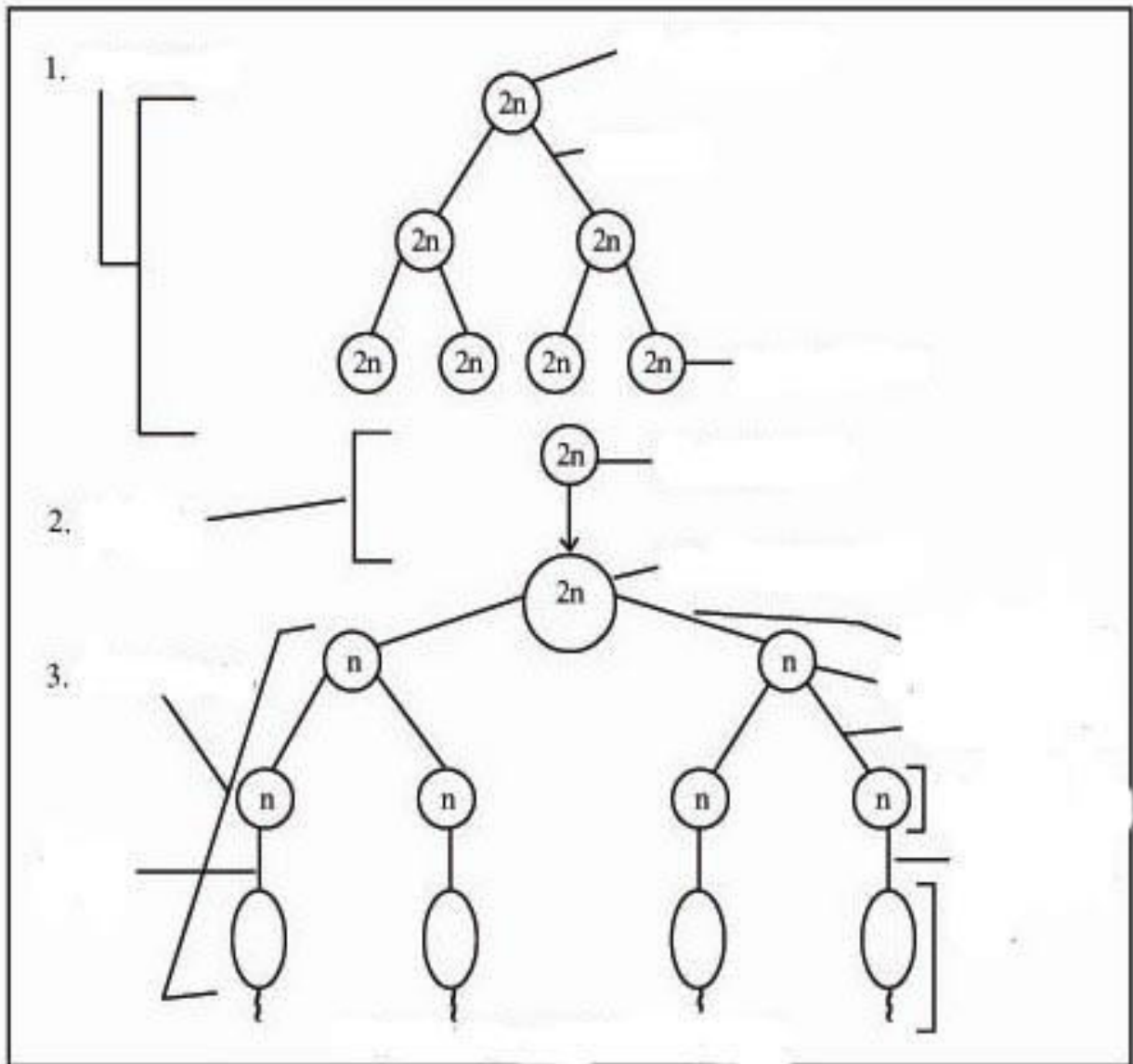
## **Spematogenesis:**

The testis of male is made up of numerous seminiferous tubules or sperm producing tubules. The seminiferous tubules are lined by **germinal epithelium**. The germinal epithelium consists largely of cuboidal primary or **primordial germ cells** which divide several time by mitosis to produce a large number of **spermatogonia**. This phase is called as **Phase of Multiplication**.

After the formation of spermatogonium cells, each spermatogonium actively grows to a large Primary spermatocyte by obtaining nourishment from the nourishing cells. This stage of changing spermatogonium into spermatocyte is called **Phase of Growth**.

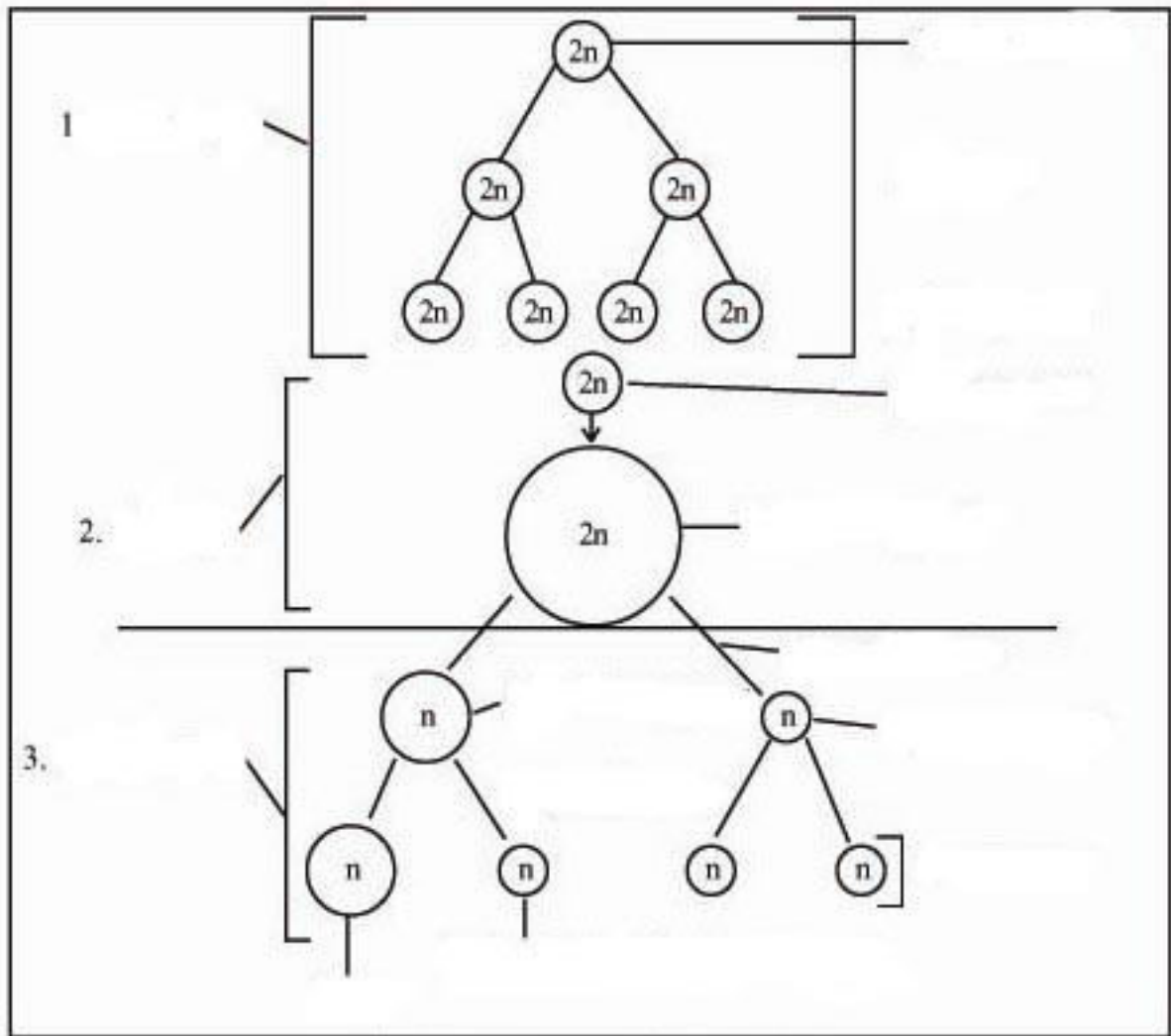
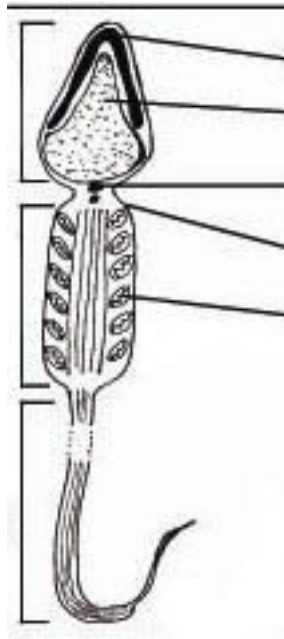
Each primary spermatocyte undergoes two successive divisions, called maturation divisions. The first maturation division is reductional or meiotic division. Hence the primary spermatocyte divides into two haploid ( $n$ ) daughter cells called secondary spermatocytes. Both secondary spermatocytes now undergo second maturation division which an ordinary mitotic division to form four haploid ( $n$ ) spermatids, by each primary spermatocyte.

Various changes or differentiations takes place in spermatids which are initially immovable to motile or movable sperms. The transformation of spermatids into spermatozoa is called **spermiogenesis**. The spermatozoa are later on known as sperms. Thus four sperms are from one spermatogonium. The time taken for the transformation of primary spermatocyte to sperm is known as **Phase of Maturation**.



### Sperm:

The sperms are microscopic and motile cells. Structurally sperm is an elongated cell having a tail. It has three parts. Head, middle piece and tail. The size of the sperm head differs with different animals. It contains anterior small **acrosome** and posterior large nucleus. The middle piece of sperm contains mitochondria. Neck is present between the head and the middle piece, contains the centriole towards the nucleus. Just below the middle piece, thread like tail is present. The sperm swims about by its tail in a fluid medium.

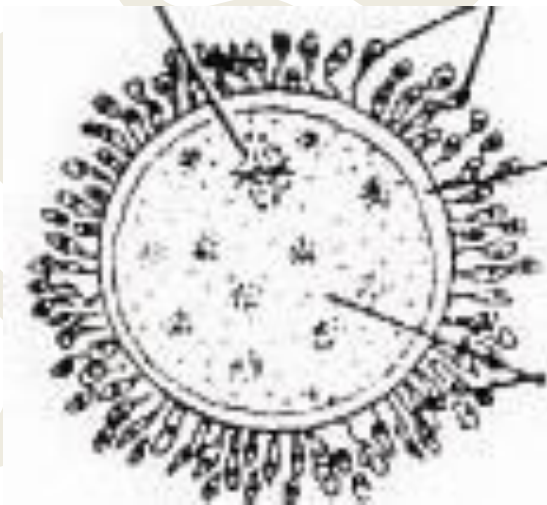


## **Oogenesis**

The process of formation of a mature female (ovum) is called oogenesis. It occurs in the ovaries (female gonads). The primordial germ cells present in the germinal epithelium (outer covering) of the ovary multiplies several times by mitosis produce a couple of million egg mother cells or **oogonia** in each ovary of foetus. This stage is known as **Phase of multiplication**.

After the formation of oogonia, each oogonium grows and attains a remarkable growth. Each oogonium gets surrounded by number of nourishment supplying cell from where its gets nourished. The oogonium grows into a large primary **oocytes**. It is known as phase of growth.

In the first stage of maturation phase, oocyte undergoes meiotic cell division. The primary oocyte divides into two very unequal haploid or 'n' chromosomal daughter cells – a large **secondary oocyte** and a smaller **first polar body or polocyte**. The difference in size is because the larger cell contains more cytoplasm as compare to the smaller cell. In the second stage of this maturation phase, mitotic cell division takes place in both secondary oocyte and first polar body. The secondary oocyte divides into two unequal daughter cells called **ootid** which grows into functional haploid **ovum** and second polar body. Whereas the first polar body undergoes mitotic division and form two second polar bodies. By the end of the maturation phase, one ovum and three polar bodies are formed.



## **Human Male Reproductive System:**

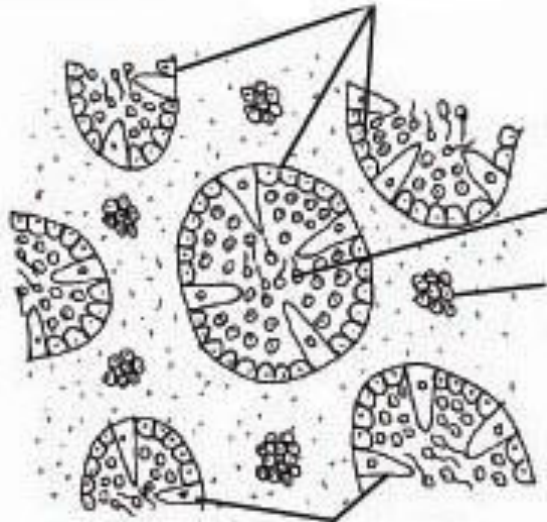
The male reproductive system consists of following part -(a) Scrotal sac (b) Testis (c) vas-deferens (d) urethra

### **(a) Scrotal sac**

In the male body, two scrotal sacs are present, each sac contains one testis. The normal temperature of the testes in the scrotum is about 2°C less than the internal body temperature (37°C), hence it is suitable for the formation of sperms. In mammals like elephant and whale two testes are found inside their body.

### **(b) Testis:**

Two testes, are present in man, are the primary sex organs. They are oval in shape. Sperms are produced from the seminiferous tubules. In between the seminiferous tubules in the connective tissue, there are present small groups of rounded **Leydig's cells** or interstitial cells which secrete **testosterone**, male sex hormones. Walls of each seminiferous tubule is formed of a single layered germinal epithelium. Majority of cells in this epithelium are cuboidal called male germ cells (spermatogonia) and at certain places, there are present tall and special type of cells called **Sertoli** cells. These cells support developing germ cells or male gametes (sperms) and provide them with nutrition especially spermatids.



### **(c) Vas-deferens:**

A vas-deferens, emerges from each side of testis travels upward into the abdominal cavity passing through an inguinal canal. The two vas deferens loop over the ureters of their sides, come together, and join the median duct, or urethra, at the back of the urinary bladder.

### **(d) urethra:**

Both semen and urine pass through urethra and excreted out of the body by the slit like opening of the penis called urinogenital aperture or urethral orifice.

## **Female reproductive system:**

Female reproductive system consist Ovary, Fallopian Tube, and Uterus.

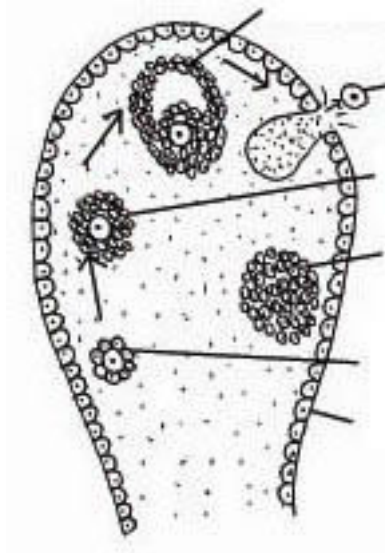
### **i. Ovaries**

Ovaries are primary sex organs in human female. The ovaries are paired structures located in the upper pelvic cavity or lower part of abdominal cavity. The ovary is covered by a layer of germinal epithelium which produces oocytes or ova. Besides producing oocytes, ovaries secrete hormones like oestrogens and progesterone. After attaining puberty, every month, one ovum develops fully in ovary and released into the fallopian tube. The development of the ovum begins with primary follicle. The primary follicle further grows and further converts into mature follicle called **Graafian follicle** which contains a matured ovum. The cytoplasm of ovum is enveloped by plasma membrane which is covered by thick noncellular homogenous membrane called **Zona**



**Pellucida.** Outer to zona pellucid there is very thick cellular layer, made up of radially elongated **follicular cells**. This layer is known as **Corona Radiata**.

The walls of the ovary gets ruptured to release the oocyte. After the release of oocyte or egg, Corpus Luteum is formed in place of Graafian follicles. It secretes a hormone called progesterone which prepares the uterus for receiving the embryo.



### ii) Fallopian tube:

The two oviducts or Fallopian tubes present in a female body are about 10-12 cm long. Near the corresponding ovary, the oviduct has a funnel-shaped opening called the oviducal funnel. The opposite end of the oviducal funnel opens into the uterus. Usually the fusion of ovum and sperm takes place in fallopian tube and zygote is formed. The zygote now enters into the uterus.

### iii) Uterus:

Uterus is a hollow pear-shaped muscular organ. It 7.5 cm long and 5.0cm broad. It is situated in the abdominal cavity or pelvic cavity between the urinary bladder and the rectum. It has two regions, an upper wider portion which receives the two oviducts and lower constricted part, the cervix or neck. The cervix of the uterus opens outside.

### Fertilization and events after fertilization

A series of rapid mitotic divisions of the zygote by cleavage process which convert single celled zygote into multicellular structure called blastula. Blastula converts into blastocyst and get attached to the uterine wall. This process is known as **implantation**. Placenta makes the intimate organic connection between the foetus (embryo) and uterine wall of the mother to exchange the materials. It is made of some part of both embryo and uterine wall. The placenta is connected to embryo through an umbilical cord which helps in the transport of oxygen and food material to embryo. Similarly, the waste materials released by the embryo are passed to placenta and then mother's body which later excreted. After implantation **gastrulation** process begins. By this process three germ layered **gastrula** is formed. The three germ layers of gastrula are **ectoderm, mesoderm and endoderm**. The three germ layers give rise to all the tissues, organs and organ systems by **organogenesis**. The duration of pregnancy in human beings is about 9 months  $\pm 7$  days which

is called gestation period. At the end of pregnancy vigorous contraction of uterus causes delivery or expulsion of foetus. This act of expelling the full term young one from mother's uterus at the end of gestation period is called **parturition**.

Sometimes the implantation process takes place inside the fallopian tube instead of uterus. This is called as ectopic pregnancy. Mother dies due wrong implantation of foetus. Ovum dies if fertilization is not being done properly.

### **Family Planning/Birth Control:**

Having limited number of children in the family and maintaining proper gap between the children is called Family planning. This programme is implemented by Government of India since 1952.

### **Various types of family planning methods**

Pregnancy can be avoided by stopping the fusion of sperm and ovum by any means. The various contraceptive methods are broadly grouped into two main types : (i) Permanent method and (ii) Temporary method.

### **Permanent methods of Birth Control**

This is a surgical or operational method. The surgical method blocks gametes transport and hence prevent fertilization. Sterilization procedure in the male is termed as **vasectomy** and that of the female **tubectomy**.

#### **i. Vasectomy:**

In vasectomy a small part of the vas deferens is removed or tied up through a small cut on the scrotum. As a result it becomes free from sperms. Now a days vasectomy is done without surgery within 10-15 minutes only.

#### **ii. Tubectomy:**

In tubectomy a small part of the Fallopian tube is removed or tied up through a small cut in the abdomen or through vagina so that union of sperm and ovum is not possible.

### **Temporary methods of Birth Control**

As per the Government of India Family Planning Act - four type of temporary methods of birth control measures are adopted. They are - (a) Prevention or obstruction method (b) Hormone method (contraceptive pills) (c) Intrauterine Contraceptive Devices (IUCDs) like (copper-T) (d) natural method.

Government has employed people in Family and Welfare Department called **Ashakarmis** to educate people about family planning and birth control. Hence children in groups can talk to Ashakarmis about this topic and clear their doubts in isolation.

### **AIDS and HIV**

AIDS: (Acquired Immune Deficiency Syndrome)

AIDS is not a disease. It is a state of human body in which the disease fighting power of the body slowly ceases. Hence a person suffering from AIDS cannot protect himself from any disease. Therefore any disease cause to AIDS infected person is difficult to cure.

The first information about the AIDS was found since the year 1960. But the first AIDS patient was found in Newyork of North America and California in the year 1981. In India the first AIDS patient was found in the year 1986. After this number of AIDS patients are increasing every year. It is a matter of concern that no medicine is discovered till date to control AIDS.

AIDS is caused by the virus called HIV (Human Immunodeficiency Virus). Like other virus its structure is also simple. Mainly the genetic material of this virus remains inside a coat made up of protein. This genetic material is RNA. The virus having RNA are called Retro Virus.

### **Pathogenecity**

WBC (White blood corpuscles) present in our blood protects us from any infections. But AIDS affected patient, the virus attacks the immune system and causes a marked reduction in **T-lymphocyte (type of WBC)**. As a result fever continues for months together. Similarly cough and dysentery continues. Problems are observed in respiratory and nervous system. The body weight of the patient decreases. As there is no successful treatment for AIDS, the patient ultimately dies.

### **AIDS infection and diagnosis**

AIDS producing virus cannot live more than one minute in outside environment of human body. It is transmitted directly from one person to another. Blood received from the AIDS patient and transmission of AIDS virus to the foetus from the AIDS affected mother is few examples. In India, 85% of AIDS is spreading due to sexual intimacy with AIDS patients. Our Indian culture of having one husband and one wife keep us safe from AIDS.

The diagnosis of AIDS can be done by a test called ELISA (Enzyme linked immune sorbent assay) but the most reliable test of AIDS Western blotting method. To create awareness about AIDS, every year 1<sup>st</sup> December is celebrated as World AIDS Day throughout the world.

### **WORK FOR YOU-1**

Dissolve about 10 gm of sugar in 100 mL of water. Take 20 mL of this solution in a test tube and add a pinch of yeast granules to it. Put a cotton plug on the mouth of the test tube and keep it in a warm place. After 1 or 2 hours, put a small drop of yeast culture from the test tube on a slide and cover it with a cover slip. Observe the slide under a microscope.

### **WORK FOR YOU-2**

Take a potato and observe its surface. Can notches be seen? Cut the potato into small pieces such that some pieces contain a notch or bud and some do not. Spread some cotton on a tray and wet it. Place the potato pieces on this cotton. Note where the pieces with the buds are placed. Observe changes taking place in these potato pieces over the next few days. Make sure that the cotton is kept moistened. Which are the potato pieces that give rise to fresh green shoots and roots?

### **WORK FOR YOU-3**

Take a Bryophyllum leaf and keep it in between pages of your notebook for some days. Now observe the margins of the leaf. What did you see? Whether roots come out of the marginal notches? Put this leaf in wet soil. Observe it after some day.

### **WORK FOR YOU-4**

Select a money-plant. Cut some pieces such that they contain at least one leaf. Cut out some other portions between two leaves. Dip one end of all the pieces in water and observe over the next few days. Which ones grow and give rise to fresh leaves? What can you conclude from your observations?

### **WHAT YOU HAVE LEARNT**

- Cell division are of two type found in organisms – Mitosis and Meiosis.
- Mitosis helps in growth and repair of an organism whereas Meiosis, gametes are formed.
- Two daughter cells are formed by Mitosis whereas four daughter cells are formed by Meiosis.
- Gametes are formed through gametogenesis. Gametogenesis has three phases – Multiplication Phase, Growth Phase and Maturation Phase.
- Special feature of any organism is reproduction and continuity of species.
- All living organisms like plants and animals continue their species either by asexual or sexual reproduction.
- Plants reproduce through a asexual reproduction like (i) fission (ii) Budding (iii) sporulation and (iv) vegetative propagation
- Sometimes Ovary develops into fruit without fertilization, is known as Parthenogenesis.
- Propagation of plants by culturing and developing tissues by culture medium and forming a large number of tissues from one tissue, from where a large number of plantlets are formed, called tissue culture.
- The reproductive parts in Angiosperms found in flower only.
- Before fertilization, the pollen grains transfer from anther to stigma by various external agents like wind, water, insects etc is called pollination.
- Gynoecium has three parts – stigma, style and ovary.
- Two stages of fertilization occur in flowering plants in Angiosperms called double fertilization. One male gamete fuses with the egg or oosphere to form a diploid zygote. It is called generative fertilization. The second male gamete descends down and fuses with the diploid secondary nucleus of the central cell to form endosperm nucleus. It is known as vegetative fertilization.
- Embryo develops from zygote and remains in seed.
- Plantlets develop after germination of seed and new plant is developed from these plantlets.
- Multicellular organisms are formed by more than one cell.
- Two types of cells are found in animals. One which help in reproduction called gametes or reproductive cells whereas other type helps in growth and development called somatic cells.
- Equatorial division or mitotic division occurs in somatic cells which retain  $2n$  chromosomes. Whereas gametes are formed through meiotic division where the chromosomes number become half or haploid ( $n$ ).

- Amoeba reproduces by binary and multiple fission, Sponge by producing gemmules and Hydra by budding, all these process are type asexual reproduction. Amoeba and Hydra also reproduce by sexual reproduction.
- The male reproductive system consists of following part -(a) Scrotal sac (b) Testis (c) vas-deferens (d) urethra
- Sperms are produced from the seminiferous tubules present in the testis.
- Male hormone, Testosterone is produced by the Leydig's Cells found in testes.
- Female reproductive system consist Ovary, Fallopian Tube, and Uterus.
- After attaining puberty, every month ovum is developed in ovary and passes to fallopian tube.
- Ovary secretes two hormones – Oestrogens and Progesterone.
- The number of children in a family can be controlled by adopting self control measures is called Family Planning.
- The various contraceptive methods of family planning are broadly grouped into two main types : (i) Permanent method and (ii) Temporary method.
- Sterilization procedure in the male is termed as **vasectomy** and that of the female **tubectomy**.
- Copper T, conceptive pills and Nirodh etc. are the temporary methods of Birth control and Family planning.
- AIDS is not a disease. It is a state of human body in which the disease fighting power of the body slowly ceases. Therefore any disease cause to AIDS infected person is difficult to cure.
- In AIDS affected patient, the virus attacks the immune system and causes a marked reduction in **T-lymphocyte (type of WBC)**.
- Having one husband and one wife rule keeps us safe from AIDS.

### ANSWER THE FOLLOWING QUESTIONS

1. Describe the various type asexual reproduction take place in plants.
2. Describe the fertilization process in flowering plants. What is the importance of it?
3. Describe the multiple fission reproduction take place in Amoeba.
4. Write about the asexual reproduction take place in Hydra.
5. Describe the Male reproductive system of a male.
6. Write the various methods of birth control / family planning.
7. Write a note on a Mitotic cell division.
8. Describe the Meiosis – I or first phase of meiosis division.
9. Differentiate between mitosis and meiosis division.
10. Write short notes on the following.
  - a. Full form of HIV and its significance
  - b. What is parthenogenesis?
  - c. Write the names of various phases occur in gametogenesis. What are all the important changes take place in these phases?
  - d. Describe the internal budding in sponge.
  - e. Write how multiple-fission takes place in Amoeba.

11. Define the following.

- a. Fertilization
- b. Temporary method of Birth control
- c. Ovary
- d. Organogenesis
- e. Scrotum

12. Answer in one line

- a. What is Callus?
- b. Name the hormone secreted by Ovary.
- c. Name the type of reproduction found in Amoeba under favourable conditions.
- d. Under which conditions, Hydra undergo budding process of asexual reproduction.
- e. Which cells of testes secrete testosterone hormone?
- f. Write two ways of detecting AIDS.
- g. What is the function of placenta?

13. Fill in the blanks

- a. \_\_\_\_\_ number of chromosomes present in Endosperm.
- b. The cell which produce all type cells is known as \_\_\_\_\_.
- c. The temperature of testis is \_\_\_\_\_ less than the internal temperature of human body.
- d. Spirogyra reproduce by \_\_\_\_\_ method.
- e. \_\_\_\_\_ is the genetic material found in HIV.
- f. The virus containing RNA is known as \_\_\_\_\_.
- g. \_\_\_\_\_, a type of WBC number reduces from the body of AIDS patient.

14. Make a correct relation

- a. Gametes : (n) : : zygote : \_\_\_\_\_
- b. Vasectomy : Vas deferens : : testosterone : \_\_\_\_\_
- c. Ovary : Oestrogens : : testes : \_\_\_\_\_
- d. Tube nucleus : Male nucleus : : Polar nucleus : \_\_\_\_\_
- e. Zoospores : Ulothrix : : Conidia : \_\_\_\_\_

15. Choose the correct answer from the options given below.

- a. Which hormone is secreted by Leydig's cells?  
(Testosterone, Progesterone, Oestrogens, insulin)
- b. From which year Family Planning Program started in India.  
(1952, 1957, 1986, 1990)
- c. In which organ of female reproductive system, fertilization takes place.  
(Ovary, Fallopian Tube, neck of the ovary, germinal epithelium)
- d. Where does sperms form?  
(uriniferous tubules, seminiferous tubules, scrotal sac, scrotum)
- e. Which type of reproduction is seen in yeast?  
(budding, vegetative propagation, sporulation, fission)

## Chapter-7

### Heredity and Evolution

#### HEREDITY

If we notice the living kingdom i.e. biotic world, we find that there is lot of similarity between the offspring and their parents. Face, colour of hair, complexion etc of a offspring matches with his/her parents, similarly if we sow the seed of balsam plant it will give white flower like parent plant and seed of a sweet mango is sown will give the same type of fruit bearing plant, etc. are some of the examples of heredity. All these phenotypic characters transmit from one generation to next. This is known as Heredity. Hence in simple language, **Heredity** is the transmission of genetically based characters from parents to their offspring.

#### Reproduction and variation:

We have already read about the reproduction in Chapter 6 of this unit. The offsprings inherit some new characteristics or traits along with basic parental characters. These new traits or characteristics transmit from one generation to next as a result variation increases and two organisms never look alike, either they are dissimilar in their features or different in genetic matter. This genetic matter carries all the characteristics of parents. Certain characters are visible in their progeny and certain disappear. The transmission of genetic matter from one generation to next result into formation of new traits and increase in variation, along with difference in the traits in every generation. Can you say how traits which are not visible in one generation many be seen in next generation?

#### Origin of Heredity:

Gregor Johann Mendel is known as **father of genetics**. He was working as a priest in a church of Australia. He used to continuously observe the pea plants (*Pisum Sativum*) sown in garden. The phenotypic variation in the pea plants of the garden made him interesting. He was interested to know the reason behind the difference of heights of pea plants in a row, various shapes and colours of pea nuts. He made a research by collecting various types of pea nuts and sowed in his garden. After continuous study of these pea plants, he found seven pairs contrasting characters. Mendel first took a pair of contrasting characters for his experiment and to study the growth of the contrasting characters while studying the process of Inheritance. He studied it for generation after generation and did not notice the other contrasting characters. Similarly, he studied the other contrasting characters and formulated theoretical explanations for interpreting his results. His explanations were further tested by him as to their validity. Mendel used statistical methods and law of probability for analyzing his results.

### 7 pair of contrasting character in pea plant.

	Character	Dominant	Recessive
1	Height of the Tree	Tall	Dwarf
2	Shape of the seed	Round	Wrinkled
3	Place of the flower	Axis	Jip
4	Colour of the Seed	Yellow	Green
5	Colour of the Skin	Gray	White
6	Shape of the pod	Swollen	Contracted
7	Colour of the tender pod	Green	Yellow

### Mendel's Experiment on Hybridisation:

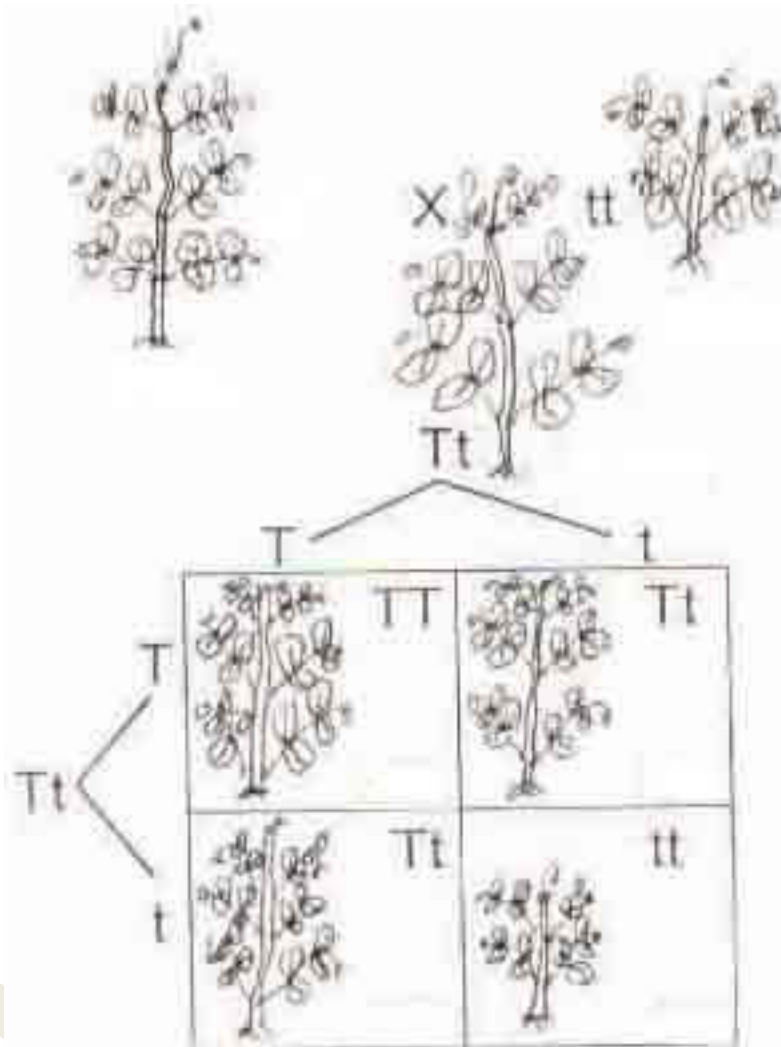
Mendel took the help of artificial method of hybridisation for his experiment on inheritance. He took two plants having contrasting characters. The androecium of the plant was plucked out carefully before its maturation. Hence the plant became regarded as a female plant. Pollen collected from contrasting character plant was dusted on stigma of female plant and made artificial pollination. In order to protect the flowers of the artificial pollinated plant from foreign pollination by other pollen grains, it is covered with paper bags either before the pollination or after pollination. Once seeds are matured, they are collected and kept safely for next year.

The two plants used for artificial pollination are called Parent (P) generation and plants produced by seeds collected after the pollination are sown called First filial or F<sub>1</sub> generation. Similarly, the plants of F<sub>1</sub> generation were allowed to perform the same method of pollination and the seeds and the plants raised from them constitute the second filial or F<sub>2</sub> generation. Mendel kept record of each generation and studied the genetic inheritance and produced a statistical methods and law of probability of contrasting characters. The cross in which only two alternate forms of a single character are taken into consideration is called monohybrid cross. Mendel also performed crosses involving two characters. They are called dihybrid crosses. Trihybrid and polyhybrid crosses were performed as well.

### Monohybrid Experiment:

Mendel took one pair of contrasting character and started experimenting on it. Before the hybridization, Mendel observed, in inheritance, out two factors or alleles representing the alternative traits of a character, one is **dominant** and expresses itself in the hybrid or F<sub>1</sub> generation and the other factor or allele is **recessive** and does not show its effect (principle of dominance). Experimenting on tall and Dwarf pea plants, Mendel observed that from the seeds of the tall





plant, tall trees are formed & from the seed of the dwarf plant, dwarf plants are produced. These are called as pure tall & pure dwarf plants and are the Parent (P) generation. He took tall and dwarf plants and made a cross the two and raised their progeny i.e. F<sub>1</sub> generation. The hybrids or plants of F<sub>1</sub> generation are all tall though they have received the factors for dwarfness. Hence Mendel imagined that the characters of each plant remain in pairs such as in tall plant (TT) and in dwarf plant (tt), where the characters of tall plant is dominant and the characters of dwarf plant are recessive. In F<sub>1</sub> generation, the resultant plants are tall (T) even though they contain the characters (Tt) where the (t) character is recessive or not expressive. The hybrids of F<sub>1</sub> plants are allowed to self breed, the plants of the second filial or F<sub>2</sub> generation appear to be both tall and dwarf in the phenotypic ratio of 3:1 where 3 tall plants and one dwarf plant. Similarly Mendel studies the other factors or alleles like colour of the seed, shape of the pea pods etc. and found that plants of F<sub>2</sub> generation, the ratio of dominant and recessive phenotypic character is 3:1. He named it as Monohybrid ration. On the basis of his observations on monohybrid cross, Mendel proposed a set of generalizations (postulations) which resulted into the formulation of two principles of inheritance and one law of inheritance. They

are like (a) Principle of unit character (b) Principle of dominance (c) Law of segregation.

### Principles of Unit Character

Each character transmitted in plant is controlled by one factor. These factors always remain in pairs such as tall (TT) dwarf (tt), yellow (YY), green (yy) etc. In each pair of character two similar type of factors (TT or tt) or complementary characters (Tt) are present. During meiosis, either of one factor transmits into gametes and when zygote is formed, the factors present in gametes reunite and form pair of factors.



**Gregor Johann Mendel** was born in the year 1822 in a poor farmer's family. He was deprived of education due to financial problems. He studied the inheritance property in garden peas when he was working as priest in a Monastery. As he was a mathematician and served as a teacher in mathematics, he could able to count the characteristics of each pea plant using statistical methods and result of his analysis was published in the form of law of probability. He worked for eight long years (1867-1865) and formulated laws on heredity called '**Laws of Heredity**' and '**Laws of Inheritance**'. Many scientists studied about the phenotype and genotype characters through artificial hybridization for few generations but failed to analyse the result using statistical methods hence could not able arrive to concrete decision or formulated any laws. Mendel presented his paper, "Versuche über Pflanzenhybriden" ("Experiments on Plant Hybridization"), at two meetings of the Natural History Society of Brno in Moravia on 8 February and 8 March 1865. Mendel's paper was published in 1866 in Verhandlungen des naturforschenden Vereins Brünn. But no one gave any importance to Mendel's research. Mendel died in the year 1884. Three scientist, Tschermak, De Vries and Correns rediscovered Mendel's research independently in the year 1900. Mendel never went to any university nor worked as a research fellow in any Research Institutes nor got opportunity to go to any Laboratories still due to his easy methods of analysis, observed the results minutely and gave strong evidences to his research made Gregor Mendel, a well known Scientist who is known as the "father of modern genetics".

### Principles of Dominance

According to this principle, after hybridization, out of two contrasting factors of F<sub>1</sub> generation, only one is able to express its effect in the individual. It is called dominant factor or dominant allele. The other allele which does not show its effect is called recessive factor or recessive allele. In the absence of dominant allele, the recessive allele became expressive. Therefore, in F<sub>1</sub> plants both the

factors for tallness and dwarfness are present. However, the factor for tallness is dominant over the factor for dwarfness, hence the trees are tall. The alleles (tt) only produce dwarf plants as it does not constitute the factor (T).

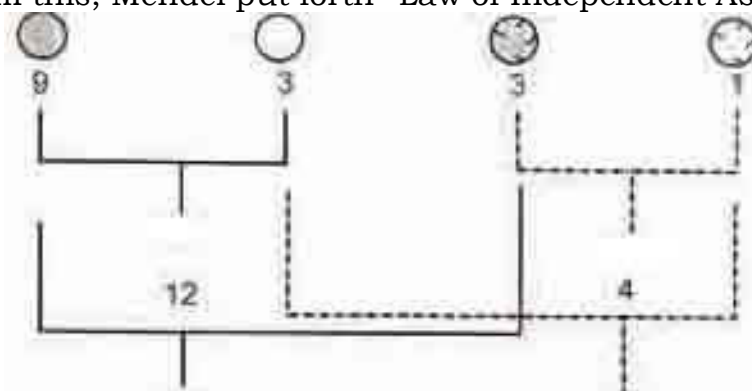
### Law of Segregation

According to this law, in  $F_1$  generation, though one copy of each of the two complementary factors present, the factors don't lose their identity and in  $F_2$  generation, though dominant factors are expressive but the recessive character though dormant but present in it.

During meiosis or reduction division, from the one pair of factors, one factor goes to each gamete that means from a hybrid plant of  $F_1$  generation two type gametes are formed. One gamete constitutes the dominant and other contains recessive factor. These factors get separated and transmitted to the next generation. Two gametes of (T) and (t) each are formed from one tall (Tt) hybrid plant. By this law Mendel proved that due to segregation, all characters of plant continue to express from generation to next.

### Dihybrid Experiment :-

Mendel carried dihybrid experiment to know how two pair of complementary characters are transmitted at a time to the next generation. For this he collected the seeds pure breeding Pea plant having yellow round seeds (YYRR) and pure breeding Pea plants having green wrinkled seeds (yyrr). He crossed and got progeny, which are parents for first filial generation  $F_1$ . The plants of the  $F_1$  have all yellow and round seeds (YyRr) because yellow and round traits are respectively dominant over green and wrinkled traits i.e. following the law of dominance. He proved that even though more than one complementary pair of characters present, always dominant characters are expressed in  $F_1$  generation. Mendel collected seeds for the  $F_2$  generation, by self pollination of the plants of  $F_1$  generation, the plants produced in  $F_2$  generation are having four type of seeds such as round and yellow, round and green, wrinkled and yellow, wrinkled and green and their phenotypic ratio of a dihybrid cross is found to be 9:3:3:1. As per the Mendel's imagination, if breeding is done independently on two pairs of contrasting characters, then as per the statistical formula, two pairs of contrasting characters are produced in  $F_2$  generation where their ratio will be equivalent to the ratio of Monohybrid ratio i.e.  $(3:1)^2 = 9:3:3:1$ . From this, Mendel put forth "Law of Independent Assortment".



### Law of Independent Assortment :-

According to law, If self pollination is carried out in hybrid plants having more than one pair of complimentary characters, transmission of expressed character from F<sub>1</sub> generation to F<sub>2</sub> generation occur independently and the characters or traits never mix with each other. Example: If self pollination is done on a hybrid plant F<sub>1</sub> generation having round and yellow seed (RrYy), then in F<sub>2</sub> generation all 4 complimentary characters are expressed separately. When each pair of complementary factor are taken separately it is found that out of 16 possible combinations, 12 plant having round seed & 4 plant having wrinkle seeds, that means the ratio of the plant having round and wrinkled is 3:1. Similarly 12 plants with yellow seeds and in 4 plants green seeds are found that means the ratio of yellow and green seeds is also 3:1.

		RRYY	x	rryy	
		Round & Yellow		Wrinkled & Green	
			RrYy		
	RY	Ry	rr	ry	
RY	RRYY Round and Yellow	RRYy Round and Yellow	RrYY Round and Yellow	RrYy Round and Yellow	
Ry	RRYy Round and Yellow	RRyy Round and Green	RrYy Round and Yellow	Rryy Round and green	
rY	RrYY Round and Yellow	RrYy Round and Yellow	rryy Wrinkled and yellow	rryy Wrinkled & yellow	
ry	RrYy Round and Yellow	Rryy Round and Green	rryy Wrinkled and yellow	rryy Wrinkled and green	

Round and Yellow-9

Round and green-3

Wrinkled and yellow-3

Wrinkled and green-1

Mendel could able to find out mathematically, the ratio of expressive and genetic factors in every pair of contrasting characters and he also could able to find the mathematical expressions for inheritance of more than one pair of complementary factors.

### **Mendel found out the ratio of expressed character and genetic factor.**

Number of complementary character	Type of expressed character in F2 generation	Ratio observed in F2 generation	Genetic ratio in F2 generation
1	2	3:1	1:2:1
2	4	$(3:1)^2$	$(1:2:1)^2$
3	8	$(3:1)^3$	$(1:2:1)^3$
n	$2^n$	$(3:1)^n$	$(1:2:1)^n$

Mendel's contribution was rediscovered again in 1909 Willholm Jhonsen. (1857-1927) named imaginary character of Mendel as gene for the first time he began the use of two words Genotype & Phenotype. Gene is the part of DNA and it controls all the function of the body. According the command of the gene (DNA) different characters are expressed in the organism.

### **Sex Determination:**

The chromosomes present in the cell are of two types such as sex chromosome and autosome. Chromosomes play an important role in determining the sex of the offspring. Sex is determined during the fertilization of sperm & ovum. The chromosome number in human is 23 pairs, out of which 22 are autosomes and one pair is a sex chromosome. In female, the sex chromosomes pair is (XX) and in male body this pair is (XY) one X and one Y. In each mature ovum, 22 autosomes and one X chromosome are present. But in half of sperms 22 autosomes and one X chromosome and rest half contains 22 autosomes and one Y chromosome. Therefore depending upon the sex chromosomes the sperms are of two types. When the sperm having X chromosome fertilizes ovum, a female child is born and sperm having Y chromosome fertilise with the ovum then male child is born. So it is clear that for the birth of the male child the sperm having Y chromosome is necessary. Hence father is responsible for determining sex of the child. Scientifically a female cannot be blamed for not giving birth to a male child.

### **Evolution:**

From where the different organisms like plants and animals found on earth have come? Various religious theories are formulated answer for this question. 'All creatures are created by the God', 'highly evolved organisms from galaxy have sown life on earth', 'The explosion of Cosmic matter resulted into existence of the basic life on earth'. Though there are different opinions regarding the formation of life on the earth surface, bio-scientist believe that life on the earth surface is created by abiotic and inorganic substances. For the first time in 1920 A.I. Oparin (1894-1980) & J.B.S. Haldane (1892-1964) put forth their Opinion regarding the formation of life on earth. After that in 1953, Stanley Miller (1930-2007) and Harold Urey (1893-1981) made a new experiment in their laboratory where some amino acid are formed by the combination of methane, ammonia, hydrogen and water vapour etc. They made

little changes in the mixture and found a nucleotide called Kelvin Adenine. In due course of time proteins are formed by amino acid chain and from nucleotide chain, RNA and DNA are formed. From all these experiments, it is proved that “life is formed from matter”.

The first living cell found floating on the sea surface was very simple and primitive. Gradually it becomes higher and complex form. The plants and animals that we see today are not similar to plants & animals found millions of years ago. Gradually they passed through different changes and reached from the simple organisms to present day complex structure. Evolution is a process of moving ahead which is unchangeable. This is very slow and continuous process. The change or evolution found in plants and animals is called organic revolution. Due to this organic evolution, we see various differences between the organisms of the earth surface. In other words bio-diversity is possible due to organic evolution.

### **Relation in between organism:**

It is impossible to calculate how many millions of plants and animal species are there in the earth surface. Each species of plant and animal are different from each other in their structure and characters. Among all the difference between the organisms many basic similarity are also there. Cell is the structural unit of all organisms. Besides bacteria & few primitive plants like algae, all plants and animals of the organic kingdom, a number of similarities are found in the cellular structure as well as in various metabolic activities taking place in the cell. Two essential processes of life are transformation of energy and synthesis of largest molecules such as nucleic acids, Proteins and carbohydrates etc. which takes place in all the different cells in same way.

Photosynthesis in green plants, release of energy from the glucose molecule by aerobic or anaerobic method and functions such as formation of new cell by using this energy etc. take place continuously in organisms.

### **Evidence of evolution:**

#### **Fossil evidence:**

The body remains of the plants and animals live on the earth crust is called as fossils. We get an idea of ancient earth and plants and animals found during that period by studying the fossils found from the different parts of the earth. By studying the fossil remains we can establish the relationship between two groups of organisms i.e. reptiles and birds. When we observe these two groups of organism we find that between these two group differences are more than similarities. But after the discovery of fossil of archaeopteryx, it is found that it has both the character of reptile as well as birds. Zoologist, after studying all these things, proved that the cold blooded, slow and less active reptiles are the ancestors of warm blooded aerial birds.

## **Structural evidence:**

In order to identify any animal, at first its structure and morphology is to be considered for the study. After studying different animals, it is found that different group of animals have similarity among them.

### **1. Homologous organs**

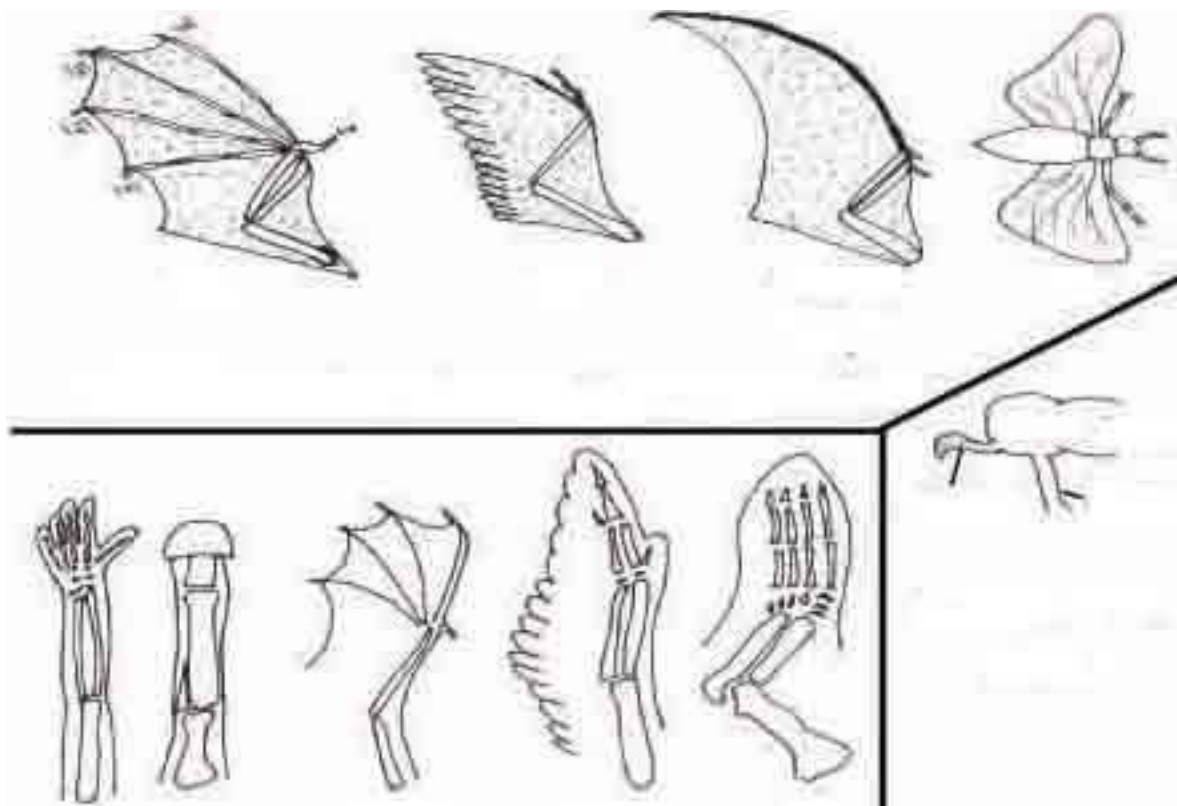
The organs which have the same fundamental structure but are different in functions are called homologous organs. These organs follow the same basic plan of organization during their development. In mammalian group, the wings of bat, paw of cat, flippers of seal and whale, limbs of horse, fore-limbs of man have different functions. But they are similar in origin, structure, arrangement and development of bones etc. Similarly, in plants, tendrils of *Curcubita* (pumpkin) and thorns of *Bougainvillea* are functionally different, but their origin is same i.e. both arising from axillary position. The fundamental structure and internal construction and origin of embryo and its course of development of these organs are same. Therefore all these organs are known as homologous organs. These organs are modified to perform different functions as an adaptation to different environments. The homologous structures are a result of divergent evolution.

### **Analogous Organs:**

The organs which have similar functions but are different in their origin, structure, way of arrangement and embryonic development are called analogous organs. The analogous structures are the result of convergent evolution. For example: Wing of mosquito, wing of pigeon or wings of bat these are called analogous organs. The functions of wings of all these animals are same, but the basic structure of wings is different.

### **Vestigial organs:**

The organs which are present in reduced form and do not perform any function in the body but correspond to the fully developed functional organs of related animals are called vestigial organs. They are believed to be remnants of organs which were complete and functional in their ancestors but remain as vestigial organs instead of total disappearance, because of adaptation to different



environment, change in habitat etc. Examples- as snakes started living in holes hence organs are not required. Vestiges of hind limbs and pelvic girdles can be seen in python even though they are not in use.

In humans, appendix which is attached to the large intestine is a vestigial organ. In herbivores have appendix which is functional. Carnivorous animals like lion, tiger etc have no appendix at all.

### **Evidence from embryology:**

In the course of the development of the embryo of vertebrates such as fishes amphibians, Reptiles, birds and mammals, it is observed that they resemble one another. The embryo of every vertebrate consists of gill clefts or its earlier state and notochord (earlier state of spinal cord). By the time, development is completed only fish have gill clefts but in all other vertebrates gill clefts are disappeared. Lungs replaced the gill clefts similarly in place of notochord dorsal spinal cord is developed.

### **Theory of evolution:**

In 1809, French biologist Jean Buptiste Lamarck (1744-1829) put forth a theory related to evolution. Lamarck's theory of evolution is well known as theory of Inheritance of Acquired Characters. His theory is also known as Lamarckism. According to Lamarckism environment influences all types of organisms. A change in environment brings about changes in organisms. It gives rise to new needs. New needs or desires produce new structures and



change habits of the organisms. Whatever an individual acquires characters in life time due to internal vital force, effect of environment, new needs and use and disuse of organs, they are inherited (transmitted) to the next generations. The process continues. After several generations, the variations are accumulated upto such extent that they give rise to new species. Lamarck explained his theory by giving the example of evolution of Giraffe. The ancestors of giraffe were bearing a small neck and forelimbs and were like horses. But as they were living in places with nor surface vegetation, they had to stretch their neck and fore-limbs to take the leaves for food, which resulted in the slight elongation of these parts. Whatever they acquired in one generation was transmitted to the next generation with the result that a race of long necked and long fore-limbed animals was developed. Whereas organs which are not in use are gradually become shorter and rudimentary and exist in body as vestigial organs. Towards the end of 19th century a German biologist August Weismann (1834-1914) carried out research on the rats. This German scientist cut off the tails of rats for as many as 22 generations and allowed them to breed, but tailless rats were never born. He observed that in following generation the rats took birth with a long tails. Though Lamarckism is being criticized in different times still we remember him as he, for the first time put forth a clear cut opinion on evolution and influence of environment on all types of organisms.

In 1859 a book was published in England written by Charles Robert Darwin. The name of the book was "The Origin of species". In that book he explained the formation of new species by the process of "Struggle for existence and natural selection".

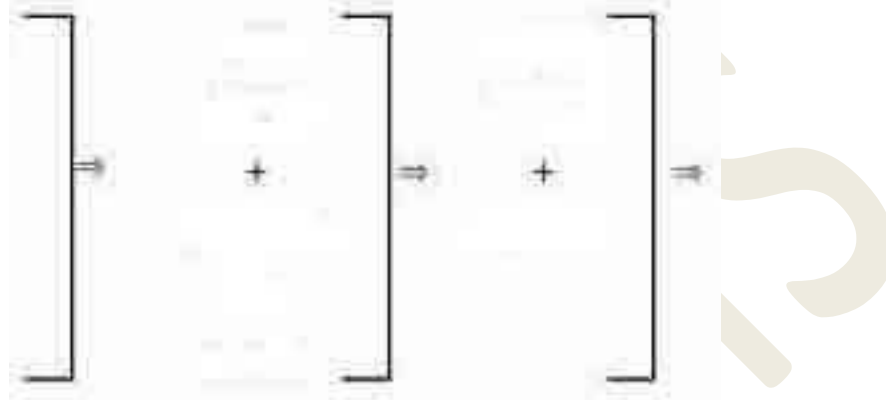
### **Darwin's Theory in Short**

All organisms that is every plant or animal possess enormous fertility. Fish lay millions of eggs at a time. Similarly plant produces thousand of seeds at a time. But all the eggs of the fish do not hatch and produce fish. If this would have been taken place, then all water bodies, sea, river, ponds and canal would have been filled with fish. All the offsprings never survive due to the shortage of food, habitation, diseases etc. Some of them grow old and do not have potential to reproduce. Hence number of species in all organisms is limited.

Every organism has to struggle hard for food, habitation and right partner. It is called "Struggle for existence". According to struggle for existence, only organisms survive who win over the intraspecific struggle (it is a struggle between the individuals of the same species), interspecific struggle (struggle between the members of different species) and environmental struggle (struggle between organisms and the environmental factors like drought, heavy rain and other natural calamity etc). That means the organisms provided with favourable variation adapt themselves with changing nature or environment would survive. Nature will accept only those organisms which can adapt or change themselves according to the changed conditions of the environment and discard unfity. Nature's acceptance means nature selects them. The organisms after getting fitted to the surroundings or selected by the nature are

transmitted their useful variations to next generation and increase in its population. Darwin called it **Natural Selection** and implied it as a mechanism of evolution.

Example : Around 230 millions of years ago, in Mesozoic period, giant reptiles like Dinosaurs were ruling the earth. During this period, variation came because of severe cold climate, the cold blooded giant size dinosaurs couldn't protect themselves from cold but small reptiles, warm blooded mammals and birds (aves) could change and adjust themselves with changing climatic conditions. The nature accepted the organisms who adapted themselves with the changed environment whereas those could not, became extinct.



### **Modern Concepts of Evolution**

Due to the development in the fields of Molecular biology and Evolutionary science, biologists modified the Darwin's theory of natural selection and often called Neo-Darwinism. Thus modern concept of evolution is synthesis is known as Synthetic theory of Evolution.

As we know that the characters or traits of every organism depend on the genes they are carrying. Genes are found in the chromosomes of organisms (plants and animals) inherit from their parents. The most important character of genes is it neither harm or change itself while transmitting to next generation. If the genetic structure remains unchanged in the progeny, variation does not occur. As a result bio-diversity does not take place. It is law of the nature. Mutation in genes occurs due to influence of various factors of nature. Mutation also occurs due to chromosomal aberration (structural change in chromosome) and genetic recombination (structural change in genes). All these changes together are called variation. It is the basic source of change in nature. The changed characters of the nature selected organisms are transmitted to their offspring through hereditary and the offspring or new organism with changed traits or characters adapt themselves with changed environment will survive in the **“survival of fittest”** mechanism. This clearly depicts the importance of role of selection by nature. Depending on the new characters of nature selected organisms, new species generated should be different with each other and with their ancestors else unnecessary interbreeding cannot be prevented. Interbreeding is not good for reproduction of new organisms. Hence, nature has

a mechanism to prevent this while reproducing new organisms. This is known as **isolation mechanism**. Using this mechanism, the process segregation of organisms is known as **isolation**. As per synthetic theory of evolution or modern concept of evolution, variation, selection and isolation play pivotal role in evolution.

### **Evolution of human**

Man is the only rational animal in the universe, who can raise questions and search for answers. For this he thinks over the courses and reasoning. He never ran away from unfavourable environmental conditions rather tried to bring changes in environment as per his requirement because man has got highly developed brain and his fore-limbs are free.

Earlier people used to think that earth was existed in cosmos and sun and moon revolve around it. God sent human as their representative to rule on other creature on earth. This thinking was continued for many years. In 15<sup>th</sup> century, Nicholas Copernicus told that like earth, there are five more planets revolving around the earth and like sun, there are billions of stars present in our cosmos. By end of 19<sup>th</sup> century, Charles Darwin proved that humans are bipedal animals and their origin can be proved. He mentioned in his book “Descent of Man and Selection in Relation to Sex” that the ancestor of today man was like apes. As Darwin did not have sufficient proof to prove his publication, people made mockery of his statement.



**Charles Robert Darwin** was born in England, on 12 February 1809 middle class wealthy family. After completion of schooling, he studied subjects like medicine, geology and botany for some years and left for expedition in ship called HMS Beagle as a Naturalist from 27.12.1831 to 2.10.1836 and reached Galapagos Islands of South America where he studied on giant saurian (lizard), tortoise, platypus etc. Later gathering his own experiences and some research done, he wrote a book called “The Origin of Species”. His controversial topic Bio-diversity though initially gained criticism but later by the end of 20<sup>th</sup> century his theory was widely accepted by all scientists. After rediscovery of Darwin’s Inheritance, Hugo de Vries put forward Mutation theory. Mutation plays an important role in evolution and Darwin theory is secondary. In 1935, the effort made by the scientists like Theodosius Dobzhansky, Julian Huxley, Sewall Wright, J.B.S. Haldane and few others and proved the relationship between Law of Heredity, Mutation theory and The Principle of Natural Selection. This later named as ‘Modern Synthetic Theory’. Darwin died in the year 1882.

In 20<sup>th</sup> century development took place in the fields like microbiology, physiology and palaeo-anthropology. Basing on these subjects, scientist evaluated Darwin's theory of evolution of human being and proved that the ancestor of man was an ape like creature. Basing on the evidence of fossils, anthropologists discovered Ramapithecus and Sivapithecus, ancestors of man were living about 20 million years ago in Africa and Asia respectively. They are the ancestors of Australopithecus who were existed 5 million years ago in South Africa. Australopithecus was the first ape like man to stand erect on two legs so that his fore-limbs remain free which help him to protect himself and for hunting. He first used weapons and various tools. From ape like creature Australopithecus, gradually different genus of homo was developed, such as Homo habilis, Homo-erectus and Homo-sapiens. Today human, Homo-sapiens, used to live in Africa about 5 lakh years ago. He was aware of the use of fire and also cross the river by the boat. Homo-sapiens migrated to other different part of the earth and settled there. Cultural evolution of man started after the biological evolution. Evolution is a continuous process and is still continuing.

#### **WORK FOR YOU-1**

Collect some green and yellow pea seeds and sow it either in your garden or school garden. Collect the seeds formed from these plants and observe how the seeds are formed in these plants. What did you observe?

- Whether the seeds of green pea plant become yellow? If yes, give reason.
- Whether the seeds of yellow pea plant become green? If yes, give reason.
- Whether the seeds of yellow pea plant become yellow?
- Which theory, you are following?

#### **WORK FOR YOU-2**

Follow the statistical formula of Mendel and cross hybrids of four pairs of complementary characters allowing self pollination. Note down the offsprings produced in successive generation and their ratio.

#### **WHAT YOU HAVE LEARNT**

- Children inherit the characters of their parents and the process is called evolution.
- In order to prove the law of inheritance, Mendel used contrasting characters of garden pea and analysed the law of heredity through statistical methods and law of probability.
- Mendel proposed a set of generalizations (postulations) which resulted into the formulation of two principles of inheritance and two laws of inheritance. They are like (a) Principle of unit character (b) Principle of dominance (c) Law of segregation (d) Law of Independent Assortment.
- Because of segregation and law of independent assortment, the contrasting characters transmitted to next generation without any aberration as per law of heredity.
- Evolution is a continuous process. It is always progressive in nature.
- The variation occurs in plants and animals is called 'Bio-diversity'.
- Somehow there is similarity in the basic trait carried by plants and animals.
- By studying the fossil remains we can establish the relationship between two groups of organisms which are now different from each other.
- French biologist Jean Buptiste Lamarck (1744-1829) was the first to say that environment influences on all organisms.

10. In 1859, the book 'The Origin of Species' was published. The writer of the book, Charles Darwin established with proof that new organisms are formed following the 'Survival of Fittest and Natural Selection' process.
11. As per Modern Synthetic Theory of evolution or modern concept of evolution, variation, selection and isolation play pivotal role in evolution.

### EXERCISE

#### Answer the following questions

1. What is dihybridisation? How Mendel propounded and explained 'Independent Law of Assortment' from this?
2. How and which laws and principles of heredity did Mendel formulate by Monohybrid experiment?
3. Explain Darwinism.
4. Write various theories about formation of new organisms.
5. What do you mean by homologous and analogous organs? Explain giving examples.
6. Discuss Modern Synthetic theory or concept of evolution theory?
7. What are fossils? What did we come to know after studying the fossils?
8. Write short notes on the following.
  - a. Write the names of primary molecules of life.
  - b. What is bio-diversity?
  - c. Mention the evidences on evolution based on fossils?
  - d. What do you mean by vestigial organs?
  - e. Write a note on evidences from embryology?
9. Answer in one Sentence:
  - a. Archaeopteryx connects between which two groups of animal?
  - b. What is the relation between tendrils of Curcubita (pumpkin) and thorns of Bougainvillea?
  - c. What is the relation between the wings of mosquito, pigeon and bat?
  - d. Name the book published by Charles Darwin in 1859.
  - e. Name the important factors of Modern Synthetic Theory.
10. Define the following
 

a. Mendel's artificial hybridization	d. Independent law of Assortment
b. Homologous organs	e. dihybrid experiment
c. Law of segregation	f. analogous organs
11. Choose the correct answer from given choices:
  - (a) Mendel's experiment on heredity was carried out on which plant?
 

(a) Sugar cane	(b) Pea	(c) Gram	(d) Rice
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  - (b) How many complementary factors were selected in Mendel's Monohybrid cross?
 

(a) 1	(b) 2	(c) 3	(d) 4
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  - (c) Which type of offspring is produced in F<sub>1</sub> generation when Mendel hybridised pure tall plant with pure short plant?
 

(a) Pure tall	(b) Tall	(c) Pure short	(d) short.
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  - (d) If self pollination is done between the tall plants of F<sub>1</sub> generation then what is the ratio of tall & short plants produced in F<sub>2</sub> generation?
 

(a) 1:1	(b) 2:1	(c) 3:1	(d) 4:1
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  - (e) How many types of visible forms are found in F<sub>2</sub> generation of dihybrid cross?
 

(a) 1	(b) 2	(c) 3	(d) 4
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## **LESSON 8**

### **SOURCES OF ENERGY**

To do any work, energy is required. We are all very much worried about the Energy Crisis. If energy can neither be created nor destroyed, we should have no worries! We should be able to perform endless activities without thinking about energy resources! This riddle can be solved if we recall what else we learnt about energy.

Energy comes in different forms and one form can be converted to another. For example, if we drop a plate from a height, the potential energy of the plate is converted mostly to sound energy when it hits the ground. If we light a candle, the process is highly exothermic so that the chemical energy in the wax is converted to heat energy and light energy on burning. What other products are obtained when we burn a candle? The total energy during a physical or chemical process remains the same but suppose we consider the burning candle again – can we somehow put together the heat and light generated along with the products of the reaction to get back the chemical energy in the form of wax? Let us consider another example. Suppose we take 100 mL of water which has a temperature of 348 K (75°C) and leave it in a room where the temperature is 298 K (25°C). What will happen? Is there any way of collecting all the heat lost to the environment and making the water hot once it has cooled down?

In any example that we consider, we will see that energy, in the usable form, is dissipated to the surroundings in less usable forms. Hence, any source of energy we use, to do work, is consumed and cannot be used again.

#### **8.1 WHAT IS A GOOD SOURCE OF ENERGY?**

What can then be considered a good source of energy? We, in our daily lives, use energy from various sources for doing work. We use diesel to run our train besides we use electricity to run electric trains, light our street-lamps and irrigate our agricultural lands. Or we use energy in our muscles to cycle to school. Due to scarcity of Electric energy, we use wind energy in place of electric energy for irrigating the farm lands.

The muscular energy for carrying out physical work, electrical energy for running various appliances, chemical energy for cooking food or running a vehicle all come from some source. We need to know how do we select the source needed for obtaining the energy in its usable form. Given the range of fuels we have today, what are the factors which would limit our choices when it comes to a particular task like cooking our food? Would the fuel selected also depend on the work to be done? For example, would we choose one fuel for cooking and another for heating the room in winter?

We could then say that a good source of energy would be one

- which would do a large amount of work per unit volume or mass,
- be easily accessible,
- be easy to store and transport, and
- perhaps most importantly, be economical.

Depending upon the availability of the energy resources, source of energy is classified as

1. Renewable source of Energy
2. Non-renewable source of Energy

**1 Renewable Source of Energy** – as the name suggests energy is formed or regenerated once again after it is being used or it can be produced naturally from the energy resources. It is also known inexhaustible source of energy and we can store them for future use. Solar energy, energy from Biomass, hydropower, wind energy, nuclear energy, geothermal energy, tidal energy are few examples of this type of energy.

### **Sun is the ultimate source of energy**

There are various sources of energy available on the earth's surface, among all Sun is the main source of Energy. The energy produced by the water currents and air currents, the biochemical energy from the dead and decaying remains of plants and plants, energy from fossils etc are from the Sun only. Can you say how is it possible? The air and water currents flow due to the sun rays only. The solar radiation affect the rainfall as result of which water current is produced. Similarly the atmospheric pressure is different in different places due to temperature difference because of solar radiation, hence the air current is generated. Boats and ships use energy produced by the water currents. Similarly the air currents are utilized to run starting from windmills to sailboats. The biochemical energy stored in plants are due to the photosynthesis where the green plants trap solar energy of sun. Through food chain this energy is used by the all animals. The land containing forests and animals sometimes get buried under the earth due to earth quake or other natural disasters and under the pressure and temperature it transforms into fossils fuels, it takes millions of years to form fossil fuels, e.g. coal, petroleum and natural gases. We get heat energy, electric energy and mechanical energy from fossil fuels. From these we can conclude that Sun is the ultimate source of energy.

### **SOLAR ENERGY**

The Sun has been radiating an enormous amount of energy at the present rate for nearly 5 billion years and will continue radiating at that rate for about 5 billion years more. Only a small part of solar energy reaches the outer layer of the earth's atmosphere. Nearly half of it is absorbed while passing through the atmosphere and the rest reaches the earth's surface. Earth receives a negligible amount of solar energy (i.e. one fiftieth million part of total solar energy) as compared to total radiation of Sun in the entire solar system. That means earth receives a constant amount of solar energy which is known as Solar Flux or Solar Constant. The solar energy reaching unit area at outer edge of the earth's atmosphere exposed perpendicularly to the rays of the Sun at the average distance between the Sun and earth is known as the solar constant. It is estimated to be approximately 2 Calories of energy per minute per square centimeter. It is always constant. Earth absorbs half the total amount of solar energy reaches the earth surface and rest reflected from the Earth back into the space or radiated back into the space is known as Albedo. The amount of solar energy absorbed by Earth is more than that of energy produced by petroleum and coal. It is estimated

that in India, the solar energy reaching unit area at outer edge of the earth's atmosphere exposed perpendicularly to the rays of the Sun at the average distance between the Sun and earth is 1.2.kW per square meter.

India is lucky to receive solar energy for greater part of the year. It is estimated that during a year India receives the energy equivalent to more than 5,000 trillion kWh. Under clear (cloudless) sky conditions, the daily average varies from 4 to 7 kWh/m<sup>2</sup>.

A black surface absorbs more heat as compared to a white or a reflecting surface under identical conditions. Solar cookers and solar water heaters use this property in their working.

### **SOLAR COOKER**

A **solar cooker** is a device which uses the energy of direct sunlight to heat, cook or pasteurize food or drink.



Solar cooker

### **MACHANISM USED IN SOLAR COOKERS AND ITS FUNCTION**

The main parts of the solar cooker are : base container, heat absorbing surface and reflector.

#### **Base container (Box)**

It is the box or base container where we can keep water or food to be heated or cooked. The outer surface of the container is coated with black colour in order to trap more heat energy.

#### **Heat absorbing surface**

The inner surface of the box or container is also coated with black colour. A transparent glass sheet is put on the top of the box to cover it. The solar UV rays are then converted to longer infrared rays that heat the pot and food. The longer UV rays are not able to pass back out through the glass (transparent) covering and are thus retained inside the box enclosure, creating a buildup of heat; raising the temperature inside to sustainable cooking levels and thus causing the food to cook.

#### **Reflectors**

Sun rays are to be concentrated on the glass covering of the box using plane or concave reflectors. Sunrays are focused on cooking vessel (box) by rotation the solar cooker as per the direction of sunrays. The reflectors are



generally made up Aluminium metal or glass. The inner surface of the reflectors are polished for maximum reflection.

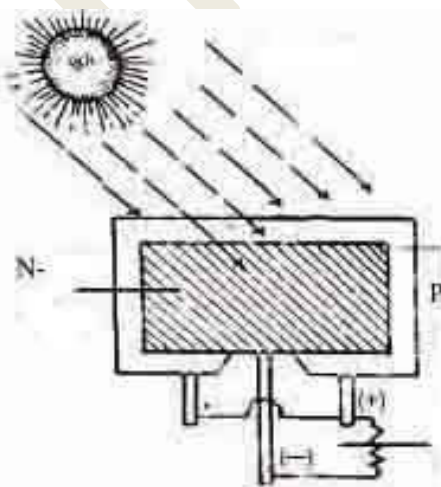
As a result the temperature inside the box increases and the food is heated with using more temperature and cooked.

### **SOLAR CELLS**

The device which converts the solar energy into electric energy is called Solar Cell. It is used in motor vehicles, radios and televisions machines. Solar cells are used in remote areas like snowy mountain ranges and spacecrafts to run machines using solar energy. The first successful experiment done on the solar cell was in 1954 in the Bell Laboratories of United States of America. Water was heated by indirect method using Solar Heat and the water vapours produced is used to rotate turbines to produce electricity. Solar cell generates a potential difference when exposed to sunlight and harnesses the solar energy. This process of trapping solar energy is known as **Photovoltaic effect**. Potential difference created in Solar Cells is same as that of Semi Conductors when the later is exposed to sun light therefore it name as Photovoltaic effect.

### **STRUCTURE OF A SOLAR CELL**

As per the diagram shown above the n-type electron is placed on p-type of silicon. Silicon is tetravalent i.e. the outer most shell of Silicon contains four electrons. Arsenic is doped to Silicon crystal to make it n-type of Silicon. As Arsenic is pentavalent when combined with tetravalent Silicon, one electron remains free which acts as a charge carrier. As it is a negatively charged electron, therefore Arsenic doped Silicon is known as n-type Silicon. Similarly, if Boron is doped with Silicon it changes into p-type Silicon. Potential difference is created when Sunrays fall on n-type and p-type Silicon. If a conducting wire is connected to terminals of the p and n-type Silicon, electric current flows. Electric current flows in solar cell as long as it receives light. In this way the solar energy is converted into the electric energy.



Solar cell

A typical cell develops a voltage of 0.5–1 V and can produce about 0.7 W of electricity when exposed to the Sun. A large number of solar cells are,

combined in an arrangement called solar cell panel that can deliver enough electricity for practical use.

Silicon, which is used for making solar cells, is abundant in nature but availability of the special grade silicon for making solar cells is limited. The entire process of manufacture is still very expensive, silver used for interconnection of the cells in the panel further adds to the cost. In spite of the high cost and low efficiency, solar cells are used for many scientific and technological applications. Artificial satellites and space probes like Mars orbiters use solar cells as the main source of energy. Radio or wireless transmission systems or TV relay stations in remote locations use solar cell panels. Traffic signals, calculators and many toys are fitted with solar cells. The solar cell panels are mounted on specially designed inclined roof tops so that more solar energy is incident over it. The domestic use of solar cells is, however, limited due to its high cost.

### **WIND ENERGY**

The use of wind energy is very old. About 5000 years ago, Egyptians used to drive sail boats using wind energy. Maritime trade between the coastal nations was taking place by ships having masts and sails. They used have this wind energy to sail their ships. But in due course of time, other activities like cutting of wood, flour mills and oil mills run by electricity converted from wind energy harnessed in wind mills.

Unequal heating of the landmass and water bodies by solar radiation generates air movement and causes winds to blow. This kinetic energy of the wind can be used to do work. This energy was harnessed by windmills in the past to do mechanical work. For example, in a water-lifting pump, the rotatory motion of windmill is utilised to lift water from a well. Today, wind energy is also used to generate electricity. A windmill essentially consists of a structure similar to a large electric fan i.e it contains the propellers of



Wind Mill

around 6m of diameter that is erected at some height on a rigid support or high towers. To generate electricity, the rotatory motion of propellers of the windmill is used to turn the turbine of the electric generator.

Government of Odisha erected wind mills Puri Sea beach with the support of Denmark Government. This wind energy farm is supplying nearly 5.5 mW power per annum. Few wind mills are also erected near Konark Sea beach.

**DO YOU KNOW** - Denmark is called the country of 'winds'. More than 25% of their electricity needs are generated through a vast network of windmills. In terms of total output, Germany is the leader, while India is ranked fifth in harnessing wind energy for the production of electricity. It is estimated that nearly 45,000 MW of electrical power can be generated if India's wind potential is fully exploited. The largest wind energy farm has been established near Kanyakumari in Tamil Nadu and it generates 380 MW of electricity.

Wind mills are mostly found in France, Germany, Denmark and Netherlands. Around 30,000 houses and 3000 factories in Netherland and Denmark get electricity by wind mills only. In India, for the first time an arrangement was done to life water using energy drawn from wind mill in National Aeronautic Laboratory, Bengaluru, in 1966. Now the wind mills are very famous in the states like Karnataka and Gujarat.

The output of a single windmill is quite small and cannot be used for commercial purposes. Therefore, a number of windmills are erected over a large area, which is known as wind energy farm or wind energy. The energy output of each windmill in a farm is coupled together to get electricity on a commercial scale.

Generators cannot be run once the wind speed is reduced as the blades of the wind mill wont rotate to produce wind energy. Since the tower and blades are exposed to the vagaries of nature like rain, Sun, storm and cyclone, they need a high level of maintenance. Hence wind mills are not very useful. Generally wind mills are very useful, in the remote area where electric current cannot be reached, for lifting water to irrigate the farm lands.

### **HYDRO ENERGY**

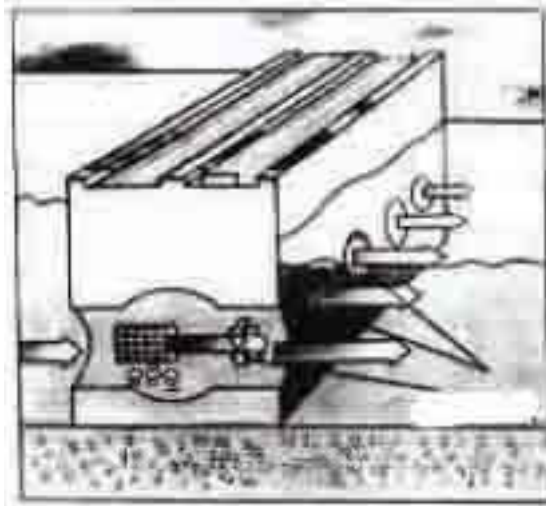
Like wind energy, energy trapped from water is known as hydro energy. Hydro Energy is of two types – i) Tidal Energy ii)Wave Energy

### **TIDAL ENERGY**

Due to the gravitational pull of mainly the moon on the spinning earth, the level of water in the sea rises and falls. If you live near the sea or ever travel to some place near the sea, try and observe how the sea-level changes during the day. This phenomenon is called high and low tides and the difference in sea-levels gives us tidal energy. Tidal energy is harnessed by constructing a dam across a narrow opening to the sea. A turbine fixed at the opening of the dam converts tidal energy to electricity. As you can guess, the locations where such dams can be built are limited. Similarly, the kinetic energy possessed by huge waves near the seashore can be trapped in a similar manner to generate electricity.

The world's first large-scale tidal power plant is the Rance Tidal Power Station in France, which became operational in 1966. The difference between the high tide and low tide near the mouth of River Rance increases the level of water by 14 m. This low and high tides occurs twice in a day and electricity can be generated by trapping and converting tidal energy produced by high tides.

To trap the tidal energy, about 20 Km long reservoirs can be built along with sluice gates. During high tide the gates remain open so that water enters into the reservoir and later gates to be closed. Now the water level increases in the reservoirs holding a large amount of potential energy. With the receding tide, this energy is then converted into mechanical energy as the water is released through large turbines that create electrical power through the use of generators.



Tidal Energy

In our country, Tidal Energy Power stations are found in Gulf of Kutch, Mumbai Gulf and near the river mouth of Hoogly river in West Bengal. India can utilize its long coastline for generating electricity by established Tidal power plants. If this is done then India will prosper in the fields of electricity generation and irrigation.

### **WAVE ENERGY**

The kinetic energy possessed by huge waves near the seashore can be trapped in a similar manner to generate electricity. The waves are generated by strong winds blowing across the sea. Wave energy would be a viable proposition only where waves are very strong. A wide variety of devices have been developed to trap wave energy for rotation of turbine and production of electricity.

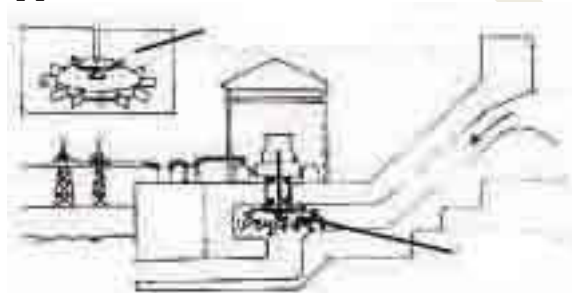
### **OCEAN THERMAL ENERGY**

The water at the surface of the sea or ocean is heated by the Sun while the water in deeper sections is relatively cold. This difference in temperature is exploited to obtain energy in ocean-thermal-energy conversion plants. These plants can operate if the temperature difference between the water at the surface and water at depths up to 2 km is 293 K (20°C) or more. The warm

surface-water is used to boil a volatile liquid like ammonia and ChloroflouroCarbon (CFC). The vapours of the liquid are then used to run the turbine of generator. The cold water from the depth of the ocean is pumped up and condense vapour again to liquid. The energy potential from the sea (tidal energy, wave energy and ocean thermal energy) is quite large, but efficient commercial exploitation is difficult.

### **RIVER DAM PROJECT**

In order to produce hydel electricity, high-rise dams are constructed on the river to obstruct the flow of water and thereby collect water in larger reservoirs. The water level rises and in this process the kinetic energy of flowing water gets transformed into potential energy. The water from the high level in the dam is carried to low level or bottom of the dam with a very high speed. As a result the hydro energy released by this rotates the turbines. The Armature attached to turbines rotate and generates electricity. As per the Electricity Supply Act 1948 of Government of India where the production and distribution of hydro electricity is done by the Government only. In Odisha hydel projects are found in Hirakud, Machakund, Balimela, Upper Kolab and Upper Indravati.



River Dam Project

Maximum power can be generated through Hydro Energy Projects and Hydro energy can easily be transformed into other energy forms. But this energy has to be harnessed by using easy and inexpensive way so that it can be exploited commercially and demand of electric supply can be fulfilled.

### **GEOHERMAL ENERGY**

The thermal energy generated and stored in the Earth is known as Geothermal Energy which can be trapped and utilized. Due to geological changes, molten rocks known as magma formed in the deeper hot regions of earth's crust are pushed upward and trapped in certain regions called 'hot spots'. When underground water comes in contact with the hot spot, steam is generated. Sometimes hot water from that region finds outlets at the surface. Such outlets are known as hot springs. The steam trapped in rocks is routed through a pipe to a turbine and used to generate electricity. But in some areas the steam and hot water comes out on earth surface automatically without using pipes. This hot water and steam can also be utilized to generate electricity.

This is the cheapest and best mode of trapping energy because it is available throughout the year. The main advantage of Geothermal energy trapping is it does not pollute the environment. The cost of production would not be much, but there are very few commercially viable sites where such energy

can be exploited. There are number of power plants based on geothermal energy operational in New Zealand and United States of America. In India, Geothermal power plants are established in Madhya Pradesh.

### **NUCLEAR ENERGY**

How is nuclear energy generated? In a process called nuclear fission, the nucleus of a heavy atom (such as uranium, plutonium or thorium), when bombarded with low-energy neutrons, can be split apart into lighter nuclei. When this is done, a tremendous amount of energy is released if the mass of the original nucleus is just a little more than the sum of the masses of the individual products. The fission of an atom of uranium, for example, produces 10 million times the energy produced by the combustion of an atom of carbon from coal. In a nuclear reactor designed for electric power generation, such nuclear 'fuel' can be part of a self sustaining fission chain reaction that releases energy at a controlled rate. The released energy can be used to produce steam and further generate electricity.

In a nuclear fission, the difference in mass,  $\Delta m$ , between the original nucleus and the product nuclei gets converted to energy  $E$  at a rate governed by the famous equation,  $E = \Delta mc^2$ , first derived by Albert Einstein in 1905, where  $c$  is the speed of light in vacuum. In nuclear science, energy is often expressed in units of electron volts (eV):  $1 \text{ eV} = 1.602 \times 10^{-19}$  joules. It is easy to check from the above equation that 1 atomic mass unit ( $u$ ) is equivalent to about 931 mega electron volts (MeV) of energy.

Nuclear power reactors located at Tarapur (Maharashtra), Rana Pratap Sagar (Rajasthan), Kalpakkam (Tamil Nadu), Narora (UP), Kakrapar (Gujarat) and Kaiga (Karnataka) have the installed capacity of less than 3% of the total electricity generation capacity of our country. However, many industrialised countries are meeting more than 30% of their electrical power needs from nuclear reactors.

The major hazard of nuclear power generation is the storage and disposal of spent or used fuels – the uranium still decaying into harmful subatomic particles (radiations). Improper nuclear-waste storage and disposal result in environmental contamination. Further, there is a risk of accidental leakage of nuclear radiation. The high cost of installation of a nuclear power plant, high risk of environmental contamination and limited availability of uranium makes large-scale use of nuclear energy prohibitive. Nuclear energy was first used for destructive purposes before nuclear power stations were designed. The fundamental physics of the fission chain reaction in a nuclear weapon is similar to the physics of a controlled nuclear reactor, but the two types of device are engineered quite differently.

### **Bio-Mass**

We mentioned earlier that wood has been used as a fuel for a long time. If we can ensure that enough trees are planted, a continuous supply of fire-wood can be assured. You must also be familiar with the use of cow-dung cakes as a fuel. Given the large live-stock population in India, this can also assure us a steady source of fuel. Since these fuels are plant and animal products, the source of these fuels is said to be bio-mass. These fuels,

however, do not produce much heat on burning and a lot of smoke is given out when they are burnt. Therefore, technological inputs to improve the efficiency of these fuels are necessary. When wood is burnt in a limited supply of oxygen, water and volatile materials present in it get removed and charcoal is left behind as the residue. Charcoal burns without flames, is comparatively smokeless and has a higher heat generation efficiency.

The Organic matter is generally divided into three categories -

1. New plants – trees, plants, cereals/grains, algae etc
2. Residue – straw, husk, sugarcane waste, forest waste (dead and decaying plants, leaves, barks, peels and roots) etc.
3. Waste Materials – decomposed waste, animal excreta, drain waste, organic waste of the factories, cow dung etc.

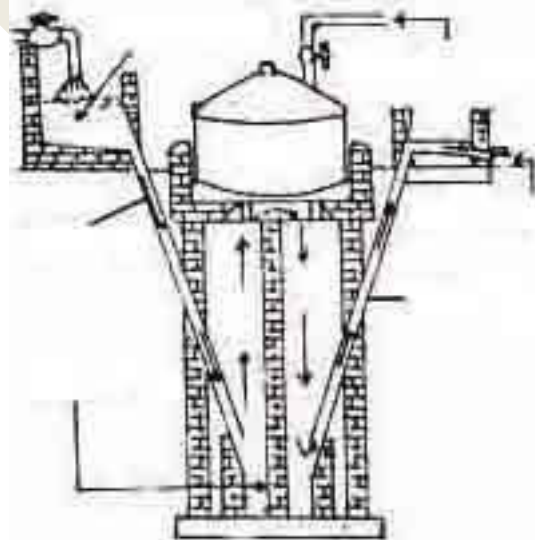
Combustion, Pyrolysis, Gasification and Liquefaction are the various steps through which bio-energy is produced from the organic waste.

### **BIOGAS**

The mixture of gases released by the breakdown of organic matter in the absence of oxygen is called the biogas. Similarly, cow-dung, various plant materials like the residue after harvesting the crops, vegetable waste and sewage are decomposed in the absence of oxygen to give bio-gas. Since the starting material is mainly cow-dung or Gobar, it is popularly known as 'gobar-gas'. The gas released from the cow dung and the organic waste is known as Methane. There are more than 30 crore cows and buffaloes available in our country. About 30 percent fuel is received from the cow dung and another 34 percent we get from the agricultural waste. About 90 crore tons of cow dung is collected from the cows and buffaloes of our country. Hence Gobar gas plants are established to generate bio-energy in an improved and easy method. Government is providing financial help to the villagers to establish gobar gas plants. The gobar gas plant can supply cooking gas to seven to eight families by collecting and using the cow dung of 4-5 cows or buffaloes.

### **STRUCTURE AND FUNCTION OF GOBAR GAS PLANT OR BIOGAS PLANT**

GOBAR GAS plant has following parts-



GOBAR GAS PLANT

1. Mixing Tank - A slurry of cow-dung and water in a 4:5 ratio is made in the mixing tank from where it is fed into the digester.

2. Digester-well – the digester-well is a sealed chamber in which there is no oxygen and its walls are built with bricks and cement. One third of this is placed above the earth and two thirds below the earth. The mixed slurry of cow-dung is stored in this chamber.

3. Metal Dome – this dome like structure is built with iron metal. Now a days this dome is built with cement and concrete. This dome like structure covers the digester-well completely and cuts off the oxygen entry. Anaerobic micro-organisms like methanogen and other bacteria that do not require oxygen decompose or break down complex compounds of the cow-dung slurry. It takes a few days for the decomposition process to be complete and generate gases like methane, carbon dioxide, hydrogen and hydrogen sulphide. The bio-gas contains about 75% of methane which is an excellent fuel. The pressure produced by the bio-gas makes the dome to rise up.

4. Delivery pipes - The bio-gas is stored in the gas tank above the digester from which they are drawn through pipes supplied to oven for use. Arrangements are made to use this gas under controlled pressure.

Bio-gas is an excellent fuel and very useful fuel. It burns without smoke, leaves no residue like ash in wood, charcoal and coal burning and does not cause any eye or respiratory diseases. Its heating capacity is high. Bio-gas is also used for lighting. The environment remains unpolluted as cow-dung is efficiently used leaves no mosquitoes or housefly breeding. If cow-dung is directly used for preparation of manure, around 50% of dung will be wasted. The slurry left behind is removed periodically and used as excellent manure, rich in nitrogen and phosphorous where only 25% of the dung is wasted. This manure does not give any foul smell and easily mixes with the soil. Apart from fuel and lighting lamps, bio-gas is used to generate electricity and also helps in working of electrical appliances. Hence, the large-scale utilization of bio-waste and sewage material provides a safe and efficient method of waste-disposal besides supplying energy and manure.

## **2 NON-RENEWABLE SOURCE OF ENERGY**

This type of energy is very limited. This energy resource is generally generated by nature only without the interference of man. It is called as non-renewable as its excessive use leads to exhaust and it cannot be renewed. Coal, Petroleum and Natural gas are few examples of non-renewable source of Energy.

**FOSSIL FUEL** - In ancient times, wood was the most common source of heat energy. Later discovery and use of coal, petroleum and natural gas etc replaced it. All these are categorized under Fossil Fuel. Coal is formed from the dead remains of the plants whereas the petroleum and natural gas is formed from remain of dead sea animals and sea plants. As these fossil fuels ( coal, petroleum and natural gases) are of very limited in nature, the excess exploitation of these fuels leads to exhaustion of it from the nature and cannot be renewed by nature. Can you think of some of these uses? The



exploitation of coal as a source of energy made the industrial revolution possible. Increasing industrialisation has led to a better quality of life all over the world. It has also caused the global demand for energy to grow at a tremendous rate. The growing demand for energy was largely met by the fossil fuels – coal, petroleum and natural gas.

**COAL** - Coal is used as an energy resource for long many years. It is found beneath the earth's crust in layers. It produces Carbon. Besides carbon it also has other compounds. Basing on the percentage of carbon, the quality of coal is classified as follows –

- a. Anthracite – it is the best quality coal which contains 94% to 98% carbon.
- b. Bituminous – this quality coal contains 79% to 93% of carbon.
- c. Lignite – this quality coal contains carbon about 72% to 78%.
- d. Peat – this type coal contains 44% to 71% carbon.

Coal containing highest carbon percentage gives maximum energy. When coal is burnt, the carbon of the coal mixes with oxygen in atmosphere process carbon dioxide which creates pressure in the atmosphere. Energy generated from coal is used as heat energy in domestic as well as industrial sector. Electricity generated from coal is used in many sectors is known as Thermal Energy. Odisha is having a Thermal Power Generation Plant in Talcher.

Coal is transformed into Coke by Destructive Distillation method which is useful in extraction of various metals. Coke is used as a reducing agent in manufacturing of Steel.

**PETROLEUM** – Petroleum is the mixture of hydrogen and carbon i.e. complex hydrocarbon compound. It also contains some amount of oxygen, nitrogen and sulphur containing carbon compounds. This valuable fuel is found in the earth's crust, formed by nature in the form of crude oil. It cannot be used as raw form i.e. crude oil cannot be used. Through Fractional Distillation method, crude oil is distilled into usable petroleum. In this process only one product is collected i.e. petroleum under constant temperature.

**NATURAL GAS** – Some petroleum mixed gases are released while extraction of petroleum from Earth's crust. This gas is known as natural gas. Sometimes Natural gas is comes out in place of Crude oil from the Oil fields. The main component of this gas is Methane. Natural gas is used as fuel in domestic and industrial purpose. This gas is extracted and collected into big tanks from where it is supplied through pipes to various places. This method of supplying the natural gas through pipe lines is found in Vadodra of Gujarat in our country. It cannot be filled into gas cylinders as it is not easy to change gas into liquid form. It is observed that Natural gas is naturally conserved in Rajasthan, Coastal Mumbai, deltaic regions of Godavari and Krishna rivers.

Burning fossil fuels has other disadvantages too. Air pollution is caused by burning of coal or petroleum products. The oxides of carbon, nitrogen and

sulphur that are released on burning fossil fuels are acidic oxides. These lead to acid rain which affects our water and soil resources. In addition to the problem of air pollution, recall the green-house effect of gases like carbon dioxide.

The pollution caused by burning fossil fuels can be somewhat reduced by increasing the efficiency of the combustion process and using various techniques to reduce the escape of harmful gases and ashes into the surroundings. Besides being used directly for various purposes – in gas stoves and vehicle, you know fossil fuels are the major fuels used for generating electricity.

### **WORK FOR YOU – 1**

- List four forms of energy that you use from morning, when you wake up, till you reach the school.
- From where do we get these different forms of energy?
- Can we call these 'sources' of energy? Why or why not?

### **WORK FOR YOU – 2**

- Take two conical flasks and paint one white and the other black. Fill both with water.
- Place the conical flasks in direct sunlight for half an hour to one hour.
- Touch the conical flasks. Which one is hotter? You could also measure the temperature of the water in the two conical flasks with a thermometer.
- Can you think of ways in which this finding could be used in your daily life?

### **WORK FOR YOU – 3**

- Study the structure and working of a solar cooker and/or a solar water-heater, particularly with regard to how it is insulated and maximum heat absorption is ensured.
- Design and build a solar cooker or water-heater using low-cost material available and check what temperatures are achieved in your system.
- Discuss what would be the advantages and limitations of using the solar cooker or water-heater.

### **WORK FOR YOU – 4**

- Take a table-tennis ball and make three slits into it.
- Put semicircular ( ) fins cut out of a metal sheet into these slits. Pivot the tennis ball on an axle through its centre with a straight metal wire fixed to a rigid support. Ensure that the tennis ball rotates freely about the axle.
- Now connect a cycle dynamo to this.
- Connect a bulb in series.
- Direct a jet of water or steam produced in a pressure cooker at the fins. What do you observe?

### **WORK FOR YOU – 5**

- Our state is having lot of natural resources. So there is no worry to conserve the fossil fuel. We should follow our forefathers how they used work to conserve energy. Energy conservation plays important role in development. Arrange a debate on this topic.

## WORK FOR YOU - 6

- Make a solar heater using materials easily available. Observe that how much heat is generated by the heater depending on the intensity of sunrays by placing it in the direction of sunrays.

### What you have learnt?

1. Energy is required for doing any work.
2. Energy can neither be destroyed nor created. It only changes from one form to another form.
3. Once energy is transformed another state it cannot come back to its original form.
4. Depending upon the availability of the energy resources, energy is of two types i.e. Renewable source of Energy and Non-renewable source of Energy
5. Solar Energy, Hydro Energy and Wind Energy etc are renewable sources of Energy whereas Coal, Petroleum etc are non-renewable energy.
6. Sun is the ultimate source of Energy.
7. It is estimated that in India, the solar energy reaching unit area at outer edge of the earth's atmosphere exposed perpendicularly to the rays of the Sun at the average distance between the Sun and earth is 1.2.kW per square meter.
8. A **solar cooker** is a device which uses the energy of direct sunlight to heat, cook or pasteurize food or drink.
9. Solar cells are used in remote areas like snowy mountain ranges and for spacecrafts to run machines using solar energy.
10. Solar cells are used to convert Solar Energy into Electric Energy.
11. Windmills are mostly used in Denmark.
12. The type of fuel we get from organic matter (plants and animals) is known as Bio-fuel or Bio-mass.
13. We can generate bio-energy from cow-dung and vegetable waste.
14. Methane gas is the mixture of Carbon, Carbon dioxide, hydrogen and hydrogen sulphide gases.
15. Anthracite is best quality coal whereas the Peat is the lowest quality.
16. Coke is obtained from coal by Destructive distillation method.
17. Methane is the main component of both Gobar Gas and Natural Gas.

## EXERCISE

### I Answer the following questions

1. Explain the structure and function of Solar Cooker with relevant diagram.
2. Discuss how electricity is generated from the Tidal Energy.
3. Draw a wind mill and explain how it functions.
4. 'Sun is the ultimate source of energy', explain.
5. Draw Gobar Gas Plant and explain its various sections and how it functions.
6. What is solar cell? How is it beneficiary to mankind?
7. How do we generate electricity through River Dam Projects?
8. Differentiate between
  - a. Renewable and non-renewable sources of energy
  - b. Hydro Electric Energy and Thermal Electric Energy
  - c. Ocean thermal energy and Geothermal Energy
  - d. Solar cooker and Solar cell
9. Write two advantages of Solar Cooker.
10. Write two disadvantages of Nuclear Energy.
11. Write two advantages of Bio-fuel.
12. Why is Solar Energy more advantageous than Bio-fuel?
13. How is Solar Energy responsible for wind blow?

## II Choose the correct answer

1. A solar water heater cannot be used to get hot water on  
(a) a sunny day. (b) a cloudy day.  
(c) a hot day. (d) a windy day.
2. Which of the following is not an example of a bio-mass energy source?  
(a) wood (b) gobar-gas  
(c) nuclear energy (d) coal
3. Which of the following is not a renewable source of Energy.  
(a) Solar Energy (b) Tidal Energy  
(c) Wind Energy (d) Natural Gas
4. Which of the following is not a non-renewable source of Energy.  
(a) Coal (b) Petroleum  
(c) Natural gas (d) Hydro Energy

## III Write the following whether the following sources of energy are exhaustible or inexhaustible

Energy source	Exhaustible/inexhaustible
Sun	
Coal	
Water	
Petrol	
Wind	

## IV Fill in the blanks by choosing one option given below

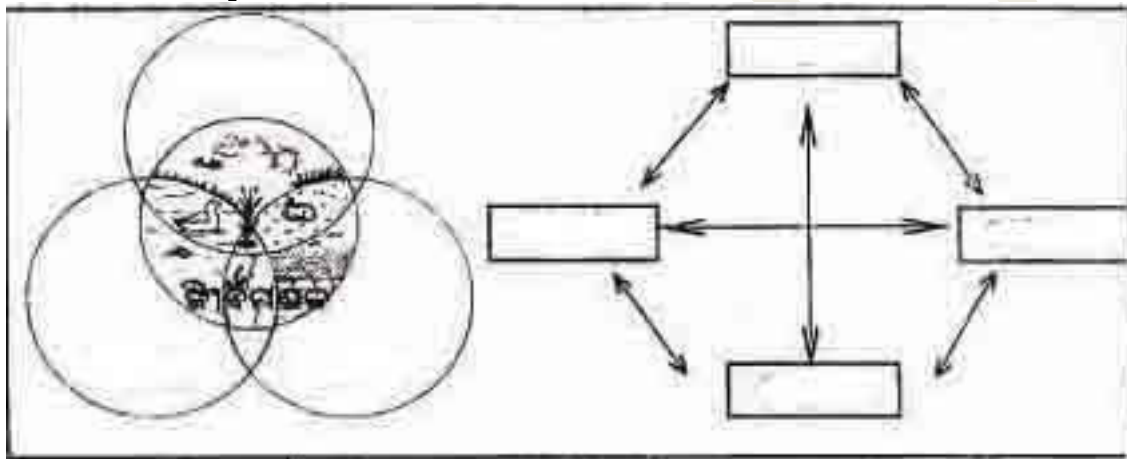
1. The main component released from Gobar gas \_\_\_\_\_ gas.  
(carbon dioxide, methane, nitrogen oxide, hydrogen)
2. \_\_\_\_\_ is an example of Exhaustible Source of Energy.  
(water, wind, coal, wave)
3. In Photosynthesis, Solar Energy is converted into \_\_\_\_\_ energy.  
(electrical energy, bio-chemical energy, hydro energy, geothermal energy)
4. Petroleum is obtained by \_\_\_\_\_ method.  
(distillation, fractional distillation, destructive distillation, decomposition)

## LESSON 9 OUR ENVIRONMENT

The planet Earth, situated around 149.6 million kilometers away from Sun i.e. in between Mercury and Venus, is different from other planets and independent. It is the only planet where life exists. It become possible because the three essential things water, wind and soil exists.

### BIOSPHERE

All types of water resources exist on Earth is known as Hydrosphere which includes Oceans, glaciers, seas, rivers, lakes, ponds, streams, waterfalls and underground water. The area of about 640 km above the earth surface is known as Atmosphere. It is made up of Nitrogen (78.62%), Oxygen(20.84%), Carbon dioxide(0.03%) and rest is water vapour and various gases. Soil, rocks, mountains, hills etc found on earth together form lithosphere. The combination and co-ordination of hydrosphere, atmosphere and lithosphere together form a favourable environment for the life to exist and its development. The part of Earth and its environment (sum total of hydrosphere, atmosphere and lithosphere) capable of supporting life is known as biosphere.



### Main components of Biosphere:

Biosphere doesn't mean only sum total of all the living things but it is sum total of the living kingdom and environment related to them. This consists of all the ecosystems present on the earth. It is regulated by the solar energy and a discipline natural process. It is known as largest ecosystem on the Earth. It is the highest layer where the living kingdom exists.

Hence the main components of ecosystem are all the living organism, atmosphere, lithosphere, hydrosphere and by products of living organisms and the substances that creates organic cycle. The equilibrium of the ecosystem is maintained by feedback system.

### ECOSYSTEM:

All organisms such as plants, animals, microorganisms and human beings as well as the physical surroundings interact with each other and maintain a balance in nature. All the interacting organisms in an area together with the non-living constituents of the environment form an ecosystem. Thus, an ecosystem consists of biotic components comprising living organisms and

abiotic components comprising physical factors like temperature, rainfall, wind, soil and minerals.

This is a structural and functional unit of nature. Where living organisms are dependent upon each other and also dependent upon the environment their mutual interaction and also both are affected by each other. As a result a very intimate relationship is developed in between, living organism and also in between organism and environment.

So, that formation of a very delicate and integrated equilibrium is possible in the ecosystem which is known as ecological balance or Natural equilibrium. Various types of equilibrium are there such as forest ecosystem, grass land ecosystem, desert ecosystem, lakes and ponds ecosystem, rivers ecosystem and marine ecosystem etc. The word ecosystem was first coined in 1935 by A.G. Tansley (1871-1955).

### **Structural components of ecosystem:**

Now we know that different types of ecosystem are present on the earth surface such as lakes, ponds, rivers, seas, grass lands, forest, deserts etc. Generally It is observed that all type of ecosystems are dissimilar with each other. But on a deep study of each ecosystem it is found they is a similarity between each system i.e. they are all made up of 4 similar components and they are

- (i) Abiotic components.
- (ii) Producers
- (iii) Consumers
- (iv) Decomposers

#### **(i) Abiotic components:**

Abiotic components of the environment includes soil, water, air, other elements, compounds etc. present in the ecosystem which are non-living substances. We can divide them in to main three parts.

- (i) Climate and factors those control climate such as temperature, humidity light etc.
- (ii) Inorganic substances taking part in Biogeochemical cycle which are water, carbon, nitrogen, sulphur and phosphorous etc.
- (iii) Organic substances such as protein, Fats and carbohydrates that help in construction of body and also create relationship between organic and inorganic substances.

#### **(ii) Producers:**

All types of green plants found in the environment such as grass, plants and phytoplankton are producers. Plants contain green coloured pigment called chlorophyll which help in photosynthesis where they use radiant energy of sunlight and change into chemical energy (carbohydrate). As green plants prepare their own food, hence they are known as autotrophs or producers.

#### **(iii) Consumers:**

Consumers do not have capability of producing own food from inorganic abiotic components. They depend upon the producers for their food directly or indirectly. That is why they are called as heterotrophs. According to the

food habit, heterotrophs are classified into primary consumers, secondary consumers and tertiary consumers or top-consumers.

Herbivores are known as primary consumers as they directly depend on producers (green plants). Grasshoppers and Rabbits are the primary consumers for grassland ecosystem whereas elephants and deer are the primary consumers for forest land ecosystem. Carnivores are the secondary consumers. Carnivores depend on herbivores for their food. Frog is the secondary consumer for grassland ecosystem as it preys on grasshoppers. They are known as primary carnivores or Carnivore order-1 or  $C_1$ . Similarly, the animals which eat the primary carnivore is known as secondary carnivore or Carnivore order-2 or  $C_2$ . Snake is the secondary carnivore as it preys on frog.

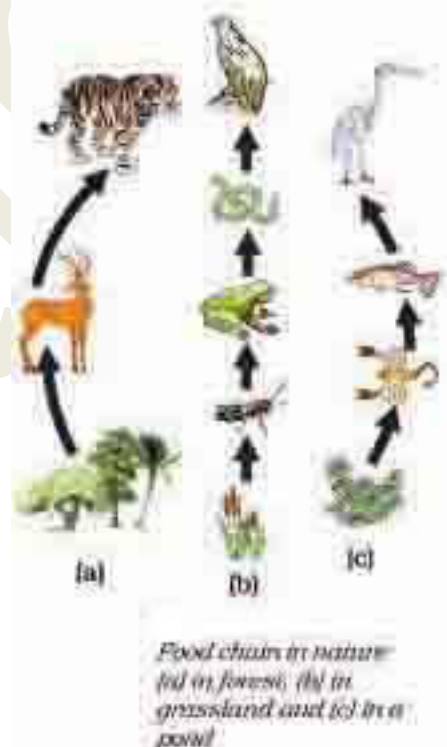
#### **(iv) Decomposer:**

The organisms which depend on dead plants and animals and waste products for their food are known as decomposers. The microorganisms, comprising bacteria and fungi, break-down the dead remains and waste products of organisms. These microorganisms are the decomposers as they break-down the complex organic substances into simple inorganic substances that go into the soil and atmosphere. Bacteria, Fungi and some protozoa are the examples of decomposers.

#### **Functional aspects of ecosystem:**

Every ecosystem depends on series of systematic functional aspects. Out of which four functional aspects are important to keep balance in the ecosystem, they are:

- (i) Food chain (ii) Energy flow (iii) Nutrient cycle (iv) Homeostasis



#### **(i) Food chain:**

In an ecosystem, green plants are the producers. Herbivores depend on producers for their food. For example - grasshopper depend on grass for its food, Carnivores eat Herbivores and live, e.g. Frog eats grasshopper and

snake eats frog for its food and ultimately both frog and snake are eaten by kite or an eagle. In this way the food prepared by the autotrophs (green plants) is eaten by herbivores and then carnivores. The energy is also flowing step by step from producers to carnivores. This flow of energy from producers to carnivores is known as food chain.

This food chain always moves in a straight line. It depicts the relationship between the living things of an ecosystem. Each step or level of the food chain forms a trophic level. The autotrophs or the producers are at the first trophic level. They fix up the solar energy and make it available for Heterotrophs or the consumers. The herbivores or the primary consumers  $C_1$  come at the second, small carnivores or the secondary consumers  $C_2$  at the third and larger carnivores or the tertiary consumers also known as top-consumers form the fourth trophic level. In some ecosystem like forest ecosystem where three trophic levels are sufficient to describe a food chain. E.g green plants or the producers are eaten by herbivore like deer or any other herbivore and on the other hand this herbivore is finally eaten by a carnivore like tiger or any other carnivore.

An English environmentalist, (Charles Elton, 1900-1991) studied the food chain of various ecosystems and arrive into a conclusion that any ecosystem has maximum of 5 Trophical levels. Because which transferring of energy from one level to another level some energy is dissipated as heat in to the environment. Hence the quantity of energy received from one level to another reduces and ultimately the last level or the 5<sup>th</sup> trophic level receives the least amount of energy. As a result survival of living things is not possible above the 5<sup>th</sup> trophic level.

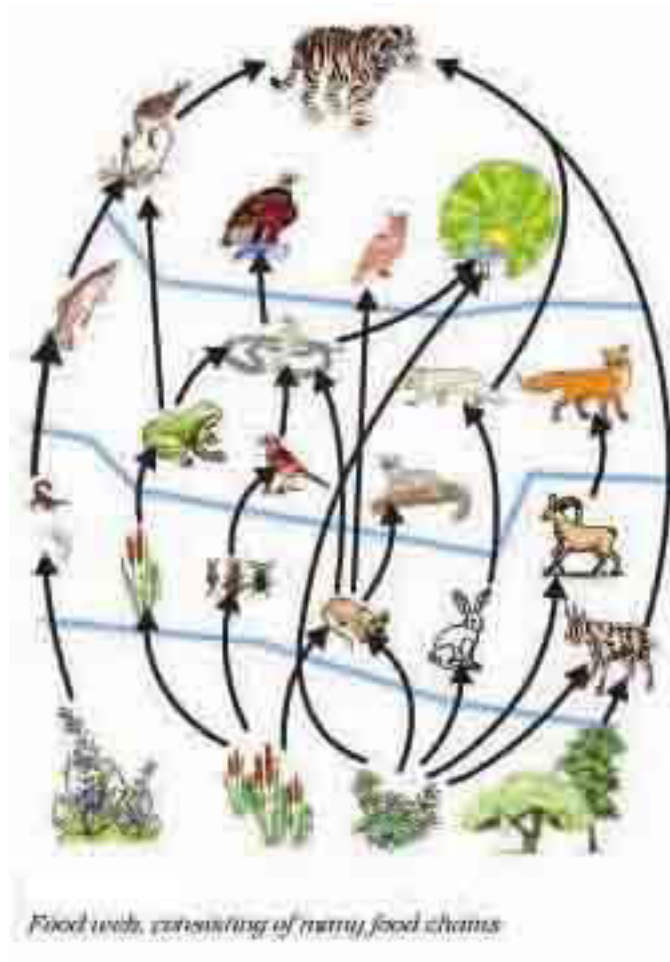
### **IMPORTANCE OF FOOD CHAIN**

We can conclude the relation between the animals and their food besides the energy flow by studying the food chain. It gives a clear picture of how the food is produced and where it flows and the relationship between the animals of the ecosystem. The energy flow of the ecosystem can be known to us. We can also understand the flow of toxic substance in an ecosystem by studying the food chain. We can find out the solutions to reduce the biomagnifications of toxic substances at the successively higher levels in a food chain.

### **FOOD WEB**

We see in our surrounding that one type of food is eaten many living things or consumers like grasshoppers, rabbits, deer and many more herbivores eat grass as their food. Unlike herbivores, few consumers like human beings never depend on one type of food, they may be carnivores ( $C_1$ ), or herbivores or omnivores. In short we can say that an animal in an environment live on different types of food and the same animal can be food for other animals. So, in an environment, the relation between the food of animals is not unidirectional or move in a straight line rather it branches into multiple branches known as food web.

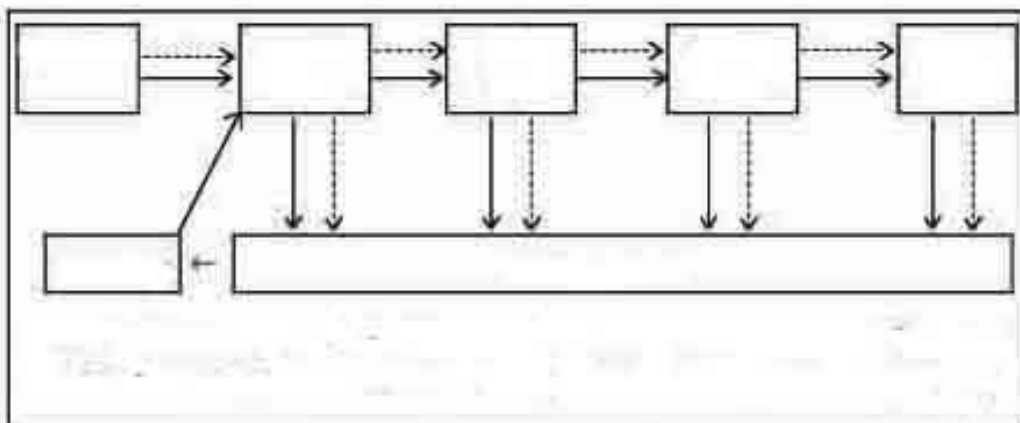




### ENERGY FLOW IN THE ECOSYSTEM

In an ecosystem flow of energy begin from the sun, passes through producers, herbivore, carnivore order-1 and 2 and reaches at the Top-consumer through food. In any ecosystem the flow of energy starts from the sun then to the green plant (autotrophs) and then moves through all consumers and decomposers directly in one direct. So, the flow of energy is always unidirectional it cannot be a cyclic process.

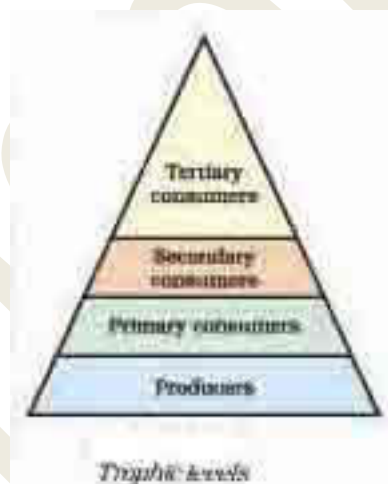
In the ecosystem flow of energy take place according to two laws of Thermodynamics. According to first law, energy is transformed form one form to the other and neither it can be created nor destroyed. Green plants capture radiant energy of sunlight and process it and transform into chemical energy is an example of this law.



According to the second law of thermodynamics, at any point the complete transformation of energy from one form to another form is never successful. Some amount of energy is always dissipated in the environment in the form of heat and cannot be used. R.L. Lindeman (1915-1942), an environmentalist studied on the amount of energy available in each trophic level. In the year 1942 he formulated the 10 percent rule. For example in any ecosystem if amount of energy is 100 calories in producer level then at the herbivore level the amount of energy is reduced to 10 calories. Similarly, at the carnivore-1 level energy availability is 1 calory and at the carnivore-2 level energy is only 0.1 calory. From this example we come to know that in any environment the highest energy is available in the herbivore level and the lowest energy at the last trophic level.

### **ECOLOGICAL PYRAMIDS**

Charles Elton in 1927 observed different types of ecosystems, he found that in an ecosystem the number of producers are maximum and gradually the number of tertiary and top consumers are least. The number goes on reducing in each trophic level starting from producers to tertiary consumers. If they are arranged as per their number then they form a pyramid shape. Hence it is known as Pyramid of Numbers.



Besides, the biomass of the organism also decreases gradually from the producer level to the next level. The flow of energy as we know, reduces in each trophic level as we proceed. Considering these two stages, Pyramid of Biomass and Pyramid of Energy is made.

### **Nutrient cycle:**

The body of each organism is made up of some elementary components. To live and grow, the organism requires these basic elementary components.

These elementary components are carbon, oxygen, nitrogen, hydrogen, potassium, calcium, magnesium, sulphur and phosphorus etc. are also known as Macronutrients. Elements like copper, manganese, zinc, boron, cobalt, sodium and iron are known as Micronutrients. Producers obtain both Macronutrients and Micronutrients from the environment. From producers, these nutrients are carried to the body of herbivores and consumers. The corpses of plants and animals mix with soil after they die.

Decomposers such as bacteria and fungi present in the soil decompose the dead bodies and break down the complex substances into simple form and release the nutrient which returns back to the environment again. Nutrients

are used by the green plants (producers) and later other organisms (consumers). So, in the ecosystem the flow of nutrient is cyclic. This type of cyclic movement of the nutrients from living organisms to environment and vice versa is called as Nutrient Cycle. Due to the decomposers the Nutrient Pool always remains full, it is never incomplete.

### **BIOMAGNIFICATION:**

Sometimes the toxic substance does not get removed from the body easily. These toxic substances are come out from body by excretory process. It rather settles in tissues and cells of organism. The concentration of the toxic chemical increases as it moves high in the trophic level of food chain and food web and ultimately reached the top-consumers. When the concentration of this toxic chemical in organism becomes beyond tolerance, organisms suffer with various types of diseases. This increase in concentration of toxic chemical inside the tissues of the organism is known as biomagnification. Due to biomagnification of pesticides, certain birds are not able to form shelled eggs and some organisms are unable to reproduce their young ones. Human beings are facing lots of problems due to biomagnification because he is an omnivore. We often read in newspapers, that the food we eat like roti, bread, rice, green vegetable, fruits, fish, meat, and cool drinks, milk everything contains pesticides. Biomagnification of pesticides found in the tissues of our body as a result of which human beings getting infected by many diseases.

### **HOMEOSTASIS:**

By the effect of seasonal change, day and night and different factors of environment, the environmental condition where the organisms live does not remain constant. In order to adjust himself with change in the environment organisms try to maintain their internal environment in response to changes in external conditions. E.g The body temperature of mammals more or less remain constant even if there is change in temperature in the external environment. In excessive heat sweat keeps the body cool and in case of seivour cold, in order to save from cold, body shivers or the hair present on the body surface straightens. The specific controlling system present the organisms help them to maintain homeostasis, the internal environment in response to external environment.

Like organisms, all the functional components of an ecosystem maintain balance between themselves in order to save homeostasis. For any reasons homeostasis is became weak or disturbed, the balance of the ecological balance will be destroyed. E.g the grass field become barren land either due to overgrazing or by accidental fire or soil pollution, grasshoppers living in the grass change their dwelling place as a result frogs will die due to lack of food which on the other hand affect snakes because they feed on snakes. In this way the ecosystem will be destroyed. Hence homeostasis plays a pivotal role in making the ecosystem function successfully.

### **ENVIRONMENTAL PROBLEMS:**

Early man lived in the forests and mountain caves. They were depending on hunting birds and animal and collecting fruits and roots from the forest for their food. He was afraid of nature and natural calamities. So, he used to worship the sun, the moon, rivers, mountains and the rain. With the

progress of science, man attained knowledge about the natural process. So, he is no more afraid of nature. Due to excessive greed and meet his requirements, he started exploiting the natural resources. He changed the flow of the nature for his own benefit. As a result of this the gradual degradation of natural wealth is taking place. The change in the environment affected the living kingdom. If this situation continues then one day the life may vanish from the earth's surface forever. Some of the environmental problems are mentioned below:

- 1) Mining, construction of roads, setting up of Industries, River dam projects, etc destroy the forest resource. It affects the biodiversity adversely
- 2) By loss of forests and soil, fallow land is created and causing desertification.
- 3) CFC (Chlorofluorocarbon) gas used as refrigerants in machines make hole in ozone layer. As a result the harmful ultraviolet radiation from the sun reaching on the earth's surface directly. This radiation is highly damaging to organisms, for example, it is known to cause skin cancer and eye diseases in human beings.
- 4) In the atmosphere due to the increase of CO<sub>2</sub> and other green house gases, green house effect is observed. By this the atmospheric temperature is rising slowly and causing global warming. Due to global warming sea level is rising and unwanted changes are taking place in the world climate.
- 5) Sulphur dioxide and Nitrogen oxide etc. gases are released from Industries and motor vehicles combine with water vapour in the atmosphere to form sulphuric acid and nitric acid which causes acid Rain. Due to this reason the productivity of the forests, grass lands and crops is decreasing.
- 6) The everyday garbage accumulation in the cities became great problem for workers Municipal Corporation for incineration. Because it is not possible to incinerate all type of garbage at one time as they differ. Some are biodegradable garbage like fruits and vegetable, leaves, paper and wood etc. decompose and mix with soil. But some garbage which does not mix with soil and are non biodegradable, if it is not taken proper care, stored in a heap in the environment. During rains this garbage decomposes and pollute air, beside it mix with the surface water and seep into the ground lead to water pollution. In big non-biodegradable substances like things made of plastic, mercury, other chemical waste and some metallic substances which cannot be decomposed by the micro-bacteria exist in environment. They settle in the environment. Some of these wastes enter into the body of the organisms through food chain and lead to biomagnification.

### **WHAT CAN WE DO?**

We should remember that we should take proper care of the environment that we inherited from our forefathers and hand over the responsibility to our next generation. The environment is heading towards destruction because of the exploitation and excessive use by the human being to satisfy his greed. Hence every country and every human being on the Earth should think about how to keep environment clean and save the environment. There is a proverb used in China – 'if you are planning for one year then sow rice fields, if it is for ten years then plant trees, if it is for 100 years then

educate people.’ Youth as well as adults should be aware of our environment. This awareness program should reach both in villages and in cities. For this regard, few active members formed Swachcha Seva Sangathans in India their programs and functions are as follows –

1. Kalpavriksha, an organization is making research since 1979 about the air pollution in around of Delhi region besides working for greenery of that area. They are also educating school children how to save environment. The same organization is also working in Dehradun to solve the problems arise due to mining in that area.
2. “Kerala Shashtra Sahitya Parishad” is an organization formed in 1970 to spread awareness in villages to use Gobar gas, smokeless coal and ovens.
3. ‘Bombay Natural History Society’ is established in the year 1988 for Conservation of Wild Life and Environment Security.

Through various awareness programs it is should be announced that Earth is a home not only for human being but also for all biotic and abiotic organisms. Human being should not think they only have rights to live on Earth. Anything which is generated by the Sun’s radiation, i.e. soil, water, air, all plants and animals have right to live on Earth. These six natural resources are not meant only for present generation. It is our responsibility to keep the environment safe and secured for our future generation.

#### **What you have learnt?**

1. Earth is the only planet where life exists.
2. Birth and survival is possible on earth due to a beautiful combination of soil, water and air.
3. Hydrosphere, atmosphere and lithosphere are the three layers exist on earth. The place where all these layers meet, life exists which is known as Biosphere.
4. Biosphere includes all ecosystems. It is a self regulatory natural system. Ecosystem is an important part of the nature.
5. Every ecosystem is made up of abiotic components like air, water, soil and nutrients and biotic components like producers, consumers and decomposers. The effect of radiation, temperature and humidity is be there on it.
6. Green plants are called producers, herbivores and carnivores are called consumers and micro-organisms and bacteria are called decomposers.
7. Decomposers decompose dead and decaying materials and mix with soil. Hence the Nutrient Pool is always remains full.
8. The functional aspects of the ecosystem are food chain, energy flow, nutrient cycle and homeostasis.
9. Green plants are autotrophs as they prepare their own food with the help of sun’s radiation.
10. All living organisms are heterotrophs or consumers as they directly or indirectly depend on plants for their food.
11. Herbivores depend on plants for their food and carnivores depend on herbivores for their food.
12. In an ecosystem, the food and energy passes from producers to top-consumers is known as Food chain.
13. The increase in accumulation of toxic chemical substances in the tissues of an organism is known as biomagnification.
14. The sun energy flows into the producers and heat energy into consumers always flow in unidirectional.
15. Food chain is made of few trophic levels. All plants occupy the first trophic level, herbivores in 2<sup>nd</sup> trophic level and rest all types of consumers subsequently occupy respective trophic levels.

16. R.L. Lindeman (1915-1942) formulated "Ten percent Rule" for flow of energy from one Trophic level to next Trophic level.
17. The cyclic flow of nutrients between the body of organisms and environment where they live is known as nutrient cycle.
18. Due to the homeostasis between producers, consumers, decomposers and abiotic sources, ecosystem is functioning well and keeping balance.

### EXERCISE

#### I) Answer the following questions

1. Give a detailed account of structural components of an ecosystem.
2. What is food chain? How is it important, discuss?
3. Explain the formation of Biosphere and its components.
4. "The flow of energy is unidirectional" explain.
5. Write short note on the following
6. What role the decomposers play in ecosystem?
7. What is biomagnification? What problem does human kind is facing?
8. What do you mean by food web?
9. What is ecological pyramid? How many types are there?
10. How is homeostasis established in ecosystem?
11. What do you mean by 'Ten percent rule'?
12. What is an ecosystem?

#### II) Define the following

- |                            |                        |
|----------------------------|------------------------|
| a) Non-biodegradable waste | b) biodegradable waste |
| c) Kalpavriksha            | d) acid rain           |
| e) Green house effect      | f) Ozone Hole          |
| g) Macronutrients          | h) Micronutrients      |
| i) Decomposers             | j) eco balance         |

#### III) Answer in one sentence

- b) What is hydrosphere?
- c) In the process of photosynthesis, solar energy changes into what energy.
- d) Why and who are known as autotrophs?
- e) Write the first law of Thermodynamics.
- f) Name the structural components of Ecosystem.
- g) What percentage of Nitrogen and Oxygen is present in Atmosphere?
- h) What is food chain?
- i) What is the function of Decomposer?

#### IV) Fill in the blanks with any one option given below.

1. Phytoplanktons are \_\_\_\_\_ in ecosystem.  
(consumers, producers, decomposers, herbivores)
2. The name Ecosystem was first coined by \_\_\_\_\_  
(Lindeman, Dawin, Tansley, Elton)
3. Organisms which prepare their own food are known as \_\_\_\_\_  
(omnivores, heterotrophs, autotrophs, decomposers)
4. Organisms depend on others for their food and energy are known as \_\_\_\_\_  
(consumers, heterotrophs, autotrophs, producers)
5. Herbivores are \_\_\_\_\_ category consumers.  
(Primary consumers, Secondary Consumers, Tertiary consumers, Omnivores)
6. \_\_\_\_\_ is a decomposer in environment.  
(plants, phytoplanktons, bacteria, human beings)
7. \_\_\_\_\_ gave the knowledge of Ecological Pyramid.  
(Darwin, Tansley, Elton, Lindeman)

#### First two words are related to each other find the relationship for the third -

1. Leaves : biodegradation :: things made of plastic :
2. Sulphur dioxide : acid rain :: CFC gas :
3. Carbon : Macronutrient :: Manganese :
4. Ten percent Rule : Lindeman :: Ecological pyramid :
5. Grasshopper : Primary Consumer :: Frog :

## **Lesson 10**

### **Conservation of Natural Resources**

On the earth's surface existence and placement of organisms is possible due to its climate and natural resources. All the plants and animals require soil, water, air and other components to live. As we have discussed earlier that due to the recycling of different elements present in air, water and soil, necessities of the living organisms are fulfilled, and hence they exist on the earth's surface since millions of years. But along with the development of human civilization, these natural resources are exploited and excessively used, as a result of which various problems such as pollution, global warming and climate related changes is taking place. How to stop the exploitation of nature and conserve air, water and soil that you have studied in your last class. Now we will read how to use the natural resources such as forest, wild life and natural fuel in planned way its conservation.

#### **Environment Related Problems:**

Environmental related problems, we come to know from various newspapers, magazines and mass media. Most of the environmental problems we face are manmade. In order to stop exploitation of natural resources and protect them, many National & International rules and regulations are formulated and planned. Those rules and environmental awareness programs are discussed below -

#### **Why is it necessary to secure, conserve and properly maintain the Natural Resources-**

We get all our daily requirements, food and shelter directly or indirectly from nature. With the increase in population, the use of natural resources is also increased. To lead a luxurious life style, people are exploited the valuable natural resources, as a result some of them are going to be extinct from our earth's surface. We should remember that natural resources are not unlimited. So a long term programme is necessary for to protect, conserve and properly manage our natural resources.

Some natural resources such as forests, wild life, water, air and mineral resources play important role in maintaining balance nature and conservation of environment. Hence while using the natural resource we should remember that our activities should not affect the environment. For example water used in factories should not be let out directly into the nearby water bodies unless it is purified. Similarly during extraction of minerals, surface soil containing comparatively less important minerals spread in nearby forest regions surrounding the mine area, which sometimes carry heavy metals also. These heavy metals damage the forest and nearby cropland and enter into our body through food, thereby causing various health problems and diseases. Slag released from the factory also damages the environment. Therefore it is necessary to adopt various plans to manage of waste materials after they are released.

#### **3R rule for conservation of Natural Resource:**

In poor countries, for survival and in rich countries, for maintaining luxurious life, natural resources are exploited, thus loss of these resources are leading to climatic

change. We helplessly tolerate these climatic changes because they are beyond our control. But we can protect, conserve and properly manage our natural resources by voluntarily contributing ourselves directly or indirectly in protecting our environment. For conservation of environment and natural resources 3'R' rule is considered as a medium. These are Reduce, Recycle and Reuse.

**Reduce:** Reduce means control use of natural resource keeping an eye upon the requirement. Many times we use natural resources in excess or more than the requirement and also spoil them. For example serving food more than we eat, brushing teeth while tap is remain open. Leaving rooms without switching off fans and lights. In order to check misuse of our resource, we have to be very much conscious about our resource.

**Recycle:** By recycling we can use waste materials as raw materials to some extent. This process is use in various sectors in our country. Glass, plastic, paper and metallic substances are recycled and used again. At first, we should segregate our waste so that it will not mix with the materials which cannot be recycled. These waste has to given to the people who collect empty bottles, paper, polythese and metallic substances. As a result we get the waste in very low cost and our environment also remains neat and clean. Recycling also cater the need of raw materials in some factories. Similarly we can use biodegradable waste as manure in agricultural waste by making compost pits.

**Reuse:** In the reuse strategy you use things again and again. It is environment friendly as well as best method of conservation of resources. If a thing is used again and again instead of throwing or destroying it after its first use then besides using it properly, conservation of resource is achieved. For example, using our old clothes, slippers, waste papers, polythene, bags, paper containers, glass and plastic bottles again for various purposes we can check pollution to some extent.

The economic development of any country is very intimately related with its environment protection and source of natural resources. Though development and environment protection seems to be opposite words, but in modern time both of them are accepted together. We should change our mentality and must think how progress and development of the nation can be achieved. In order to achieve this we should follow all rules and regulation. By this our natural resources can be conserved and also they will meet current basic human need.

### **Conservation of forest:**

Forest resource means conserved and non-conserved forests and bushes found all around our surroundings. Once up on a time man was living inside the forest like other animals. Gradually he set up society and lived in the society as a social animal. He cultivated some plants thinking that they are valuable and useful and started domesticating some animals of forest. Besides, he always remains dependant on the forests. He collected wood, leaves, fruits, roots, flowers, medicines, animals, birds from the forest to meet his requirements. Even today lakhs of people in our country especially the tribal people live in and around the forest depend on forests



for their day to day life. So forests are regarded as a most valuable resource. Forests are the main source of biodiversity or 'Bio-diversity hotspots'. Bio-diversity refers to all type of plants animals and micro-organisms living in a particular place. In forest environment, a large variety of living organisms (plants and animals together) are found in a relatively limited area. But due to exploitation of forest resources by human, rapid deforestation is taking place, as a result number of species also reducing rapidly. As forests are cleared for setting up of factories, roads, railway lines, habitation and cultivation purpose, big forests are being fragmented to smaller ones. As a result some animals such as cheetah wild fox, musk deer, kite, vulture, some snakes etc are going to be extinct from the earth surface forever. Similarly many types of medicinal bushes and plants and other plants have also gradually dying out from the forest. It has become the cause of many unwanted changes in the environment. Hence conservation of forest and wild life has become very important for us.

The type plants and bushes in a forest depend upon its soil, rainfall, climate, and other factors of environment. Varieties of animals live in forests due to its density and environmental conditions. Their population/number is regulated by food chain and food web.

People living cities, rural areas and forest region are not equally dependant on the forests. But all of them are regarded as the stakeholders of the forest resource. Forest department, nature lovers and industrialists are also known as Stakeholders of Forest Resources besides common man.

Tribal people and people living near vicinity of the cities are mostly dependant on the forest. They collect food, firewood, leaves, honey resin and fodder for their domestic animals etc from the forest and lead their lives. They also collect all the materials required for construction of their house, medicinal bushes and even animals flesh, from forest. People dwell in cities are benefitted indirectly by forest and forest products. They use processed/ prepared medicines from the medicinal bushes of the forests, doors, windows and furniture made of wood. As a result forest resource is narrowing day by day and per capita forest is decreasing. In many areas after deforestation, type of trees such as teak, pine eucalyptus etc are planted which is leading to reduction in biodiversity damaging the forest environment and the quality of soil is also reducing. Numerous microbes and organism of soil are being killed and lost from the animal kingdom forever.

Forest Resources are controlled and protected by Forest department as a stakeholder of the Forests. Forest department is trying to protect forest by putting a limit over the use of forest resources by the inhabitants of the forest. The economic and social progress of the forest inhabitants are influenced by the forest to great extent. If the inhabitants of forests are prohibited to enter and use the forest product without making an alternative source of income for their livelihood, a lot of problem may arise. On the other hand, a long term benefit may take place if forest department allow forest inhabitants as the one of the stakeholders of the forest resources and seek the help of these local people for development of forest resources.

Industries consider the forest as merely a source of raw material for its factories. Forest products are used as raw materials in many industries from which many usable things are produced. Industries producing paper, wood, sports equipments and ayurvedic medicine use forest products as raw materials. As a result forest resources are decreasing rapidly.

Conservation of existing forests and establishment of new forests is possible due to hard work of few Nature lovers and Swacha Sevis (volunteers of clean and green India) working for Society. Through awareness programs and with the help of Government, they could successfully be able to protect endangered animals and plants. Conservation projects and reserves like Protection of Gandhamadha Hill range (a biodiversity), Save Rhinos project of Kajiranga, Tiger conservation Project of Similipal, Birds Sanctuary of Chilika are made to protect endangered animals and plants.

Adivasi (Tribes live in Jungle) and people live in and around jungle are blamed for over utilization of Forest Resources and narrowing of Forests. Hence they are prohibited from cutting trees from forests, hunting, grazing cattle in Forests. But we are all equally responsible for exploitation of Forests. Inhabitants of Forest are directly dependent on Forest produce, prohibiting them from entering into the forest will lead to drastic drop of their economic condition and they will enter into the Forests to collect their livelihood from forest resources without obeying any rules and regulation. On the other hand if these people are taken into confidence and are to be provided with a deserved share out of the profit incurred from the forest conservation, which will help in Forest Management as well as conservation of forest resource. Social Forestry Project and Joint Forest Management etc are implemented by the Government of India to look after the Forest Resource.

**SOCIAL FORESTRY PROJECT:** the main aim of implementation of this project in 18<sup>th</sup> century by Government of India is to plant trees on all unused and fallow land involving common people with the purpose of helping in the environmental, social and rural development. Government is trying to increase forest areas that are close to human settlement and have been degraded over the years due to human activities needed to be afforested. Trees were to be planted in and around agricultural fields. Plantation of trees along railway lines and roadsides, and river and canal banks were carried out. Even Government is providing them with seedlings on free of cost to encourage to plant trees on their land and develop forests. Though it did not result in successful development of Forests, but they become successful in developing awareness among people to plant trees and develop unused land and fallow land into forest. As result of this project it became possible to see planting of trees in schools, railway lines and roadsides and coconut plantation on canal banks.

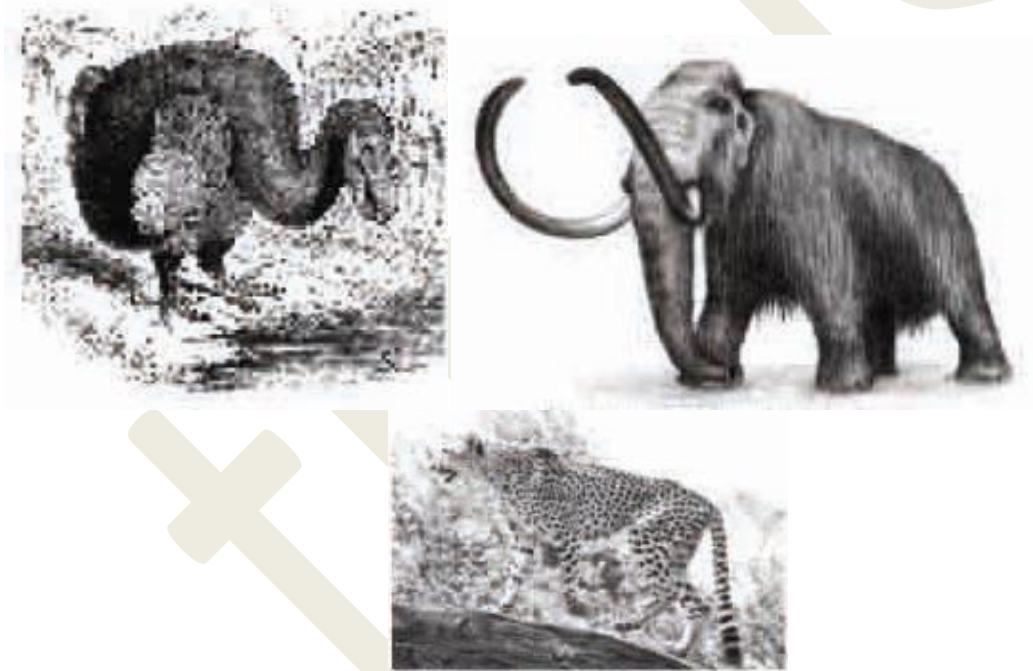
**JOINT FOREST MANAGEMENT :** JFM or Joint Forest Management is an agreement formed between the stakeholders (local communities) and Forest Department to protect and manage forest resources smoothly. The local people and direct stakeholder of Forests were included in this joint agreement program. The main aim of this agreement is to seek help of these people for development and protection of Forests with affecting their rights. Hence, a village committee called Forest Protection committee is formed in every village wherein total five to ten members are elected by villagers. Government involve these members directly into various programs like planting trees, collection forest produce, tax collection etc from the Forest Area attributed to that village. Villagers are allowed to enter into the forest allocated to them and collect the forest produce with certain restriction and also provide a part of tax collection is used for social development of the villagers. As a result villagers directly come forward to involve themselves into the project.

**Conservation of wild life:**

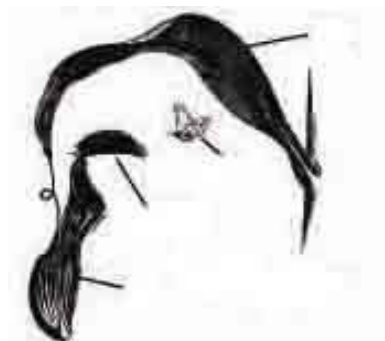
A number of animal and plant species become extinct from the earth's surface due to the deforestation of dense forest, fragmentation of natural habitat, loss of forest resources and excess exploitation of forest resources by human beings. Besides, extinction many more animals and plants are in the verge of remain in unprotected and endangered state. Hence it is necessary to taking care of these endangered animals. For this an International organisation named International Union for Conservation of nature and Natural Resources- IUCN has been formulated. This organisation has classified these threatened species into following groups.

**Extinct species:**

These organisms have been disappeared nearly 50 years ago and it is regarded that they are no more existing on the earth's surface. Indian Cheetah, Tasmanian tiger, Mountain Goat, Polar tiger etc are belongs to this species. Besides, Dodo, a bird was found in Mauritius island of Indian ocean has also been extinct during recent past. Similarly giant tusked woolly mammoth (elephant) is also become extinct.



**Endangered species:** The number of species belongs to endangered category are reducing and fear of their extinction is there. Endangered species include giant panda, double horned rhino, rauwolfia plant (Paatal Garuda), Pitcher plant, one horned rhino, great Indian Bustard. Pitcher plant is a carnivorous plant. It is a modified leaf. The structure of it leaf tip is modified like a lid and blade is modified like a bag called pitcher, if an insect or animal gets in to the pitcher the lid closes immediately and animal or insect is trapped inside. This is found only in Kaziranga National Park, Assam in India.



### **Vulnerable species:**

Excessive hunting and use of some animals put them into vulnerable species. No special steps are taken for conservation of these species hence they are called as vulnerable species. We are afraid of the fact that these animals may be extinct in near future. Many kinds of medicinal bushes, reptiles and herbivorous animals are included under this category.



**Rare species:** Very few groups of organisms belong to rare species as they found only in some particular place on the earth's surface. They are uncommon, scarce or



Infrequently encountered. The growth of their number is very slow, so special steps must be taken for their conservation. The Golden Langur found in Manas National Park in Assam is an example of this species which is not found anywhere in the world.

**Insufficiently known species:**

A category of species which are suspected but not in human reach are known as insufficiently known species. These species are said to be away from human society. Animals and plant species under deep sea and in the islands which are beyond human reach are included under this category.

**Laws for conservation of forest and wild animals:**

The IUCN Red List of Threatened Species (also known as the IUCN Red List or Red Data List), founded since 1966, is the world's most comprehensive inventory of the global conservation status of biological species. The International Union for the Conservation of Nature and Natural Resources (IUCN) is the world's main authority on the conservation status of species. A series of Regional Red Lists are produced by countries or organizations, which assess the risk of extinction to species within a political management unit.

The IUCN Red List is set upon precise criteria to evaluate the extinction risk of thousands of species and subspecies. These criteria are relevant to all species and all regions of the world. The aim is to convey the urgency of conservation issues to the public and policy makers, as well as help the international community to try to reduce species extinction.

Various laws have also been formulated to preserve the existence of these species. It is possible to conserve forests and forest animals through awareness programs, efforts and responsibility shown by stakeholders etc.

Forest Act in 1927 and National Forest Policy in 1988 are formulated in our country for the protection of forest and its right way of utilization of forest produce by human. Besides this Wild Life Protection Act is formulated in 1972 and later amended the Act in the year 1991. The Act provides for the protection of wild animals, birds and plants, no hunting and harvesting these species can be done. Hunting and harvesting these species liable to punishment as per law. In the year 2004 Indian government has formulated National Biodiversity Act for the conservation of bio-diversity. This law includes the conservation of habitat and agrobiodiversity. Besides, Biodiversity conservation is done through establishing National Parks, Botanical Gardens, Zoos, Animal Parks, Sanctuaries and Bio-sphere Reserves.

Bhitarkanika of Kendrapara is a National Park in our State Odisha. A proposal is already made to change it to Biosphere Reserve. Various steps have been taken for conservation of crocodiles, besides it is also regarded as a safe or protected place for birds. Similarly, Nalabana of Chilika, famous for migratory birds, has been declared as a Birds Sanctuary. Similipal of Mayurbhanj is the first National Park of Odisha and is recognised as Biosphere Reserve.

Many protection measures are taken in many places outside Odisha to conserve wild animals. Sundarbans of West Bengal (Conservation of Royal Bengal Tigers), Kaziranga of Assam (Save Rhino Project), Bharatpur of Gujarat (Bird Sanctuary), Corbett National Park of Uttarpradesh (Conservation of Tigers) are famous.

Various organizations like National Wildlife Committee, India Board of wild life, National Biodiversity Board and World Wild Life Fund etc. are formed to provide monetary help for conservation of forest resource and wildlife.

**Role of common people in Forest Resource Management:**

Public think that forest resources belongs to only government and they do not have any right over the forest. But without awareness programs and cooperation of common people it is impossible to conserve forest resources and wild animals. People should be made aware off the impact of deforestation and exploitation of forests will lead to change in Global Climate as well as climate of a particular region.

Various movements are carried out by few eminent persons and organizations to save forest resources. Most popular Forest Conservation Movement is Chipko Movement of Reni Village of Gharwal District occurred in the year 1970. Sunderlal Bahuguna was one of the prominent leaders of the Chipko movement. He could create public awareness regarding the importance of forest resource for the people and for the climate. So when contractors came to fell the trees the villagers embrace the trees and did not allow lumbermen to cut the trees. As a result trees could be saved and contractors were no more allowed to cut the trees in that forest. Like Chipko movement, "Appiko movement" also began in Karnataka in the year 1983. Appiko also means "to embrace". This movement gradually spread to other different parts of the Nation where people came forward to protect the forest of their areas. An excellent example of this movement is conservation of Sal forest in Arabari Forest region of West Bengal and conservation of Periyar forest in Kerala.

**Conservation of Coal & petroleum:**

If forests and water resources are managed properly then it can fulfill our basic needs. But some natural resources which cannot be renewed or reproduced again. These are called as non-renewable resources. Coal and petroleum belongs to this group are also known as fossil fuels, which are important sources of energy for us. Since the industrial revolution, we have been using increasing amounts of energy to meet our basic needs and for the manufacture of a large number of goods upon which our lives depend. These energy needs have been largely met by the reserves of coal and petroleum. These fossil fuels are used excessively in motor vehicles and agriculture. So to meet our demands we are extracting more and more of coal and petroleum. If their extraction continues in the same rate, then it will exhaust one day. From a statistics it is found that petroleum will exhaust within coming 50 years and coal will be finished within 100 years.

Burning of coal and petroleum pollutes the atmosphere. By the increase of CO<sub>2</sub> in the atmosphere, temperature rises and causes "green house effect". To protect us and bio-diversity, we must control the use of coal and petroleum and use of renewable resources need to be accelerated. The following steps are required to be taken.

(a) In our country, Thermal Electricity is produced mainly by burning coal in thermal power plants. The amount of coal we can save depends on the quantity of electricity is saved. Low watt and Compact fluorescent lamp (CFL) must be used. Lifts, fans and bulbs must be switched off when they are not in use.

(b) Instead of using own vehicle as far as possible we can go by public transport, so as to reduce petroleum expenditure.

(c) Solar cooker for cooking, solar heaters for boiling water, wide windows to lighten the house etc can be used, so that gas and electricity expenses can be reduced to some extent.

(d) Instead of using old ones new vehicles to be used. Vehicles with modern or latest engine should be used so that proper consumption of fuel takes place and we can cover more distance with less expenditure.

(e) Increase in use of alternative source of energy should be encouraged and reduction in dependence on coal and petroleum, so that these sources can be available for longer time.

#### **Conservation of water resources:**

Water is a basic necessity for all terrestrial forms of life. Water is indispensable for sustenance of life. We know our body made up of 85 to 90% water and cells and all physical processes of living organisms takes place in presence of water. Though maximum part of the Earth's surface is covered with water but the quantity of fresh water is very less. Since millions of years, fresh water only is fulfilling our requirement. We know that by public awareness and human involvement, conservation, development and proper management and use of water resource is possible.

Water resource plays a pivotal role in the development of any Nation. As Water resource is essential for agriculture, industry and transportation, every developed country take proper care of conservation and management of their water resource. In most of the poor nations of the world acute water scarcity is an obstruction for their industrial development. So the necessity of water resource can be imagined. Water resource of a place though depends upon the rainfall of that area, but this is also controlled by many other factors. Among these, industrial growth of that place, underground water resource, area covered with forest and river dam projects etc are important.

Rains in India are largely due to the monsoons. We receive 85% of rain fall from June to September month. This means that most of the rain falls in a few months of the year. Though India receives highest rainfall still we face water scarcity during *summers as we are unable to store water.*

With the increase in population and food requirement, more and more water is utilised by agriculture and industrial sectors. Hence along with using the surface water we are also using underground water through tube wells and lift irrigation. On

the other percolation of water into the Earth is reduced because of deforestation and cutting of trees of Mountain hills as a result the quantity of underground water is reducing day by day. Hence along with conservation of water, steps should be taken for proper management.

## **Necessary Steps for Development Of Water Resource**

### **River Dam Projects :-**

The necessity water for irrigation in our country, the then British Government conceived and implemented River Dam projects on large and perennial rivers. After independence our newly formed Government has taken further steps for development of number of water reservoirs through large river dam projects. Hirakud River Dam Project, Bisweswarayya dam of Karnataka , Sardar Sarovar Dam of Gujrat are few examples of this. Supply of water for drinking and irrigation, to various part of the country, canals are constructed along with river dam projects. Distant places as well as places face water scarcity receive through canals only. For example Indira Gandhi canal project water supplying water to vast deserted area of Rajsthan .

We face lot of problems due to large river dam projects. People are not equally benefitted due to faulty water distribution and mismanagement of water resource. Many breaches in canal embankments occur while distribution of canal water causing floods. Similarly, people demolish canal embankments as the flow of water is very less as compare to require amount of water flow is creating more problems. Besides, few other problems faced like rehabilitation and displacement. Sometimes people have to leave their native place and settle somewhere else as the villages and crop fields get submerged under water due to reservoirs. As a result people lose everything such as lands, houses, parental property and crop field, business etc. A sever social and economical problems arise as people lose everything and get no compensation and employment.

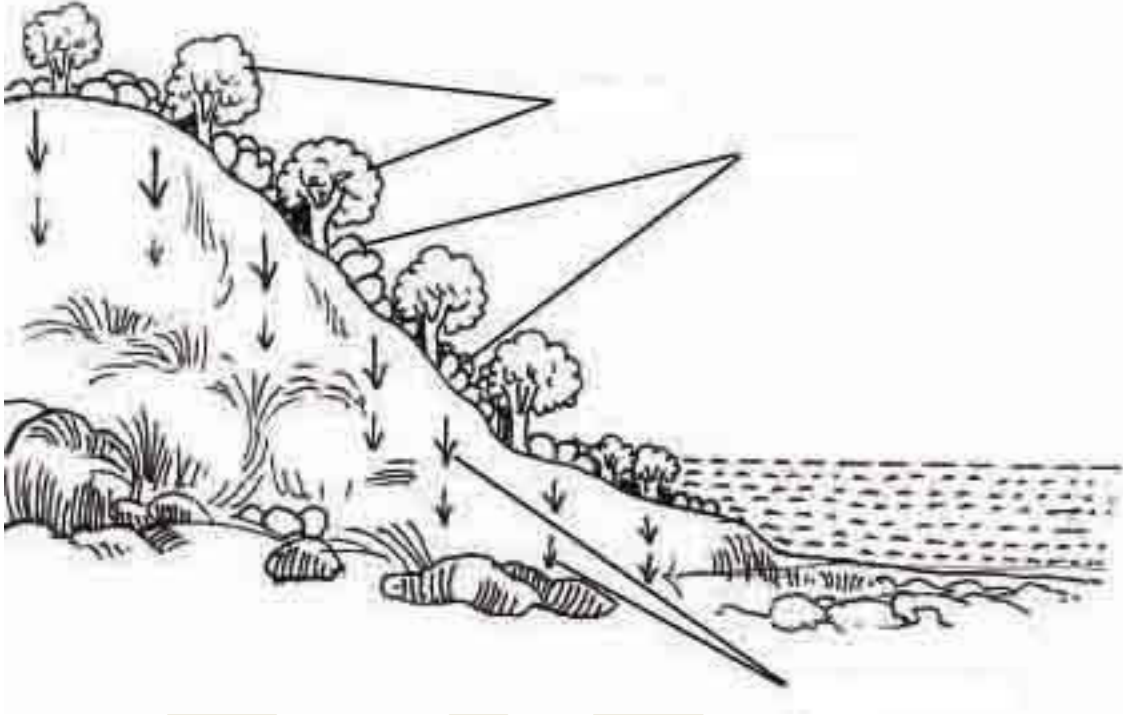
People dwelling near the Hirakud Dam Project are still fighting for their rehabilitation and compensation. “Save the Narmada Movement” or Narmada Bachoa” movement led by Megha Pathak is still continuing to protest against the raising of height of Sardar Sarovar Dam project on River Narmada. Besides in many places the forest areas are getting destroyed as they are submerged under water due to reservoirs. As a result it is they cause Environmental problems because they contribute enormously to deforestation and the loss of biological diversity.

We have to find out the alternative source of storing water instead of constructing large river dam projects. If water is stored in various places by constructing small river dykes and dams, equal distribution of water and mismanagement or overexploitation water resource can be controlled. In our state, a number of small river dams/dykes are built in Khadakhai (Mayurbhanj) Naraj (Cuttack), Munduli (Athagad) Deras (Bhubaneswar) and salia (Banapur) to supply water for drinking and irrigation. Besides, we can also reserve water by construction small river dam projects, digging ponds and artificial lakes etc. The Government of Odisha has taken a very good step i.e. “Mo Pokhari”, a project to reserve water.



### **Watershed Management:**

As we have already discussed that due to deforestation of Forests in hilly areas, water instead of percolating in to the ground, flows rapidly down on to the plains by which soil erosion is caused and also underground water is reducing day by day. In order to control soil erosion and conserve underground water, afforestation is being in forest hill slopes, bundhs/dams are built to check the down flow of water so as to increase the percolation of water into the ground. This process is called as watershed management and hill slopes are known as watershed regions. Following steps are taken for watershed management



(a) To check the forest loss in hill slopes and creating new forest there by replantation .

(b) Contour Bundhs/dams are to be built from top of the hill to its foot, so that rainwater will flow down the hill slope slowly and it will take lot of time to reach to the plains. As a result sufficient water can penetrate to underground.

(c)cutting of trees and deforestation by local inhabitants of hilly areas and inculcation of afforestation can be done by accelerating agriculture activity in watershed regions, and hence the source of income of the local people.

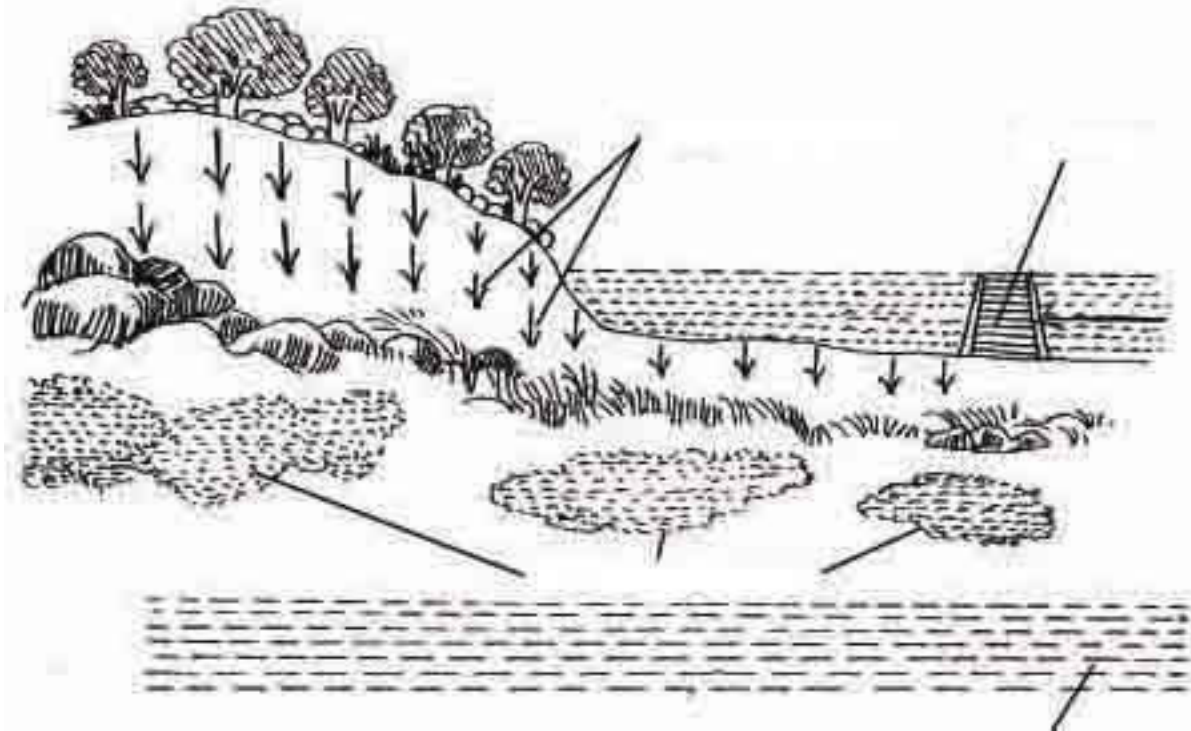
### **Rainwater harvesting:**

In our country conservation of rainwater to be used at the time of need is a traditional method. For this reason, a pond is found at the end of each village. If water is stored in ponds and tanks then water seeps into the ground slowly and the

level of underground water is raised. This underground water is made available through wells and tube wells as drinking water in each house. By conservation of surface and underground water, humidity of the soil increases and also water is available for plants and crop lands.

In plain regions new technical methods/modern methods are applied for rainwater harvesting. Small Check dams are built using soil or concrete and rain water is stored, this water seeps into the ground increase the underground water level. Only in low lying areas, rain water is available as surface water throughout the year and cultivation done during summer season in the water accumulated areas where irrigation is done by lifting underground water.

In urban areas as concrete jungle is built everywhere which restricts percolation of rainwater to underground as a result the rain water flows into the rivers. Hence it is necessary to conserve rainwater to and make the arrangement to seep into ground in order to increase the level of the underground water. We can increase the level of underground water by digging holes and fill with sand so that rainwater from the roof tops fall onto the sand beds, this water is absorbed by the sand bed and flow downward to mix with the underground water. Besides, we can use rain water directly by collecting it in to water tanks.



### **Recycling of water:**

In comparison to water require for agriculture and drinking, industries use more water. If the liquid industrial waste is release out without purification, then it mixes with surface water and polluted it. Hence it is compulsory to check the quantity and quality of water used and released from industries. Water pollution can be checked if

Industrial water waste is purified and recycled instead of releasing into the surface water and if the recycled water is reused then dependence on surface water will be decreased to some extent. Besides, industries can arrange their own rain water harvesting system similar to their own power plant and conserve rain water for their later use.

### **WORK FOR YOU 1**

Collect the waste of your house for 2-3 days. Dry it and segregate it into recyclable and non recyclable waste. Now weigh the dried waste and answer the following questions –

- a) What part of your daily waste can be recycled?
- b) Make list of things which are used more than its requirement?
- c) Give an account of the quantity of recyclable waste generated by the people of your village or city.

### **WORK FOR YOU 2**

Make a list of various types wastes thrown around your house and answer the following questions

- a) Where from this waste has come?
- b) Is there any chance to reduce the quantity of waster thrown?
- c) What amount of waste can be reused and in what way?

### **WORK FOR YOU 3**

Dig a pit near your house and put the waste generated in one day in your house. Every day put some on this water to keep it wet, continue it for atleast 15 days. Now open this pit and take out the waste. What did you observe?

- a) Find whether the whole waste is degraded.
- b) Some waste is not degraded. If it is so then write the reason behind the non degradation.
- c) How to manage the non degradable waste?

### **WORK FOR YOU 4**

Make a list of forest produce used by you and your family members. Classify the forest produce into parts of wild plants or animals.

### **WORK FOR YOU 5**

Make a list of forest produce used factories/industries. What situation will arise if industries use forest produce continuously?

### **WORK FOR YOU 6**

Arrange a group and discuss how forest resource getting destroyed due to our mismanagement and over exploitation of it. Discussion should include the following topics –

- a) Whether Guest houses should be built in forest for natural loving tourists?
- b) Whether cattle should be left for grazing in protected forests?
- c) How should we manage the non-biodegradable wastes like plastics, polythene, glass bottles etc thrown in forest by tourists?

- d) Whether tax or any act should be implemented to control the tourists throwing non biodegradable waste in the protected forest area?

### **WORK FOR YOU 7**

- a) Make a detail list of rainfall pattern in India. Mention the areas facing problems due to water scarcity.  
b) Write a concept note about how to reduce water scarcity in the less rainfall areas.

### **What you have learnt?**

- (1) Various problems arise in our environment is due to exploitation and destruction of Natural Resources.
- (2) Long run programs are required for protection and management of natural resources.
- (3) Reduce, Recycle and Reuse or the 3R rule through which we can reduce manage waste and conserve natural resources.
- (4) Proper utilization of everyday things and Environment friendly alternative methods should be adopted.
- (5) Protection of forest resources is important to protect environment. Deforestation is the main reason for decline of biological diversity.
- (6) There are 4 stakeholders to look after the Forest Resource – people living in and around the Forest, Forest department, and Industrialist and Nature lovers.
- (7) IUCN classified the threatened animals into Extinct, Endangered, Vulnerable, Rare and insufficiently known species.
- (8) Air pollution is due to smoke coming out of burning of Coal and Petroleum. Besides CO<sub>2</sub> gas come out from half burnt method and mix in atmosphere.
- (9) Coal and Petroleum can be conserved and used for long run by conserving the energy, proper use of energy and utilization of alternative source of energy.
- (10) Problems like displacement and rehabilitation are faced even though facilities to reserve water and irrigation are done by implementing large River dam projects.
- (11) We can conserve water and increase the level of underground water by Watershed management method.
- (12) We can check water pollution by purification and recycling of waste water and reuse it so that proper utilization of water could be done.

### **Exercise:**

1. What is 3R rule? How can we conserve our natural resource using 3R rule, explain?
2. Describe the reasons for destruction of forests.
3. Who are the stakeholders of the forest? what role do they play to protect forests?
4. Forest is the source of biodiversity. Justify this statement.
5. Describe the steps to manage to keep forest resources forever.
6. What are reasons for reduction in underground water level? How can it be improved?
7. Describe the methods of rainwater harvesting?
8. What benefits we get from large river dam projects? Why we need to think about alternative methods of water harvesting ?
9. Write in short :-
  - (a) What is watershed management?
  - (b) How is small river dam project useful?
  - (c) How water harvesting is done in plains?

- (d) What are the demerits of large river dam projects?
- (e) Write a note on pollution caused by coal and petroleum?

10. Short notes :-

- (a) Reuse
- (b) Role of nature loving people in conservation of natural resources
- (c) vulnerable species
- (d) role of public awareness in protection of forests
- (e) Chipko movement .

11. Answer in one or two sentences :-

- (a) What benefits we can get by recycling?
- (b) What habitat fragmentation?
- (c) Which industries are dependent on forest resources.
- (d) How can endangered species be conserved?
- (e) Where is the largest river dam situated in our state?
- (f) What is watershed?
- (g) Why coal and petroleum are called non-renewable sources of energy?
- (h) What are the alternative sources of energy?

## 12. Choose the best answer

1. Which is not a recyclable waste material

- (a) Paper
- (b) Organic waste
- (c) plastic bottle
- (d) glass bottle

2. Which is not included under 3R method ?

- (a) Reduce
- (b) Extraction
- (c) recycle
- (d) reuse

3. In which year National forest policy was formulated .

- (a) 1927
- (b) 1972
- (c) 1991
- (d) 1988

4. In which year, Conservation of Wild Life was formulated.

- (a) 1927
- (b) 1972
- (c) 1988
- (d) 1991

5. Which movement was started by Sunderlal Bahugana?

- (a) Chipko Movement
- (b) Appico movement
- (c) Ganga Bachao movement
- (d) Narmada Bachao Movement

6. Which one is a fossil fuel?

- (a) Wood
- (b) Coal
- (c) Leaf
- (d) fats

7. Which fuel produces SO<sub>2</sub> gas?

- (a) Petroleum
- (b) wood
- (c) fats
- (d) leaves

8. Which is used as fuel in thermal power plant?

- (a) Wood
- (b) petrol
- (c) coal
- (d) diesel