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SECONDARY BIOLOGY

Class IX-X

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PREFACE

Education is the key to development. A progressively improved education system largely determines the pace and the quality of national development. To reflect the hopes and aspirations of the people and the socio-economic and cultural reality in the context of the post independent Bangladesh, new textbooks were introduced in the beginning of the 1980s following the recommendations of the National Curriculum and Textbook Committee.

In 1994, in accordance with the need for change and development, the textbooks of lower secondary, secondary and higher secondary were revised and modified. The textbooks from classes VI to IX were written in 1995. in 2000, almost all the textbooks were rationally evaluated and necessary revision were made. In 2008, the Ministry of Education formed a Task Force for Education. According to the advice and guidance of the Task Force, the cover, spelling and information in the textbooks were updated and corrected.

To make assessment more meaningful and in accordance with the need of the curriculum, Creative Questions and Multiple Choice Questions are given at the end of each chapter. It is hoped that this will reduce the dependency of students on rote memorisation. The students will be able to apply the knowledge they have gained to judge, analyses and evaluate real life situation.

In the revised curriculum. Botany & Zoology has been included in one book Biology. The study of Biology has been Presanted through both theory and practical classes. The practical experiments have been given separately. Students can gain knowledge about Biology and their interest in science will increase when they complete the experiments with the help of the teachers. I hope that the textbook of Biology properly reflects the objectives of the curriculum.

This book of Biology for class IX & X is the English Version of the original textbook entitled 'Maydhamic Gibobiggayan' written in Bangla.

We know that curriculum development is a continuous process on which textbooks are written. Any logical and formative suggestions for improvement will be considered with care. On the event of the golden jubilee of the Independence of Bangladesh in 2021, we want to be a part of the ceaseless effort to build a prosperous Bangladesh.

In spite of sincere efforts in translation, editing and printing some inadvertent errors and omissions may be found in the book. However, our efforts to make it more refined and impeccable will continue. Any constructive suggestion towards its further improvement will be gratefully considered.

I thank those who have assisted us with their intellect and effort in the writing, editing and rational evaluation of this book. We hope that the book will be useful for the students for whom it is written.

Prof. Md. Mostafa Kamaluddin
Chairman
National Curriculum and Textbook Board
Dhaka

Contents

CHAPTER ONE
INTRODUCTION TO BIOLOGY

Now a days we find contributions of Aristotle, Socrates, Theophrastus and many other scholars of the past age in different fields of knowledge. This is not possible for the scholars of the present time. A question may arise in your mind as to why it is not possible today. The reason is that in ages long past the extent of knowledge was limited. People engaged in achieving knowledge were also small in number. Today the dimension of knowledge has been increased many times. To contribute in more than one field is quite difficult at the present time. For convenience to know and understand things we have divided our world of knowledge in many branches. In this way Science, Literature, Arts, Social Science and many other branches have been created. As a whole, knowledge of human beings is undivided. But it has been divided into various branches for easy learning and understanding.

You may have known that the knowledge of science is increasing rapidly. It is becoming possible because of the research of a large number of scientists in different fields of science. Many people think that knowledge of science is becoming double in every eight years. New subjects of science are being created. It is not possible to realize and understand this huge store of knowledge for an individual alone. As a result, scientists are engaged in research in particular subject or topic. At different times many scholars have divided the knowledge of science in various ways. The division and different branches of science are constantly spreading with the increase of knowledge in science. The two main branches of science are Physical science and **Biological Science.**

Physical Science is otherwise called the Science of non-living things. In Physical science characteristics, actions-reactions, multiformaity and many similar other properties of non-living objects are examined and discussed.

Observation, examination and discussion of livings beings are included in Biology. Biology is the science of living beings. The term Biology comes from two Greek words (bios means life and logos means knowledge). Aristotle is regarded as the father of Biology.

We find two types of life in nature. One is plant while the other is animal. Accordingly Biology has been divided into two branches: Botany and Zoology. Botany deals with theoretical discussion and research about characters and other features of plants, while Zoology is limited in subjects relating to animals.

PRINCIPAL BRANCHES OF BIOLOGY

Biology has been divided into Botany and Zoology on the basis of nature of living beings. Inspite of this, now-a-days extensive research has been done on Microorganism. They influence human life in various ways. So for discussion about them a new branch is made. This is known as **Microbiology.** Considering the subjects of living bodies on which discussion is made the whole range of Biology is divided into the following main branches.

1. Morphology: This branch deals with both the external and internal structures of organism. The subject concerning internal . structures is also known as Anatomy.

2. Cytology: Each living organism consists of one or more cells. Structures and functions of cells are treated in this branch of Biology.

3. Histology: In this branch discussion is made on structure, location and function of different tissues.

4. Physiology: This branch includes all the activities of living things e.g growth respiration, excretion, photosynthesis and other biological activities.

5. Taxonomy: In this branch discussion is made on identification nomenclature, and classification of plants and animals into groups and subgroups.

6. Genetics: How different characters are inherited from parents to offsprings, and how the processes can be controlled and improved etc. are brought under study and research in this branch.
7. Ecology: This branch considers the effects of environment on living organisms or living communities and also interaction between them.
8. Evolution: This branch deals with the origin and successive transformations of living organisms.

The groups discussed above are the basic branches of Biology. Scientists gradually started to utilize the knowledge of these branches for human welfare, and as a result applied branches of Biology were created. **Agriculture, Medical science, Breeding etc.** are some of the important applied branches of Biology. Applied Biology also includes **Forestry** and **Horticulture, Fishery, Pest Control. Animal Husbandry** etc.

There are numerous varieties of plants and animals on earth. Generally similar plants or animals are arranged in particular groups. Some special branches of Biology have been created on the basis of different types of living things are under discussion and research: for example. **Phycology** includes only members of algae; fungi are treated in **Mycology; Virology** deals with viruses only; bacteria are considered in **Bacteriology; Helminthology** is based on study of worms only; insects are discussed in **Entomology.**

Each of the above mentioned divisions has been divided into subdivisions or branches. It has been mentioned earlier that research in Biological fields has greatly extended now-a-days.

Biology, as it appears today, was not the same the past 50 years ago. It was believed that sweat-soaked warm clothing of men and some wheat, if kept together in a box for few days, rats would be produced. This wrong concept about the origin of life prevailed for a long time. Subsequently ideas about origin of life have changed by the research works of various scientists. Modern

Biology is the result of research and thinking of some great scientists. This chapter introduces you with some of these scientists.

Aristotle (384-322 B.C): The great Greek scientist, Aristotle is regarded as the father of Zoology. He first established Zoology as a branch of Science. Aristotle was simultaneously a scientist, poet, thinker and philosopher. It is he who first mentioned about the basic similarities in the structure of plants and animals. He stayed in an island named Lesbos for five years continuously and made research on animals. He wrote a book on animals and named it "Historia animalium" which is full of information and knowledge.

Theophrastus (370-285 B.C.): Little amount of works of the Greek philosopher Theophrastus is known to us. Of those available, nine volumes of "On the History of Plants" and six volumes of "On the causes of plants" are important. Theophrastus was the pupil of great philosopher Aristotle. He divided the plant community into four groups. For example: Trees shrubs, Undershrubs and Herbs. He is regarded as the Father of Botany.

Al Biruni (973-1048): Known as an world famous scientist and educationist. Al Biruni was an Arabian citizen. His real name is Abu Raihan Mohammad Ibne Ahmed Al Biruni. He made contributions in different branches of science. He visited India during the reign of Sultan Mahmud of Ghazni and described the conditions prevailing in India in an attractive way.

Ibne Sina (980-1037): He was a renowned Muslim philosopher and scientist. He had excellent skill in Chemistry, Medicine, Mathematics, Astronomy and Literature. His full name is Abu Ali Hussain Ibne Abdullah Ibne Sina. He composed more than hundred books on different subjects. Sixteen of which were written on Medicine. He had a fourteen volume compositions named Al-**Kanun**' on Medicine.

A1 Nafis: He was an Arabian scientist. He first (300 years before William Harvey) described correctly the system of blood circulation in human body. He was also a successful physician. His actual name was Abu Al Hasan Ali Ibne Al Nafis, He dedicated himself in the field of science for a long time, and died in Damascus at the age of eighty.

William Harvey (1578-1657): William Harvey was a British scientist. He rediscovered the system of blood circulation in 1628 and as a result some of the previous ideas about it came to an end. In 1651 he pointed out that life starts from the egg cell. He is considered to be the father of Animal Physiology. He clearly described the systems of blood circulation and excretion in animals, and explained the relationship between the two processes. He published a book "On the motion of the heart and blood in animals".

Anthony Von leenwenhoek (1632-1723): Dutch scientist leeuwenhoek first built the microscope. But his microscope was not like that of today. Descriptions of bacteria, nerve cell, Hydra, Volvax, etc. were written by him on observations through his microscope. They have been found to be precisely correct.

Carolus Linnaeus (1707-1778): Swedish scientist Linnaeus introduced the system of Binomial Nomenclature for plants and animals. A physician by profession, he was the professor of physiology in Uppsala University, Sweden. Collecting numerous plants and animals he classified them and made their nomenclature. His "Systema Naturae" composed on classification of living beings is a famous research work. Besides this his other two famous Botanical books titled "Species Plantarum" and "Genera Plantarum" are based on research work. He is considered to be the father of modern Taxonomy.

Charles Robert Darwin (1809-1882): English naturalist Darwin introduced the Theory of Natural Selection. He expressed his findings and ideas in his famous research publication, "Origin of Species by Means of Natural

Selection" in the year 1859, after observing the living communities of Galapagos Islands.

Alfred Russel Wallace (1823-1913): English naturalist Wallace made observation and research works in the Amazon plateau for four years. His renowned book `Travels on the Amazon and Rio Negro" was written on this experience. He wrote "The Malay Archipelago" on his eight years research experience in Malay Peninsula. The huge collection of insects he made has been kept preserved in the Hope collection centre of Oxford University. He is famous for the introduction of Natural Selection Theory along with Charles Darwin.

Gregor Johann Mendel (1822-1884): Austrian Priest Mendel performed research work with pea plants in his church garden for a long time. Based on this research he established two laws concerning genetics, which are followed till today. He is regarded as the father of Genetics.

George Bentham (1800-1884): The most notable work of this English Botanist is the composition of three volumes of "Genera Plantarum" along with Joseph Dalton Hooker.Other books written by him are `Handbook of the British Flora'. `Flora Hongkongensis', Flora `Australiensis' etc.

Thomas Henly Huxley (1825-1895): Renowned British Zoologist T.H. Huxley did a lot of works on birds. He termed birds as `glorified reptiles' and proved that birds have been evolved from the reptilian ancestors. Besides, he made extensive research on Zoology. He was a notable supporter of Charles Darwin's theory of Natural Selection. Huxley described protoplasm as the physical basis of life.

Aristotle

Theophrastus

Anthony Von Leewenhoek

Carolus Linnaeus

Charles Darwin

Gregor johann Mendel

Alexander Fleming

Selim Ali

Watson

Alexander Fleming (1881-1955): Alexander Fleming was a Microbiologists He observed in 1918 that some bacterial growth stops in a culture media where Penicaillium is grown. He tried to find out the reason behind it. From his quest and research he subsequently discovered the drug penicillin that has saved millions of lives. He won Nobel Prize along with two other winners in the year 1945.

David Prain: David Prain was an English physician. He obtained degree in medicine from Aberdin and Edinburgh. Joining Indian Medical Service he came to India in 1883. His first Place of Posting was Luxmipur in Noakhali. Later he started research with the plants of this region. He was the Director of

Calcutta Botanical Garden from 1887 to 1897. His famous book, "Bengal Plants", Published in two volumes, widely treats plants of Bangladesh and adjoining areas. "Flora of Sundribuns" is another notable book written by him.

Salim Ali (1896-1987): Known as the Birdman of India, Salim Ali was a renowned ornithologist. He scientifically observed all birds of India and wrote an informative book. The title of the book is "The Indian Birds" In addition to this he composed many other books on birds. His autobiography is also a famous publication. In 1983 the Indian Government awarded him "Padmabhushan" title in recognition of his research work.

Sir Hans Krebs (1900-1981): English scientist Krebs won Nobel Prize in 1953 along with F.A. Lipmann in medicine and physiology for his research work on metabolism of cells. He was appointed as the departmental head of Biochemistry in the Oxford University in 1954. Krebs cycle of respiration in living beings is his discovery.

James Watson and Francis Crick: The two British scientists, Watson and Crick are famous for making the model of the molecular structure of DNA which bears the hereditary factors of human beings. While carrying out the research for PhD Degree in Cambridge University they discovered the molecular structure of DNA in 1953. They won Nobel Prize in the year 1963 for this work. Watson and Crick first noticed that DNA molecule is structurally a double helix and spiral.

Melvin Calvin (Born in 1911): Calvin, a professor of California University U.S.A. is famous for his research concerning the pathway of carbon assimilation in green plants. In co-operation with other scientist Bassham, discovered the biochemical steps of Carbon assimilation known as Calvin Bassham pathway of photosynthesis. He obtained Nobel Prize in 1961.

CHARACTERISTICS OF PLANTS AND ANIMALS

Taking a few main characteristics from many we shall now compare plants with animals.

1. **Size and shape:** Plants have no definite size and shape while animals have definite size and shape.
2. **Life Time:** Life time is not limited for plants and under suitable conditions they live for a long period. But animals live up to a certain length of time under suitable conditions.
3. **Growth:** In suitable environment growth of many plants continue for a long period. Growth in animals takes place up to a certain stage of life and growth ceases after that.
4. **Movement:** Most land plants remain fixed in soil with the help of roots as a result they cannot move. But some organs of plants may show some movement. A few animals (Such as Sponge) are not capable of movement. Most of the animals can move freely.
5. **Nature of Food:** Plants cannot take solid food Animals can take solid and liquid type of food.
6. **Nutrition:** Plants are autotrophic, it can prepare food through photosynthesis. Animals cannot prepare their own food. For foods they are to depend on plants and other animals.
7. **Structure of Cell:** A Plant cell has dead cell wall. Most of the mature cells have a large vacuole and plastids. The animal cell has no cell wall and it contains small vacuoles and centrioles.
8. **Reproduction:** Plants reproduce by vegetative, asexual and sexual methods. Reproduction in animals mainly takes place by sexual method.Vegetative and asexual reproduction may be found in some animals.
9. There are different systems in animal body. But plants have no body system.

ROLE OF BIOLOGY IN SOCIAL, ECONOMIC AND ENVIRONMENTAL DEVELOPMENT

The two main branches of Biology are Botany and Zoology. In addition to these, there are other branches and sub-branches of Biology. You have come across some of those in the preceding parts of this chapter. Now let us discuss the importance of Biology on the basis of knowledge you have already attained.

Agricultural science has many branches of which Agronomy, Horticulture, Plant breeding, plant pathology, Fishery, Animal husbandry, Poultry, Honeybee culture (Apiculture), Sericulture etc. are important. With the application of knowledge of these branches economic development is possible.

Both plants and animals are the essential components of natural environment. It is known to you that plants and animals are interdependent in many ways. Ecology makes us alert about the importance of plants and animals and also the necessity of their presence in nature, Educated and conscious citizens can play important role in conservation and development of environment. Economic development sometimes produces adverse effects on natural environment. Environmental degradation and hazards can be encountered through proper application of our knowledge in ecology, Economic solvency and good environment help social development.

NATURE AND ORIGIN OF LIFE

You know what nature is. We live in nature. We have soil, water, air different plants, animals, insects and worms etc. all around us. All these together constitute nature. Millions of years ago nature was not as we see it today. Nor will it remain the same after millions of years. This indicates that nature is always changing. Nature undergoes changes due to various natural forces such as river-currents, earthquakes, volcanic eruptions etc. Different human

activities, such as destruction of forests, construction of dams etc. also bring about changes in nature.

Scientists have been thinking about the origin of nature. There are different theories about the origin of the Earth. Among these the commonly acceptable theory explains that a part of the Sun or a similar star got detached as a result of the attraction of another star. The planets including the Earth and then satellites have been created from the detached part of the sun.

According to this theory at the beginning the Earth was in a hot, gaseous state Subsequently the Earth gradually cooled and condensed to form the Earth as it is now. The core of the Earth is still in an extremely hot liquid and gaseous state. Nature of the Earth at the primary stage was not at all suitable for inhabitation of life. Gradually it became favourable for the existence of living forms. Now a question may arise in your mind as to how life originates in nature. Did plants and animals exist in nature from the very beginning?

There are different theories regarding the origin of life on the Earth. In the beginning of this chapter we have described an old concept of the origin of life But the theory presented by Oparin, a Russian scientist, about the origin of life is still accepted.

According to the theory of Oparin nature was quite hot when life was created Different gases such as ammonia (NH_3), hydrogen (H_2), methane (CH_4) hydrogen cyanine (HCN) etc. were present in the atmosphere. During that period there was heavy rainfall and thunderstorm. Under such environmental condition amino acids were formed by the interaction of various gases and these amino acids are considered by scientists to be the first molecule of life The first cell or life came into being through incorporation of amino acids. It is also believed that life was created first in the primitive aquatic environment.

3. According to the Oparin's theory and established scientific reasons which one of the following is correct if arranged chronologically from origin of life to the recent?

a. Amino acid ⟶ Unicellular Algae ⟶ Bacteria ⟶ Unicellular Amoeba.
b. Amino acid ⟶ Unicellular Amoeba ⟶ Bacteria ⟶ Unicellular Algae.
c. Amino acid ⟶ Bacteria ⟶ Unicellular Algae ⟶ Unicellular Amoeba.
d. Amino acid ⟶ Bacteria ⟶ Unicellular Amoeba. ⟶ Unicellular Algae

4. According to the Oparin's theory and established scientific reasons which one of the following animals came into being at the last in the terrestrial environment?

a. Bird
b. Man
c. Buffalo
d. Banyan tree

Creative questions

1. Kalidas became curious about plants and animals when he was studying at Shingua High School. Seeing his curiosity the teachers of that school advised him to study biology when he will be grown up. According to that advise Kalidash studied on Botany in the University. The subjects he studied included both pure and applied branches of Biology. But afterwards he started working on applied branch and invented many high yielding fruits & crops. He is still engaged in this works.

a) What is Biology?

b) Why is physiology called the pure branch of Biology?

c) Explain that why is the works of Kalidash included in the applied branch of Biology.

d) Analyse the importance of pure branch in the success of Kalidash.

The first cell had protoplasm, amino acid and later on DNA molecules are formed by union of amino acid molecules, But the cells did not have any nucleus. This non-nucleated cell successively gave rise to nucleated cell and multicultural organism.

Exercise

Multiple choice questions

1) Why is Gregor Johann Mendel famous for?

a. For Natural Selection theory.

b. For the invention of blood circulation mechanism.

c. For the invention of penicillin.

d. For the law of heredity.

2) Which scientist contributed much for detail description of plants in Bangladesh?

i. Aristotle

ii. Theophrastus

iii. David Prain

Which of the following is correct?

a. i. b. ii.

c. iii. d. ii & iii

Give answer to the question no. 4 and 5 according to the following paragraph.

The theory presented by Oparin about the origin of life in nature is more accepted. According to the theory at the beginning of life amino acids, the first molecule of life were formed by the interaction of various gases. Then the first cell or life came into being through incorporation of amino acids in the aquatic environment. The first cell did not have any nucleus. This non-nucleated cell gave rise to a nucleated cell and successively multicellular organisms.

CHAPTER-TWO
Structure and Nature of Living Cell

Those who have life are living beings. Microorganisms, Plants and Animals have life, so they all are living beings. Living world is composed of microorganisms plants and animals. One or more cells make every living being. Cell is the structural and functional unit of living body. All sorts of reaction and anti- reaction in living body are cell centered. So to know about any living beings one should know about the living cell at first.

All living cells are not alike. As they are, different in structure, they are different in size, shape and functions. Different types of cell are described below in brief.

All the cells of Plants and Animals are eukaryotic but they have differences as well. Difference between Plant cell and Animal cell are shown in a tabular form at the end of this chapter. However the main difference between them is the Plant cells have a non-living cell wall, which is absent in the Animal cells.

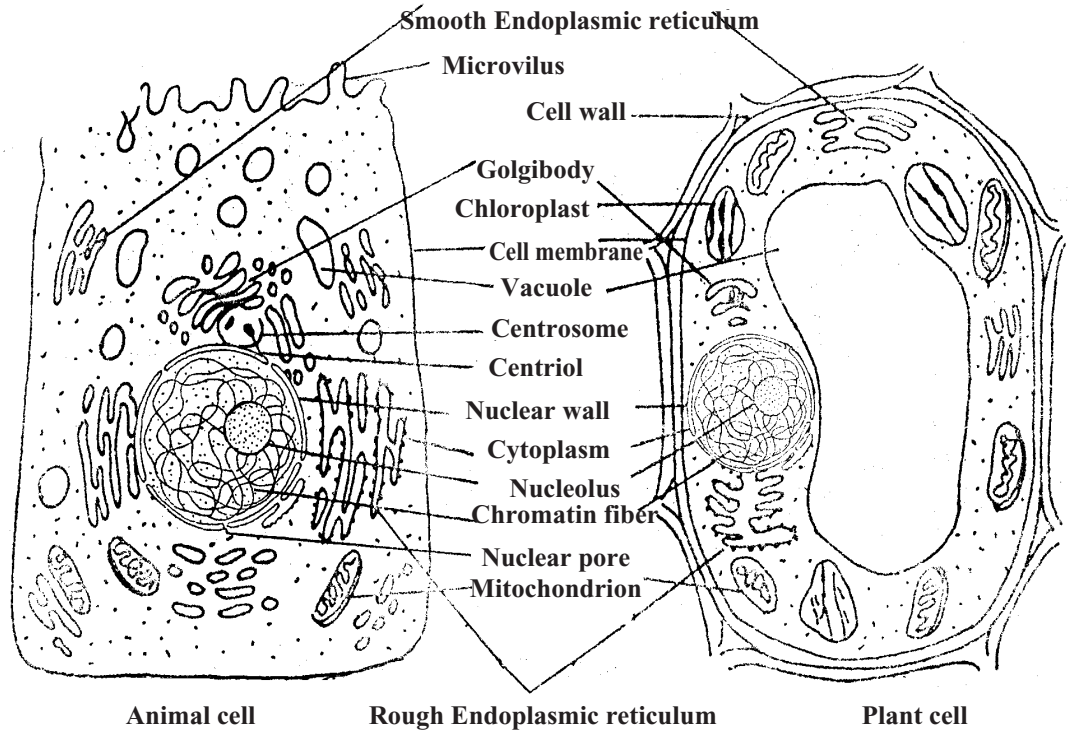


Fig : 2.1 :- Generalised Plant and Animal Cells (Seen under Electron Microscope)

A. On the basis of Nuclear Structure

Prokaryotie cell or Proto cell : Nucleus is not well organized in these cells; nuclear membrane and nucleolus are absent here. In these cells Chromosome contains only DNA. Generally no other organelles are present except Ribosome. Cell division happens here through Amitosis process.

Eukaryotic cell or Eucell : There are well-organised nucleus in these cells with membrane and nucleolus. Chromosome contains DNA, proteins Chloroplasts, Mitochondria and other organelles. Cell division happens through mitosis process.

B. On the basis of Function

Somatic cell : These cells construct the living body but do not take part in reproduction. In the lower group of living objects they are haploid i.e. only one set of chromosomes are present, but in higher groups they are diploid i.e. there are two sets of chromosome in the nucleus.

Reproductive cell: These cells take part in sexual reproduction but do not construct the main body. These cells are also haploid. Sperm and ovum are examples of reproductive cell.

Size, shape and Structure of Living cell :

It is normal to have some diversity in size, shape and structure of cells. The size, shape and structure of a eukaryotic cell (eucell) are described below in brief.

Size : A cell may be 0.1 μ (micron) to 55cm (centimeter) or even more.

[1 Millimeter = 1000 Micron]

Shape: Cells are of different shapes. Mainly they are spherical, oval, rectangular, barrel shaped or polygonal.

Structure of typical cell :

Structurally cells are of various types. For that in a certain cell all the organelles or structural ingredients may not be present. For that reason, considering the presence of all the organelles in a certain cell, it may be termed as a Generalized Cell. A generalized cell has mainly two parts- Cell wall and protoplasm.

Cell Wall:

Cell wall is the unique characteristics of a plant cell. The non-living and hard wall, which constructs the plant cell, is called the cell wall. At first Robert Hook observed it in 1665 AD. There is no cell wall in Animal cells.

Chemical composition of cell wall:

The cell wall is mainly composed of cellulose, hemicellulose, pectose, lignin, suberine etc. Those are made by different carbohydrate compound. The cell wall of fungi is made of a carbohydrate called chitin. The cell wall of bacteria made of protein, lipid and polymer.

Function of cell wall:

The functions of cell wall are to give a definite shape to the cell. It protects the Cell from external injury and gives necessary rigidity and to regulate the flow fluid between external and internal side of the cell.

Protoplasm:

Protoplasm is made by the mixture of different complex compounds. It is jelly like, translucent, viscous, colourless semi solid-living substance. All the pro perties of life are present in it. Protoplasm is divided into three parts: Plasma membrane, Cytoplasm and Nucleus.

1. Plasma membrane or Cell membrane:

Just beneath the cell wall there is a soft living membrane surrounding the whole protoplasm. This is called cytoplasmic membrane or cell membrane.

Stucture:

Plasma membrane is bi-layered. Under electron microscope there revealed a light layer between two dark layers. In the cell membrane of some epithelial cell there found some finger like out growth-these are called **Microvilli (Singular : Microvillus).** They increase the absorption surface of the cell. The membrane between two adjacent cells modified in various forms to make the

Connection between two cells rigid. They also make the movement of different substances between the cells easier. In many cells spaces in the cell membrane may be broader.

Functions of Cell membrane :

(a) Transportaion of different materials inside and outside the cell, (b) Absorption of different substances (mainly nutrients) from outside the cell, (c) protection of the cell body and giving the cell a definite shape.

2. Cytoplasm :

Outside the nucleus, the part of protoplasm, which is surrounded by the cell membrane, is known as cytoplasm. It is composed of different organic and inorganic compounds like water. different nucleic acid and enzymes. The outer area of cytoplasm is more concentrate. less granular and hard, which is called Ectoplasm, and the central area, Which is less concentrated, called Endoplasm.

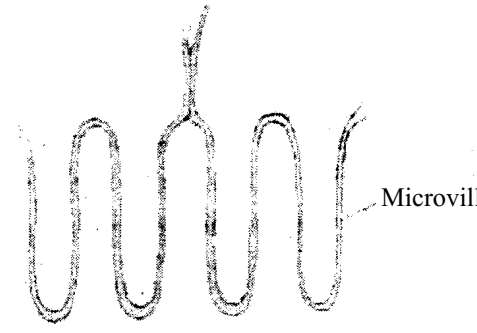


Fig.2.2: - Bi-Layered Cell Membrane

Different organelles like plastids, mitochondria, endoplasmic reticulum, ribosome, golgi bodies, lysosome, centrosome and different nonliving substances are present in the cytoplasm.

Function of Cytoplasm : (a) to hold different organelles and (b) to perform some organic functions.

Description of organelles present in cytoplasm is given below :

Plastid :

Plastids are largest in size among the organelles present in cytoplasm. They can be seen clearly under microscope. Plastids are not present in Fungi, Bacteria and Animal cells.

Plastids are mainly of two types: Leucoplastid or Leucoplast and Chromoplastid or Chromoplast. Leucoplastids are colourless and Chromoplastids are coloured. Chromoplastid again is of two types Chromoplast and Chloroplast.

Leucoplast: They are colourless, as they have no pigment. Leucoplast may be converted into Chromoplast or mainly chloroplast in contact with sunlight. In absence of light the case may be reversed.

Position: Leucoplasts are present in the cells of organs like root. underground stem etc. which do not come in contact with sunlight.

Shape: Leucoplast may be semicircular or tubular in shape

Function: Their function is to store food.

Chromatoplast: Chromatoplasts are green or other colour; when green, it is called **chloroplas**t and when they are other colour it is called **Chromoplast.**

Chromoplast: They are variously coloured, other than green, mostly yellow and red in colour. They are also variable in shape. Chromoplast occurred in coloured part of plants. e.g. petals, coloured fruit and seeds, roots of carrot etc.

Function: Flowers are coloured and beautiful due to their presence.

Chloroplast: They possesses green pigments named chlorophyll in excess as a result they are green. Other pigments are also present to some extent. Every cell may contain one or more chloroplast.

In higher plants the shapes of chloroplast is lenceolate. In Algal cells their shapes are of various types, e.g. cup shaped, spiral, reticulate, star shaped. semicircular etc.

Structure of chloroplast: The following parts make Chloroplast :

1. A bi-layered semipermiable membrane surrounds the whole chloroplast. It is composed of protein and lipid. This is called lipoprotein.
2. A hygroscopic matrix surrounded by a membrane is there. This matrix is called **stroma.**
3. In the stroma, 40-80 well-arranged barrel shaped grana (sing: granum) are present. In one granum there are 5-25 granum disc. Inside

the granum disc, there are spaces. Probably chlorophyll and other photosynthetic materials are present in this chamber.

4. Some granum discs of two adjacent grana are connected by minute tubular bodies, which are called **stroma lamelli.**

5. Many crystalline bodies are arranged in the membrane of grana disc. These are called **quantosome**. In the dark phase of photosynthesis, carbon-di-oxide is assimilated mainly in the quantosome.

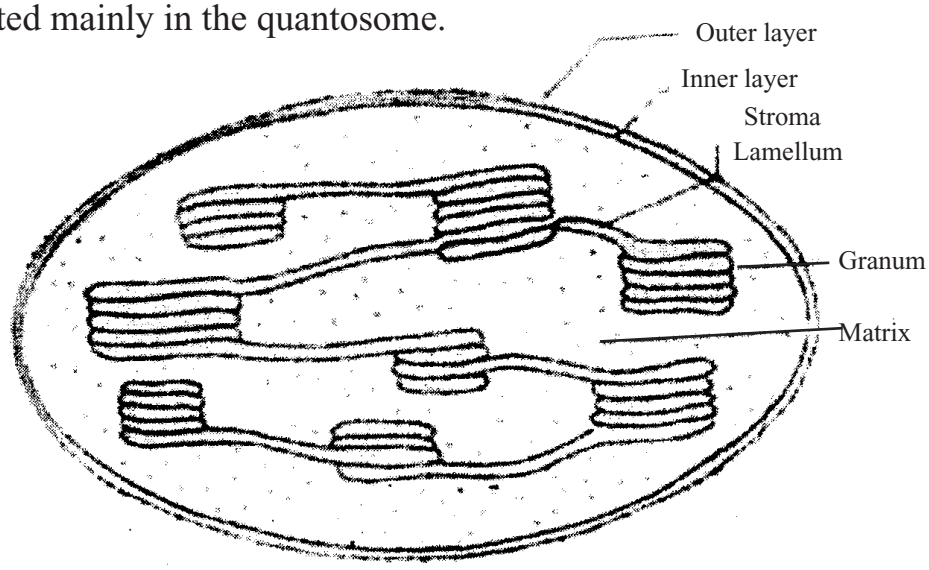


Fig : 2.3 :- Different Parts of Chloroplast (Seen under Electron Microscope and then simplified)

Function: Its function is to prepare carbohydrate food by the process photosynthesis.

Mitochondria: Krebs cycle, fatty acid cycle, electron transport system etc. take place in mitochondria (sing: mitochondrion). All energy producing process occurs in mitochondria for which mitochondria are compared to the powerhouse of the cell. Number of mitochondria may vary according to the species. Normally each cell contains average 300-400 mitochondria. Their shape may be globular, rod, thread, star-shaped or ring-shaped. The outside of mitochondria is surrounded by a bi-layered membrane. The membrane is made by lipoprotein, which is enriched with lipid and protein. The outer membrane is smooth but the inner one has a series of enfolding into the inner cavity of mitochondria. These enfolding are called cristae. Small stalked granular bodies are arranged on the cristae and they are called auxisome. Various enzymes.

Endoplasmic reticulum: ER

In a mature cell a network is found in the cytoplasm. This is called endoplasmic reticulum. Endoplasmic reticulum is of two types - smooth and rough. ER having ribosome on its body is called rough endoplasmic reticulum.

Structure: They are bounded by double-layered semipermiable membrane. Normally they are branched but may occur in parallel. They are continuous with the nuclear membrane and the cell membrane. Chemically the membrane is made by lipoprotein. Small granular bodies may be present on it.

Function: They form the skeleton of protoplasm. Protein synthesis occurs in rough endoplasmic reticulum. Lipid, in alternative opinion, different hormones, glycogens etc. are synthesized in the smooth endoplasmic reticulum. They play the role of internal carrier of lipid and protein.

Ribosome:

Ribosomes are small spherical /granular organelle. They may occur freely in the cytoplasm
and may be attached on the outer wall of endoplasmic reticulum.

Structure: These are spherical and bounded by double layered membrane. Mostly they are made by protein.

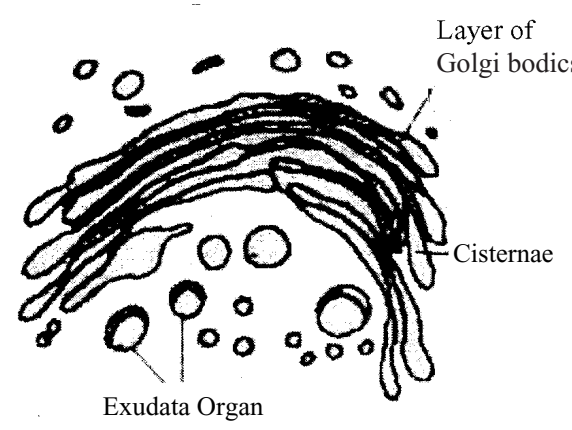


Fig. 2.6 Structure of Golgi bodies

Function: In ribosome various amino acids are combined to synthesize protein.

Golgi bodies/Golgi apparatus:

Golgi bodies may be flat, spherical or elongated. Normally they are present near the nucleus. It was first observed by a scientist named Golgi in 1898 AD in the nerve cells of owl and cat. This organelle is afterward named Golgi apparatus after his name. In plant cells their number is small for which it is not always visible under microscope.

Structure: Golgi apparatus is tubular, small vesicle, vacuolar, elongated vessel like or lamillar bodies. They are vacuolar space bounded by double-layered membrane.

necessary for respiration are well arranged in auxisome. About 70 types of enzymes and 14 types of co-enzymes are present in it. Matrix is also present inside the free space of mitochondria. The main function of mitochondria is to produce energy, like- respiration, oxidative phosphorilation, electron transport system etc.

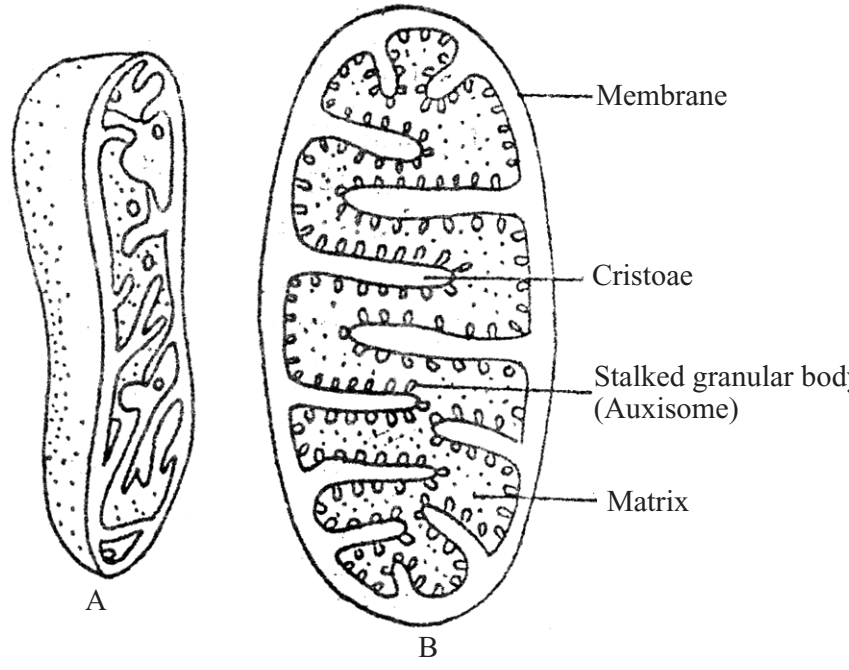


Fig: 2.4 A and B L.S. of a Mitochondrion as seen under electron microscope. (A) Three-dimensional (B) Thin L.S.

Rough Endoplasmic Reticulum **Smooth Endoplasmic Reticulum**

Fig. 2.5 Endoplasmic Reticulum (Simplified)

Function: Function of Golgi bodies are- synthesis of lysosome and non-protein substances, releasing some enzymes, expelling cell water and attaching substances to its membrane produced by endoplasmic reticulum.

Lysosome:

Lysosome is formed by various enzyme bounded by a membrane. Normally they are spherical. Their membrane is bi-layered.

Function: Their functions are phagocytosis i.e. to eat the invading enemy in the cell, to protect different organelles in the cell by dissolving enzymes and to help in digestion.

Centrosome:

In animal cell there is a spherical body outside the nucleus, which is called centrosome. The fluid by which it is composed is called centrosphere. At the center of centrosphere there are two cylindrical objects called centriole. At the time of cell division the pair of centriole is separated and moves to two opposite pole (of the cell).

Function: At the time of cell division centrosome directs the poles of spindle apparatus and help in cell division.

Vacuole:

The open spaces that found in the cytoplasm is the vacuole. In immature cell their number are many and small in size. But in a mature cell all the vacuoles combined together to form a large vacuole. The thin membrane that covers the vacuole is called tonoplast. The internal fluid of the vacuole is called cell sap. Different kind of inorganic salts, organic acid, carbohydrate, protein, fat, various complex substances and various colour are present in the cell sap.

Nucleus:

Denser and clearer organ found in the protoplasm is Nucleus. Robert Brown discovered and named nucleus in 1831 AD in the cell of orchid leaf. Normally each cell contains one nucleus. Some eukaryotic cell like sieve tube, mature red blood cells of mammal do not have nucleus. Usually nucleus is spherical and present at the centre of the cell. They may be present by the side of a large vacuole. Nucleus may smaller or larger in size and shape.

Function : Nucleus controls the total activity of the cell.

Structure: Chemically they are made of nucleic acid and protein. It contains some protein, trace of DNA (Deoxi-ribo nucleic acid) and RNA (Ribo Nucleic Acid), little amount of Co-enzyme and other materials. Physically they are made by the following parts: - Nuclear membrane, Nucleoplasm, Nucleolus and Chromosome

Nuclear membrane: The double layered transparent membrane, which make the outer covering of the nucleus is the nuclear membrane

The outer membrane porous but the inner one is not. Chemically the membrane is made of protein and lipid.

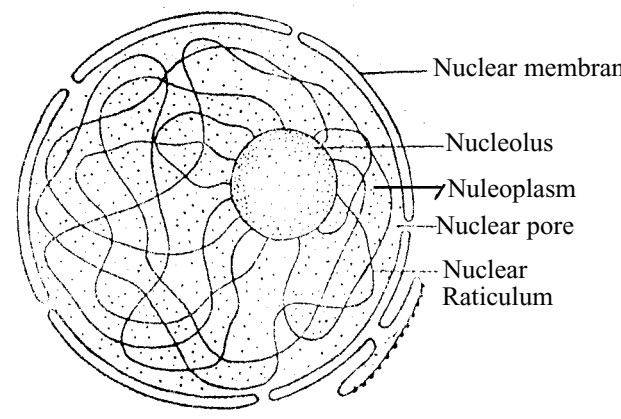


Fig. 2.7 A Nucleus as seen under electron microscope

Function: The main function of this membrane.is to keep the nucleoplasm, chromosome and the nucleus distinct from cytoplasm. Transportation and communication between internal materials and cytoplasm is also done through this membrane.

Nucleoplasm: It is a transparent and dense fluid bounded by nuclear membrane. Nucleolus and chromosomes are present in it.

Function: It holds chromosomes and performs various organic functions.

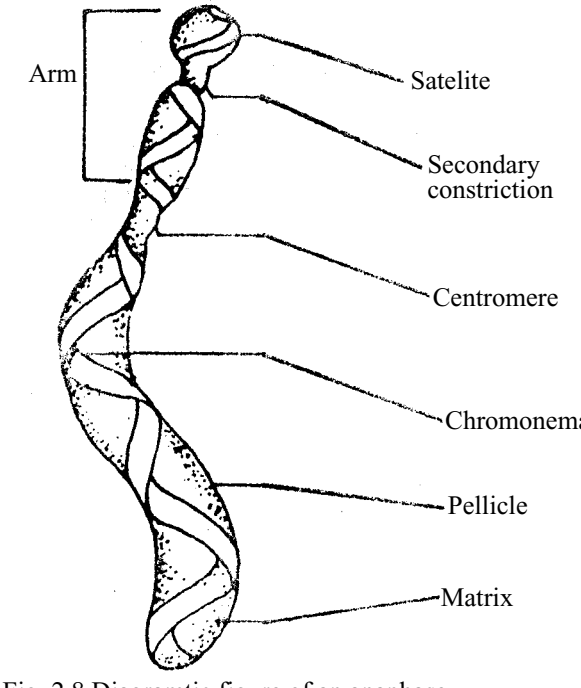


Fig. 2.8 Diagramtic figure of an anaphase chromosome

Nucleolus: The denser, small and round body found in the nucleus is the nucleolus. Every nucleus normally contains a single nucleolus. Nucleolus is usually attached to a certain area of a Particular chromosome. The region of chromosome where it remain attached is called `secondary constriction'.

Chemical composition: The main compositions of the nucleolus are protein, RNA and a trace of DNA.

Physical structure: Nucleolus is usually divided into three parts namely fibrous, granular and matrix.

Function: To synthesise various types of DNA and protein and preserve them.

Chromosome: In every nucleus there is a definite number of chromosomes according to the characteristic of definite species. It can be seen under microscope after proper staining, only in a dividing cell. Every chromosome contains one or more centromere, one chromonema or more chromonemata and some chromosome may have satellite. Chromosome bears a number of gene and genes are responsible for expressing characteristics of different species.

Chemical composition of chromosome: Chemically each chromosome is composed of DNA, RNA, Histon and non-histon protein. Besides, some calcium and magnesium are also present here.

Function: Chromosome is the bearer and carrier of hereditary properties of the organism.

4. Ergastic substances :

In a mature cell, in addition to the above-mentioned substances. there are various types of non-living objects. They are present in the cytoplasm. Non-living objets may be classified into three types, namely reserve food, secretory materials and excretory materials.

Main differences between Plant cell and Animal cell

Plant cell	Animal cell
1. Most plant cells are bounded by a non-living cell wall made of cellulose.	1. No cell wall is present in animal cell.It is surrounded only by plasma membrane.
2. Different types of plastids are present.	2. Plastids are not available here.
3. Usually one or more vacuoles are present.	3. Except some lower group of animals most of the animal cell do not have any vacuole.
4. Normally no centrosome is present in plant cell.	4. Animal cell always bears centrosome
5. Golgi bodies are rarely seen in plant cell under microscope.	5. Golgi bodies are frequently seen here under microscope.
6. In plant cell reserve food is mainly starch.	6. In animal cell reserve food is mainly glycogen.

Exercise

Multiple choice questions

1. In which organ of a plant the Leucoplast is present?

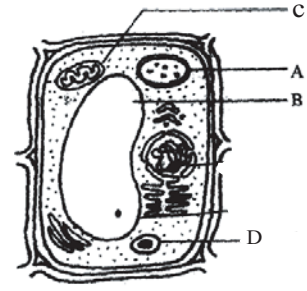
a. Flower b. Stem
c. Root d. Branch

2. The appropriate statement about the nucleus is, itÐ

i. Stays in the middle of the cell
ii. Controls cell devision.
iii. Contains Chromosomes.

Which one of the following is correct?

a. i b. ii
c. i & iii d. ii & iii



Fig

See the above diagram and give answer to the question no. 3 and 4

3. Which one is available in the part labelled C?

a. Centrosome b. Auxisome

c. Quantosome d. Chromosome.

4. In what ways the organ are labelled A help the organism to keep alive?

i. To Produce food

ii. To perform the respiration.

iii. To perform the osmosis

Which one of the following is correct?

a. i b. ii

c. i & ii d. i, ii & iii

Creative questions

1. See the diagram given below & answer the following questions.

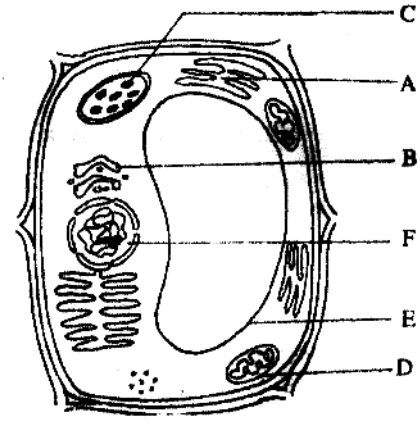


Fig.

a) What is the name of the part labelled D?

b) Write two differences between the labelled A & B.

c) Draw a labelled diagram of the cell showing the position of organelle in absence of organelle labelled E.

d) Analyse the importance of organ labelled C in a living cell.

CHAPTER - THREE

CELL DIVISION

Every living body is composed of cell. Some living bodies are made of only one cell. They are called unicellular organism, e.g. Bacteria, **Amoeba, Plasmodium,** some Fungi and some Algae. Some living bodies are made of more than one cell. These are called multicellular organism. There are many living bodies, which are made of millions of cells. Living bodies like human. beings or mango tree etc. are composed of millions of cells. Unicellular organisms increase their number (multiply) by cell division. In this process one cell divides into two, two to four and so on. In multicellular organisms, a large body consisting of millions of cells develops by cell division from the embryo, which also develops from a single fertilized egg. A young seedling developed to a large tree by cell division. Again new generation is created from male and female gametes formed by cell division. But all these divisions are, not alike. The processes of division are of different types and the results are also different.

Types of cell division:

Cell division is of three types: **(i) Amitosis (ii) Mitosis and (4i) Meiosis.**

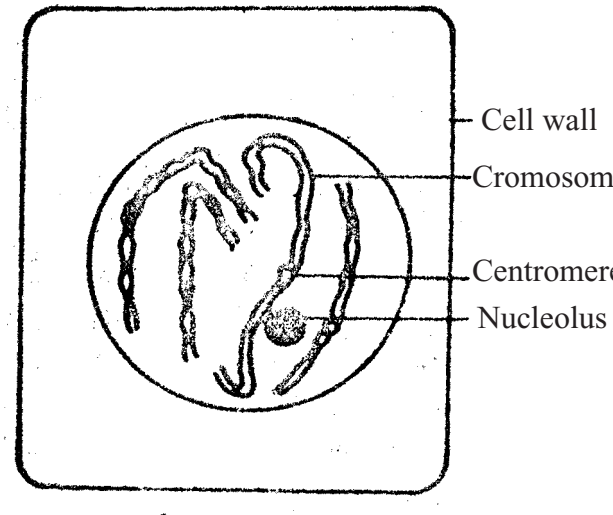
1. **Amitosis:** This type of cell division occurs in unicellular prokaryotic organisms like Bacteria, Yeast etc. In this division, at first the nuclear materials are directly splitted into two portions and then the cell divides into two from the middle region. As a result, from one cell there' develops two.
2. **Mitosis:** Mitosis is a type of cell division by which a eukaryotic cell divides into two by a special method. In this process, the nucleus and chromosome are divided once and the number, structure and properties of chromosome in the newly formed cell remain just alike the mother.

cell. Mitosis is also termed as equational division. Normally this division occurs in somatic cell. As a result of this division, the plant and animal increases in length and breadth. Mitosis occurs in all meristamatic cells of plants.

3 **Meiosis:** Meiosis is a type of cell division by which a Eukaryotic cell divides into four cells by a special method. In this process the nucleus divides twice but the chromosome divides once. The number of chromosome in the newly formed daughter cell reduces to the half the number of mother cell. As the number of chromosome reduces to half this process is also termed as reduction division. In Greek `Meiosis' means `to reduce' and from this the term Meiosis comes in use. This division occurs in reproductive mother cells of diploid organisms. As a result haploid gametes develop. In haploid organisms, this. division occurs in the zygote, as a result of which the organism becomes haploid again.

Stages of Mitosis :

Mitosis is a continuous process. The process is completed by a complex method. According to the sequence and stages, this continuous process is divided into five stages. The stages are: (1)Prophase, (2) Pro-Metaphase, (3) Metaphase, (4) Anaphase and (5) Telophase.



Prophase

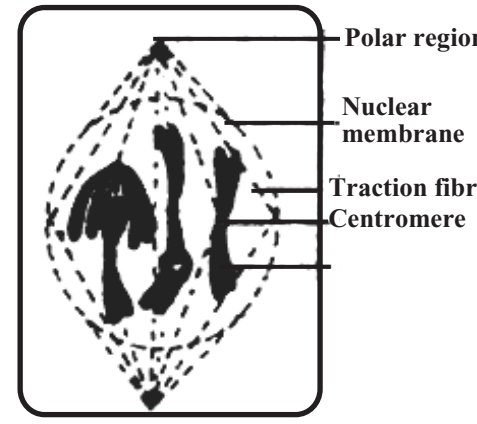
1. Prophase: At this stage, the nucleus swells up. Chromosomes begin to be de-hydrated. As a result, the chromosomes gradually become shorter and thicker.

Then they are visible under microscopes. At the end of this stage nucleolus and nuclear membrane become disappear.

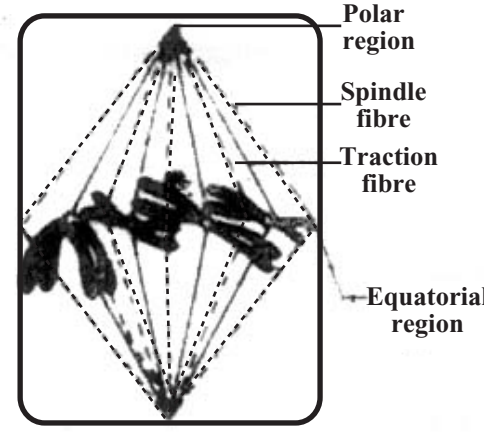
2. Pro-Metaphase : At the beginning of this stage. the fibrous protein converse to form a bi-polar spindle apparatus. Each chromosome is then become attached to a fibre of the spindle apparatus by its centromere. Each fibre of the spindle apparatus is called spindle fibre. The fibre to which the chromosomes are attached is called traction fibre. As they are attached with the chromosomes so they also called chromosomal fibre. In animal cell aster rays are radiated from centrioles present at two poles.

3. Metaphase : Chromosomes are arranged at the equatorial plane of the spindle. The centromere of each chromosome remains at the equatorial plane and the two arms are placed towards two poles. At this stage, the chromosomes become maximum thick and short. Two chromatids of a chromosome become maximum thick and short. Two chromatids of a chromosome become clearly visible and the centromere is divided in to two parts.

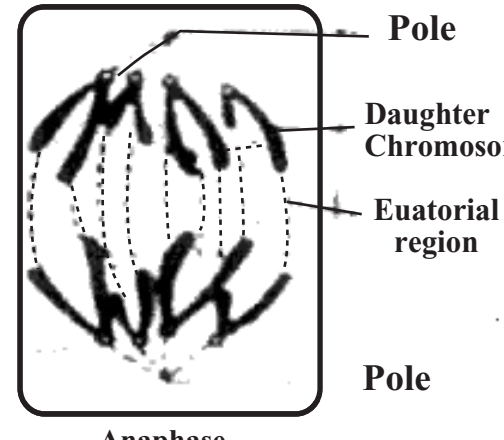
4. Anaphase : Two separate chromatids of a chromosome move towards the opposite pole of the spindle apparatus. Centromere goes ahead at the movement of the chromatids towards the pole and the arms follow them. when the daughter chromosomes reaches near the poles the anaphase stage ends.



Pro-Metaphase

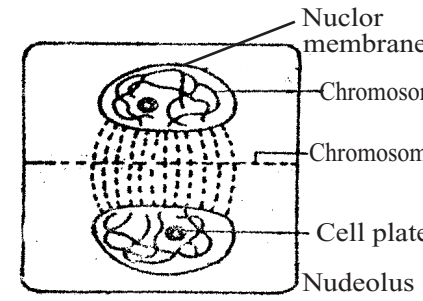


Metaphase



Anaphase

5. Telophase: Daughter chromosomes take position at two opposite poles. Chromosomes gradually take water and become elongated, thin and long. Nuclear membrane develops encircling the chromosomes. Nucleolus reappears at the secondary constriction of the Sat chromosome. Spindle apparatus disappears. At the end of this stage, gradually a cell wall develops at the equatorial region of the cell.



Telophase

As a result, the mother cell divides into two daughter cells. In case of animal cells, instead of formation of cell wall the cell membrane is constricted inwardly and the cell divides into two.

Significance of Mitosis:

The significance of mitosis in the living world is unlimited. Some of them are described here:

1. Growth of the body: Growth of the body of a living being takes place by mitotic division. A unicellular zygote is transformed to a human body consisting of millions of cells. A small zygote forms a large Banyan tree.

2. Maintaining equality of Chromosome number: By this division the number and properties of a chromosome in each cell of a multicellular body remains constant.

3. Keeping the size and shape constant: By this division the definite shape and size of the cell remains constant.

4. Healing of injuries: By producing new cells this process repairs the various types of damage of multicellular organisms.

5. Formation of sex organs: By this process sex organs are formed. As a result, continuity of reproductive sequence is maintained.

6. Qualitative stability: Qualitative stability is maintained by mitosis.

Abnormal cell division :

We are all acquainted with the terms, 'Tumor', 'Cancer', etc. These are the result of abnormal cell division. In mitosis one cell divides into two, two to four and in this way the number of cell increases But there is a regularity in this process. If by any circumstances this regularity is lost, cell divides abnormally. As a result, a tumor is formed.

Cancer cell is also a product of uncontrolled abnormal cell division. It has been found in experiment that various type of Papilloma virus help to produce cancer cell. Two genes named E6 and E7 of this virus (Papilloma) produce some chemicals, which displace two protein molecules responsible for controlling the cell division. As a result, control over cell division is lost and thus a tumor is produced. Sometimes these two genes may be united with-the genes of host cell and stop the action of protein to control the cell division and thus there develop cancer cell or Cancer.

Cancer is a fatal disease. Every year five to six hundred thousand of patients die only because of various forms of cancer. Cancer generates in liver, lunge, brain, breast and skin i.e. almost all the organs of the body. No effective medicine has yet been discovered to prevent this disease.

Male-Female determining chromosome:

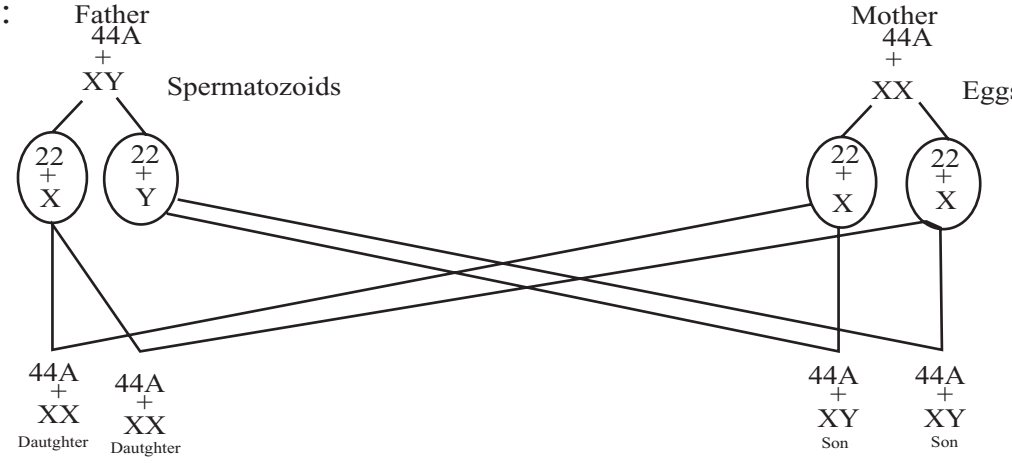
Every living being has a definite number of chromosomes. In human beings there are 23 pairs of chromosome. Among them 22. pairs are similar in both male and female, these are Autosomes, AA. Members of the remaining pair of chromosome are different in male and female. This pair of chromosome determines the sex of human beings. As they determine the sex, so they are called X and y sex chromosome or sex determining chromosome. One of the sex chromosomes is X chromosome and the other is Y chromosome. If the sex chromosome pair is XY, the child will be male (son), and if it is XX, the child will be female (daughter). In Drosophylla (a fly) also XX indicate female and

XY male. So in case of determining the sex, the role of X and Y chromosome is vital.

Whether the child will be a son or daughter:

Now we will discuss whether the father or mother is responsible for the birth of a son or daughter. Both male and female have 44 autosomes, A and a pair of sex chromosome. Sex chromosome of a female is XX and that of the male is XY. The male gamete (sperm) bears X and Y chromosome. But the female gamete (egg) bears X and X. If the X bearing egg of the female is united (fertilize) with Y bearing sperm of the male, the child will have XY. A child having such chromosomes will be a male child. It is seen that if there is no Y chromosome, the child will never be a son. There is no Y chromosome in a female; Y chromosome is present only in male. So if a couple do not have any male child, the husband is responsible not the wife. A figure on this issue

shows:



The role of sex chromosome in determining sex of the child (i.e. whether the child will be a son or a daughter) is known to you. Now work with this grid. Write which child will be a son and which one a daughter.

♀ Mother / ♂ Father	X	Y	X	Y
X	XX Daughter			XY Son
X				
X				
X				

Exercise

Multiple choic Questions

1. In which stage the nucleus enlarges in size?

a. Prophase b. Metaphase

c. Anaphase d. Telophase

2. By the Process of Mitosis living organisms generally-

i. Ensure the distribution of equal number of chromosomes.

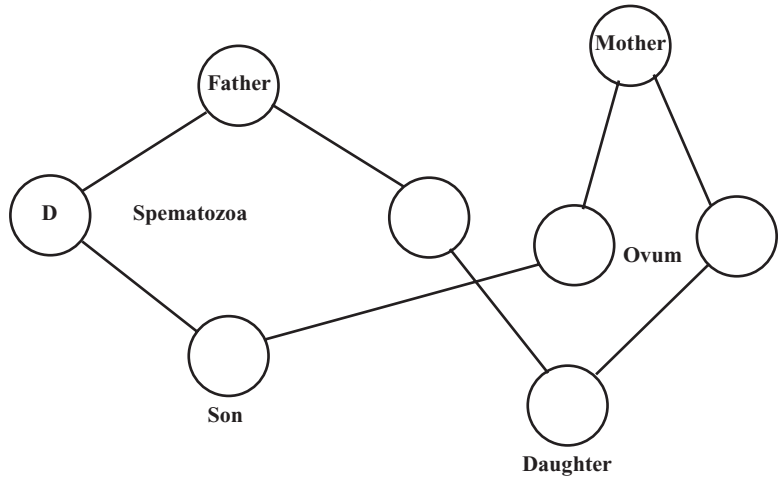
ii. Ensure the equality of properties.

iii. Produced haploid gamete.

Which one of the following is correct?

a. i & ii b. i & iii

c. ii & iii c. i, ii & iii



Answer the question no 3 and 4 on the basis of the above diagram.

3. What is the position of father's or mother's chromosomes in the diagram?

a. Haploid b. Diploid

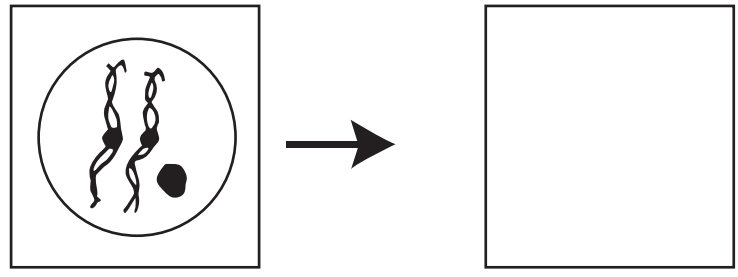
c. Triploid d. Tetraploid

4. What type of sex chromosomes will be in the gamete D & daughter H?

	D	**H**
a.	X	XY
b.	X	XX
c.	Y	XX
d.	Y	XY

Creative questions

Various type of cell division are seen in all cases starting from prokaryotic organism to multicellular organism. Someone of these increases the body shape, some one create germ cells and someone increases the number by the process of binary fission. Diagram of 1st stage of one type of cell division is given below.



a. In which process of cell division prokaryotic organisms generally multiplied

b. Explain the process of cell division of plant root.

c. Draw a labelled diagram of the stage 2 and describe one characteristic.

d. Analyse with example what will be the probable consequence is the process of division of stage no. 2 is not under control in a living organism.

CHAPTER-FOUR
Division Of Labour In Multicellular Plants : Tissue and Tissue System

Tissue :

In unicellular organisms a single cell does all the functions. There is no chance of division of labour on the basis of cell. In contrast, this kind of division is found in multicellular living body. In this case, it is observed that a group of cells performs the duty of manufacturing food; another group stores it, while the other group conducts the transport of food materials. There is further a group of cells that gives mechanical strenght to some organs. In many cases it is observed that a group of cells originating from a single origin remain closely attached in a place and collectively perform a similar type of function. This type of cells in a group is called tissue. In multicellular organisms division of labour is the main cause of formation of tissue.

Types of Tissue :

Cells of all tissues do not have the power of cell division but some of them have. Therefore tissues are of two types in terms of the power of cell division :

1. Meristamatic tissue &
2. Permanent tissue

1. Meristamatic tissue : Meristamatic cells compose the Meristamatic tissue. The cells of this tissue divide repeatedly. These tissues are found in the tress. Due to their presence plants increase in size very rapidly. Other permanent tissues are originated from Meristamatic tissue.

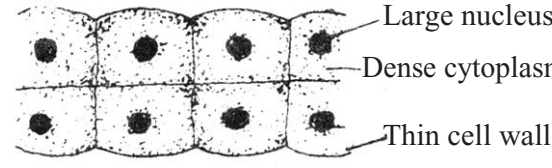


Fig. 4.1 Meristamatic Tissue

Characrteristics of Meristamatic tissues :

Characrteristics of Meristamatic tissues are as follows :

1. Cells possess the power of cell division.
2. Usually the cells are rectangular of oval.
3. Cell wall is made of cellulose and is thin.
4. Nucleus is large and the cytoplasm is denser.
5. Usually no vacuole is seen in the cell.
6. Usually there is no intercellular space in Meristamatic tissue, so the cells are arranged compactly.

Meristamatic tissues are present at the apex of roots and stems. According to their position they are **Apical meristems** and accroding to their origin they are **Primary meristems,** because they are originated from the embryonic stage. Stem and root increase in length by the division of cells of these tissues.

In the roots and stems of gymnosperms and dicotyledonous plants there develops a new Meristamatic tissue, they are called 'Secondary meristems. According to their position they are **Secondary meristems.** Due to the cell division of these tissues the breath of the root and stem increase i.e. the root and stem gradually become broader in breath

2. Permanent tissue:

Cells of permanent tissues are not capable of cell division, for which they are called **Permanent tissue.** They are originated from Meristamatic tissues. All tissues other than the Meristamatic ones are permanent tissues.

Characteristics of Permanent tissue:

1. Cells of these tissues have no power of division.
2. Cells are well developed and properly shaped.
3. Cell wall is comparatively thick.
4. Nucleus of the cells are bigger and cytoplasm is dense.
5. Usually there are vacuoles in the cell.
6. There may have intercellular spaces in between cells.

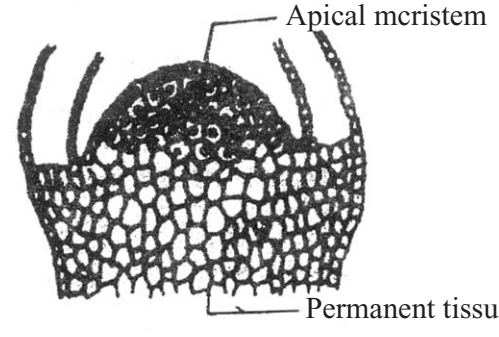


Fig. 4.2 Apical Meristamatic tissue of st

Types of permanent tissue : Permanent tissues are of three types, namely -

(a) Simple tissue, (b) Complex tissue and (c) Secretory tissue .

(a) Simple tissue: Tissues of same kinds compose simple tissue. Simple tissues are of three types, namely

Parenchyma: Characteristics of parenchyma tissue are as follows:

* Cells are almost uniform in length, breath and depth.
* Cells are round, oval or polygonal in shape.
* Cell wallls are evenly thick.
* Cells are living and contain sufficient protoplasm.
* There may have intercellular spaces between adjacent cells.

Permanent - tissues that Thin cell wall contain chlorophyll are called **Chlorenchyma.** The chlorenchyma of leaf IS called **Messophyll.**

Parenchymatous tissues with large air spaces In aquatic plants are **Aerenchyma.**

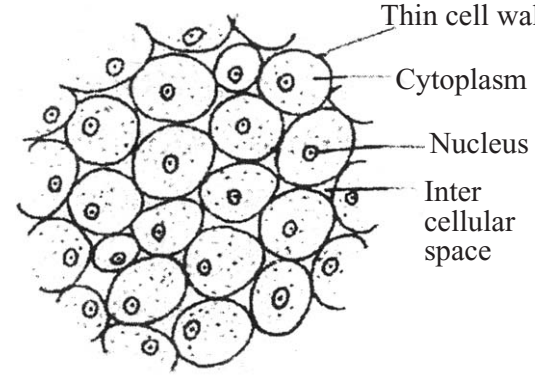


Fig. 4.3 Parenchyma Tissue

Functions:

q Chlorenchyma manufactures food materials.
q They store reserve food.
q They help ,in transporting the food materials.

Parenchyma in the epidermis act as a defensive organ.

Position: Usually pith, pith rays, epidermis and most of the cortex are made of this tissue.

Collenchyma: Characteristics of collenchyma tissues are as follows:

q Cells are to some extent elongated. '
q Cells are living with protoplasm.
q Cell wall is unevenly thick, thickness is greater at eorners of the cells.
q There may have intercellular spaces between adjacent cells

Functions:

q Cells with chlorophyll manufacture food.

q It gives mechanical strength ' to the growmg organ.

Position: It is found under the epidermis, in the petioles and veins of leaves and in the flower stalks.

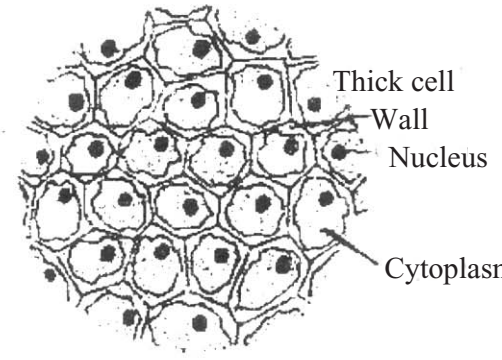


Fig. 4.4 Collenchyma Tissue

Sclerenchyma: Characteristics of Sclerenchyma are as follows:

q Cells elongateq and the ends are pointed.

q Cell walls being lignified become thick and the thickness is uniform. Mature cells are dead and without nucleus and protoplasm.

q In transverse section they are polygonal.

Functions:

q To give mechanical strength to different organs of the plant is the main function.

q Some dead cell may store excretory substances of plants.

q Sometimes it forms hard outer wall to protect the inner soft portion, e.g. seeds of coconut and date-palm

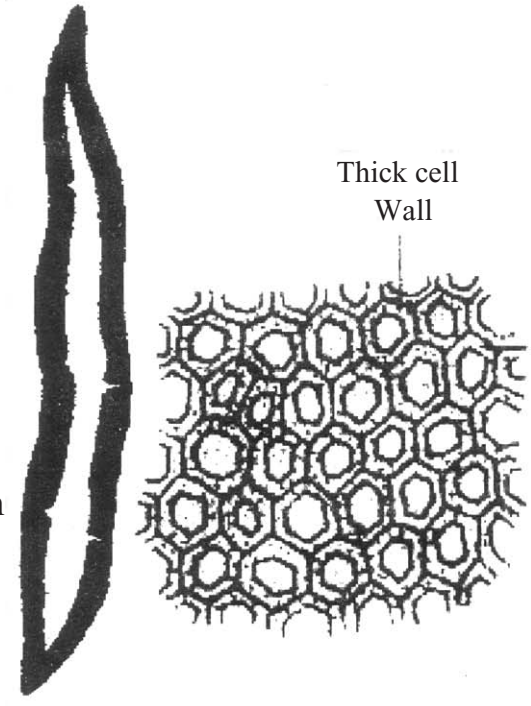


Fig. 4.5 Sclerenchyma Tissue

Position : They are present in cortex, phloem and pericycle.

(b) Complex tissue: Complex tissue is composed of more than one kind of cells. They are two types, namely **Xylem** tissue and **Phloem** tissue.

Xylem tissue: Xylem tissue consists of four types of cells, namely: Tracheids, Vessels or Trachaea, Xylem fibre and Xylem Parenchyma.

q **Tracheids:** Cells are dead, long with transverse ends, containing large vacuole. Cell walls are hard, strong. and lignified. Their main functions are to gIve mechanical strength and to supply water and dissolved minerals from root to the leaves.

q **Vessels or Trachaea:** Cells are broad and short, placed end to end to form a continuous hollow tube. Water and waterdissolved minerals are conducted from root to leaf by these cells.

q**Xylem fibre:** These are sclerenchymatous cells. Their main function is to give mechanical strength to the plant.

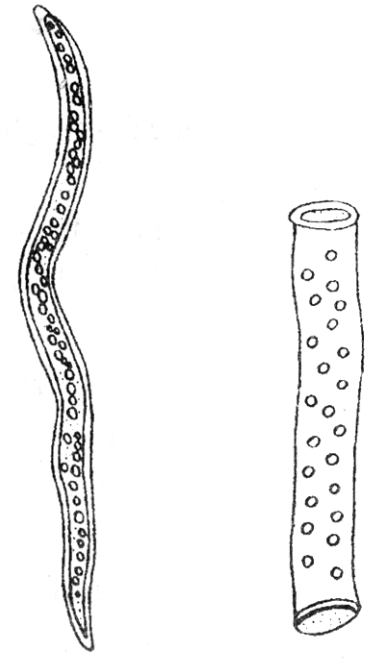


Fig. 4.6 Xylem Tissue

Xylem parenchyma: These are parenchymatous .
cells. Functions of these cells are storage and conduction of food materials.

Functions of xylem tissue: Their functions are to give mechanical strength to the plant body, conduction of water, minerals and food materials and storage of food.

Phloem tissue: Phloem tissue consists of four types of cells, namely: sieve tubes, companion cells, phloem fibres and phloem parenchyma.

Sieve tube: These are elongate hollow cells placed end-to-end forming.

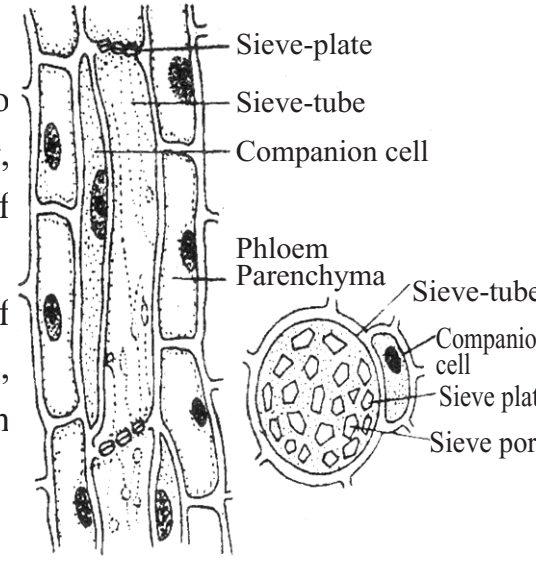


Fig. 4.7 Phloem Tissue

a long tube. The partition walls between two adjacent sieve cells are perforated and known as sieve plate. In m4;iture sieve tube there is. no nucleus in the cell. Conduction of food, prepared in the leaves is its main function.

q **Companion cells:** These are parenchymatous, narrow, elongated cells, and are closely associated with the sieve tube. They have dense cytoplasm and a large nucleus. Conduction with the sieve tube is done through the pores present on the walls of these cells. They help the sieve tubes in conduction of food materials.

Phloem fibre: These are Sclerenchymatous cells. They are also known as bast fibre. Its function is to give mechanical strength.

q **Phloem parenchyma:** These are parenchymatous cells. They help in storage and conduction of food materials.

Function of Phloem tissue:

q There main function is to conduct food materials, prepared in the leaves, to different parts of the plant.

q They give mechanical strength to plant organ.

q In case of necessity they store food materials.

Importance of Complex tissues:

In respect of physiological and economic aspects, complex tissues are of great importance.

Physiological importance:

Complex tissues perform the duty of conduction of raw food materials to leaves and prepared food materials to all the living cells.

q Beside preparation of food, water is necessary for various reactions. This water is conducted from root to stem through the complex tissue named xylem.

q Through xylem tissue dissolved minerals along with water also passes upwardly.

q Water used in transpiration also moves to leaf through xylem tissue.

Economic importance

q The most important economic crop in Bangladesh is jute fiber. Jute fiber is the secondary phloem or bast fiber.

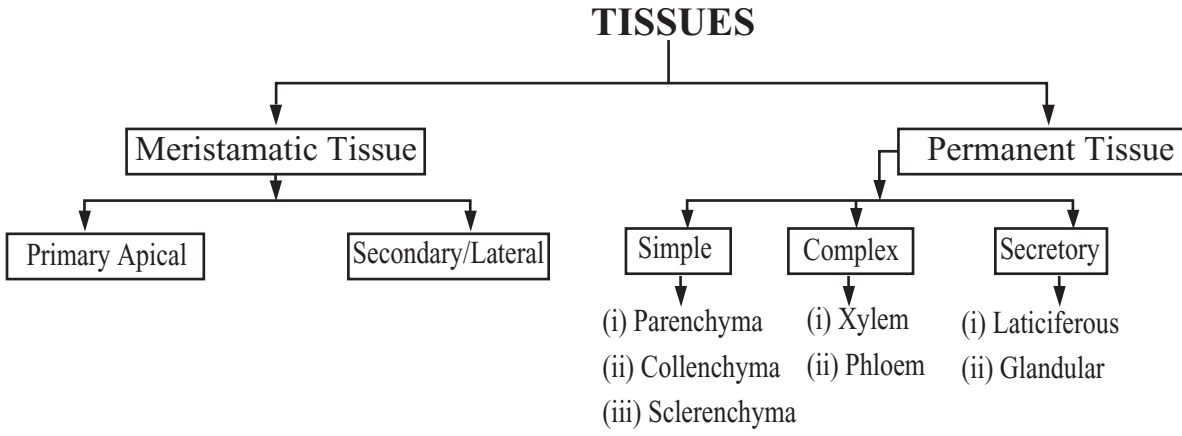
q The wood we use, in the construction of houses, in making furniture, boat or musical instruments or as fuel, is the secondary xylem.

(c) Secretory tissue: Secretoy tissues are those tissues, which secrets various liquids, Resins, gums, rubber etc. are collected from secretory tissues. They are of two types: .

Laticiferous tissues and Glandular tissues.

Laticiferous tissue: Latex is a white, yellow or colourless liquid Carbohydrates, protein, gums, and fats etc. are mixed in **Latex,** Latex is found in various plants like;- Musa **(KALA)** Ficus **(BOT),** Hevea **(RUBBER),** Papiver **(OPIUM),** Calotropis **(AKONDO),** Alstonia **(CHHATIM),** Argement **(SHIALKATA).**

Glandular tissue: Honey, Enzymes, Gums, Resins, Oils etc. are usually found in the glandular tissues :



Tissue System

When one or more kinds of tissues are united and together perform a similar function, then it is known as tissue system. They are classified into three types namely: i) **Epidermal Tissue System, ii) Ground Tissue System and iii) Vascular Tissue System.**

i) Epidermal Tissue System: - This tissue system makes the outer cover of plant organs like, roots stems, branches, leaves, fruits. etc. Typically it consists of a closely arranged single layer of parenchymatous cells. There may have unicellular or multicellular hairs.

Functions: To give protection to the internal portion of the plant organ.

ii) Ground Tissue System :

Theses are the main bulk of tissues of roots and stems. The ground tissue is differentiated into outer **cortical** region and inner medulla or **pith** region. In dicot stem the cortical region is ususlly subdivided into three zones namely:-

(a) Hypodermis, (b) General, Cortex and (c) Endodermis, Medulla and Medullary Rays encircled by, the **Pericycle** form the central Pith.

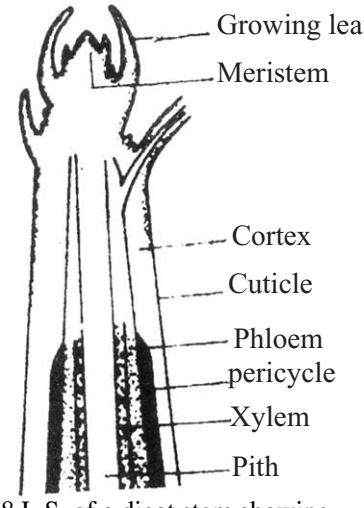


Fig. 4.8 L.S. of a dicot stem showing different tissue system

Functions : Functions of this tissue system are to give mechanical stregth to the stem and to store food materials.

iii) Vascular Tissue System:- Vascular tissue system comprises of two complex tixssue, namely; **Xylem** and **phloem,** These tissues are embedded in the ground tissues. In dicotyledonous stems xylem and phloem lie side by side on the same radius and between them there is a kind of **Meristamatic** tissue named **Cambium.** Phloem tissue lies towards the periphery and xylem toward center of the stem.

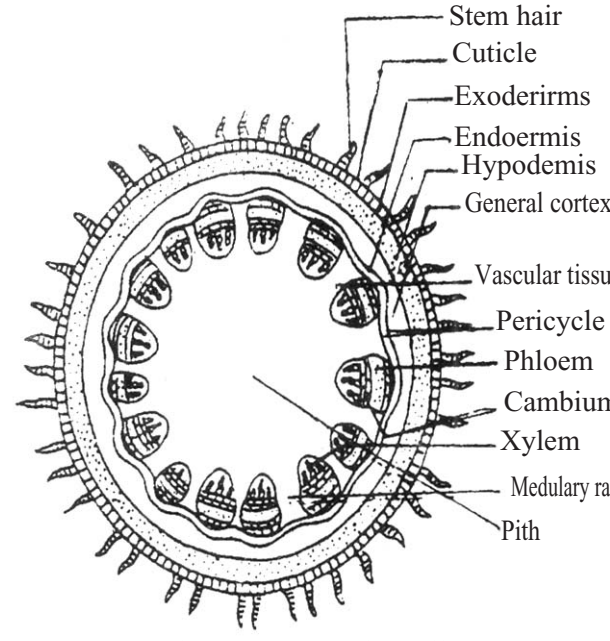


Fig. 4.9 T.S. of dicot stem showing different tissue system

Arrangement of different tissue system of a dicot stem is shown In longitudinal (I.S.) and transverse section (T.S) [Gig: -4.8 & 4.9]

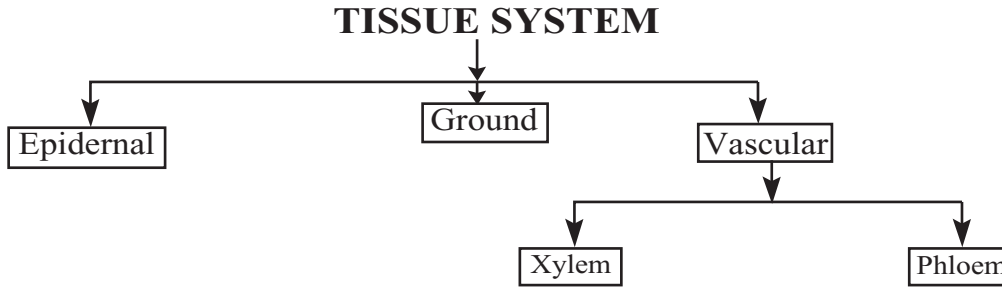
Function

Conduction of water and dissolved food materials.

Conduction of prepared food.

Give mechanical strength to the stem, and

Storage of food where necessary.



Exercise

Multiple choice questions

1. Which one has Aerenchyma?

a. in Murtha grass b. in Lily

c. in Bamboo d. In Guava

2. In case of permanent tissue-

i. The cell wall is comparatively thick

ii. The cell has vacuole

iii. The cytoplasm of the cell is thick.

Which one of the following is correct?

a. i b. ii

c. i & ii d. i, ii & iii

Give answer to the question no 3 & 4 on the basis of the following diagram.

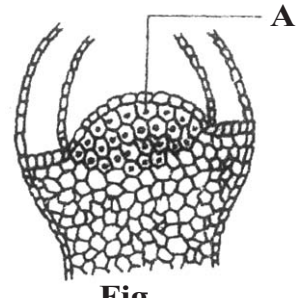


Fig.

3. In the diagram what is part labelled A?

a. Permanent tissue b. Meristamatic tissue

c. Xylem tissue d. Phloem tissue

2. For the part labelled A in the diagram the plant-

a. stem increases in girth b. stem increases in length

c. root increases in girth d. root increases in length.

Creative Questions

Bacteria, Amoeba and other living beings do not have tissues but Man, Mangoes, Berry etc. have tissues. The tissues are again of two types: Meristematic tissue and Permanent tissue. A part of the transverse section of stem of Dicot plant is shown below.

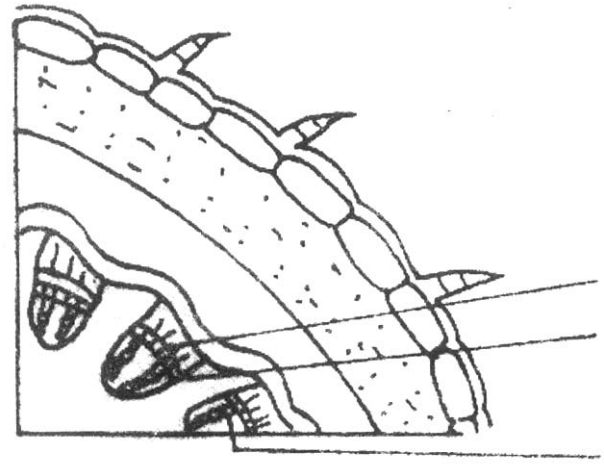


Fig.

a. What is meristamatic tissue?

b. Why bacteria do not have tissues explain.

3. Explain the function of the part B after drawing its labelled diagram.

4. Analyse the cause of creation of above B & C tissues in a mango tree.

CHAPTER-FIVE

ANIMAL TISSUE, ORGAN AND ORGAN SYSTEM

There is only one cell in the body of the animals of the phylum Protozoa. Animals of the Phylum Porifera are simplest multi-cellular animals. Their cells do not form actual tissue. Though tissues, organs and systems are not formed in members of the phylum Cnidaria (previously known as Coelenterata), their body cells are, however, arranged in two layers.

In the animals from phylum Platyhelminthes to Chordata, tissues, organs and organ systems are seen. Members of those phyla are three layered. From there three embryonic cell layers (namely ectoderm, mesoderm and endoderm), tissues, organs and systems are formed.

Tissue: In the body of multi-cellular animals some cells remain together and performa particular function. These cells are either formed from the ectoderm, mesoderm or endoderm of the embryo and remain close together. Inter-cellular materials or matrix are present between these cells. These cells may be similar or of different types. Arising from the embryonic cell layer when certain types of cells when remain in a particular place of the animals' body and collectively perform a common function, those cells and the inter-cellular materials or matrix secreted by them are collectively called the **Tissue.** That is to say, cells of a particular tissue are similar in its, origin, function and structure. The subject in which the different types of tissue are discussed is called **Histology.**

Differences between Tissue and Cell:

A. Tissue: Originating from a same place when more than one cell with similar structure and function performs a common function, then those groups of cells are called Tissue. For example, blood is a kind 'of fluid connective tissue. In the liquid matrix or plasma of blood there are red corpuscles, white corpuscles and platelets. Blood is developed from the mesoderm of the embryo.

B. Cell: Cell is the structural and functional unit of tissue. For example, Red blood corpuscles (Erythrocytes), White blood corpuscles (Leucocytes) and Platelets (Thrombocytes) are various types of blood cells. Of these the red

courpuscles transport oxygen and carb.on dioxide, white corpuscles take part in the defense of the body and the platelets take part in blood clotting at the site of injury and stop unwanted blood loss.
Blood cells and the plasma together form the blood tissue.
Blood generally takes part in the internal transportation of the body.

Types of Tissues :
On the basis of number of cells, characteristic and the presence or absence of the intercellular materials or matrix secreted by cells, the tissue is mainly divided into four categories.

1. The Epitherlial Tissue.
2. The Connective Tissue.
3. The Muscular Tissue.
4. The Nerve Tissue.

Location, Structural characteristics and Function of different types of Tissue of the Animal Body :
1. Structural Characteristics, Function and Location of Epithelial Tissue:
Structural Characterisics : The cells of the epithelial tissue lie closely or side by side on a basement membrane. There is no matrix in this tissue. On the basis of cell size, location in the animal body and nature of work, this tissue is of three types, sch as;
a. Squamous Epithelial Tissue: Cells of this tissue are flat like scales; rnucleus is large (Fig- 5.1)
Example: Wall of the Bowman's capsule of Kindey.
Function: Mainly filtration and covering. ~
b. Cuboidal Epithelial Tissue: Cells of this tissue are cuboidal, as the length, breadth and height of the cells are nearly equal (Fig-5.2).
Example: Collecting tubules of the kidney.
Function: Mainly absorption and covering.
Columnar Epithelial Tissue : Cells of this tissue are narrow and elongated like a column (Fig-5.3)
Example: On the internal wall of intestine.
Function: Mainly secretion, protection and absorption.

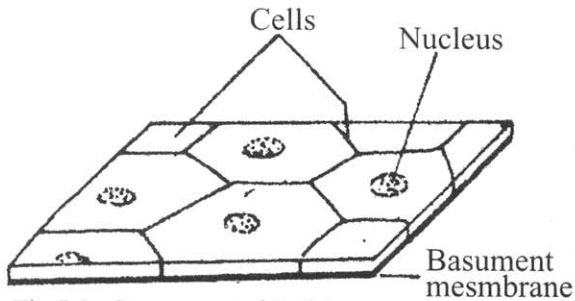


Fig 5.1 : Squamous epithelial tissue

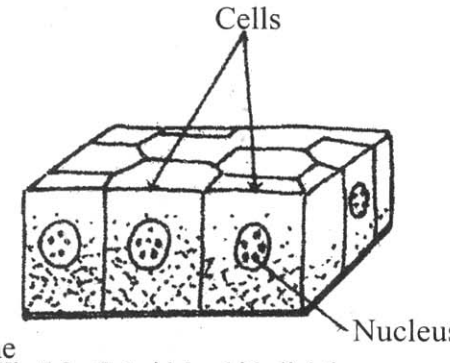


Fig 5.2 : Cuboidal ephithelial tissue

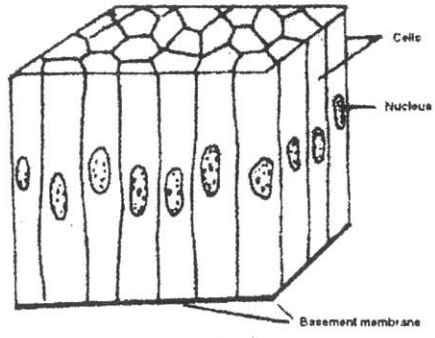


Fig 5.3 : Columnar epithelial tissue

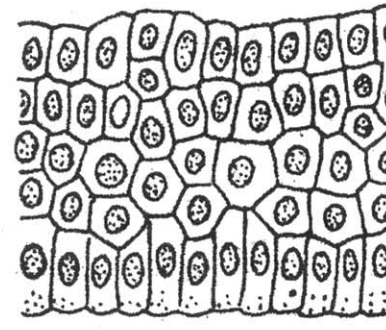


Fig 5.4 : Stratified Epithelial tissue

On the number of cell layers arranged on basement membrane, epithelial tissue is of three types. As :

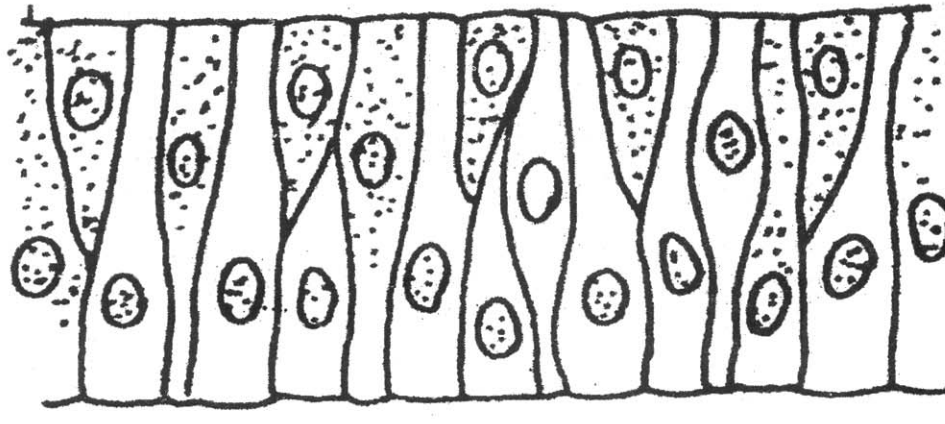


Fig. 5.5 Pseudostratified epithelial tissue

i. Simple Epithelial Tissue: On basement membrane the cells are arranged in a single layer.

Example: Bowman's capsule of ki4ney; renal tubules, intestinal wall (Fig-5.1,5.2:5.3).

ii. Stratified Epithelial Tissue: Cells are arranged on the basement membrane in more than one layer (Fig-5A).

Example: Integument of vertebrate animals.

iii. Pseudo stratified Epithelial Tissue: .Cells, of this tissue are arranged in a single layer on basement membrane. The cells are not of the same height. So this tissue appears to be stratified tissue (Fig-5.5).

Example: Trachea.

Besides the cells of epithelial tissue. are transformed variously for different functions. As:

1. Ciliated Epithelial Tissue: Found in the wall of the respiratory tube of vertebrate animals.

2. Flagellated Epithelial Tissue: Found in the endoderm of Hydra.

3. Pseudopodia Epithelial Tissue: Found in pseudopodial cells in the endoderms of Hydra and in the intestine of vertebrate animals.

4. Glandular Epithelial Tissue: This is a kind of epithelial tissue transformed into gland in the stomach and intestine of vertebrate animals.

5. Germinal Epithelial Tissue: This, is a kind of transformed epithelial tissue. From this tissue sperms and ovum are formed.

General Functions of Epithelial Tissue:

1. This tissue form, the external and internal- covering of any organ or tube.

2. After transformation this tissue takes part in , protection; secretion, absorption, diffusion, transportation etc. So, it can be said that epithelial tissue being transformed into glandular tissue and germinal tissue perform various important functions.

2. Structural Characteristics, Functions and Location of Connective Tissue .

Structural Characteristics: The. amount of matrix is more in connective tissue but the number of cells is comparatively less. Matrix may be jelly like, soft or hard and fragile. One or more than one type of fibre and materials like calcium carbonate may remain present in matrix (Fig-5.6):

Functions: Connective tissue connects muscle with muscle and bone with bone. Connective tissue may transform into skeletal tissue, fibrous tissue and. fluid connective tissue.

On the basis of structure and function connective tissue is mainly of three types. As:

A. Films Connective Tissue: This type of connective tissue lies below the body-integument and sparsely in muscles. In their matrix numerous fibres are present.

B. Skeletal Tissue: Internal structural building tissue of the body is called the skeletal tissue.

Functions:

1. This tissue forms the internal structure of the body, e.g. skeletal system.
2. It gives the body definite shape and firmness.
3. It helps in organ movement and locomotion.

I4. It protects the soft and sensitive organs of the body (as brain. spinal cord, lungs, heart etc.).

5. It produces various types of blood corpuscles.
6. It forms the surface for the attachment of voluntary muscles.

Depending on the formation, skeletat tissue is of two types.

a. Cartilage: Cartilage is a kind of flexible skeletal tissue. Their matrixes are solid but they are soft and their cells have large spaces. Cartilage is suited at the two ends of the humerus, femur, and pinna of the ear and nose of the mammals.

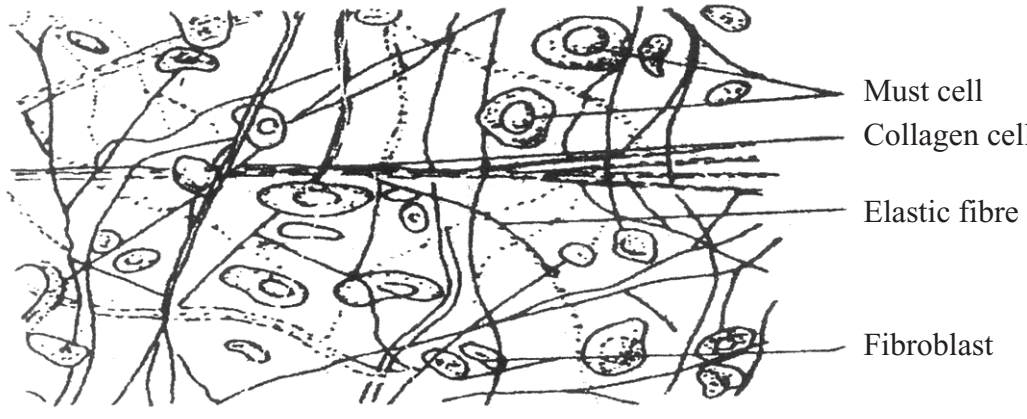


Fig : 5.6 Connective

b. Bone: Bone is hard, fragile and unflexible skeletal connective tissue.
Bones become rigid due to deposition of lime in their matrix. Some bones are solid. For an example, long bones of hind limb of vertebrates. Parts of long bones near-the bone cavities are sponge like.

c. Fluid Connective Tissue:

Structural Characteristics: Matrix of this tissue is liquid. In he matrix there are various types of organic materials in the form of colloid.

Function: The main function of vascular tissue is to maintain circulation in the interior of the body and resistance from disease. This tissue is of two types: Blood and Lymph.

1. Blood: Blood is a type of alkaline, stightly saline, red coloured, liquid connective tissue. Flowing through the artery, veill and capillaries, blood takes part in internal circulation. Blood, blood vessels and heart together form circulatory system.

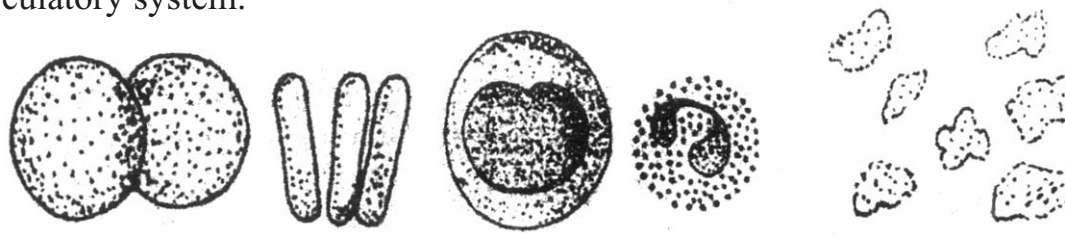


Fig : 5.7 Different types of blood cells

Structural Characteristics: Blood is formed of two components:

i. Plasma: It is the liquid part of blood. It is straw coloured. It contains (91-92) % water and (8-9) % organic and inorganic materials. The organic substances include various types of blood protein and waste materials. The inorganic part contains different minerals like sodium, potassium, iron. calcium, magnesium etc.

ii. Blood Cell or Blood Corpuscles: Blood corpuscles form the major components of blood. Blood cells are of three types. These are:

Red Blood Corpuscle or Erythrocyte: These blood corpuscles contain haemoglobin. Due to haemoglobin colour of blood is red. the red blood corpuscles of the amphibians are biconvex, nucleated and oval. On the

contrary, the red corpuscles of the blood of mammals are biconvex, non nucleated and round. Haemoglobin is combined with oxygen forms a unstable compound oxyhaemoglobin. It breaks down and releases oxygen in places where it is needed. '

Functions: To, carry oxygen and some carbon dioxide.

a. White Blood Corpuscle or Leucocyte: These generally lack definite shape and are nucleated. Cytoplasm of white corpuscles are either granular or non granular.

Functions: To destroy germs and take part in self defense.

Thrombocyte or Platelets: These are present in the blood of vertebrate animals. These are usually nucleated and spindle shaped. Nucleus is absent in the Thrombocytes of mammals. The thrombocyte of mammal is also called platelet.

Function:. Thrombocytes take part in blood coagulation or blood clotting.

2. Lymph:- The fluid materials stored in the spaces between different tissues are collected by some small vessels. These small vessels are united together to form larger vessels. The system formed by these vessels known as lymphatic system. These vessels are lymph vessels and the' fluids are lymph. The large lymph vessels enter the vain in the shoulder region of man. There are some cells in the lymph known as lymphocyte. Lymph is a kind of slightly alkaline, transparent -and yellow coloured fluid.

3. The Muscular Tissue:

The particular type of contracting and expanding tissue originates from embryonic, mesoderm is called Muscular tissue (Fig-5.S).

Structural Characteristics: Matrix is nearly absent in muscular tissue. The muscle cells are elongated and fibre-like. The fibres are spindle shaped. The fibres are known as myofibril. The cytoplasm of muscle cell may have one or more nuclei. The cell membrane of the muscle cell is known as sarcolemma. The myofibrils with transverse striation are known as striated muscle and without striation are known as smooth muscle.

Function: Muscle cells through contraction or expansion take part in organ movement, locomotion and internal circulation. On the basis of location, structure and functions, muscle tissue is of three types. Such as:

Voluntary or Striated Muscle: This Type of muscular tissue can be contracted or expanded at the will of the living beings. The cells of the voluntary muscle tissue are tubular, not branched and provided with transverse striations. These have generally more than one nucleus. This muscle can contract or expand quickly. This muscle is also, called **striated or skeletal muscle.**

Location: Voluntary muscles remain attached with the skeletal system as muscles of-hand, and feet of man.

Function: To control the movement and mobilization of different organs by voluntary movement of various bones.

b. Involuntary or Smooth **Muscle:**

Structural Characteristics: The contraction and expansion of this muscle tissue is not at all of the living beings. This muscle tissue is spindle shaped. Transverse striations are not present here. That is why this muscle is called smooth **muscle.**

Location: Involuntary muscles are found on the walls of blood vessels, alimentary canal etc. of the vertebrate animals.

Function: Involuntary muscles mainly take part in the movement of internal organs, e.g. peristalsis. of intestine.

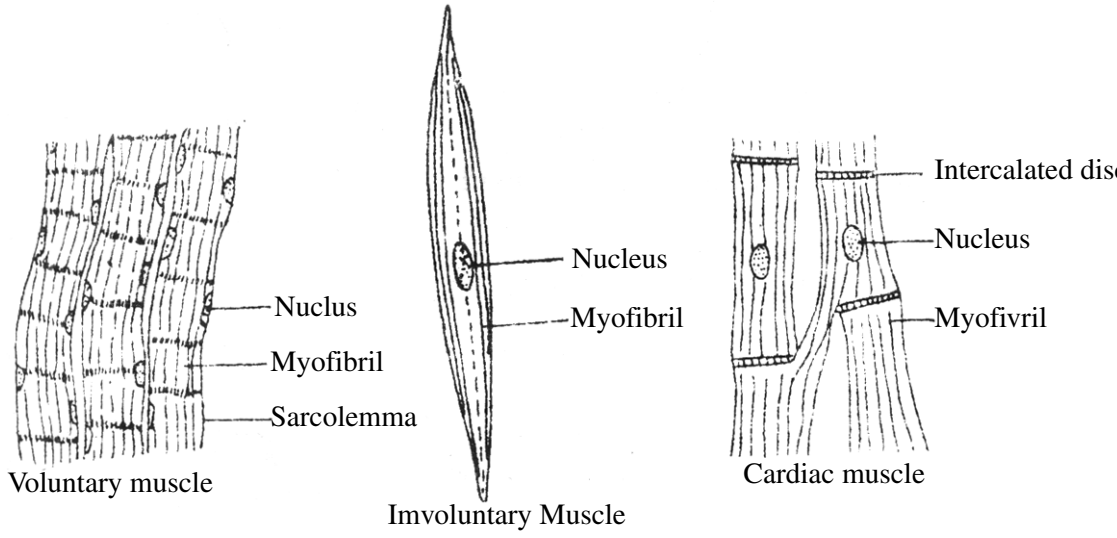


Fig. 5.8 : Different types of muscle

Cardiac Muscle :

Structural Characteristics: The special type of involuntary muscle that forms the heart of vertebrate animals is called the cardiac muscle. The cells of this mucle tissue are tubular (very similar to those of voluntary muscle), branched and provided with transverse striations. Between the cells of this tissue intercalated disc are present. The contraction and relaxation of this tissue is not dependent on the will of the living beings. That is, the structure of heart muscles is ,like that of voluntary muscle and the function is like that of involuntary muscle. The cells of cardiac muscle, attached by branch joined together by branch. The contraction and expansion of all cardiac muscles take part combindly.

Function: Through rhythmic contraction and relaxation, the cardiac muscles control the circulation of blood within the body from a particular stage of the embryonic condition until death.

4. The Nerve Tissue:

Structural Characteristics: The particular type of tissue, which forms the nervous system, is called nerve tissue. Receiving stimulus from the environment, the nerve tissue transmits it within the body and accordingly appropriate responses are created. The special type of cell which forms the nerve tissue is called nerve cell or neuron (Fig-5.9) So a neuron is the structural and functional unit of nervous system. It is ectodermal in origin.

Neuron or nerve cells can receive various types of external and internal stimuli or nerve-sensation and can transmit those inside the body.

Structure of a Neuron: A mature neuron has three parts

These are:

1. Cell body: The cell body is generally polygonal and nucleated. The cytoplasm of the cell contains mitochondria, golgibody, ribosome, endoplasmic reticulum etc. But as there is no active centriole in the cytoplasm of neuron, the neuron cannot divide.

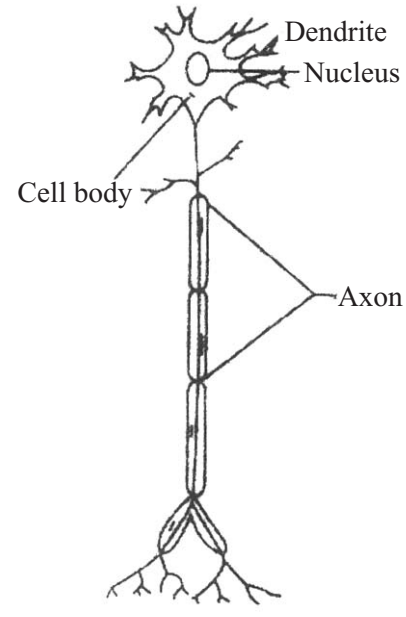


Fig. 5.9 : Neuron (nerve cell)

2. Function: Originating from the cell body, two or more branches transmit stimuli or nerve impulse to the neuron's cell body. Generally they are one or several in numbers and present opposite to the axon.

3. Axon : From the neuron's cell body a long fibre branch carries nerve impulse towards dendrite of the next neuron. A neuron has only one axon. Between the with the dendrite of the other. It is called **synapse.** Through the synapse stimuli of a nerve is transmitted from one neuron to another.

Location : Nerve tissues are located within the nervous system. There are innumerable neurons is the nerve tissue of any animal.

Function :

1. To receive stimuli and create proper sensation.
2. To store memory in higher animals.
3. To control the works of different organs of the body and coordinate their activities.

Organs : An organ is a part of animal body formed by the combination of one or more than one type of tissues performing a particular function is called an organ. That is to say, in any organ there may be one or more than one type of tissues and the organ can perform a particular work. The branch of biology where organs are discussed is called anatomy.

Necessary Organs of Human Body : According to location there are two types
of organs in human body. The branch of Biology, where the morphology of external organs like eye, ear, nose, hand, foot, head etc. are discussed, is called **Morphology.** Again, the branch of Biology where the internal organs of the organism are discussed in detail is called **Internal Anatomy.** Eye, ear, nose, hand, foot, head etc. are external organs and stomach, duodenum, ileum, rectum, heart, liver, pancreas, spleen, lung, kidney, testis, ovary etc. are internal organs of human body.

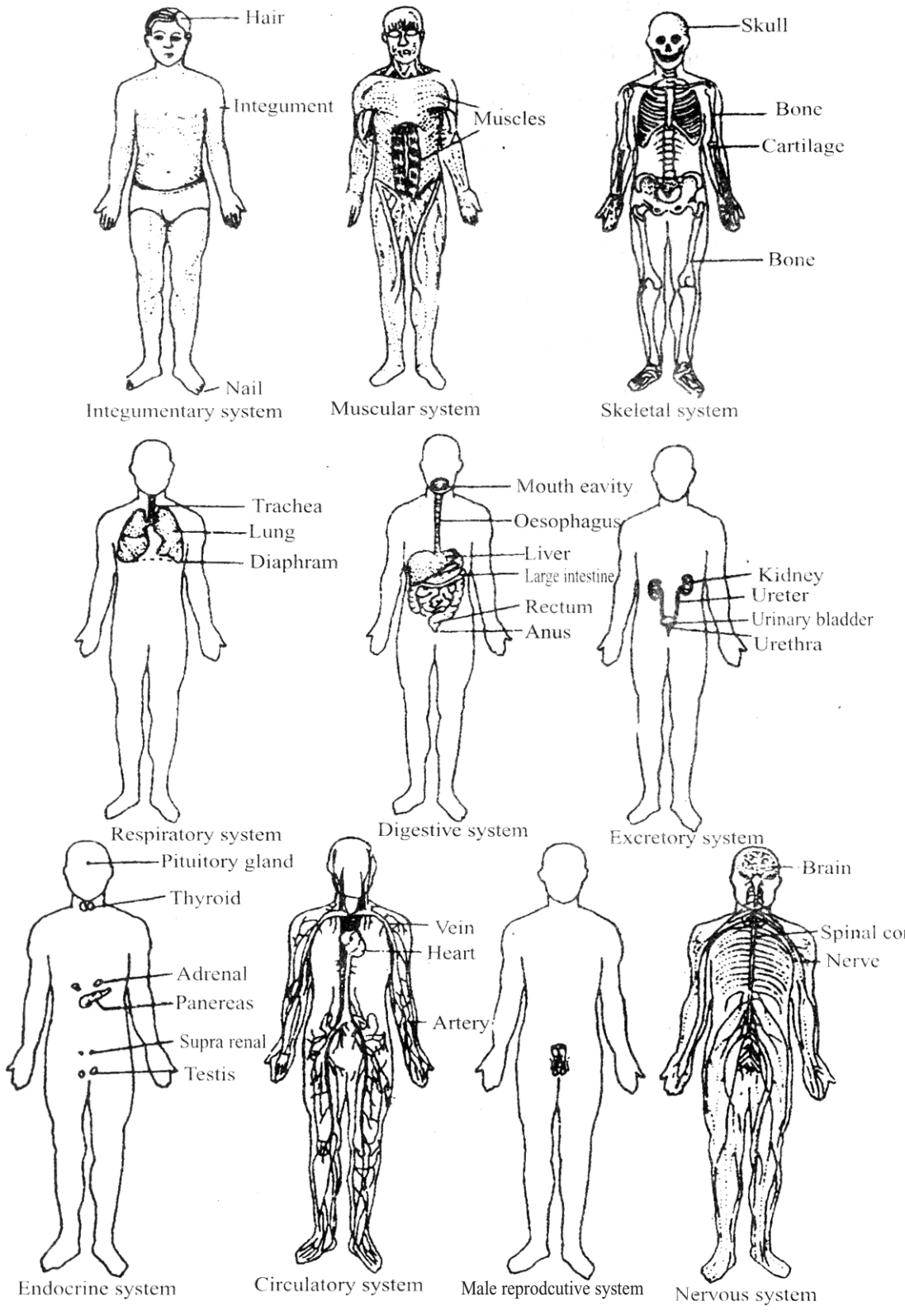


Fig-5.10 : Simple figures of various systems of the human body

Systems: For performing various physiological f~nctions, such. as digestion, respiration, excretion, reproduction etc. several organs together form the organ systems in animal body. These are:

1. Digestive System: This system ,is associated with ingestion, digestion, absorption of food and removal of undigested residues. Digestive system has two main parts as:

a. Digestive Canal: This canal consists of mouth opening, mouth cavity, pharynx, oesophagus, stomach, duodenum, ileum, rectum and anus.

b. Digestive Glands: In man salivary glands, liver and Panereas work. as digestive glands.

2. Respiratory System: This system with the help of oxygen taken from the environment produces energy by the oxidation of food present in the body cells to help the body to do every days work. In man the respiratory system .consists of nasal aperture, pharynx, larynx, trachea, bronchus, bronchiole and a pair of lungs made of alveoli.

3. Nervous System: The function of this system is to receive external and internal stimuli of the body and to create appropriate sensation. Nerve system is formed of brain spinal cord and cranial nerves and spinal nerves. Besides, the nerve system has also a part named **Autonomous Nervous** system. This part of the nerve system controls the involuntary works of the body.

Excretory System: Due to various physiological metabolic activities some waste materials are produced within the body as by products. These materials are generally toxic to the body, so they need to be removed. The process of removing unnecessary waste materials from the body is called **excretion.** The system by which the excretion is performed is called **excretory system.** The excretory system of human beings consists of a pair of kidney, a pair of ureter, one urinary bladder and one urethra.

5. Reproductive System: Through this system an animal produces one or more offsprings of its type to maintain the contiriuation of the species. On

the maturity, the child becomes capable to reproduce. Man is unisexual. Both males and females have individual reproductive system of their own. Besides, males have a few more important systems, such as: .

a. Integumentary System: The membrane covering the body from outside is called integument or skin. This system covers the body, protects from external injury and control the movement of various material from outside and inside the body.

b. Endocrine System: There are few endocrine glands within the body of the human beings. Secretions of these glands are known as hormone. There are no ducts for transportation of hormone. Blood carries the hormone from one place to another. The endocrine system is formed with the endocrine glands like Pituitary, Thyroid, Parathyroid, Islets of Langerhans of Panqreas, and Suprarenal etc.

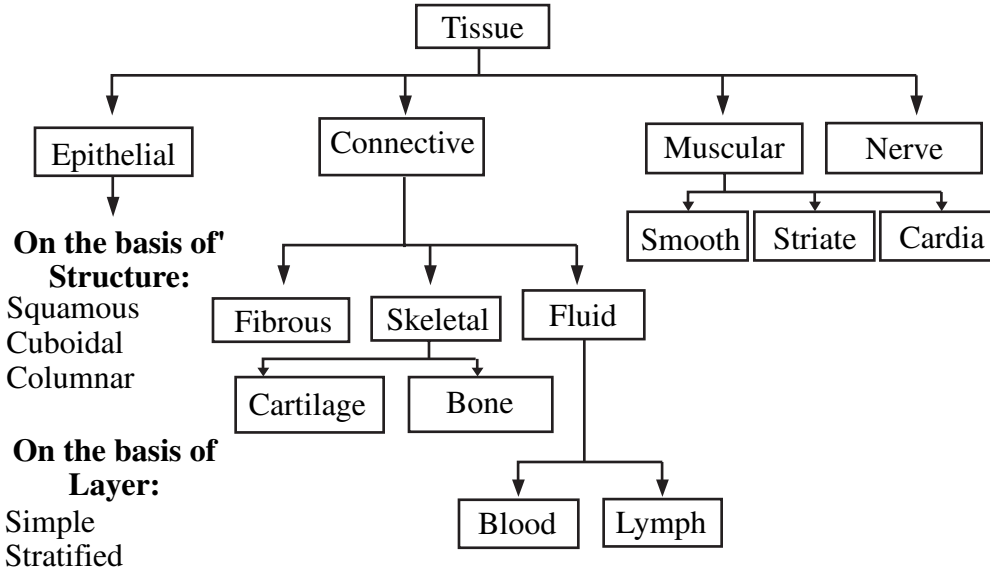
Differences between an Organs and a System:

Content	Organs	System
1. Definition	An organ is a part of animal body formed by the combination of one or more than one type of tissues performing a particular function or functions.	System is formed in combination of more than one related organs. Each system performs the particular functions separately.
2. Example	Eye, ear, stomach, heart, liver, kidney, testis, ovary etc.	Digesti ve system, blood circulatory system, excretory system, reproducti ve system, nervous system, etc.

Co-ordination between Organs and Systems to keep the body fit:

The body of man and other higher animals is formed in coordination with some systems. A particular system is again formed of some related organs. Each of these organs has particular structure and functions. There exists coordination among the functions of the organs of a system. Each system works separately and each has its own specific functions. For example, the function of the digestive system is mainly intake of food, dig~stion of food, absorption of digested food, and temporary storage and excretion of undigested food. Of this system the digestive glands named salivary glands; liver and pancreas take part in digestion by secreting various digestive enzymes. In this system, the pharynx and oesophagus take part in food intake,

stomach and duodenum in digestion of food, ileum both in digestion and absorption of food and the rectum in storing the undigested food. In any living beings, all these systems are interrelated. So, a system works properly only when each of the component organ of that particular system function properly and systematically. Again, through the coordinated work of different systems, living beings do their regular activities. In case of all higher animals, nervous system and endocrine system together control and conduct the works of all organs, i.e. all systems to keep the body healthy and fit. The work of the nervou5 system is performed directly and generally quickly. On the other hand~ the functioning of the hormones secreted by the endocrine glands or ductless glands are comparatively slow.



On the basis of' Structure:
Squamous
Cuboidal
Columnar

On the basis of Layer:
Simple
Stratified
Pseudostratined

On the basis of Modification:
Ciliated
Flagellated
Pseudopodial
Glandular
Epithelium
Germinal
Epithelium

Exercise

Multiple choice questions :

1. Which one of the following is the excretory sysetm?

a. Lungs b. Liver

c. Kidney d. Heart

2. Cartilage is-

i. epithelial tissue

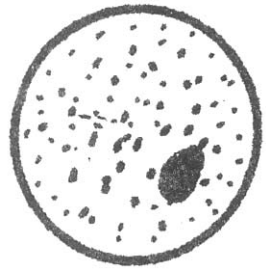
ii. connective tissue

iii. muscular tissue.

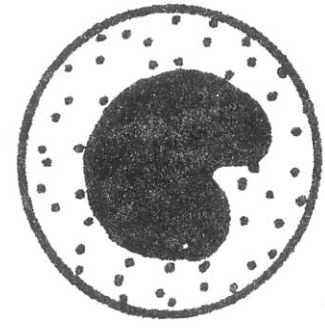
Which one of the following is correct?

a. i b. ii

c. i & iii d. ii & iii



A



B

Answer to the question no 3 & 4 in support of the above diagram.

3. In the body what is the function of the labelled part B?

a. Protection b. Blood coagulation

c. Respiration d. Digestion

4. In which animal the nucleus is absent in the labelled Cell-A?

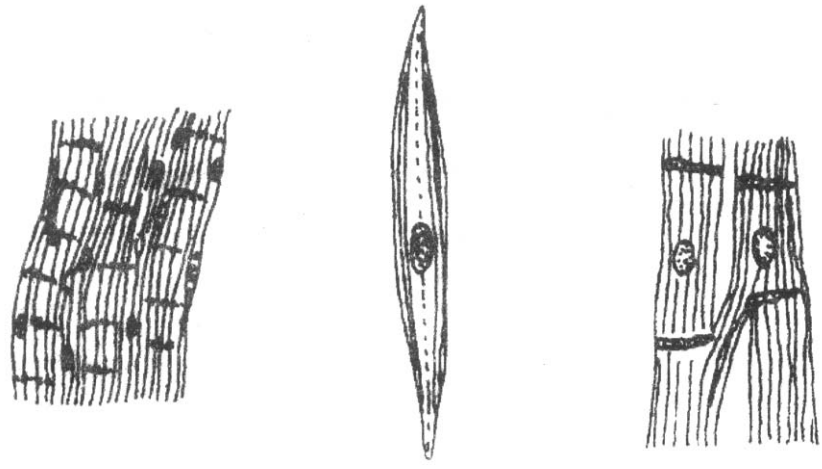
1. Whale
ii. Crocodile
111. Monkey

Which one of the following is correct?

a. i & ii b. i & iii
c. ii & iii d. i, ii & iii

Creative questions

In animal there is a special tissue layer commonly known as flesh is present under the skin and attached with the bony structure. The diagram of the different types of tissues are given below.



A **B** **C**

a. Mainly how many types of tissues are there in the animal body.

b. Explain why does the tissues of the figure A can contract and expand at the animal.

c. Explain what problem would be arisen in the body if the tissues of the fig. no B are damaged.

d. Describe the similarities and dissimilarities between the tissues of the fig. no. A & B with the tissues of the fig. no. C

CHAPTER - SIX

CLASSIFICATION OF PLANTS

The Creator created the world with various types of diversified plants. There are such small plants, which cannot be seen with the naked eyes, again there are also such big plants that can be seen from a long distance. There are many pants. whcih do not have flowers. Again there are such plants which cannot be differentiated into root, stem and leaf. There are some plants, which have got no chlorophyll. They are not green and cannot prepare their own food. The number of plants in this diversified plant world is innumerable. They are in lacs not in thousands. How can we know this great plant world? For this there needs a well thought and well organized system. This is the system of plant classification.

Classification is a system of arrangement in which one can know the plant kingdom easily. Considering the characteristics of plants of the vast plant kingdom, plants having similar characteristics are arranged in groups, i.e., one kind of plant is placed in one group. Thus plants are successively arranged in groups and sub-groups namely: Division, Class, Order, Family, Genus and Species etc. This systematic arrangement is called classification.

The main objective of classification is to know easily the vast plant kingdom in short time.

Aim of classification :

1. To acquire knowledge about each group and sub-groups.
2. To focus on the diversity of plant kingdom.
3. To preserve properly the acquired knowledge.
4. To present the full knowledge in a nutshell.
5. To give a name to every unit.
6. To identify useful plants for the benefit of mankind.

Unit of classification and Taxa:

There are certain steps for classification of plant kingdom. These step are called Taxa and is singular Tax.on. Using the steps classification is to be done ICBN or International Code of Botanical Nomenclature is the International constitution for naming the plants. Seven main. steps are recognised by ICBN These are:

1. Kingdom: The plant kingdom is composed of the whole number and types of plants present in the world. The plant kingdom is comprises of about 450000 specIes.

2. Division: Plant Kingdom is divided into seven Divisions.

3. Class: Each division is divided into several classes.

4. Order: Each class is divided into several orders.

5. Family: Each order is divided into several families.

6. Genus: Each family is divided into several Genera (PI. of Genus).

7. Species: Each genus is divided into several species.

There are aboqt 250000 fruit producing plants. The name of the species should be written in small letters. Usually several members comprises the higher step, e.g. several species constitute a genus and several genera constitute a family etc. Sometime only one member of a Taxon may constitute a higher Taxon. In case of necessity any unit may be splitted to sub-unit for which the term sub should be prefixed against the main unit (Taxa).e.g. Sub Order, Sub-
Family Sub-Genus, Sub-species etc.

Binomial Nomenclature:

Name of a plant consisting of two parts - Generic (Genus) Species. name (Species) together make a complete name of a plant. For example Artocarpus heterophyllus is the. scientific name. of jackfruit, the national fruit of Bangladesh. In this name there are two words, first one is Artocarpus and the second one is heterophyllus. This type of nomenclature, i.e. one name consisting of two words, is called Binomial Name and the method of naming plants by two words is called Binomial System of Nomenclature. ICBN formulate the regulations of giving a scientific name to a plant. According to ICBN a scientific name (Botanical name) of a plant:

1. Shall be binomial.
2. Shall be in Latin.
3. The first name, the generic name, should be started with a capital letter and the second name, the specific name, should be written with a small letter.
4. Shall be written in Roman letters.
5. Shall be printed in Italic form i.e. bending at right.
6. In case of hand writing names should be underlined.

Swiss scientist Carolus Lidnaeus introduced the **Binomial System of Nomenclature.**

The main principle of classification is to arrange all plants of a similar character (one type of character), in a group. Previously the entire living creatures were placed either in Plant or in Animal Kingdom. But as more and more information regarding characteristics of various living beings, there develops a controversy regarding these two kingdoms theory. There established a concept of five kingdoms. According to this concept:

(1) The entire Prokaryotic creature is placed in the Kingdom Monera. As a result Virus and Bacteria are separated from Plant Kingdom.

(2) There were some controversies regarding some uniCellular Eukaryotic organisms (e.g., Euglena), that whether they are plants or animals?

Because they simultaneously possess some characters of plant and some characters of animal. To solve this controversy now all the unicellular prokaryotes are placed in the Kingdom of **Protista** or **Protoctista.** All the unicellular Algae and Protozoa are placed in this Kingdom.

(3) Rest of the multicellular eukaryotic organisms are arranged in there different kingdoms depending on their nutrition and food habit. They are, **(A) Plantae** - Autotrophic, photosynthetic green creatures. **(B) Fungi -** Saprophytic, those which intake (absorb) liquid food from organic bodies and **(C) Animalia -** Rest of the heterotropic creatures. As a result of this classification the range of Plant Kingdom. become reduced, as Algae, Fungi, Bacteria and Viruses are separated from Plant Kingdom.

A tabular form showing present position, characteristics and name of different plant groups are shown below :-

Name of Kingdom	Name of Plant groups	Characteristics of the groups	Example
Monera	Virus	They are ultra-microscopic and acellular. No nucleus and cytoplasm are present in the body; it IS made only by nucleic acid and protein. They can increase their number in a definite living cell. Usually they are known as germs.	*T2 Phage, TMV, Influenza virus etc.*
	Bacteria	The unicellular, prokaryotic microorganism. They may be round (Coccus). rod shaped or comma In shape. They Increase their number by binary fission. Normally they do not bear chlorophyll.	*Closteridium, Bacillus, Vibrio etc.*
	Cyano-Bacteria	They are unicellular prokaryotic, they bear blue-green pigment and can manufacture their own food (Autotrops). Previously they were know as blue green algae and were placed under Algae. But due to their prokaryotic nucleus they are placed under Monera.	*Nostoc Anabaena etc.*
Protoctista	Algae	They may be unicellular or multicellular and are Eukaryotic. They do not have any vascular tissue.	*Spirogyra, Ulothrix etc.*
Fungi	Fungi	There are no photosynthetic pigments in their body. Fungi may be unicellular or multicellular. They are Eukaryotic. They do not have any vascular tissue. They are either Saprophyte or Parasite.	*Mucor, Agaricus, Penecillium etc.*

Plantae	Bryophyta	Plant body of some member of this group may be divided into stem and leaf but bears no root. They do not have any vascular tissue. They do not produce flower.	Riccia, Bryum, Burbula etc.
	Pteridophyta	Vegetative body IS divided into root, stem and leaf, There is vascular tissue in their body. They do not produce flower.	Pteris, Dryopteris Marsilea etc.
	Gymosperm	Vegetative body IS divided into root, stem and leaf, There is vascular tissue in their body. They produce flower but do not produce fruit. because there is no ovary in the flower.	Cycas,Pinus, Gnetum etc.
	Angiosperm (Monocotyledon)	They produce flowers and fruits, Seeds are present in the fruits. There IS a vascular tissue in their body. The root system is fibrous; venation of leaf is parallel, flower trimerous. Seed bears only one cotyledon.	*Oryza sativa, (paddy), Cocos nucifera (Coconut) etc.*
	Angiosperm (Dicotyledon)	They produce flowers and fruits. Seeds are in the fruits, have got vascular tissues in the body. The root system IS taproot system. Venation of leaf is reticulate. Flowers are tetramerous. Seeds bear two cotyledons	Spirogyra, Ulothrix etc.

VIRUS

There are various types of viruses in the world, As a representative of viruses, T_2 Phage is itroduced here with its importance.

Structure : T2 Phage is a cellular. Its body is divided into two parts- head and tail; the head is a hexagonal and the tail is rod shaped, a protein shell surrounds the body. Inside the shell there is a' double-strand DNA in its head. At the upper end of the tail there is a collar, and at the lower end there is a base plate, some spikes and attachment fibres. In Viruses there is no nucleus, cell membrane, cytoplasm and other organelles.

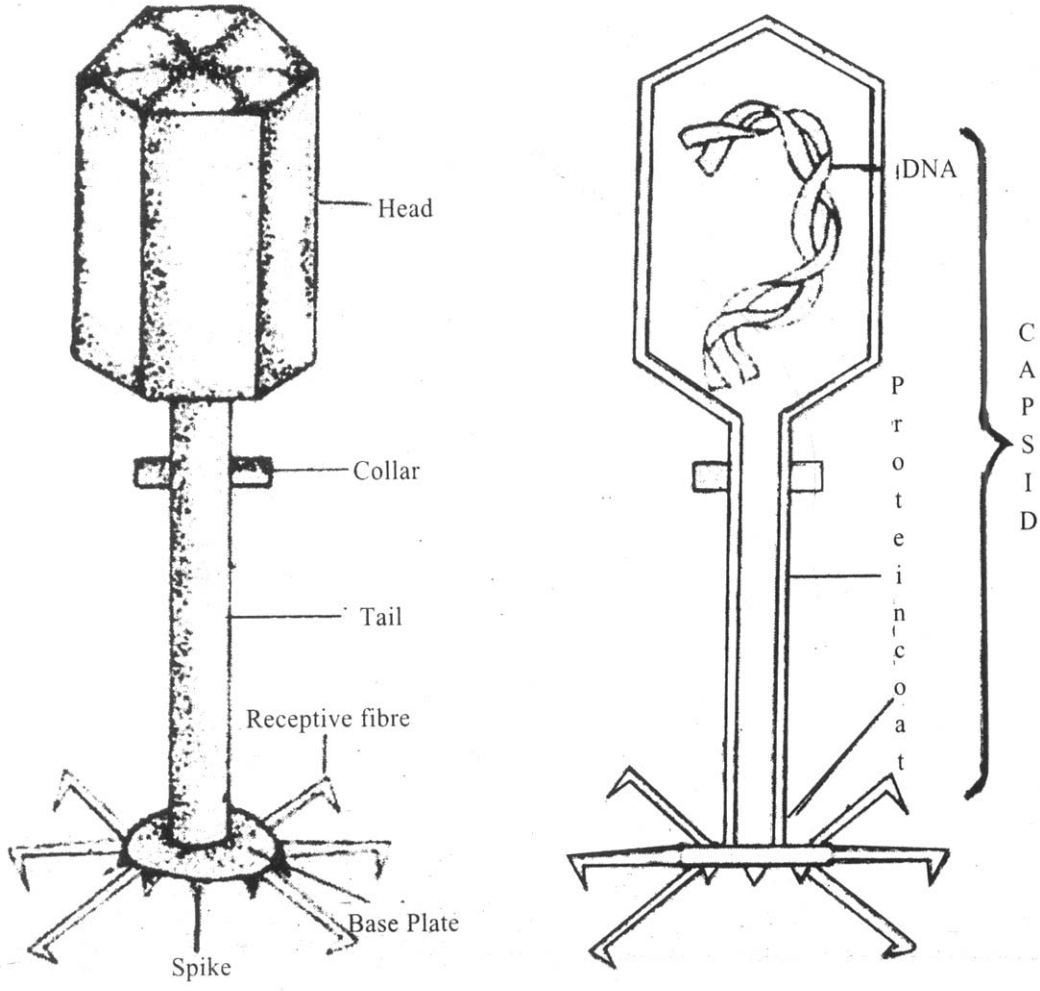


Fig: 6.1 The structure of T_2 Virus

Multiplication:

Viruses can multiply only inside some other living cells. T2 Phage attacks a Bacterium. It keeps the protein shell outside; its DNA enters into the Bacterial cell. Later on it (the Viral DNA) makes the Bacterial DNA inactive

and make many new Viruses. Ultimately the Bacterial cell is destroyed and new Viruses came out.

Importance:

(l) T2 Phage kills Bacteria, (2) Widely used m Genetic Engineering.

Importance of Viruses:

Deadly human diseases like Measles, Pox, Polio, Hydrophobia, Influenza, Harpies, Viral hepatitis etc. are caused by Viruses. Viruses cause about 300 diseases of various plants and crops. Many diseases of domestic animals like - Cow, Goat, Pig, etc. are caused by Viruses. Vrtises are also responsible for fatal diseases like - AIDS (Acquired Immune Deficiency Syndrome), Cancer etc. Vaccines of several diseases like -Pox, Polio, and Hydrophobia etc. are also produced from Viruses.

Bacteria:

Innumerable Bacteria are surrounding us even inside our body. As a representative of Bacteria, the structure and importance of Closteridium IS described here. **Structural features:**

1. It is rod shaped and unicellular.
2. They live in the intestine of human being, other animal or even in soil.
3. They are without photosynthetic pigments.
4. They are prokaryotic, i.e. there is no nuclear membrane and nucleolus in their cell .
5. There are flagella around the cell wall.
6. They are anaerobic, Gram positive and Spore producing.

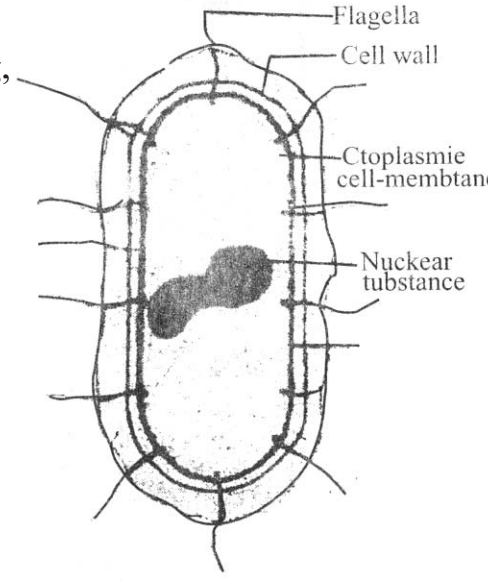


Fig: 6.2 A Bacterium-Clostridium

Importance of Closteridium:

Closteridium tetani is the causal bacteria of **tetanus** and *Closteridium botulinum* is the causal organism for **botulism** (Food poisoning)

Importance of Bacteria :

Structure : Deadly diseases of human being, like - Phthisis (Tuberculosis), Pneumonia, Typhoid, Cholera Diphtheria, Dysentery, Tetanus, H60ping cough, Meningitis etc are caused by different Bacteria. Besides Bacteria is also responsible for various plant diseases. Food putrification and food poisoning, water pollution and demannuring of soil etc. are also caused by Bacteria. Some antibiotics are prepared from Bacteria. Vaccines of Cholera, Typhoid, and Phthisis etc are also prepared from Bacteria. Besides Bacteria also perform the important works like; decomposition of rubbish, blending of tea, coffee, tobacco, 'preparation of butter, curd, cheese from milk, extractivn of Jute fibre, extraction of hairs from skin in tannery, preparation of some B-Vitamins, proper management of sewerage lines, and nitrogen fixation etc.

Algae:

Thousands of Algal species are found in this world. They have diversity in shape, size and structure, but all of them contain different photosynthetic pigments and thus they are **autotrophic.**

A short description of *Spirogyra,* as a. representative of algae, is stated there.

Structure : They are green, un-branched filamentous algae. Their chloroplasts are band shaped, spirally arranged in the cell. The name- *Spirogyra* comes from this spiral chloroplast.

There are pyrenoids in the chloroplasts. The vegetative cell's are elongated and each cell contains a well-organised nucleus and a large vacuole. Their body is slippery and the cell wall is three layered.

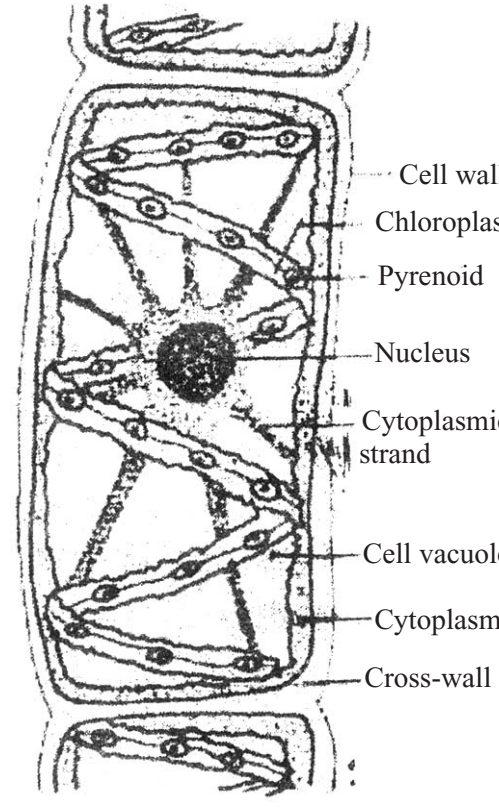


Fig : 6.4 A portion of spirogyra

Reproduction:

Sexual reproduction occurs by the process of conjugation. They also reproduce by fragmentations (Filament break up into short pieces and each part grown into a new filament) or by spore formation.

Importance of Spirogyra:

It is an important source of fish- food. It may .also be used for human food by special processing. It plays a great role in the natural food cycle.

Fungi:

Fungi (Sing: Fungus) are non-green; there are no photosynthetic pigments in their body. They depend on dead organic substances or other living bodies for their food. A short description of Agaricus- a member of fungi is stated here:

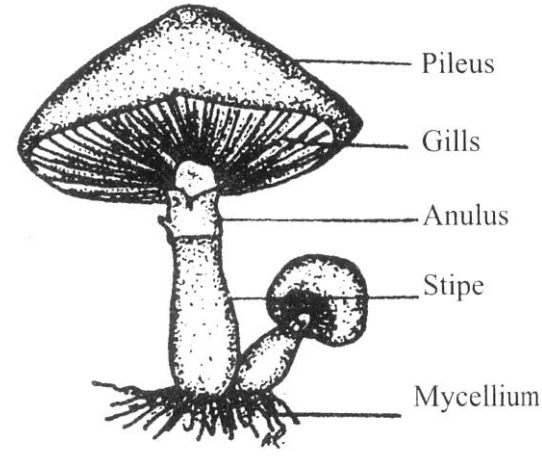


Fig : 6.4 Agaricus

Structure: Agaricus is a well discussed fungus. In BANGLA it is known as 'BANGER CHAATA' (Umbrella of frog). The main vegetative body of Agaricus is very thin, thread like and branched. In the vegetative cells there are Nuclei (PI. of Nucleus), granular protoplasm, oil drops and vacuoles. Colourless thread like vegetative body usually lies under the soil surface and spread there. At last they interwove to form a special organ and rise above the soil. This special organ above the soil is called the **Fruit body,** which also known as **Basidiocarp.** A mature fruit body or an umbrella like body is known as Mushroom. It consists of an expanded umbrella like top, called Pileus and a stalk or stem like portion called the **Stipe.** Gills are arranged at the ventral surface of the Pileus from where spores are born.

Reproduction: They reproduce by the formation of **Basidiospores.**

Importance: Agaricus campestris is well cultivated in home and abroad. They are marketed as **'Mushroom'** and are served as a delicious food in luxurious hotels. There are different kinds of valuable food ingredients in it. In the fields there may have poisonous Mushroom too. So without being certain one should not eat it.

Bryophyta:

There are about 23,000 species of Bryophyta in the world, of which Mosses constitute a major portion of this group. Mosses grow abundantly in Bangladesh. Characteristics of **Bryum** moss are described here. **Bryum** grows on damp soil, on tree trunk and on the old walls etc.

Characteristics :

1. Plant body is divided into Rhizoid (instead of root), Leaf and Stem.
2. There is no vascular tissue in its body.
3. Male and female plants are different.
4. Bi-flagellate sperms, grown in male plants, united with the non-motile egg. grown in the female plant, initiate the sporophyte.
5. Sporophytes are developed on the top of the female plants.
6. Spores produced in the capsules germinate to produce algae like filamentous Protonema.
7. Moss plants develop from the Protonema.

Importance of Moss plants : Mosses help to grow soil on the stony surface. It helps to hold water. Pit coal is develop from Sphagnum (a Moss).

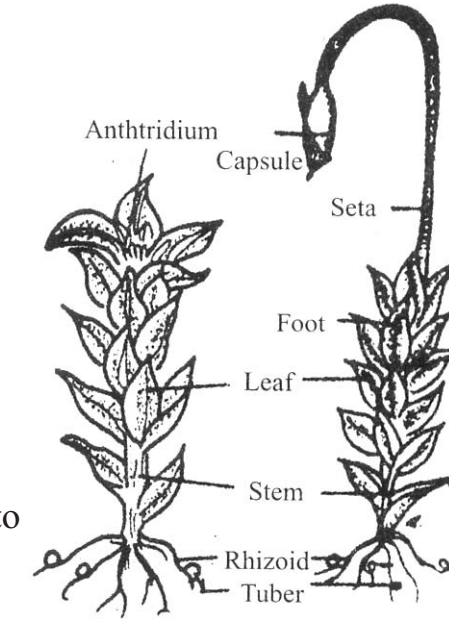


Fig. 6.5 A moss-Bryum

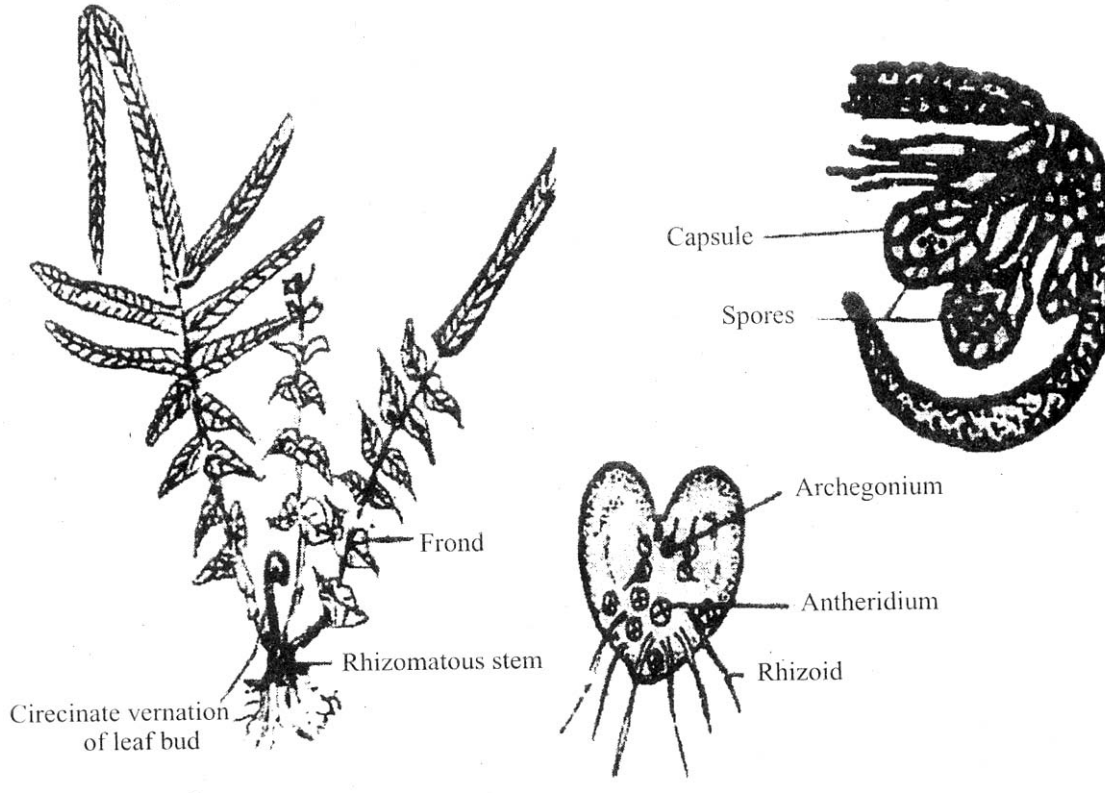
Pteridophyta:

Pteridophyta is the first vascular plant (which Possesses vascular tissues). The number of species of pteridophyte is about 10,000 species. As a representative of Pteridophyta, the description of Pteris is given below. Pteris is also known as sun fern.

Characteristics;

1. Pteris plant is sporophytic.
2. Plant body is divided into root stem and leaves.
3. The stem is Rhizomatous and bears scales.
4. Leaves are evergreen and pinnately compound. Leaves of fern are known as **Frond.**
5. Vemation of young leaf is circinate.
6. **Sporangia** (Sing: Sporangium) develop along the margin of the mature leaves. The swollen portion of a sporangium is called the capsule. Spores are borne in the capsule,

7. The spores germinate and give rise to green heart-shaped gametophytes-called **Prothallus.** Male and female sex organs develop on Prothallus, and by the union of the male and female gametes a new Pteris plant is born. Pteris are found to grow on old, broken walls and old bricks heap.



Fig; 6.6 Different parts of a *Pteris* plant

Importance of Fern: Many ferns are planted in pots as ornamental plants Some ferns are taken as vegetables and some produce medicines.

Gymnosperm:

Gymnosperms produce flowers and seeds but do not bear any fruit. Once they were well spread around the world but at present their, number is becoming very limited. The total number of species of gymnosperms in the whole world is only 27. In Bangladesh only 3 gymnosperms are found to grow naturally in the forests. As a representative of gymnosperm the characteristics of Cycas is described here:

Characteristics of Cycas:

1. The Cycas plant is sporophyte. Their body is divided into root, stem and leaves.
2. They have vascular tissues.
3. Leaves are compound, look like the leaves of coconut tree, and are arranged spirally as a crOWR on the top of the stem.
4. Vernation of the young leaves is circinate.
5. There are two types of root - (i) Primary root or taproot and (ii) Coralloid root, which resemble the sea corals.
6. Female and male plants are different

Fig. 6.7 A Cycas Plant

7. Female **Sporophylls** (Megasporophylls) are borne on the top of the female plant and the male Sporophylls (Microsporophylls) are on the top of the male plants. The male Sporophylls together form a cone like body, known as **Male Cone.**
8. Seeds are developed after pollination and fertilization. New plants develop from the seed.

Importance : Cycas is planted in the garden only for beautification Cycas is found to grow wild in the forests of Chittagong.

Monocotyledonous or Monocot plants:

Monocot plants bear one cotyledon in their seeds. Their roots are fibrous, leaves have parallel venation; flo:vers are trimerous (each floral parts being 3 in number). Examples of monocot plants are Paddy, Wheat, Sugarcane, Bamboo, Palm, Coconut, Betel nut and Date-Palm etc. As a representative of Monocot plants, here the characteristics ap.d importance of coconut tree is described briefly with a diagram.

Characteristics:

1. It is a tree without branch.
2. Leaves are pinnately compound and are
3. Arranged as a crown on the top of the stem. Flowers are in inflorescence, and the inflorescence is covered with a woody Bract.
4. Flowers are unisexual; number of female flowers is less and is present at the base of the inflorescence stalk. Number of male flowers is more and is present at the top of female flowers.
5. In flowers there are 3sepals, 3petals and 6stamens in male flower and 3united carpel in female flower.
6. Fruits are fibrous and one seeded.

Fig : 6.8 A Coconut tree

Importance of Coconut plants: Green Coconut is a soft drink; the mature coconut is used in preparation of sweetmeat, treated with vegetables in curry. Again coconut oil also is obtained from it. Ropes, mats etc. are made from its coir. Leaves are used to make roof of hut or cottages. Brumes are made from the midrib of the leaflets. Leaves and stem are also used as fuel.

Dicotyledonous o,r Dicot Plants:

Dicot plants bear two cotyledons in their seeds. The root system. is **Tap Root System;** leaves are with reticulate venation, flowers are **Tetramerous** or **Pentamerous.** In the world the number of dicotyledonous plant is more. Examples of Dicot plants are: Mango, Jamboline (JAAM), Litchi, Jackfruit, Shaal, Teak, Mehogoni, Garjan, and Sundari etc. As a representative of Dicot plants, the characteristics and importance of Psidium guava (PEYARA) is described with a.diagram of a small twig of it.

Characteristics :

1. Psidium plants are sporophyte. The plant is a small tree with multiple branches.
2. Leaves are simple and opposite.
3. Flowers are stalked, solitary. It develops from the axils of the leaf.
4. Ovary is situated below, the other parts (whorls) of the 'flower is above the ovary. 5. Flowers are bisexual and actinomorphic; sepals 5 free, petals 5 free and white in colour; stamens many and free, carpels 5 syncarpous (united).

Fig : 6.7 Aportion of Psidium Plant

Importance :

6. The fruits of Psidium are of great importance. The plant is cultivated for its fruits. Ripe fruit is very tasty and the whole of it is edible. Jam, jelly etc. are prepared from its fruit. Leaves are used in the treatment of diarrhoea and dysentery. Water boiled with Psidium leaves is a good curative of gum pain.

Multiple Choice questions

1. **Water boiled with leaves are very useful for the relief of teeth pain?**

   a. Nim b. Berry

   c. Guava d. Chirota

2. **The umbrella like expanded part of Agaricus is-**

   i. Fruit body.

   ii. Pileus

   iii. Mushroom

Which one of the following is correct?

a. i b. ii

C. iii d. i, ii & iii

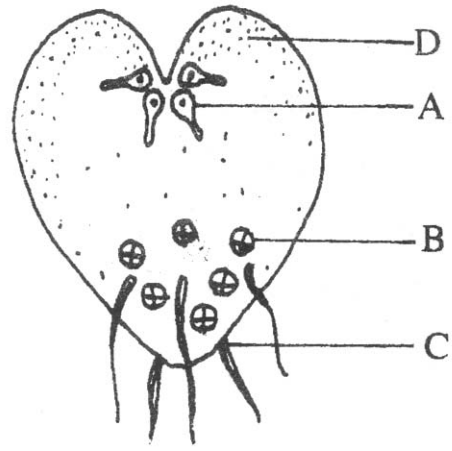


Fig .

Answer to the question no 3 & 4 in support of the above diagram.

3. Which part shown in the diagram produce male gamete?

a. A b. B

c. C d. D

4. The displayed diagram is-

i. Gametophyte

ii. Sporophyte

iii. Capsule

Which one of the following is correct?

a. i b. ii

c. i & ii d. i, ii & iii

Creative questions

The students of schools in France often go to camping in the forest in groups during the winter vacation. Once in such a camping students found various kinds of Mshroom besides the road in the forest and all of them engaged in Mushroom eating festival. As a result some students fell ill. Then they were sent to the hospital without any delay.

a) What is Mushroom.

b) Explain the probable cause of some students falling ill?

c) Describe what should be done to avoid such accident in future?

d) Represent with argument the utility of including Mushroom regularly in the food menu of the people of Bangladesh.

CHAPTER - SEVEN

ANIMAL DIVERSITY AND CLASSIFICATION

ANIMAL DIVERSIY

Innumerable small and large plants and animals live in harmony in the diverse geographical, environment and climatic conditions of the world. Organisms of the same species living successfully under different environments become modified or adopted differently. As a result, from a common ancestor with diverse characters animals and plants evolve. This diversification of organisms is called bio-diversity. So, the diversification found among the animals is known as Animal diversity and the diversification among the .plants is known as Plant diversity.

To survive and disseminate successfully under various geographical regiotns the diversities that have arisen among the animals through adaptations and essential modifications of their external and internal morphology, size, shape, behavior etC. is called animal diversity. Due to this diversification various species of animals have arisen in the world.

SHORT DESCRIPTION OF DIVERSIFICATION OR BIO-DIVERSITY:

Due to diversification among the animals, the zoologists have categorized the animal kingdom into the following criterions:

1. On the Basis of Shape and Size:

Animals are grouped into two categories on the basis of their shapes and sizes, such as: .

a. Microscopic Animal

Light Microscopic: These animals can be seen well with the help of simple light microscope.

Example: Amoeba, Hydra Cyclops Daphnia etc.

b. Large Animals: These are not microscopic. These can be seen by naked eyes. Innumerable small, medium, large and very large animals belong to this group. Example: Ant, Fly, Mosquito. Leech, Earthworm, Cockroach, Frog, Turtle, Lizard Snake, Crocodile, Dog, Cat, Goat, Cow, Bat, Whale, Man etc.

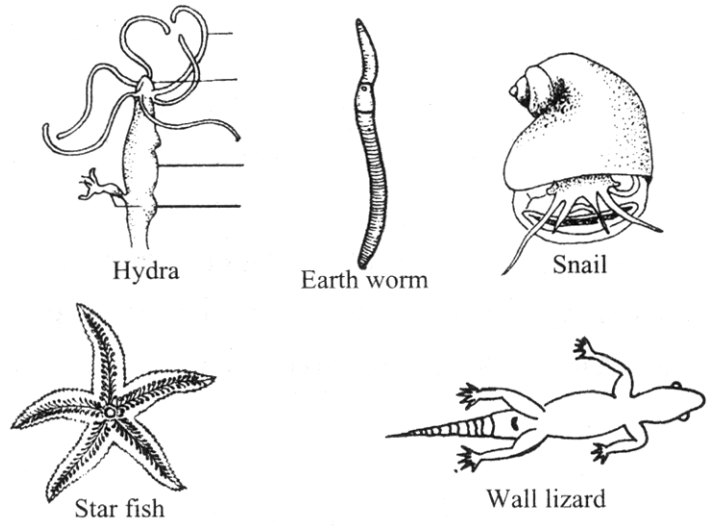


Fig: 7.1.various type of symmetry

2. On the basis of Symmetry:

Description of the relative proportion of the shape, structure, SIze etc. of various organs of the animal body is called symmetry. The symmetry of animals is mainly of three types.

a. Asymmetry: Not capable of being halved in any plane, e.g. Amoeba, snail etc.

b. Bilateral Symmetry: Capable of being halved in one and only one plane, e.g. Cockroach, Lizard, Frog, Fish, Man etc.

c. Radial Symmetry: Capable of being halved in many planes, e.g. Hydra, Jelly fish, Star fish, etc.

3. On the basis of habitat: Animals are of different types such as:

a. Terrestrial: They live on land, e.g. Cockroach, Toad, Goat, Cow, Tiger Man.

b. Aquatic: They live in water.

Aquatic animals are of two types:

i. Fresh water animal: Hydra, Singh, Kai, Frog, turtle, crocodile

ii. Marine animal: Lotia fish, Whale, Dolphin, Jellyfish, Shark, Starfish and Coral.

c. Flying: This animals can fly in the sky, e.g. Butterti.y, Bats and various species of birds

d. Tree-living Or Arboreal: They live on trees, e.g. Tree frog, Python, various species of Monkeys, Lemur and Leopard.

e. Desert dweller: They are animals of the desert, e.g. Camel, Dumba etc.

f. Boreal: Rat, Fox, Platypus, some species of snakes, Earth worms etc.

g. Polar: Some animals live in the Polar Regions, e.g. White bear, Antelope and Penguin.

h. Forest dweller: Tiger, Bear, Monkey, Deer, Peacock, various species of Snakes and Birds, Boar, wild Buffalo etc. They live in deep forest.

i. Mountain dweller: Gayal, Mountain goat, Elephant etc, are animals living in mountain areas.

4. On the basis of habits:

On the basis of habits animals are of two types; mainly:

a. Diurnal: They are active during day timer e.g. Deer, Squirrel, Cow, Horse, Duck, Hen, Vulture, Butterflies, Hoppers, Eagle and King stock.

b. Nocturnal: These animals are active during night time, e.g. Tiger, Fox, Owl, Moths, Shrew, etc.

5. On the basis of feeding habits animals are mainly of three types:

a. Herbivorous: These animals eat grass or other plant materials, e.g. Goat, Sheep, Cattle, Elephant, Horse, Rabbit, Guinea pig, etc.

b. Carnivorous: They are generally predacious and feed on animals, e.g. Tiger, Lion, Jackal, Vulture, Hawk, Hyena, etc .

c. Omnivorous: Animals of this category eat all kinds of food, e.g. Cockroach, Crow, domestic Dog, Cat and Man.

6. On the basis of nutrition:

a. Holozoic or heterotrophic or zootrophic:

For nutrition they depend upon plants or animals, because they cannot prepare their own food. Heterotrophic animals are again mainly of three types:

i. Scavengers: They get their food from dead plants and animals, e.g. Cockroach, Crow, Vulture, Hyena etc.

ii. Parasites: They take nutrients from other organisms i.e. the host's body. They are smaller in size than the hosts. They live outside or inside the host body e.g. Round worm is an internal parasite of human body and pediculus is an external parasite.

iii. Predators: They are generally bigger in size than their prey animals. They kill their hunts and eat their flesh e.g. Tiger, Lion, Jackal, Wolf, etc.

7. On the basis of the presence or absence of vertebral column:

Depending on the presence or absence of vertebral column in animal body, animals can be divided into two principal groups. Such as:

Invertebrates: Earthworm, Cockroach, Roundworm, Jelly fish, Starfish, Octopus, Snail, Oyster, Hookworm etc, are the animals without backbones. Vertebrates: Embryonic notochord (an identifying character of the phylum chordata) of these. animals transforms into vertebral column. When fully formed, e.g. Fishes, Amphibians, Reptiles, Birds and Mammals. Vertebrate animals have been placed in the subphylum vertebrata under the phylum chordata ..

8. On the basis of economic importance animals can be divided into two main groups: .

Beneficial animals: There are many worms, insects, birds and beasts in the world which benefit man in various ways directly or indirectly, e.g. Bee, Silk worm, various species of fresh water and marine Fishes, Dog, Cat, Goat, Cow, Horse, Ass, Elephant, various species of birds etc.

Harmful Animals: Many animals do harm to man directly or indirectly, e.g. Mosquito, Fly, White ant, Ribbon worm, Round worm, Snakes. Rat, Tiger, Lion etc.

Though apparently, they are harmful to man, in the animal world all animals in one way or the other are necessary. All animals have a particular role in' keeping the natural balance, food chain etc. So to preserve the existence of animals including the human being, no organisms should be killed unnecessarily. For that the balance of ecosystem may be disturbed, which ultimately will have direct or indirect harmful effects on human society. To understand the beneficial role of animals, every body should have at least a first hand knowledge about the animal kingdom. Animals are valuable and essential resource of a country. It is the duty of all conscious people to be sympathetic towards them and to conserve them. Otherwise many of the animal resources will vanish from the surface of the earth. In the long run the future human society will adversely be affected.

TAXONOMY

In the world there are numerous plants and animals of diverse nature. It is not possible for anyone to know about each of them separately. So the organisms (that is the plants and animals) are scientifically arranged into various taxon (plural taxa), based on the similarities and dissimilarities among them. The process. of arranging the organism into various taxa is known as classification.

The science of classification is called Taxonomy.

There are different basis of classification. The natural or modern classification is more applicable compared to others. Swedish naturalist, Carolus Linnaeus, introduced the rules of modern natural classification.

NECESSITY OF CLASSIFICATION:

a. With the help of classification we can learn scientifically with less labour and time about the plants and animals of the world.'

b. When the classification of an organism (plant/animal) and the identifying characters of the taxa of that classification are known, we can easily get an idea about the features of that particular organism.

c. Unfamiliar organism can easily be marked and identified by comparative studies of the similar and dissimilar characteristics. Harmful and beneficial organisms can be identified.

Through comparative studies, particularly of the structural characteristics of any plant or animal, placing that organism under a phylum, class, order, family; genus and species is the object of classification. Species is the unit and lowermost taxonomic category.

Example:

Classification of cockroach

Kingdom	:	Animalia
Phylum	:	Arthropoda
Class	:	Insecta
Order	:	Dictyoptera (in Britain & Europe) Orthoptera (in America)
Family	:	Blattidae
Genus	:	Periplaneta
Species	:	P. americana

RULES FOR MODERN OR NATURAL CLASSIFICATION

1. Kingdom, Phylum, Class, Order, Family, Genus and Species names are to be written one below the other in definite order.
2. Names of the step can be written either in English or in BangIa. But the Phylum name must be written in English, e.g. in the case of writing the classification of man. Man is a.n animal of the phylum Chordate. Here at the time of writing, general name of the taxon can be written in English or in BangIa but the Phylum name chordata must be written in Roman alphabet never to be written in BangIa.
3. When writing in hands, in both the cases of plants and animals, the generic and specific names must be underlined individually. For example, in case of Man when writing in hand, Genus: Homo, Species: Homo sapiens. This can also be written as H.sapiens:
4. When printed Genus and species names are to be printed in italics. as:
Genus: Homo and Species: Homo sapiens, H sapiens ..
5. Excepting the generic and species names, no other taxon should not be underlined.
6. For the name of family of all animals there should be an ending of four letters 'idae', such as: Hominidae (family of human) Bufonidae (family of toad).
7. In case of invertebrate animals, it is enough to write seven taxonomic categories in English, namely kingdom, Phylum, Class, Order, Family, Genus and Species. But in case of the vertebrate animals like Man, Frog, Snake Fish etc. you are to write the taxon subphylum, under ,the phylum chordata. For example the classification of Man and Toad are given below.

a. Classification of Man

Kingdom	Animalia
Phylum	Chordata
Subphylum	Vertebrata
Class	Mammalia
Order	Anthropoidea
Family	Hominidae
Genus	Homo
Specie	H. sapiens

Kingdom -	Animalia
Phylum -	Chordata
Sub-phylum -	Vertebrate
Class -	Amphibia
Order -	Salientia
Family -	Bufonidae
Genus -	Bufo
Species-	B. melanostictus

N. B. In case ofveliebrate animals like Toad. Man etc, you are to write in total of eight taxa including sub phylum vertebrata.

8. You must write in full the scientific or species name of any animal, such as scientific name of toad: in print you are to write *Bufo melanostictus* but while classifying species names can be printed both as B. melanostictus or Bufo *melanostictus* and in hand B. melanostictus. But it never can be printed *melanostictus* or written melanostictus.

9. Scientific name is to be written in combination of two parts. Of these two parts, the first one is the genus part of the scientific name and the other is the species part, e. g. scientific ,name of Toad is Bufo melanostictus. Here Bufo is the genus part and melanosticutus is the species part. This system of naming the animals was approved by the ICZN (International commission on Zoological Nomenclature) in 1961.

So, the process of scientific naming of organisms (plants and animals) with the combination of two words using the genus name first and species name thereafter is called Binomial Nomenclature.

Binomial Names of Some Animals :

No	Name of animal	Name of phylum	Genus	Species
1.	Malarial Parasite	Apicomplexa	Platsmodium	vivaz
2.	Cockroach	Arthropoda	periplaneta	americana
3.	Bee	Arthropoda	Apis	indica
4.	Rohi fish	Chordata	Labeo	rohita
5.	Hilsha fish (National fish)	Chordata	Tenualosa	ilisha
6.	Frog	Chordata	Rana	tigrina
7.	Doel (National bird)	Chordata	Copsychus	Saular is
8.	King Cobra	Chordata	Naja	Naja
9.	Royal Bengal Tiger (National Beast)	Chordata	Panthera	tigris
10.	Lion.	Chordata	Panthera	leo
11.	Jungle fowl	Chordata	Gallus	gallus
12.	Man	Chordata	Homo	Sapiens

Like animals, unicellular organisms were placed into phylum protozoa. But now they are separated from the animal kingdom and placed in protista or protoctista of 5-kingdom classification. However, as phylum protozoa were a part of the animal kingdom, previously therefore they are still taught in zoology. In the last decade, about the 80's, the International Protozoologist Committee decided that the unicellular protozoans are of vast variety and that they should be included in a single phylum. Thus they have classified protozoans under 7 phyla. In this classification, protozoa is a subkingdom of protista or protoctista kingdom. Among them the amoeba is included in-the phylum Sarcomastigophorea and malarial parasite is in Apicomplexa. The names of nine major phyla of animal kingdom are mentioned below with their **identifying characteristics and examples:**

1. Plylum - Sarcomastigophorea Kingdom - Protista

Habit and habitat: The organisms of this phylum are cosmopolitent. Some members of these phyla are free living but some are colonial, some lives on damp and wet soil, many species lives in fresh water and marine water. Many members are external or internal parasite of plants or animals, such as (Amoeba) free-living organism of fresh water.

Identifying Characters:

a. Animals of this phylum are unicellular, mic~oscopic. All of functions are perforn1ed by the single cell.

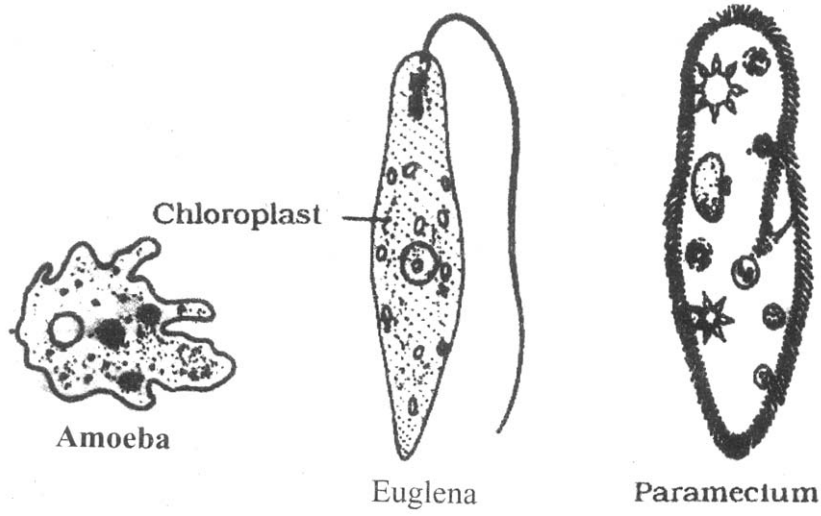


Fig. 7.2 Different types of Unicellular Animals

b. They have no cell wall (outside the cell membrane); in the cytoplasm there is a centriole, one vacuole is present, no plastid.

c. They locomote with the help of pseudopodia:

d. They live singly or in colonies.

e. They are free living animals. Example: Amoeba proteus.

Kingdom Animalia:

Habit and habitat: Animals of this phylum are generally known as sponge. They are of different sizes, shape and colour. They are distributed worldwide. In adult stage they live under water. attached with some objects. They live in colonies. They look like a plant. Major members are marine but some live in fresh water.

Identifying Characters:

a. These are simplest multi-cellular animals.

b. There are many small pores or ostia in their bodies

c. Internal circulation is maintained by canal system.

d. There is no separate well-formed tissue, organ or system.

Example: *Scypha gelatinosum* (Marine sponge). *spongilla fragilis* (Fresh water sponge)

2. Phylum - Cnidaria

Habit and Habitat: Many members of this phylum live in worldwide in fresh water, drain, canal, river, lake, stream etc. But maximum are marine species. They are of different colour, shapes and sizes; they are the beauty of sea they are attached with floating wood, leaves or something else or free swimming.

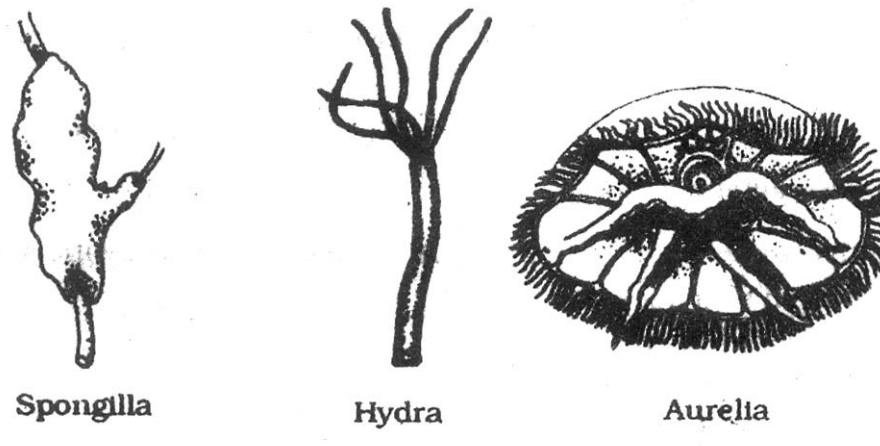


Fig: 7.3 Animals of Different Phyla

Some species are free living and some are colonial. As: Hydra (fresh water animal) Jelly fish (Marine water animal) and Corals (Marine).

Identifying Characters:

a. They are two layered animals; body is formed of two embryonic cell layers ectoderm and endoderm. Between these two layers there is a non-cellular layer called mesoglea.

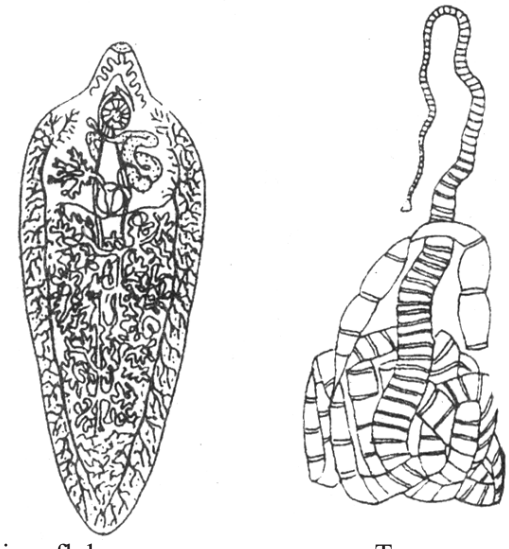
b. A body cavity named coelenteron or gastrovascular cavity takes part both in digestion and water circulation.

c. In the ectoderm there are specialized cnidoblast cells. Example: Hydra

Example : Hydra vulgaris, Aurelia aurita.

3. Phylum Platyhelminthes:

Habit and habitat: Members of this phylum are mainly ectoparasite or endoparasite of other organisms but a few species are free living. They live in fresh water, drain; stream etc. and some species live in saline water, some member of this phylum live in damp and moist soils.



Liver fluke Tape worm

Fig. 7.4 Liver fluke and Tape worm

Identifying Characters:

a. They are flat bodied, worm like diocious and mostly endoparasitic animals.

b. Body is covered by a thick cuticle.

c. Sucker or hooks are present.

d. Flame cell is the excretory organ.

e. Digestive system incomplete or absent.

Example: *Taenia solium* Tape worm Fasciola hepatica liver fluke.

4. Phylum Nematoda.

Habit and habitat: Most members are parasitic. Some of them lives as parasites of plant roots or grains (Wheat. paddy) Intestine, blood and other organs of different animals. some are free living they live in soil and water. On the basis of number they are second largest phylum of animal kingdom.

Fig. 7.5 Ascaris lumbricoides

Identifying characters:

a. Body cylindrical, covered with thick cuticle and bilaterally symmetrical.

b. Complete digestive system (Mouth and anal opening present).

c. Body cavity uncovered, there is no true coelom.

d. Circulatory and respiratory system absent.

e. They are generally unisexual.

Ascaris lumbricoides (Round worm)

Ancylostoma duodenale (Hook worm)

Enterobius vermicularis (pin worm)

Rhabditis- free living, Live in soil.

5. Plylum Annelida:

Habit and habitat: Majority of the annelid animals live in temperate and tropical counties of the world. They show wide diversity in their structure, habit and habitats. Many live in fresh water, saline water. Some occur in moist soil, some members lives in seashore, some in bottom of shallow sea, some species live in grooves on stone and soil.

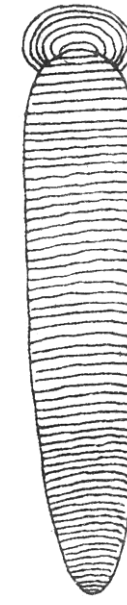


Fig : 7.6 Leech

Identifying characters:

a. Body metamerically segmented, body covered with thin cuticle.

b. Ciliated, glandular, coiled tubules named nephridium acts as excretory organ.

c. Generally setae are used as accessory organ for locomotion.

Example: *Pheretima posthuma* (Earthworm), *Tubifex* (Live in fresh water. used as food of aquarium fish *Hirudo madicinalis* (leech).

6. Phylum Arthropoda:

Habit and habitat: This phylum is. the largest. in animal kingdom. About 60-65% of the known animals belong to this phylum. They are - universally distributed and are adapted to live in almost all types of environments.

Many species are either ecto or endoparasite. They are terrestrial or aquatic. Many of them are capable of flying like cockroach, butterflies, Bagdaprawn, king crab, spider etc are members of this phylum.

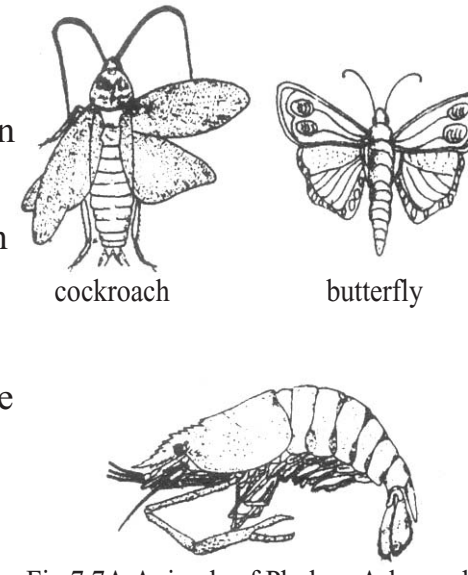


Fig 7.7A Animals of Phylum Arhropoda

Identifying characters:

a. Body is divisible into different regions, namely head, thorax and abdomen of cephalothorax and abdomen or head and trunk.

b. Appendages of the animals of this phylum are jointed or formed by many segments.

c. Body is covered by cuticle enriched with chitin.

d. In the head there is a pair of compound eyes and antenna.

e. They have blood filled body cavity named haemocoel.

Example: *periplaneta americana* (Cockroach) *Bombyx mori* (Silkworm) *Carcinoscorpius* (King crab -a living fossil).

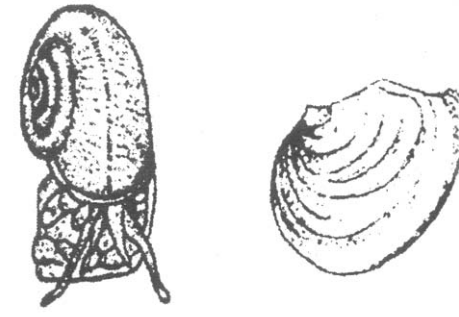


Fig. 7.78 Antmals of phylum Mollusca

7. Phylum Mollusca:

Habit and habitat: Member of this phylum shows a great variety in structural organization, habit and habitat. Most of the members have shells. They are marines and some occur in hilly region and in forest or in plain land. Some species live in different types of fresh water, e.g. snail, octopus and bivalve.

Identifying characters:

a. Body is soft, generally covered by hard shell.

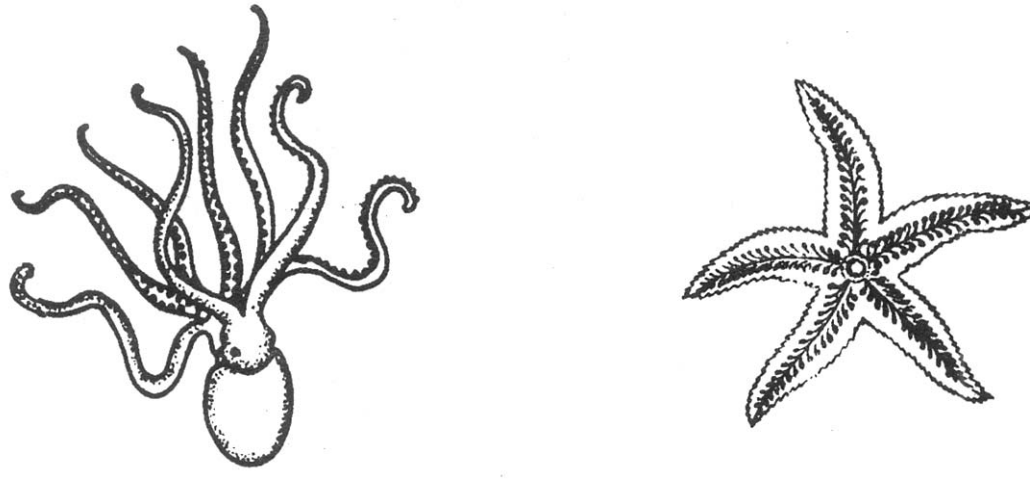
b. Muscular foot present on the ventral side of the body for locomotion.

c. Respiration by gills or lung.

Example: *Pila globosa* (Apple snail) *lamellidens* (Bivalve) *Octopus vulgaris* (Octopus)

8. Phylum Echinodermata:

Habit and habitat: All members of this phylum are marines. None occurs on land or fresh water. Different species of Echinodermata are found in all seas of the world. Majority of them are free living, but some are at the adult stage lead a stationary life.



Octopus Starfish

Fig: 7.8 Octopus and Starfish

Identifying characters:

a. Integument spinous

b. Body radially symmetrical or can be divided into five similar parts

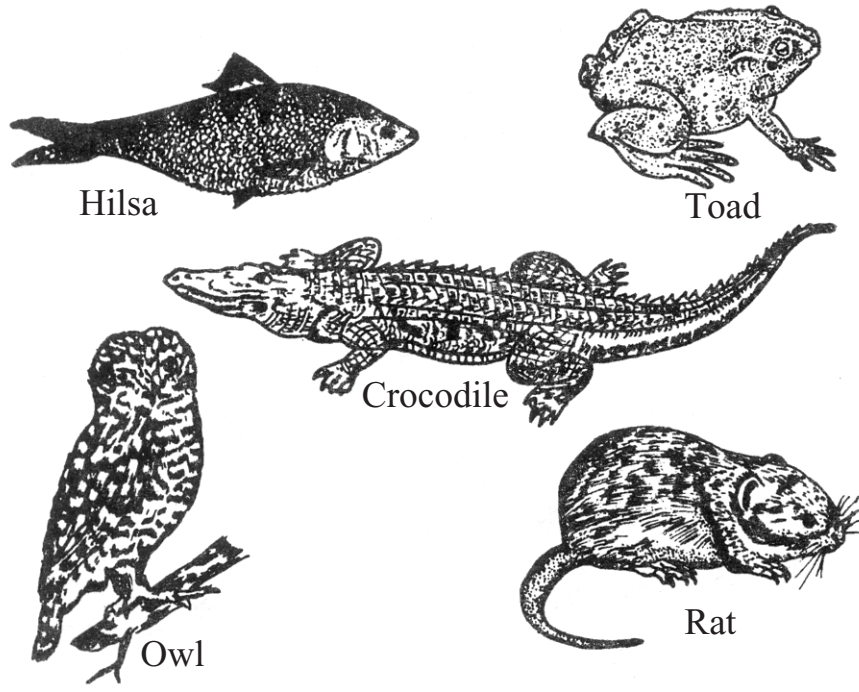
c. Water vascular system controls the locomotion and respiration

d. In adult animal, head, dorsal and ventral side is not marked clear, oral and aboral surfaces are present.

Example: *Asterias rubens* (Star fish) *Echinus esculentus* (Sea urchins)

9. Phylum chordata:

Habit and habitat: Animals of this phylum are found in almost all habitats of world. Some species live in land. Among the aquatic chordates some live in fresh water and some in marine water. Many species are arboreal, desert dweller, polar, cave dweller and carsorial. Some members of phylum chordate are ectoparasite on other animals.



Identifying characters:

Through out life or only at the embryonic stage animals of the phylum chordata have four principal characteristics:

1. Notochord: They have in the middle of the dorsal side of the body a soft. flexible. rod shaped, firm, un-segmented structure called notochord, throughout the life or only in embryonic condition. In higher chordates, it.is replaced by bony vertebral column.

2. Nerve cord: A single medium, hollow nerve cord on the dorsal side of body is present.

3. Throughout life or at any stage of the life-cycle there are lateral ***pharyngeal gill slits.***

4. In case of aquatic chordate body behind the anus modified into a muscular tail which is accssory organ of locomotion.

Example: *Bufo melanostictus* (Toad) *Crocodylus porosus* (saline water crocodile) *Homo sapiens* (Man) *Bubo bubo* (owl) *Catla catla* (catla fish) *Ascidia* (Ascidia) *Scoliodon* (shark) *Tenualosa ilsha* (Hilsa fish) *Mus musculus* (Small rat) *Bandicota indica* (Large rat)

EXERCISE

Multiple Choice questions

1. Which one has haemocoel in the body.

a. Hydra b. Leech

c. Prawn d. Pila

2. Which one is applicable in case of Elephant?

i. Forest dweller & Carnivorous

ii Mountain dweller & Herbivorous

iii. Polar dweller & Omnivorous

Which one of the following is correct?

a. i b. ii

c. iii d. i, ii & iii

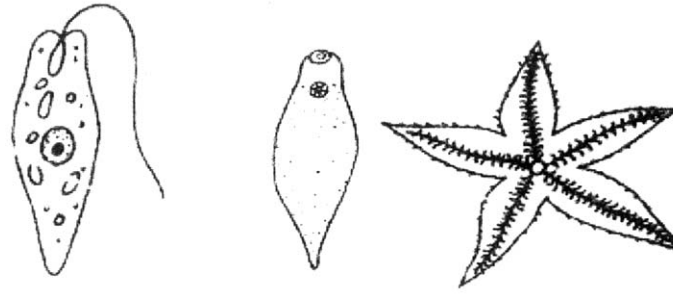


Fig-A Fig-B Fig-C

Answer to the question no 3 & 4 in support of the above diagram.

3. Which animal nutrition in the picture is autotrophic?

i.A

ii.B

iii. C

Which one of the following is correct?

a. i b. ii

c. i & ii d. ii & iii

4. The remarkable characteristic of the animal of the figure no. B are-

i. internal parasite.

ii. flame cell is present

iii. ostium is present

Which one of the following is correct?

a. i & ii b. i & iii

c. ii & iii d. i, ii & iii

Creative questions

1. There lived different types of animals in the diverse geographical environment of the world. On the basis of the similarities and dissimilarities of characteristics among the membrs of the Animal Kingdom the Biologists have classified the animals into different classes, Four animal species are shown in the following diagram.

Fig-1 Fig-2 Fig-3 Fig-4

a. What is animal diversity?

b. Describe one reason how Bio-diversity is evolved?

c. To which phylum does the animal of figure no-4 belong-to-explain?

d. In the diagram which two animals have much similarities and which two animals have much dissimilarities on the basis of both classification and habitat explain.

CHAPTER-EIGHT

STRUCTURAL ORGANIZATION AND ACQUAINTANCE OF ANIMALS

Amoeba: Amoeba proteus is a simple one celled animal. It is so small in size that it cannot be seen clearly without a microscope. Amoeba is an excellent example of Subkingdom Protozoa, Kingdom Protista or Protoctista. Though they are members of protista at present, they are discussed with animal. Following that tradition, they will be discussed along with. the living beings. Though the body of Amoeba is formed of a single cell, the functioning of this cell is not so simple. Within the cell of Amoeba, many physiological functions like respiration, nutrition, reproduction, excretion, stimulation etc. are performed.

Habit and Habitat: Amoeba is found throughout the world. It lives in pond, river, and 'other freshwater pools. Soft wet soil, leaves and stems of aquatic plants or any hard surface may harbour Amoeba, It is a free living animal. By producing finger like pseudopodia they move and intake their food.

Body structure: Amoeba appears as a colourless and transparent drop of jelly when viewed under a microscope. It lacks a definite body shape because it changes its shape by producing the pseudopodia every moment. So, it is not possible to describe its definite shape, anterior or posterior ends, dorsal and ventral surfaces. Moreover, as Amoeba's shape is changeable, its body cannot be divided into two similar parts. This condition is called ,asymmetry. In size, a full grown Amoeba generally may be from 1/20 mm to. 1 mm. The body of Amoeba can be divided into two main parts, Plasmalema and Protoplasm.

A. Plasmalema or Plasma membrane: The body of Amoeba is covered with plasmalema formed by the combination of protein and lipid. This membrane is extremely thin, living, semi-permeable and elastic.

Functions:

1. Plasmalema of Amoeba gives its shape.
2. It holds the various organelles inside the protoplasm.
3. The membrane being elastic it can produce pseudopodia easily.
4. By the process of diffusion, through the plasmalema it takes oxygen and water. It also discharges carbon dioxide and excretory materials through the membrane.
5. It helps the Amoeba to become attached to any solid surface.

B. Protoplasm: The thick jel1y like substance surrounded by the plasmalema is the protoplasm. It can be divided into two parts, Cytoplasm and Nucleus.

1. Cytoplasm: Without the nucleus, the rest of the protoplasm is cytoplasm. It is divisible into two parts, such as Ectoplasm and Endoplasm.

Ectoplasm: The part of cytoplasm immediately behind the plasma membrane is known as ectoplasm. This part is thick, transparent, non-granular and contractile.

Functions:

1. Ectoplasm protects the organelles inside the body.
2. It helps to maintain the shape of the body.
3. It assists the Amoeba in producing pseudopodia

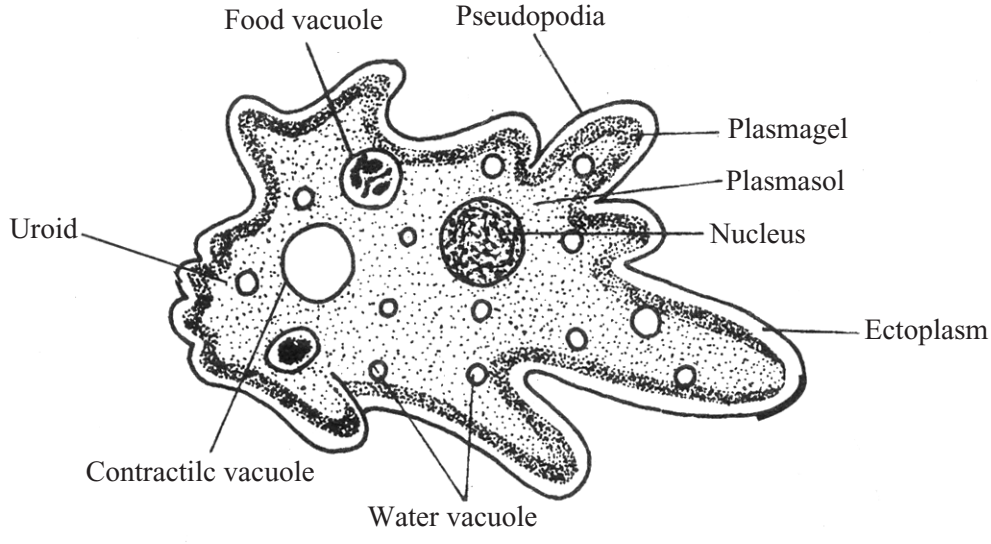


Fig. Structure of Amoeba scen under microscope

Fig: 8.1

Endoplasm: The granular portion of cytoplasm which is surrounded by the ectoplasm is known as the endoplasm. This part is semi transparent and less viscous.

The relatively thick outer part of endoplasm is called plasmagel and inner liquid part plasmasol. The granules of plasmagel generally always remain stable. But the granules present in plasmasol show active movement. The difference between plasmagel and plasmasol is .not consistent because one can be transformed to other.

Functions:

1. Endoplasm contains the organelles of the cell,
2. It assists in various physiological functions.
3. Frequent change in the density of the plasmagel and plasmasol helps in producing pseudopodia.

2. Nucleus: At the middle of the endoplasm the translucent round body seen is the nucleus. It cannot be clearly seen in the body of living Amoeba. There is only one nucleus in Amoeba., The nucleus is covered by the nuclear membrane made of protein and lipid. Inside there remain chromatin fibres and the nucleolus. The amount of nucleoplasm is scanty in the nucleus of Amoeba.

Functions:

1. Nucleus conducts the functions of the Cell body.
2. Nucleus takes active part in reproduction.

Cytoplasmic organelles:

(A) Pseudopodia: Froml any part of the body of living Amoeba finger like growth are produced continuously. These are known as pseudopodia. Pseudopods are made of plasmalema, ectoplasm and endoplasm. These are unstable outgrowths of the body and disappear soon. The anterior part of pseudopods is round and blunt.

Functions:

1. Pseudopods help in capturing the food materials.
2. They play an important role in locomotion.
3. Pseudopods indicate the anterior part of the Amoeba at the time of locomotion.

(B) Vacuoles: There are several types of vacuoles in Amoeba. Presence of the vacuoles is an important characteristic of Amoeba. The nature of formation of these vacuoles is rather simple. The vacuoles help in various physiological functions. There are three types of vacuoles in Amoeba.

1. Contractile Vacuole: In the endoplasm of Amoeba some bubble like vacuoles are seen. These vacuoles are transparent and fast growing. In the body of the living Amoeba these vacuoles can continuously be contracted or expanded, so, these have been named as contractile vacuoles.

Functions:

1. Contractile vacuoles store the watery substance of the body.
2. They-help in the removal of excess water and excretory products.
3. They help in the expulsion of carbon dioxide produced during respiration.

2. Food Vacuole: In the body of Amoeba food vacuole is formed surrounding the food material. There may be one or more of this vacuole. Size, shape and number of these depend on the size, shape and number of food materials.

Functions:

1. Food vacuoles store the food material.
2. They help in the digestion of food.
3. They have also roles in excretion of faecal materials.

3. Water vacuole: The smallest transparent, round water filled vacuole in the body of Amoeba is the water vacuole. In number it can be one or more. Water vacuole is noncontractile.

Functions: Water vacuole contains water and keeps the balance of water constant of the body. If an Amoeba is examined under high-powered microscope some organelles are seen as.

Goigi bodies: Within the'stained body of Amoeba some structures are seen which looks like small tubules and vesicles. These are known as Golgi bodies.

Function: Golgi bodies help in secretion and excretion of food.

Mitochondria: Around the contractile vacuoles some rod or dot like structures are seen. These are mitochondria.

Function: They take part in respiration and in energy generation.

Reserve food: In the endoplasm of the body of Amoeba food particles remain stored as fat and starch. When necessary these stored food materials provide nutrition to Amoeba.

Crystals: Crystal particles of different shapes and sizes are found in the body of Amoeba. It is assumed that these crystals are simply the faecal substances produced during metabolism.

Locomotion: Animals move from one place to another for food, self-defense and in search of favourable environment. Such voluntary movement of animal is known as locomotion. Amoeba move very slowly and its locomotion is irregular. Amoeba move with the help of special type of finger-like out growth known as pseudopodium (Plural-pseudopodia).

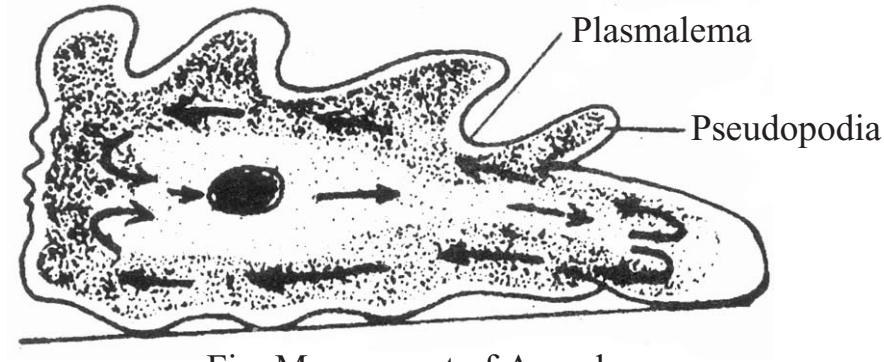


Fig. Movenment of Amoeba

Fig:8.2

The meaning of pseudopodium is "false foot"(pseudo means False and podos means foot). Amoeba at the time of locomotion, produce pseudopodia from different parts of the body and these again disappear within the body. This particular type of locomotion of Amoeba is called **Amoeboid movement.**

At the time of locomotion pseudopodia come out from any part of the body and the animal advances in that direction. Simultaneously with the formation of pseudopodia, the protoplasm of the body of Amoeba flows in that direction and with that other parts of the body move that way. In this way Amoeba advances towards its target. It can form pseudopodia at any part of its body and always move at the direction of pseudopodia. When new pseudopodia are formed on one side of the body, the old pseudopodia disappear. In this way, Amoeba moves by rolling.

Nutrition: Energy is required for physiological function. Food is the source of this energy. Nutrition is a process, By this process Amoeba performs its food ingestion, digestion, absorption, assimilation and excretion of faecal materials Body reorganization and growth also occur through this process.

Food: Amoeba takes small algae, bacteria, diatom and various micro organisms as its food.

Process of intake of food: Amoeba has no digestive system. For the intake of food there is no mouth or any other fixed organ. At the time of food intake Amoeba becomes attached to a surface and with the help of pseudopodia ingest food by various methods. It can select organic and inorganic foods. It takes about 2 to 3 minutes to ingest the food. Amoeba intakes food mainly by the following five processes:

1. Circumvallation
2. Circumfluence
3. Import
4. Invagination
5. Pinocytosis

1. Circumvallation: In this process Amoeba takes mobile and solid food substances. With the help of pseudopodia it surrounds the food material. Without touching the food material, the edges of the pseudopodia come close together and with the ectoplasmic membrane form the food vacuole along with water. When the pseudopodia surround the food material it looks like a cup. It is called "Food cup". The ectoplasm transforms into endoplasm and protects the protoplasm.

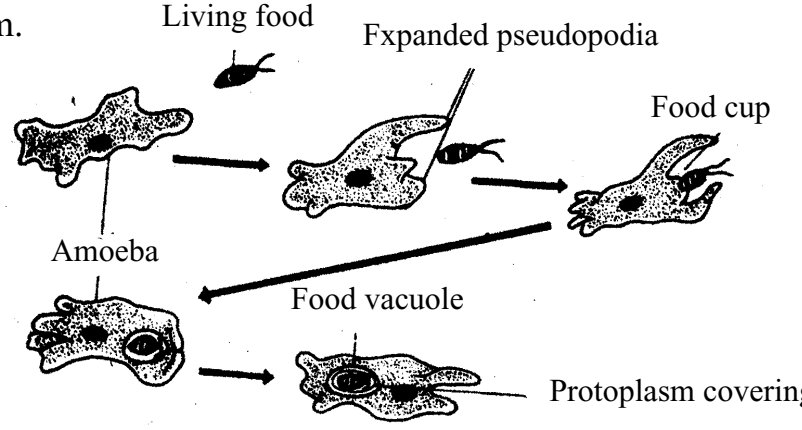


Fig. Circumvallation

Fig : 8.3

2 Circumfluence: In this process Amoeba takes immobile food materials. Immediately after coming in contact with the food material, amoeba forms a "food cup" and by stretching the pseudopodia it brings the enclosed food in direct contact with the body. In this way, Amoeba takes the food material inside the body.

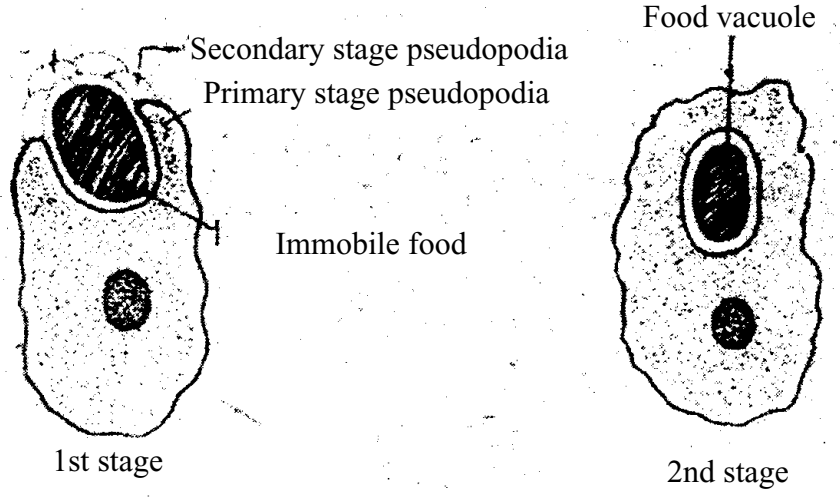


Fig : Circumfluenee

2nd stage

Fig : 8.4

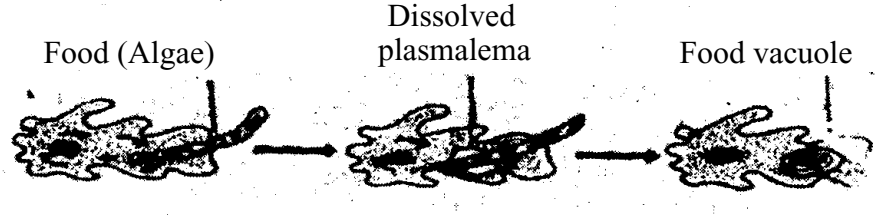


Fig : Import

Fig : 8.5

3. Import: If any food material comes on its body, by being motionless and without stretching any pseudopodia, Amoeba makes the food inactive. Then the inactive food material is taken inside the body. This is called import process.

4. Invagination: When the body of amoeba comes in contact with any food particle it secretes

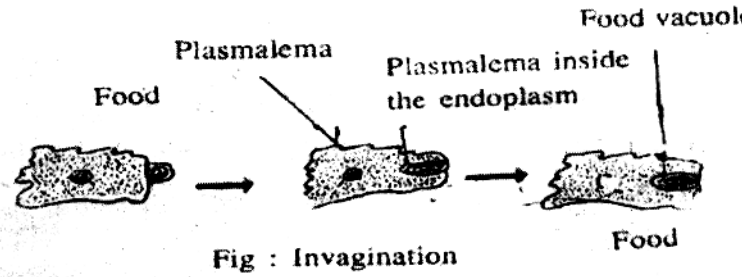


Fig: 8.6

sticky substance and fixes it with the body surface. Besides Amoeba secretes a kind of toxic juice from the body which kills the living food material. The ectoplasm along with the food enters the endoplasm in the form of a tube. Then the plasma membrane disappears and forms a food vacuole. In this process no pseudopodium is required to receive the food material.

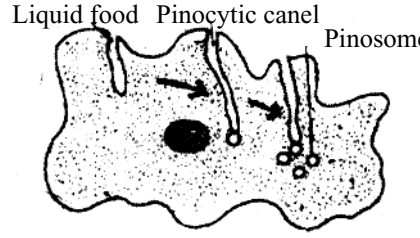


Fig. Pinocytosis

Fig: 8.7

5. Pinocytosis: In this process Amoeba takes liquid food materials. At many times in different parts of the body surface of Amoeba the plasmalema gets folded and enters into the endoplasm,"as a result of which a tube like structure is formed. This tube is called pinocytic tube. With liquid food materials the tube forms pinosome or small cavities, which later on is taken within the endoplasm.

Digestion: The cytoplasm of the body cannot absorb directly the food materials which Amoeba intakes. Reacting with various enzymes these food materials are converted into simple components for assimilation. This is digestion process.

Digestion occurs in two process-acidic and alkaline. Amoeba has no digestive system. Food is digested inside the food vacuoles. Along with the body

movements the food vacuoles are brought well inside the endoplasm. Inside. the endoplasm, hydrochloric acid from the inner membrane of the vacuoles works on the food. It kills the living food materials and makes the contents acidic. Thus the acidic process is finished. Next alkali is secreted from the neighboring cytoplasm which brings the partly digested food material into the alkali media. At this time, various types of enzymes are secreted from the endoplasm enters the food vacuole along with the food. In the digestion of food more than one enzyme participates. It is however not known definitely which enzymes take part and what their order is. It is assumed that there is a possibility of the presence of protease, lipase and carbohydrates enzymes. The enzyme named protease is secreted when food remains in an acidic medium inside the food vacuole. It converts the complex protein food into simple peptides.

When the food vacuole becomes alkaline, the enzyme peptidase becomes active. Due to this reaction peptide is transformed into amino acids. Lipase transforms the fat portion of the food into fatty acid and glycerol. The enzyme amylase acts on the carbohydrate part of the food and transforms it into glucose. As the digestion process continues, the form of the food material is gradually changed.

Absorption: Through the actions of enzymes complex food materials are converted into simple materials. These simple food components inside the food vacuole are absorbed by the endoplasm.

Egestion : Inside the endoplasm of amoeba, the digested food is absorbed and the remainder is stored in the food vacuole. The food vacuole gradually approaches to the cell membrane of the body opposite to pseudopodia. At one stage the contents of the vacuole are thrown outside the body through the plasma membrane.

Respiration: There is no definite structure for respiration in Amoeba. They respire through aerobic process. In absence of any definite organ, there respiration is accomplished by the plasmalema. Respiratory work mainly occurs through diffusion. The amount of dissolved oxygen of water where Amoeba lives is higher than the oxygen content of cytoplasm. As a result, oxygen can easily enter the body of Amoeba by diffusion process. Oxygen is

required for respiration. To meet this requirement diffusion continuously occurs in the body of Amoeba. Carbon dioxide produced due to chemical reaction, is eliminated from the body in the same manner. This process can easily happen as the amount of carbon dioxide is more in the cytoplasm of Amoeba than in the water.

Excretion: The process by which the nitrogenous waste materials are collected and removed from the animal body is called excretion. The excretory material of Amoeba is mainly ammonia. In dissolved condition these excretory materials are discharged outside through the plasmalema by the process of diffusion.

Reproduction: Reproduction is one of the most important characteristics of organisms. The biological process by which an organism, to check its extinction, either singly or with the help of the opposite sex of the same species, produces progeny is called reproduction. Amoeba mainly produces its progeny by asexual process. Asexual reproduction process is of two types, **Binary fission** and **Sporulation.**

1. Binary fission: Growth of the body is an important characteristic of organisms. With suitable environment and proper food, the amount of cytoplasm of the body of Amoeba increases also with the volume of body. The growth of the body reaches to such an extent that its cytoplasm cannot perform the metabolic activities smoothly. At this stage Amoeba starts to multiply by binary fission. In this process one mother Amoeba divides into two daughter Amoebas.

The process is described below:

At the beginning of the division, Amoeba withdraws its pseudopodia. The body then takes a circular shape. Its nuclear membrane disappears and the nucleus becomes larger and conspicuous. Gradually the nucleus takes a long shape and the mid-section contracts. At this time the endoplasm around nucleus becomes slightly loose. The chromosomes situated in the nucleus divide longitudinally. The two daughter chromosomes move towards the two opposite poles and the mid-section becomes narrow. As a result the nucleus takes the shape of a dumbell.

The cytoplasm then deposits surrounding the nucleus. About the same time plasmalema being folded enters towards the interior. Next the nucleus is divided into two parts and the plasmalema folds meet together. As a result the mother *Amoeba* transforms into two daughter *Amoeba.* In the meantime the cytoplasm surrounding the nucleus which is being divided approaches the fold. At this stage, the nucleus is divided into two parts to form two

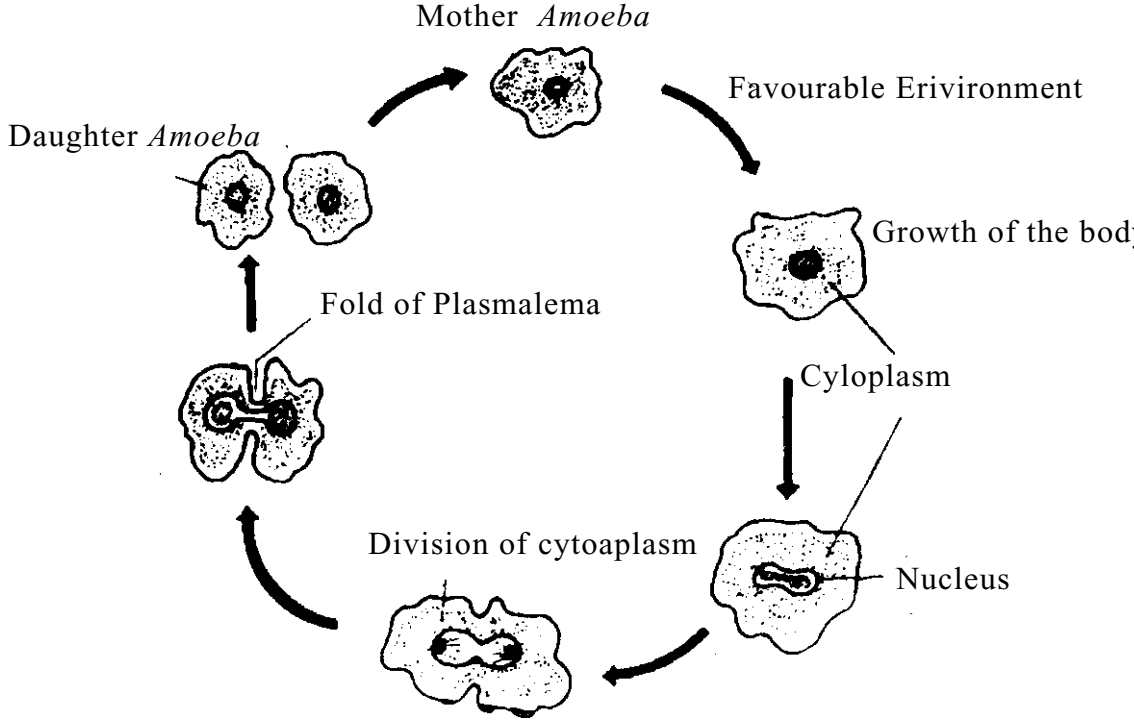


Fig. 8.8 Binary fission of *Amoeba*

daughter nuclei. Finally the cytoplasm surrounds each nucleus. Next the plasmalema is formed outside the cytoplasm. As a result, the mother *Amoeba* becomes transformed into two new small Amoebas. Then these new daughter Amoebas begin their own free life.

To survive under unfavourable environment *Amoeba* produces a thick wall around its body. This is called cyst wall. This stage is known as cystic stage.

2. Sporulation: Surrounded by an cyst wall in unfavourable condition, the nucleus of *Amoeba* is divided by multiple divisions and forms numerous spores. This process is known as sporulation.

In this process first nuclear membrane of *Amoeba* disappears and the nucleuos is divided into several chromatin segments by repeated divisions. They remain in free state inside the endoplasm. These chromatin parts then become encloses by nuclear membrane.

Later on cytoplasm surrounds these small parts and finally plasmalemma is formed around them. Next the spore membrane is formed outside the plasmalema. In this way in the body of an Amoeba more than hundred spores may be formed. Breaking the plasmalema, next these spores come outside. In a favorable condition, daughter *Amoeba* comes out from the spores.

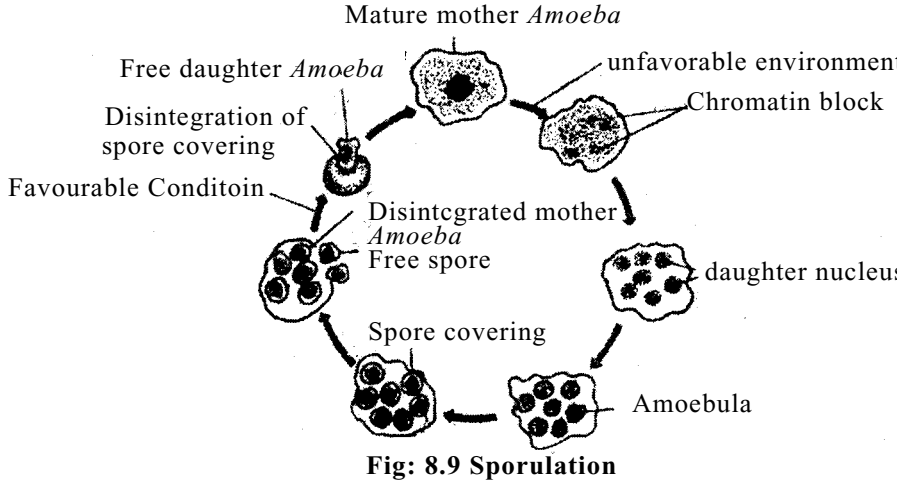
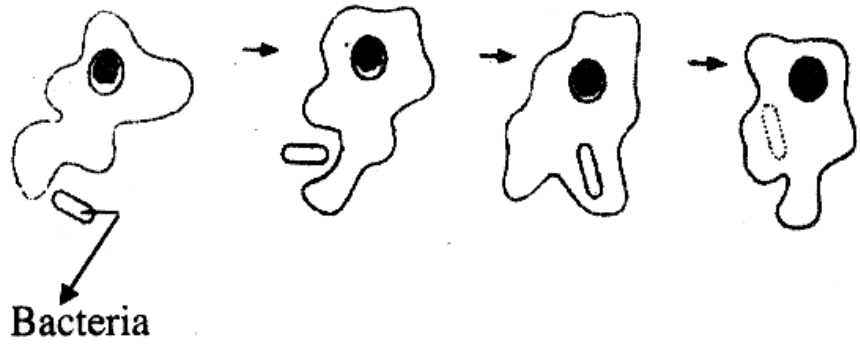


Fig: 8.9 Sporulation

Exercise

Multiple choice questions :

1. What indicates in the following motion picture?



a. Process of ingestion of food in *Amoeba.*

b. Process of Locomotion in *Amoeba.*

c. Process of Locomotion in Leucocytes.

d. Germ destroying process of Erythocyte.

2. Which one is applicable in case of respiration in *Amoeba?*

i. Respiration is done aerobically.

ii. Plasmalema worked as respiratory organ.

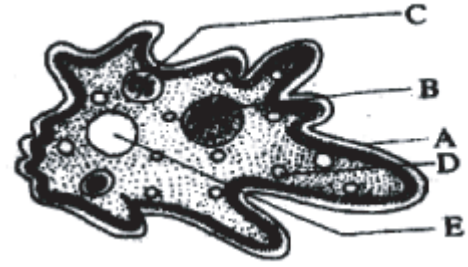
ii. Respiratory work occurs through diffusion.

Which one of the following is correct?

a. i & ii b. ii & iii

c. i & iii d. i, ii & iii

Answer the question Nos. 3 & 4 in support of the following diagram.



3. Which part of the diagram is temporary?

a. A b. B

c. C d. D

4. In the diagram the part E-

i. Can contract

ii. Helps in the removal of excretory products

iii. Helps in the digestion of food.

Which one of the following of is correct?

a. i & ii b. ii & iii

c. i & iii d. i, ii & iii

Creative questions

1. Reproduction is one of the most important characteristics of organisms. Different organisms perform their reproduction in different process. *Amoeba* transforms into two Amoeba by the process of binary fission Again under unfavorable condition produce cyst for the survival and numerous spores are produced within the cyst. In the favourable condition these lead an independent life as *Amoeba.*

A process by which amoeba reproduced is shown below.

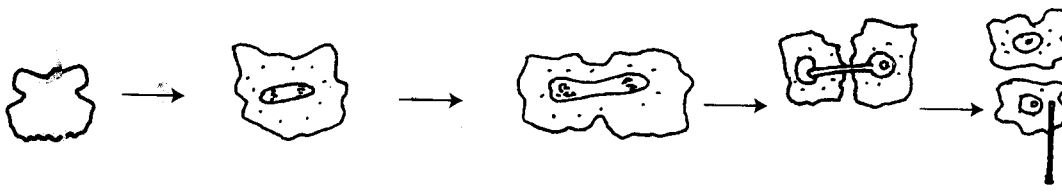


Fig-1 Fig-2 Fig-3 Fig-4 Fig-5

a. What is Amoeba?

b. What type of cell division occurs during the binary fission of *Amoeba* and why?

c. Which one is mother and which one is daughter *Amoeba* between the Amoeba produced in the diagram no. 5-explain it.

d. Analyse your views about the death and immortal condition of *Amoeba* according to the above facts.

ROUND WORM

Roundworm is found throughout the world. Ascaris lumbricoides is generally known as the roundworm. They live as an endoparasite in the intestine of man. Compared to other worms the roundworms are bigger in size and tubular in form, like an earthworm. Eggs of the worm enter the human body with air, water, green fruits and vegetables. Man is the only host of the round worms.

Habitat: Roundworm is widespread throughout the world. Its outbreak is seen in Bangladesh, India, China, Korea and Philippine etc.

External morphology: A live roundworm is generally dull white in colour. It looks tubular like the earthworm. In the body of roundworm, we can see four longitudinal lines, one dorsal, one ventral and two laterals in position. In length, the female roundworm can be up to 20-25 cm while the male is up to 15-20 cm. Mouth is situated at the anterior end of the body. There are three lips on the mouth. Of these one is on the upper side and the other two on the two sides of the mouth cavity. To discharge excretory materials, there is a cloacal aperture or anus on the lower side of the posterior end of the body. Reproductive cells are discharged through this cloacal aperture in male worm. Two spine-like structures come out from the cloacal aperture, of the male worm. These are called penial setae. The cloacal and genital apertures are separate for female worm. The genital aperture of the female is situated on the ventral side of the anterior end of the body.

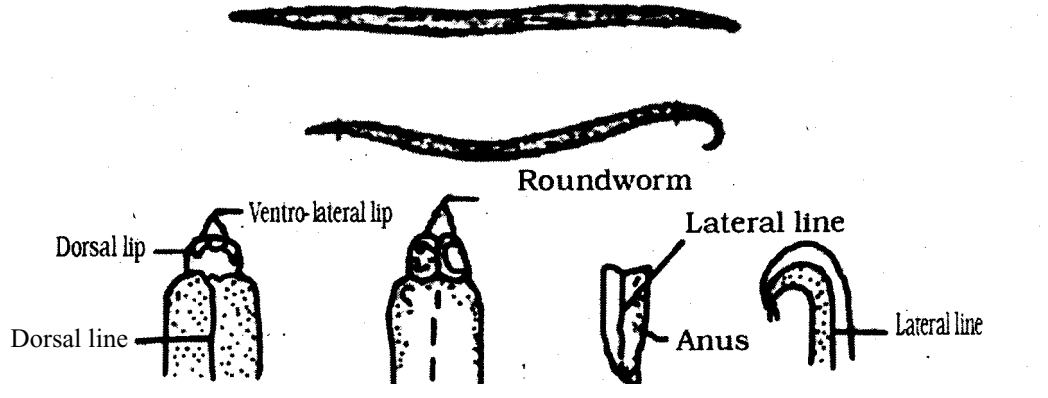


Fig. 8.10 : Anterior end of round worm and posterior and of male and female worm

Difference between the male and female roundworms

Male worm	Female worm
1. Male worm is small in size	1. Female worm is larger in size than male worm.
2. The posterior end of male worm is pointed and bend.	2. The end behind the tail of femaleworm is strait and blunt.
3. Its cloacal and genital apertures are not separate.	3. It has separate cloacal and genital apertures.
4. Excretory materials and reproductive cells are discharged through the cloacal aperture of the male worm.	4. In the female worm the excretory products are discharged through the cloacal aperture and the productive cells through the genital aperture.
5. There are spines like penial setae behind the cloacal aperture.	5. There is no penial setae in female worm.

Digestive system: The structure of the digestive system of round worm is very simple. The Pharynx alimentary canal is formed of mouth aperture, buccal cavity, pharynx and intestine. Mouth is situated at the anterior end of the body. Mouth aperture opens into the buccal cavity. The pharynx is situated behind the buccal cavity. The pharynx is somewhat bulk muscular and divided into three chambers. With the help of the pharynx the roundworm sucks food materials from the intestine of its host-body and gets nutrition. Behind the pharynx is situated the narrow intestine. Posteriorly the intestine joins the rectum. The rectum opens outside through the cloacal aperture.

Round worm has no digestive gland. As they directly absorb simple liquid food from the body of the host they do not require digesting it further.

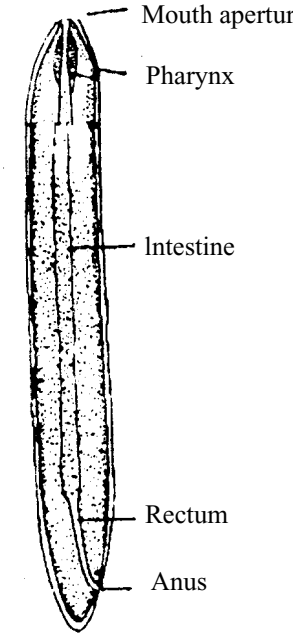


Fig : 8.11 Digestive system of Round worm.

Parasite : An organism that lives permanently or temporarily on or inside the body of another organism and depends fully or partly on the host organism for its nutrition is called a parasite.

Characteristics of Parasites :

1. Their Physiological systems are of simple type.
2. The external body covering of the endoparasites is firm but semipermeable.
3. The parasites have higher reproductive capacity.

On the basis of the location of parasites on the host body, the parasites are of two types, **Ectoparasite** and **Endoparasite.**

1. Ectoparasite : They live on the outer side of the host body, e.g. Leech.

2. Endoparasite : They live inside the host body, e.g. malarial parasite.

Parasite and parasitism : We have learnt earlier that the round worm lives as a parasite inside the host body and gets nourishment by taking digested food materials from he intestine of its host. So it is called an endoparasite. Round worm gets shelter and nutrition from the host body, as a result of which the host suffers from anemia and malnutrition. The relationship that is formed between the host and the parasite is known as parasitism.

Excretory System : Excretion is the process of discharging unwanted nitrogenous waste materials from the body. The structure of the excretory system of round worm is very simple. The system consists of two-long tubes at the two sides of the body against the lateral lines. Meeting together at the other end, the two tubes open outside through the excretory pore or cloacal aperture.

Reproductive System : The round worm is a unisexual animal. Generally the male worm is smaller in size than the female and the posterior part of its body is bent.

Male Reproductive System : The male reproductive system consists of a testis, sperm duct, seminal vesicle and an ejaculatory duct. The testis is formed like a coil and occupies a greater portion of the body. The sperm duct is located behind and the bulky posterior part is the seminal vesicle. It later opens into cloacal aperture. They have a pair of penial setae. Male round worm discharges sperms through the cloacal aperture.

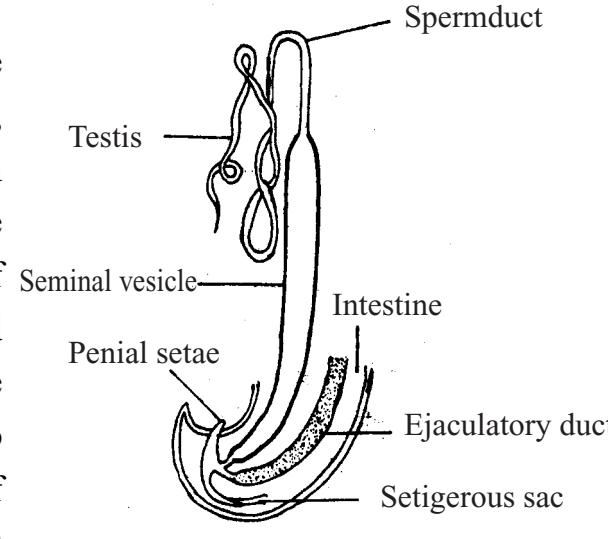


Fig. 8.12 : Male Reproductive system

Female Reproductive System : The Female round worm is larger in size than the male. The female reproductive system consists of two ovaries, two uteri and one vagina. These organs, are situated in the posterior half of the body of the worm. The ovaries are coiled and narrow. Eggs are produced at the. posterior part of the ovary. The oviducts are connected with the ovary. The eggs produced in the ovaries pass to these ducts. A part of the oviduct enlarges to form a seminal receptacle. Here the sperms are stored. The oviduct meets the uterus. The two uteri uniting together form the tubular vagina. The vagina opens outside. through the female genital aperture.

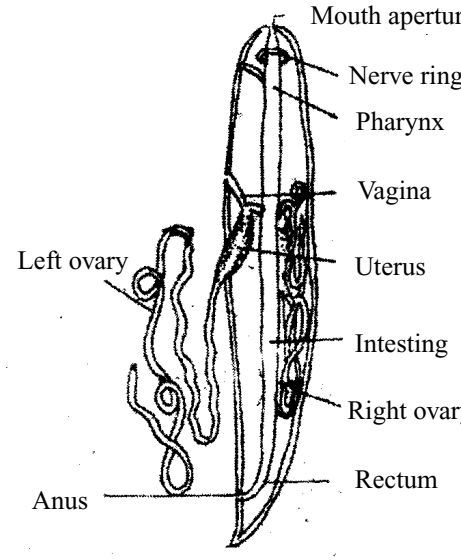


Fig. 8.13 : Female reproductive system.

Life cycle : The ovum and sperms of the round worm meet together at the upper side of the uterus. After fertilization the zygote or fertilized egg is covered by a wall made of chitin. The eggs of roundworm are very small and elongated. Along with the faeces of the host these eggs come outside of the host body. Embryo formation begins inside the fertilized egg when it remains within the shell. The primary larval stage of the roundworm is called Rhabditiform larva.

Infection : No intermediate host is required for the infection of round worm. Eggs enter directly into the body of the new host along with contaminated air, food and drinks.

Hatching of embryo : Hatching of embryo usually occurs within two hours after the egg reaches the intestine through stomach of the host body.

Transformation to adulthood : After the entry of the egg in the intestine of the host, the shell is dissolved by the intestinal juice of the host and the larva is freed from the shell. They pierce the intestinal epithelium and enter into the lymphatic vessels or the blood capillaries. They travel to various organs along with the blood circulation: At this condition, for sometime, the larvae are

entrapped in the lungs. Ascending the respiratory tube the larvae reach to the pharynx. Due to their presence the throat of the host irritates and this may cause coughing. Along with cough the larvae comes up to the throat. They again reach the intestine if one swallows the cough. The larvae once again change their shell in the intestine. Here ends their migratory life. When inside the intestine, they are nutrited by taking digested food juice from the host. Within a few days the larva changes into a full worm. In Bangladesh the incidence of infection of this worm is very high. Most of the children of our country suffer from this infection. A single host may contain 100 to 400 worms. They produce **Ascariasis** disease in children. When intensity of infection is high, the illness may take a serious turn. An affected person shows the following symptoms:

1. The belly of the children becomes swelled up.
2. When the number of worms increases in the intestine, vomiting tendency and loss of appetite are observed. In the final stage worms may come out with vomit.
3. Indigestion and physical weakness are seen.
4. Balance between acid and alkali is lost in the intestine.
5. Due to infection with round worm the patient feels pain in the belly and anemia is developed.

Prevention: In the mean time, we have known that most of the children of our country get infected with round worms. As a result, these children suffer from anemia and malnutrition. Following measures should be taken if one wants to get-rid of the round worms:

1. Stop the habit of discharging faecal matters at open places and use sanitary latrines.
2. Take green fruits after thorough washing with pure water.
3. Keep your hands clean and clip your nails.
4. Before taking food and after using latrine wash your hands well.
5. Abstain from taking cold and rotten food.
6. Get rid of the worms by taking medicine after consulting a physician.

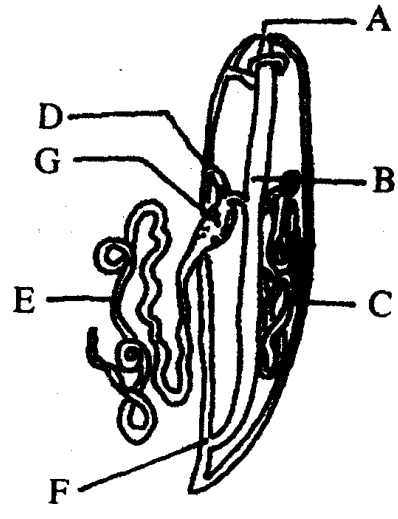
ROUND WORM
Exercise

Multiple choice questions

1. **Which statement is correct in case of host and parasite relationship?**
   a. Host lives in the body of the parasite.
   b. The host supplies the complete nutrition of parasite.
   c. Parasite partly helps the host.
   d. The life times of parasite & host are equal.
2. **Which one is applicable in case of excretory system of round worm?**
   i. The excretory canal is situated at the two sides of the body in each lateral line.
   ii. This system consists of two long tubes only.
   iii. The two tubes at the anterior part meet together open by an excretory pore.

Which one of the following is correct?

a. i & ii b. i & iii
c. ii & iii d. i, ii & iii



Fig

Answer to the question no 3 & 4 on the basis of the above diagram.

3. Which labeIled parts in the diagram constitute the female reproductive system of round worm?

a) A, B, C, D b) B, C, D, F

c) C, E, F, G d) C, D, E, G

4. The gamete discharges through-

i. labelledA

ii. hlabelled D

iii. labelled F

Which one of the following is correct

a. i b. ii

c. iii d. ii & iii

Creative questions

Rita is a six year old girl. Her body is weak, belly is bigger in comparison with the body. She often feels pain in the belly. In this condition Rita's father took her to a doctor. After diagnosis doctor said, Rita was attacked with Ascariasis disease due to round worm endoparasite. He further said that human beings are the only host of round worm and it is more harmful than external parasite.

a) What is another name of round worm?

b) Explain the saying 'human beings are the only host of Round worm'.

c) Describe how the internal parasite is spread in the Rita's body.

d) The internal parasite is more harmful than the external parasite-analyse.

TOAD

Toad is an amphibian animal. Among the vertebrate animals the amphibians live in water at the first stage of their life, respire by gills and when mature, live on land and respire with the help of lungs and integument. For this reason they are known as amphibian animal. The scientific name of Toad is ***Bufo melanostictus.***

Following are the characteristics of amphibian animals:

1. They are cold blooded animals.
2. The integument is rough and the integumentary glands keep the integument moist.
3. They have two pairs of appendages and a three-chambered heart.
4. Females lay eggs and the fertilization takes place outside the body.
5. At the primary stage of life cycle generally tadpole larva is seen.
6. At the tadpole stage they respire with gills and when mature with lungs.
7. In the fore limb there are four and in the hind limb there are five fingers.

Habitat: The toad lives in shady and dark moist places, corners of the house, in the bushes or in the stacks of bricks or in pools. In Bangladesh frogs and toads are more commonly seen. Besides there is another kind of frog called "Tree frog".

Habit: Toad is cold-blooded animal. During the daytime they hide in the dark and moist places. They come out at night in search of food and eat live worms, insects, earthworms and even snails. Temperature of their body varies along with that of the environment. They cannot stay in dry and sunny environments. For this reason, during winter we cannot feel the presence of toads. During this time, they lead an inactive life in the holes or crevice of trees. They do not even come out to have food. They get energy from the reserved fatty materials inside the body. This mode of inactive life of toad during winter is called **hibernation.**

At the beginning of the summer season, toads come out of the holes. Rainy period is the reproductive season of toad. To attract the male for sexual contact, the toad calls the female by making croaking sounds. Most part of their life cycle is spent on land. During breeding time they have to come to water.

Toad hops around when they moves on land and swims when in water. The body colour of toad is grey, as a result of which, it can hide easily at the corner of the houses, in crevices of trees, and under stack of bricks etc.

External morphology of Toad :

Toad is an ugly animal. Its skin is grey coloured with warts. Toad is 10-13 cm long and 7 cm wide. Its body can be divided longitudinally into two similar parts. So they are bilaterally symmetrical.

The body of toad can be divided into two regions head and trunk. It has no neck. A fully-grown toad has no tail and the fingers of the feet are clawless.

Head : The front portion of the head of toad is blunt and the posterior portion wide. At the front end of the head there is a wide mouth situated transversely. There are two jaws above and below the mouth aperture. There are no teeth in the jaw. At the upper side of the mouth towards the front end of the head there are two apertures provided with thin valves. These apertures are the nasal apertures. Two round eyes are situated at the posterior part of the nasal apertures. In the eye of toad there are three eyelids, upper eyelid, lower eyelid and a transparent thin membrane. This thin membrane is called nictitating membrane. There are no hairs in the eyelids of toad, nictitating membrane protects the eye from dust and keeps it moist.

At the back of each eye there is situated a round, smooth membrane they are tympanum. At the back of the ears there are two glands on the two sides. These are called parotid glands. From these glands toxic juices are secreted. Toad utilizes this secretion for self-defense. At the junction of head and trunk of male toad, that is, on the ventral side of the mouth cavity, there is a blackish sac. It is called vocal sac. Vocal sac takes part in the production of sound.

Trunk : The trunk of the toad is small and the thorax and abdomen cannot be marked separately. The trunk is wider and bulkier than the head. They have a pair of legs in front and a pair at the back of the trunk. Front pair of legs is called forelimbs and the posterior pair is called hind limbs. As the base of the fingers of their legs is partly joined together by a thin membrane, they are called webbed feet. In the forelimb of toad there are four and in the hind limb there are five clawless fingers.

During the breeding season at the lower side of the forelimb of the male toad a kind of pad is seen. It is called nuptial pad. At the end of the posterior there is an aperture. This aperture is known as cloacal aperture, through which faeces, urine and reproductive cells are discharged outside. Observing the external characteristics, it is possible to separate the female toads from the male ones. During the breeding season these differences are more obvious.

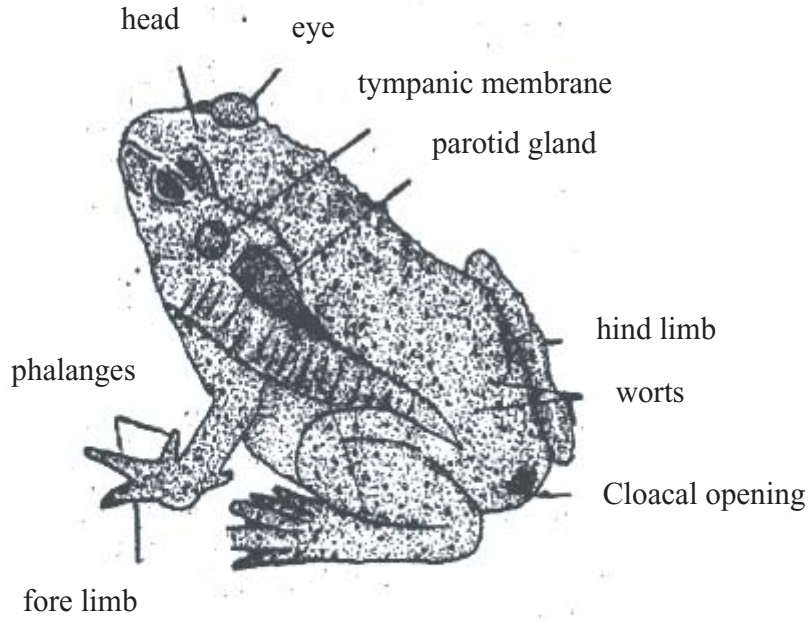


Fig. 8.14 : External characterstics of Toad

Comparison of male and female Toads

Male Toad	Female Toad
1. When matured, the male toad is smaller in size than the female toad.	1. When matured, the female toad is bigger in size than the male toad.
2. The abdomen of the male toad is narrow and elongated.	2. During the breeding season the abdomen of the female toad becomes much wider
3. The male toad has vocal sac.	3. The female toad lacks the vocal sac.
4. During the breeding season the male toad develops a nuptial pad on the lower side of the forelimb.	4. The female toad has no nuptial pad.

In our country mainly two types of toad are available; One is the toad and the other is frog. They both feed on insects, worms and other small living creatures, Many of the insects, worms and the living creatures harm the crops. Toads eat them to benefit men. The differences between these two types of toads are given in the following table.

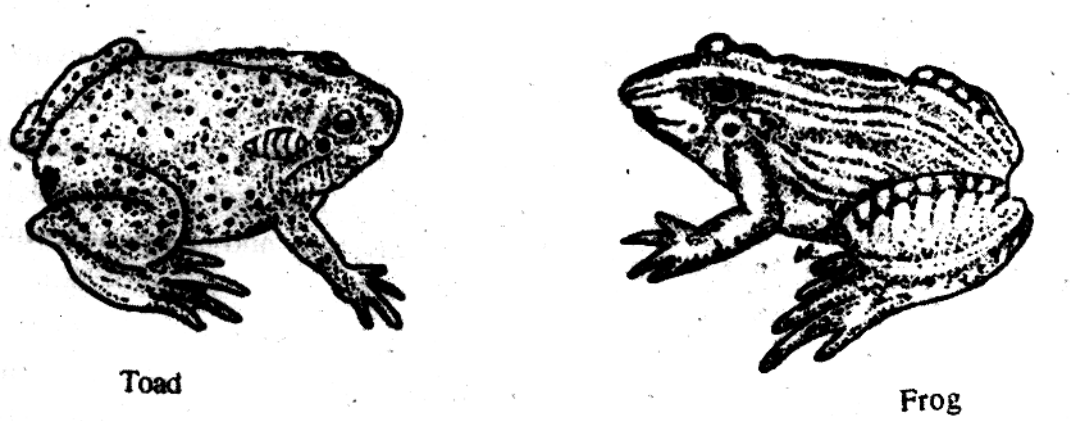


Fig. 8.15 : Toad and Frog

Differences between Toad and Frog	
Toad	**Frog**
1. They live in the corners of the houses, moist places, crevices of the trees and bushes, and dark places. During breeding season they live in water.	1. Frogs live in aquatic environments, In search of food they sometimes may come on land.
2. The colour of the skin is grey.	2. The skin is smooth, with green and brown stripes.
3. Integument is rough, warty, and dry but it remains moist due to the secretion of the integumentary lands.	3. Integument , is moist and smooth. There is no wart gland in the integument.
4. Behind the ear drum there are conspicuous parotid gands.	4. Frogs do not have any parotid gland.
5. Head is blunt and semicircle.	5. Head is pointed and triangular.
6. Fingers of hind limb is partly webbed.	6. Hind limb is fully webbed.
7. Limbs are comparatively small. They can jump shorter distance.	7. Limbs are stronger and they can jump longer distance.
8. Toad is comparatively small in size.	8. Frog is comparatively large in size.
9. Toad has no teeth in jaws.	9. Frog has teeth in jaws.
10. Toad is a nocturnal animal.	10. Frog is active during day time.

Skeletal system of Toad : The system which gives the body its structure, a definite shape and protects the soft organs (like heart and lungs) is called skeletal system. The skeletal system of toad is mainly formed by the combination of bones and cartilages. Bones of the skeleton remain attached with one another by various muscles and ligaments. The skeleton of toad is mainly divided into two categories, **Axial skeleton** and **Appendicular skeleton.**

Axial skeleton : The axial skeleton is situated along the mid dorsal line of the body and is formed by the combination of skull and vertebral column. The axial skeleton is extended from the anterior end of the head to the posterior end of the body.

Skull : The part of the axial skeleton which forms the frame of the head and protects the brain is called skull. It consists of various small and large bones. A skull has different parts, such as cranium, upper jaw, lower jaw, nasal, capsule eye cavity, ear cavity, hyoid apparatus etc.

The small cavity at the middle of the head surrounded by small bones, in which the brain lies, is called the cranium. At the posterior part of the cranium there is a big aperture called foramen magnum. Through this opening the spinal cord comes out from the brain and enters the vertebral column. At the floor of the buccal cavity of the toad, there lies a plate like structure made of cartilage called hyoid apparatus. Upper and lower jaws surround the mouth aperture. The upper jaw is firmly attached with the cranium but the lower jaw can move up and down. In the wall of the cranium there are several paired pores. Through these pores the cranial nerves from the brain comes out.

Functions of skeleton : The skeleton does the following functions:

a. It gives structure and firmness to the body- The skeleton forms the hard structure of the body and gives it a definite shape.

b. It protects soft organs - The skeleton protects the important soft organs of the body such as, heart, lungs, brain, etc.

c. It stores fat and produces blood corpuscles- White bone marrow stores the fat and red bone marrow produces the red blood corpuscles.

d. It helps in the attachment of muscles- Skeleton forms the surface for the attachment of muscles, muscle ligaments and mesenteries and helps in keeping the various organs of the body in definite positions.

e. It carries the weight of the body and assists in locomotion-The coordination of skeleton an skeletal muscles helps in carrying the weight and movement of the body.

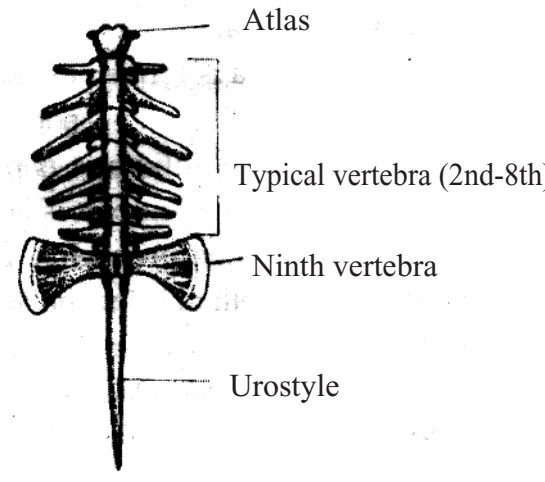


Fig:8.16 Vertebral column of Toad

Vertebral column: The vertebral column is extended from back of the head till the posterior end of the body of the toad. It is also called the backbone. Vertebral column surrounds the spinal cord. The vertebral column of the toad is formed by nine ring like bones called **Vertebrae** and a long bone called Urostyle. The structure of the first and ninth vertebra of the vertebral column is different. The structure of the second to eight vertebrae are almost alike.

Atlas: The first vertebra of the vertebral column is called the atlas. It is connected with the skull in front and the second vertebra (at the posterior). The atlas looks like a ring. It has no transverse process, neural spine and prezygapophysis. Its neural canal is comparatively bigger in size. Atlas meets the next vertebra with the help of post zygapophysis.

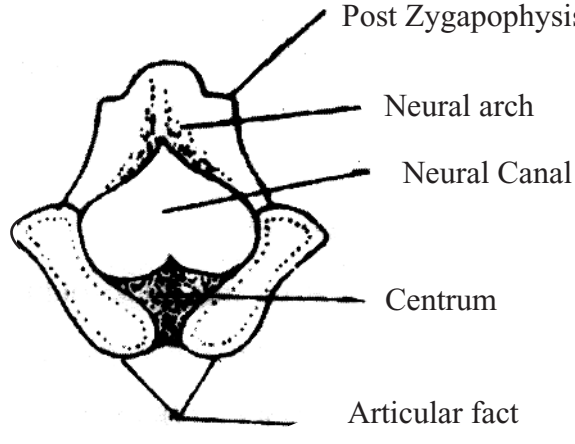


Fig. 8.17 Atlas

Typical vertebra:

An ideal vertebra is formed of centrum, neural canal, neural arch, neural spine, transverse process, pre-zygapophysis, and post-zygapophysis.

a. Centrum: This solid part is present in the middle of the ventral surface of every vertebra. Its front part is concave and the back part is convex. This type of centrum is called **procoelus**. Due to this structure, the vertebrae can easily be attached to both in front and at the back.

b. Neural canal: The cavity surrounded by the neural arch is called neural canal. The spinal cord Passes backward through this.

c. Neural arch: The tip two bones generating from the two sides of the dorsal surface of the centrum forms a circular ring. This ring is called the neural arch, which surrounds the spinal cord.

d. Neural spine: Two neural arches joining together form a spine like process. This spine like part is the neural spine, muscles attaching with it gives the body firmness.

e. Transverse process: From the side of every neural arch, a long bone extends transversely. This bone is known as transverse process. Different muscles are attached with the process.

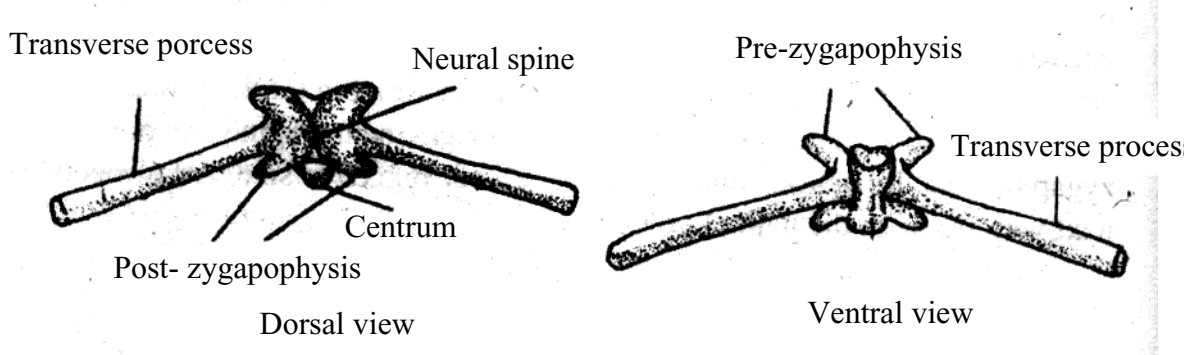


Fig : 8.18 A Typical vartebra.

f. Pre-zygapophysis: The up looking spoon like thick fold that comes out from the front of every neural arch is called pre-zygapophysis. It gives the body firmness by attaching itself with the two post-zygapophysis of the vertebra in front.

g. Postzygapophysis: The two down looking spoon like folds that come out from the back of every neural arch are called posti-zygapophyss. They remain attached with the pre-zygapophyses of the posterior vertebra. As a result the attachment of the vertebrae becomes firm.

Ninth vertebra: The ninth vertebra is also called the sacral vertebra. It is bigger in size and hard. Transverse process of this vertebra is hard, flat and wide. This feature of the ninth vertebra enables it to be differentiated from other vertebrae very easily. The posterior end of this vertebra has been transformed into two convex parts. The Urostyle is attached with these two convex parts. The transverse process attaching with the Ilium of the pelvic girdle bears their weight.

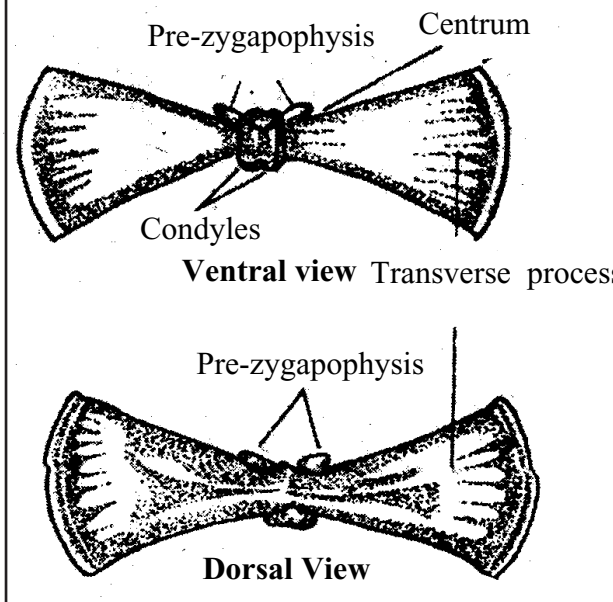


Fig : 8.19 Ninth vertebra.

Urostyle: Urostyle is a long rod shaped bone situated at the back of the ninth vertebra. Several vertebrae are fused together to form this structure. It is situated at the end of the vertebral column in between the two iliums. On the dorsal side of this bone there is a knife-like ridge called neural crest, and the bone is gradually narrowed towards the back. The concave part of the front end of the urostyle remains attached with the convex part of the ninth vertebra. There is very fine neural canal between this concave facet and neural crest.

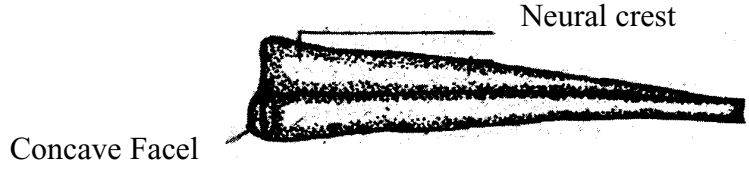


Fig : 8.20 Urostyle.

Functions of vertebral column:

1. The vertebral column by giving a definite shape forms to the frame of the body.
2. It surrounds the spinal cord and protects it.
3. Being attached with the pelvic girdle it assists in bearing the weight of the body and its movement.
4. Being attached with the transverse process and neural arches of the muscles, vertebrate make the movement smoother.

Appendicular skeleton: The appendicular skeleton of toad is divided into two regions, one is **Girdle region** and the other is **Limb region.**

In the body of toad there are two girdles. The fore limb is attached with the anterior girdle or the pectoral girdle. Similarly the hind limb is attached with the posterior girdle or the pelvic girdle.

Pectoral girdle: The pectoral girdle almost encircles the anterior part of the trunk region of the body. It occupies almost the whole interior region of the body excepting the midline of the dorsal side. This part is covered with skin and muscle. The pectoral girdle of toad can be divided into two equal or symmetrical parts. Each symmetrical part is formed with the combination of bones and cartilages. This girdle remains attached with the backbones by muscles as a result of which by keeping it in a proper place, completion of different types of work becomes very easy.

Functions:

1. Pectoral girdle holds the fore limb.
2. It protects the soft organs of the body such as lungs, heart etc.

We have known earlier that the pectoral girdle can be divided into two similar parts. Each part consists of the following components:

a. Supra-scapula: It is a wide, plate like cartilage. One end of the supra - scapula is joined with the scapula and the other end remains free. The free end is attached with the backbone by muscles and ligaments.

b. Scapula: Scapula is a narrow hard long bone. One end of this bone is attached with the supra-scapula and the other with the **clavicle** and **coracoid.**

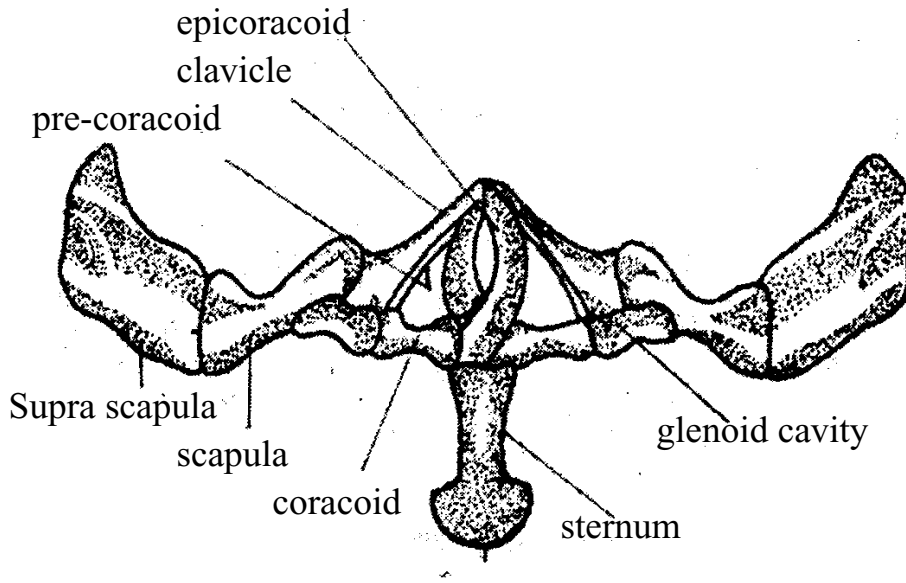


Fig:8.21 Pectoral girdle of toad

c. Clavicle: Clavicle is a narrow and long bone. It is also called collar bone. This bone is situated in front of the scapula and it covers the pre-coracoid. Its one end takes part in the formation of scapula and the other end in the formation of glenoid cavity.

d. Coracoid: This bone is hard bulky and thick. One end of the coracoid, which is attached with the scapula, forms the glenoid cavity and the other end is joined with the precoracoid.

e. Precoracoid: It is an axe-like part formed from a long and narrow cartilage. Precoracoid is situated at the bottom and side of the clavicle and remains enclosed by the clavicle.

f. Epicoracoid: It is a bent cartilage whose one end is joined with the coracoid and the other end with the precoracoid.

g. Glenoid cavity: In every half of the pectoral girdle there is a cavity in between the junction of scapula, coracoid and clavicle. This cavity is known as glenoid cavity.

h. Sternum: At the ventral side of the body there is an expanded part made of cartilage behind the coracoid of the two halves of the pectoral girdle, it is called the sternum. The posterior end of the sternum is rounded in toad.

Fore limb

The fore limb of toad is formed by the combination of some small and large, bones. The description of these bones is given below:

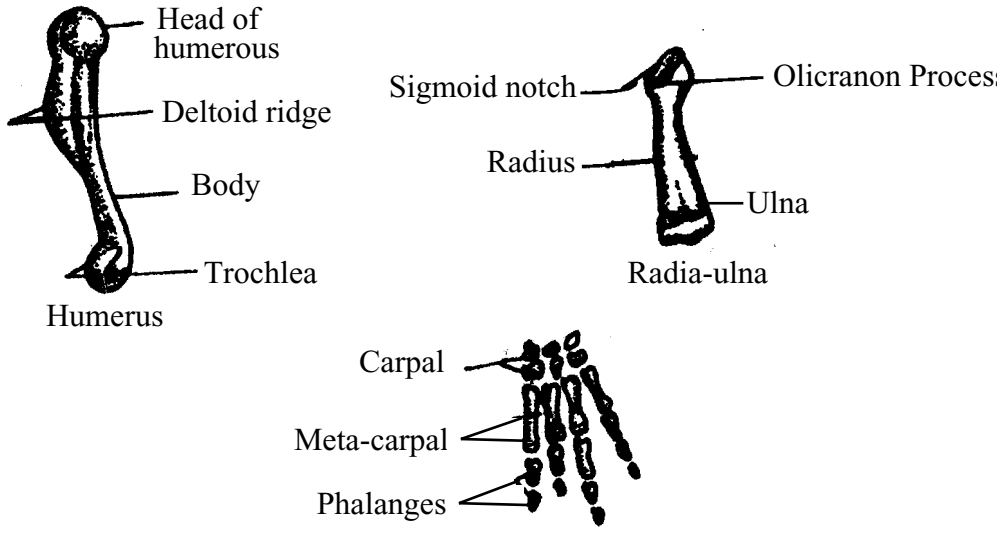


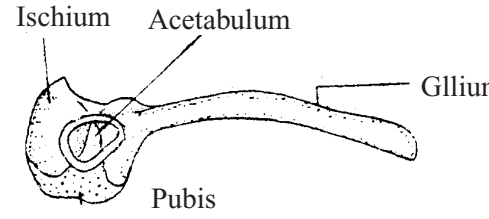
Fig:8.22 Bones of the Forelimb

a. Humerus: The upper most bone of the fore limb is called the humerus. It is long and slightly bended. Both ends of the bone are stout. A ridge called the deltoid ridge is found on the upper of the humerus. The head of the anterior part of the bone is round. With this head, the humerus remains attached with the glenoid cavity of the pectoral girdle. At the other ends of the humerus, lies a rounded bone mass. It is known as trochlear process. It helps in attaching itself with the next bone.

b. Radia-ulna: The middle bone of the fore limb of toad is the radia-ulna. Actually this bone is formed by fusion of two bones the radius and the ulna. At the junction of the two bones there lies a longitudinal mark. The bone in the inner side is known as radius and the one located outer side is known as the ulna. In front of this bone there is a carve known as sigmoid notch. The trochlear of humerus is jointed there. Near the notch there is a projection called olecranon process.

c. Carpal: The carpal is formed by the six small bones of the wrist. With three bones in each row, a total of six bones are arranged in two rows. The posterior end of radia-ulna is joined with the carpals.

Metacarpal: The palm is formed with four narrow bones. These bones are called metacarpals. They bear the weight of the palm of forelimb and remain attached with the phalanges.



e. Phalanges: In the forelimbs of toad, there are four fingers. The finger-bones are called phalanges. There are two phalanges on the first and second. fingers and three on the third and fourth fingers.

Pelvic girdle: The pelvic girdle can also be divided into two equal parts like the pectoral girdles. This girdle attaches the hind limb with the backbone and bears the weight of the body. This girdle looks like English letter `V". Each part of the pelvic girdle consists of three separate bones and one cavity.

a. IIium : The longest bone of pelvic girdle which is slightly bent and rod shaped is called ilium. Its front end remains attached with the ninth vertebra.

b. Ischium: It is a semi lunar bone situated between the ilium and pubis.

c. Pubis: It is a triangular cartilage situated between ilium and ischium.

d. Acetabulum: A cavity situated at the junction of the three bones of the pelvic girdle is called the acetabulum. With the acetabulum the head of the femur of the hind limb remains attached.

Hind limb:

a. Femur: The first solid bone of hind limb is femur. The two ends of the femur are swollen and the middle portion is bent. The rounded part of the anterior end remains attached with the acetabulum.

b. Tibia-fibula : The knee bone is called tibia-fibuala. This bone is formed by the fusion of two.

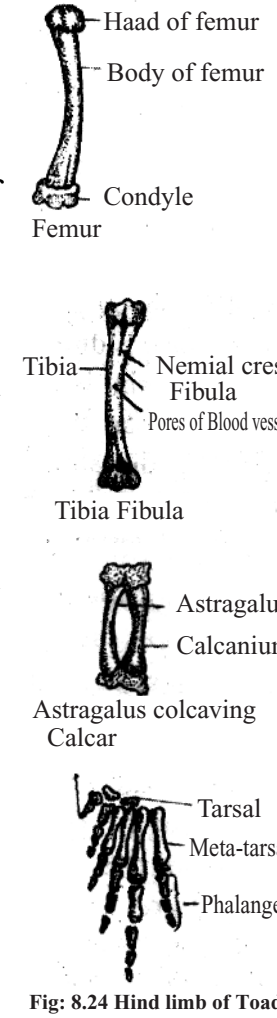


Fig: 8.24 Hind limb of Toad

bones named tibia and fibula. The tibia is situated in the inner side of the body and the fibula is in the outer side. There is a ridge at the junction of the two bones, known as cnemial crest.

c. Tarsals: The ankle bones of the feet are called tarsal. These bones arranged in two rows. The two bones of the upper row are known as astragalus and calcanium. The ends of these bones bear cartilages. The space between the two bones is hollow. The two bones of the second row are small and shapeless

d**. Metatarsal:** The sole of the foot of toad is formed of five narrow stick-like bones. These bones remain attached with the phalanges at the lower portion.

e. Phalanges: In the hind limb of toad there are five fingers. There are two phalanges in the first and second fingers, three in the third and fifth fingers and four in the fourth finger. Besides, towards the inner side of the hind limb there is a bony extension named calcar.

Digestive system:

The toad lives on worms, insects etc. The cells of the body cannot assimilate these food substances directly. Hence digestion of food material is required. The system which takes part to perform this work is called the digestive system. In other words, the system by which food is ingested, digested, absorbed and the undigested portion is ejaculated from the body as faeces are called the digestive system. Digestive system of the toad can be divided into two parts such as **Alimentary canal and Digestive glands.**

a. Alimentary Canal: The canal extended from, the mouth opening to the cloacal aperture is called the alimentary canal or gut. Sometimes this canal is narrow and sometimes it is wide and coiled.

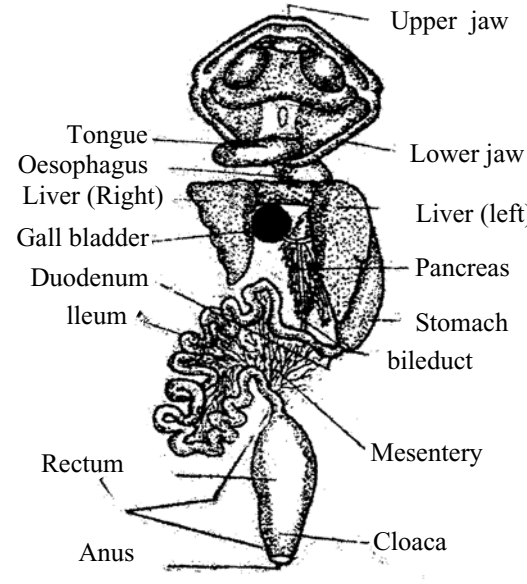


Fig: 8.25 digestive System of toad

(i) Mouth: At the front end of the body of the toad the mouth or mouth opening is situated. The mouth of the toad is quite wide and semicircular. There are two jaws on the upper and lower sides of mouth. It cannont move the upper jaw, but it can move the lower jaw. The jaws are toothless.

(**ii) Buccal cavity:** Behind the mouth opening the wide buccal cavity is situated. On the lower side of the buccal cavity lies the wide muscular tongue. Its front end is attached with the lower jaw and the posterior end is free. Tongue is the main organ for capturing prey. The toad catches worms and insects throwing the posterior part of the sticky tongue in a reverse way and brings them directly into the mouth. Internal nasal apertures, aperture of the eustachian tube etc. are situated inside the buccal cavity.

(iii) Pharynx: The narrow extended part of the gut between the buccal cavity and oesophagus is the pharynx.

(iv) Oesophagus: The stout, short and canal like part next to the pharynx is the oesophagus. Through the oesophagus, food substances reach the stomach.

(v) Stomach: Behind the oesophagus the curved sac like part is the stomach. Its wall is thick, muscular and glandular. The glands remain within the inner surface of the wall. The stomach is divided into parts, cardiac and pyloric part. Comparatively the thicker part which is close to the oesophagus, is the cardiac part and the part which is close to the small intestine is the pyloric part of stomach. There is a round muscular valve at the junction of the stomach and intestine. It controls the entrance of food into the small intestine.

(vi) Intestine: The coiled duct extended from behind the stomach up to the cloacal aperture is the intestine. The intestine is divided into two parts, Small intestine and Large intestine.

Small intestine: The narrow, coiled anterior part of the intestine behind the stomach is the small intestine. The small intestine is again divided into two parts, Duodenum and Ileum.

a. Duodenum: The first part of the small intestine which is like the English

letter 'U' is called the duodenum. The stomach and the duodenum remain suspended in the body cavity by a thin transparent membrane called peritoneum. The bileduct and the pancreaticduct together open into the duodenum.

b. Ileum: The second part of the duodenum is the ileum. This cannal is comparatively longer, narrower and more coiled. The inner walls of ileum bear finger-like projections called villi and digested food materials are absorbed through the surfaces of the villi.

Large intestine: Posterior to the small intestine, the comparatively thick part is the large intestine. It is divided into two parts, **rectum** and **cloaca**. In the rectum, salts and vitamins are absorbed and the undigested part of the food is stored here. No food material is digested here. Cloaca is the terminal part of the large intestine. Here separately open the urinary duct and the reproductive duct The cloaca opens outside through an opening called the cloacal aperture. Through the cloacal aperture come out the faeces, urine and the recrpoductive cells.

b. Digestive glands: The glands which secrete digestive juices and digestion and helps in the digestive process are called the digestive glands. Toads have two main digestive glands, **Liver** and **Pancreas**.

Liver: Liver is the largest gland of the body, located on either sides of the heart. This gland is divided into two parts, right and left, which are connected together by a middle part. Liver is a large chocolate or dark brown colour gland. The gall bladder remains in the middle of the two parts. The bile secreted from the liver is stored in this bladder. The functions of the liver are

a. Liver stores glycogen, fat and vitamins. That is why it is called the store house of the body.

b. It assists in protein synthesis.

c. In the liver the nitrogenous excretory paroducts are transformed into urea.

d. Red blood corpuscles originates in liver.

Pancreas: Pancreas is a very important digestive gland of the vertebrate animals. This gland is situated in between the stomach and duodenum. It looks

like a leaf and is light yellow in colour. The bile duct and the pancreatic duct join together to form hepatopencreatic duct and open into the duodenum.

Nutrition and Digestion: Intake of food, digestion of food, absorption of digested food materials and elimination of undigested waste materials are included in nutrition.

Toad is a carnivorous animal. The main food of toad is live worms, insects, earth worms, snails etc. With the sticky tongue it catches the prey and swallows it. Like all vertebrate animals, in the food of toad protein, carbohydrate, fat, salt, vitamins and water components are present. These six types of components can be obtained from the bodies of worms and insects. It is not required to digest salt, vitamins and water. The cells of the body of toad can directly absorb these three types of food. But protein, carbohydrate and fat are complex organic substances; hence the body cells cannot absorb them directly. In the presence of enzymes these insoluble, complex and non absorbable food substances take part in organic chemical reactions and transforms into simple and absorbable liquid components. These changes of food substances are called digestion.

After the intake of the food, there are no chemical changes inside the buccal cavity. The food substances become slippery by the mucus secreted from the walls of the buccal cavity. Food substances reach the stomach through the oesophagus where digestion begins.

Digestion in stomach: Inner walls of the stomach are glandular. After the food substances reach the stomach a hormone is secreted from its walls. This hormone is called gastrin. By the influence of gastrin, digestive juice is secreted from the gastric glands. The digestive juice contains mucin, hydrochloric acid and pepsin. Pepsin is a kind of enzyme.

Mucin: It is not an enzyme. It makes the food substance slippery. **Hydrochloric acid**: It destroys the germs coming in with the food substances, and creates the acidic medium to activate the pepsin. In this situation the action of pepsin hastens.

Pepsin: From the gastric gland inactive papsinogen is secreted. Hydrocloric acid transform this inactive pepsinogen enzyme into active pepsin. Pepsin converted the protein into proteose and peptone.

$$\text{Pepsinogen} \xrightarrow[\text{Catalyst}]{\text{HCI}} \text{Pepsin}$$

$$\text{Protein} + H_2O \xrightarrow{\text{Pepsin}} \text{Proteose + Peptone (Polypeptides)}$$

The stomach continuously contracts and expands. Thus food materials in the stomach are transformed into semi liquid substances. This half-digested liquid is called chyme.

Digestion in duodenum: When the chyme reaches the duodenum from the stomach, it comes in contact with the bile, secreted from the liver and pancreatic juice from pancreas. Bile converts the fat food into smaller droplets and makes it suitable for reaction with enzyme. Besides, it neutralizes the acidity of the food and brings them to alkaline medium. As a result, action of pancreatic juice hastens. There is no enzyme in the bile. The name of the digestive juice secreted from the pancreas is pancreatic juice.

Three enzymes are present in this juice, e.g. Trypsin, Amylase and Lipase.

Trypsin: Trypsin converts the proteose and peptone into soluble and absorbable amino acid.

$$\text{Proteose + Peptone +} \xrightarrow[\text{Amino}]{\text{Tripsin}} \text{> Amino Acid}$$

Amylase: This enzyme converts the carbohydrates or starchy food into glucose. The reaction is as follows:

$$\text{Carbohydrate} \xrightarrow{\text{Amylase}} \text{Glucose}$$

Lipase: This enzyme breaks the fat droplets and converts it into fatty acid and glycerol.

$$\text{Fatty substance} \xrightarrow{\text{Lipase}} \text{> Fatty acid + Glycerol}$$

Digestion in Ileum: When the digested food substance reaches the ileum, enzymes are secreted from its walls. There are Protein splitting trypsin, carbohydrates spliting amylase, moltase, sucrase, lactase and fat splitting lipase enzymes. As a result, rest of the undigested protein, carbohydrate and fat are converted into amino acid, glucose (monosaccharide) and fatty acid and glycerol respectively.

Absorption: Digested liquid and simple food i.e. glucose and amino acids are absorbed by the capillaries of the villi of the small intestine and the fatty acid and glycerol being absorbed by the lacteal ducts of the villi. Excess glucose reaches the liver through hepatic portal vein. Here glucose is transformed into glycogen and is stored. Excess amino acid being transformed into urea is discharged as excreta through the kidney and the fatty food stored at different places of the body as fat.

Egestion: After the absorption of digested food, the undigested part of the food reaches the large intestine from the small intestine. Here water and mineral salts are absorbed. The rest of the waste material is stored in the rectum. Afterwards these are thrown out of the body through the cloacal aperture as faeces.

Circulatory system: To sustain life toad requires food and oxygen. Body cells cannot directly take the ingested food substances and oxygen from air. So digested food substances and oxygen from air are required to reach each cell. Similarly it is required to expel carbon-dioxide and other wastes from the body formed as a result of metabolism. For this reason an efficient transport system is build in the body of the animal. Blood and lymph work as internal transport media. Blood and lymph supplies oxygen, hormone and digested food to the cells and help in egestion of excretory products of cells. This process is called circulation.

The circulatory system is formed of blood, heart, blood vessels and lymph vessels.

Blood is a kind of liquid connective tissue. The blood of toad is red. It is produced from the mesoderm cell layer of the embryo. Blood is divided into two main components, **Plasma and Blood corpuscles.**

Plasma : Plasma is the main component of blood. It is trasparent. slightly alkaline substance and light yellow coloured. Besides water in the plasma, food, hormone, mineral salt, carbon-dioxide, fibrinogen and various gaseous components remain in dissolved condition. In plasma the blood corpuscles remain suspended. The primary function of the plasma is to transpot the blood corpuscles and other substances to different parts of the body.

Blood corpuscles are mainly of three types, such as:

1. Red blood corpuscle or Erythrocyte.
2. White blood corpuscle or Leucocyte.
3. Platelets or Thrombocyte.

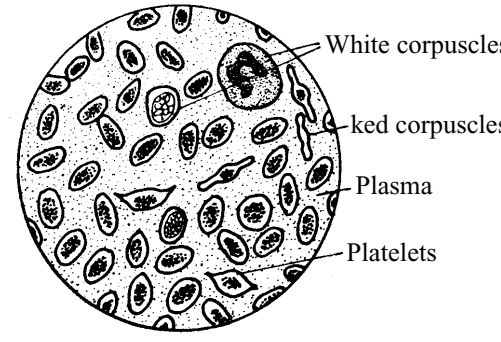


Fig : 8.26 three types of blood corpuscles

4. 1. Red blood corpuscle : The red blood corpuscle is oval, biconvex and nucleated. The reddish colour of blood is due to the presence of haemoglobin. Haemoglobin is a kind of iron mixed protein, The amount of this corpuscle is highest in blood. Red blood corpuscles are produced in bone marrow, liver and spleen. Haemoglobin easily mixes with oxygen to form oxyhaemoglobin. In a similar way oxyhaemoglobin being reduced transforms into haemoglobin and the red blood cell supplies oxygen to the cells.

2. White blood corpuscle: White blood corpuscle is bigger in size, less in number, colourless and has nucleus. White corpuscles are produced in bone marrow, spleen, and lymph glands. They can change shape like the *Amoeba* and destroy germs. If necessary they may come out from the thin membrane of blood vessel and destroy harmful substances if there is any.

3. Platelets: Among the blood cells the smallest corpuscles are the platelets. These cells are spindle shape and are nucleated. These are originated in the bone marrow. Platelets help in the clotting of blood.

Functions of blood:

1. **Supply of essence of food and water:** Plasma supplies the digested food materials and water to various parts of the body.
2. **Supply of oxygen:** Blood supplies oxygen to each of the living cell of the body.
3. **Discharge of carbon-dioxide**: Plasma collects carbon-dioxide from the cells and brings it to lungs and integument for removal.
4. **Transportation of hormone**: Blood carries the hormone and supplies it to the places where necessary.
5. **Discharge of waste substances**: Collecting the nitrogenous waste substances produced in the body, the plasma assists in removing these outside the body.
6. **Destruction of germs**: The white blood corpuscles help the body to keep fit by destroying the germs if they enter the body.
7. **Clotting of blood**: If any part of the body is injured or if the blood vessel is ruptured, platelets stop the bleeding by clotting the blood.
8. **Role of blood in metamorphosis**: The white blood corpuscles of tadpole help in metamorphosis by eating cells of the tail by phagocytosis.

Heart: Heart is the most important organ of circulatory system. It is a sort of pump in the body of toad. This organ is situated in between the lungs and remains covered by the membrane named pericardium. The wall of the heart is quite thick and three layered **Epicardium, Myocardium,** and **Endocardium.** The outer layer of the heart is epicardium. The middle layer is myocardium which is made of cardiac muscles and quite thick. The inner layer is known as endocardium.

The heart of a toad is divided into three main chambers: Two auricles and one ventricle. Besides there are two sub chambers named sinus venosus and conus arteriosus.

Auricle: The two upper chambers of the heart are named auricles. The two auricles are divided into right and left parts by a septum. Right auricle is bigger than the left. By a common auriculo ventricular aperture the right and left auricles open into the ventricle.

Ventricle: In the heart of toad, there is one ventricle. The wall of the ventricle is quite thick and towards the inner side there are some longitudinal projections. These projections do not allow to mix the oxygenated blood and deoxygenated blood.

Sinus venosus: The triangular chamber situated on the dorsal side of auricle is named sinus venosus. Two anterior vena cavae and one posterior vena cava enter into it. Through the aperture named sinu-auricular aperture the sinus venosus opens into the right auricle. At the opening of this aperture a pair of one way valves is present.

Conus arteriosus: Placed obliquely form the right end of the ventricle of the heart up to the left auricle the chamber is named conus arteriosus. The two parts of conus arteriosus in front of the auricle named called truncus arteriosus or aorta. From here comes out the three main arteries. There. is a spiral shaped valve inside the conus called spiral valve. This valve divides the conus cavity into right and left parts.

Circulation of blood through the heart: Like all other land animals, the toad has double circuit circulatory system. Blood is circulated through successive contraction and relaxation of heart. The two anterior vena cavae and the posterior vena cava carry the carbon-dioxide enriched blood into the sinuis venosus. This blood enters the right auricle through the sinu-auricular aperture Almost simultaneously the right auricle relaxes and from the lungs oxygen enriched blood enters into the left auricle through the pulmonary vein. Right and left auricles simultaneously contracts and from the right and left auricles carbon dioxide and oxygen enriched blood through the common auriculo-ventricular aperture enters the cavity of the ventricle. Later, the wall of the ventricle contracts and through the control of the semilunar valve, blood from the ventricle enters the cavity of the conus arteriosus. Afterwards oxygenated and carbon-dioxide enriched mixed blood through the right and left aorta circulates respectively through the carotid, systemic and pulmocutaneous arteries.

Blood vessels: The tubules through which the blood is circulated inside the body are called blood carrying vessels or blood vessels. These vessels are directly or indirectly connected with the heart. The blood vessels are of three types, **Artery, Vein** and **Capillary**.

Artery: The vessels which carry oxygenated blood away from the heart to various organs of the body are called arteries.

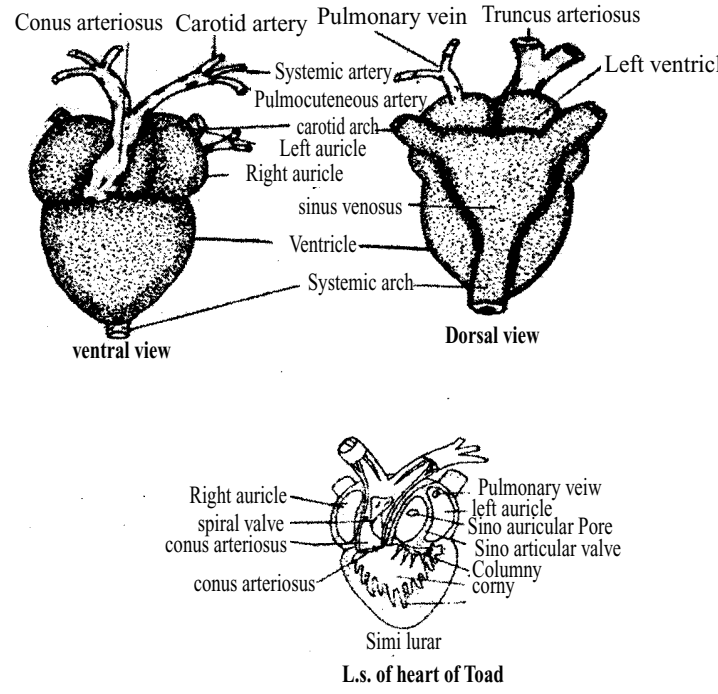


Fig : 8.27 Heart of Toad

Capillary: The aorta originates from the heart and then branches into extremely narrow arteries or arterioles. These branches further divide many times and form fine networks. Later these fine nets joining together form the vein. Arteries and veins are connected by those fine networks. These nets which connect the arteries and veins are called capillaries. The wall of the capillary is very thin. Its wall is formed by one layered thin epithelial cells, as a result, exchange can easily occur between the blood inside its cavity and the food juice and waste substance inside the cell.

Vein: The vessels which carry blood from various organs of the body toward the heart are called veins. Veins generally carry deoxygenated or carbondioxide enriched blood. But the pulmonary vein carries oxygenated blood from the lung to the heart. Veins originate from the capillaries. The main difference of artery and vein are given below on the table.

Differences between artery and vein

	Antery	Vein
1. Direction of blood flow	From the heart towaeds the body	From the body towards the heart
2. Ending	Artery ends in capillaries	Veins origination from the capillaries end in the sinus venosus of heart.
3. Type of blood	Excepting the pulmonary artery all other arteries carry oxygen enriched blood	Excepting the pulmonary vein other veins carry carbon-dioxide enriched blood.
4. Wall	Thick, stout and elastic	Soft thin and non-elastic
5. Lumen	Narrow	wide
6. Valve	Absent	present

Arterial system: We have known earlier that the blood vessels which supply blood to various organs of the body from the heart are called the arteries Arteries, arterioles and capillaries together form the arterial system.

Arising from the ventricle the conus arteriosus crosses the heart transversely. This sub chamber of the heart is the main or root of the arterial system. At the terminal end of the- auricle the conus arteriosus is divided into right and left truncus arteriosus. Three arteries originate from the truncus arteriosus. These are **Carotid arch or carotid artery (in front), Systemic arch (in the middle) and Pulmocutaneous arch (behind).**

Carotid arch : Arising from the truncus arteriosus this artery has gone up being divided into two parts. The upper and lower arteries are respectively called external carotid and internal carotid. These arteries supply blood to the buccal cavity tongue and outer side of the skull and brain.

Systemic Arch or Aorta: A systemic aorta arising from the middle of each of the two sides of the truncus arteriosus meet together behind the heart surrounding the two sides of the left and right lungs. This joined artery is called the dorsal aorta. From each systemic aorta arise some branched arteries such as Laryngeal artery, Occipito vertebral artery and Subclavian artery.

1. Laryngeal artery: This artery is the first branch of systemic arch. Being divided into branches and sub-branches it supplies blood to the vocal sac.

2. Occipito-Vertebral artery: This artery originates from the middle of the systemic arch and goes toward the dorsal side. The occipito-vertebral artery being divided into branches and sub-branches supplies blood to the pharynx, hind part of brain, back bone and spinal cord.

3. Subclavian artery: Subclavian artery arises from the outer side of middle region of the systemic arch. This artery supplies blood to the shoulder and fore limb of toad. Only from the left systemic aorta, a branched artery comes out and supplies blood to the oesophagus. It is called the oesophageal artery. From the right systemic aorta no such blood vessel originates.

Dorsal aorta: Dorsal aorta of toad runs along the mid dorsal line. From this aorta comes out branches and sub-branches. These branches and sub brancnes supply blood to the alimentary canal and posterior regions of the body. Following branches come out from dorsal aorta:

1. Coeliaco-mesenteric artery: From very near to the origin of the dorsal aorta, a branched artery comes out and after proceeding to some distance it becomes divided into two portions. The first one is called coeliac and the second one mesenteric. Coeliac supplies blood to the stomach, liver, pancreas and gall bladder. The mesenteric artery supplies blood to the spleen and intestine.

2. Renal artery: Four to five pairs of arteries enter the kidneys while the dorsal aorta passes through the middle region of the kidneys. These arteries are called renal atreries and they supply blood to the kidneys.

3. Genital artery: Arising from the branches of the renal arteries some branches enter the genital organ. These are named genital arteries. They supply blood to the reproductive system.

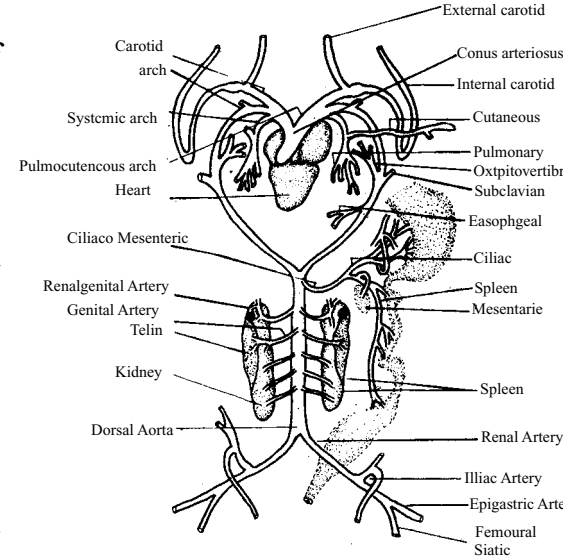


Fig : 8.28 Arteiral system of load

At the distal end of the trunk the dorsal aorta divides into two branches. These are named respectively the right and left iliac.

From each iliac artery a branched artery comes out. This artery supplies blood to the urinary bladder and the ventral side of the body. Afterwards the iliac artery divides into two portions. One femoral supplies blood to the knee and the other sciatic to the other part of the foot.

Pulmo-cutaneous artery: The posterior most arteries arising from the truncus arteriosus is the pulmo-cutaneous artery. One of its branches carries deoxygenated blood directly to the lung. It is called the pulmonary artery. The other branch carries blood to the integument. It is called cutaneous artery. Being divided and subdivided these arteries enter the integument.

Coronary circulation: By continuous contraction the heart pumps blood to various organs of the body. The heart tissue itself also requires the supply of food and oxygen. So, within the heart blood vessels are present. The coronary circulatory system is formed by the blood vessels of heart.

Venous system: The blood vessels which carry the deoxygenated blood from various parts of the body to the heart are called veins. Veins originate from the capillaries. The only exception is the pulmonary vein. This vein carries oxygenated blood to the heart. The whole venous system of toad is generally divided into three main branches, such as:

A. Pulmonary venous system.

B. Systemic venous system

C. Portal system.

A. Pulmonary Venous system: One pulmonary vein originates from each lung. The two pulmonary veins meet together and form one common pulmonary vein and finally it opens into. the left auricle. It is an exceptional vein which carries oxygenated blood from the lungs directly to the heart.

B. Systemic Venous system: Systemic venous system is formed by the veins which are originated from the capillaries carrying carbon-dioxide enriched blood to the heart directly. Three main vena cavae with their branches form the systemic venous system. The three vena cavae open in the three corners of

sinus venosus. Two from anterior part of the body and the other from the posterior part carry deoxygenated blood. Each anterior vena cava or pre-caval vein is formed by three main veins, such as, **External Jugular, Innominate** and **Subclavian vein**

1. External Jugular Vein :

The two veins carrying deoxygenated blood from the tongue and face are called external jugular veins.

2. Innominate Vein: This vein is formed by the combination of two veins. It collects deoxygenated blood from the shoulder and corners of the jaw.

3. Subclavian Vein: This vein is formed by the combination of two veins. Its function is to collect blood from the fore limbs, muscles and integument.

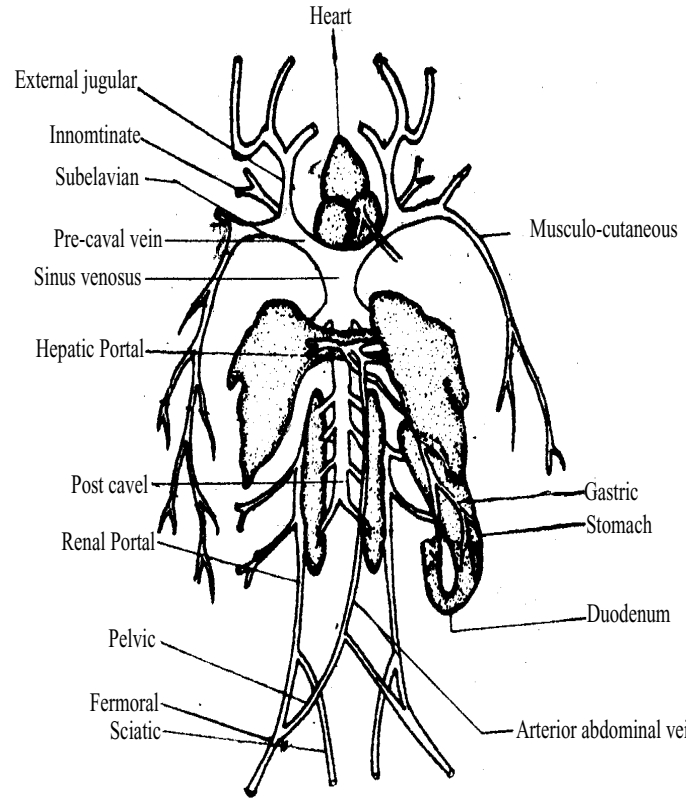


Fig : 8.29 Venous system of toad

Hepatic Vein: Two veins, named hepatic veins, coming from the two parts of the liver, open into the post caval vein or posterior vena cava. Its main function is to collect huge amount of blood from the liver.

Renal Vein: Four pairs of renal veins coming out from the kidneys and enter the post caval vein. To collect blood from the kidney is the function of the renal vein.

Genital Vein: Some finer veins coming from the testis of the male toad or ovaries of the female toad meet with the two pairs of renal veins. These are known as "genital" veins. The function of the genital veins is to collect blood from the reproductive organs.

C. Portal system: There is a type of vein in the body of the toad which originating from the capillaries of any organ instead of reaching the heart directly, again enters into other organs and terminates in the capillaries. These are called portal veins. The portal system is formed by the combination of such veins. In the body of toad there are two kinds of portal venous system such as, Hepatic Portal System and Renal Portal System

A. Hepatic Portal System: Some veins coming from the stomach, intestine, pancreas, spleen and hind limb meet together and form this system. The two pelvic veins from the inner side of femoral vein of each side of the hind limbs of a toad meet together and form the anterior abdominal vein. This vein approaches the liver. When nearing the liver, veins coming from various parts of the alimentary canal, meets this vein. These joined veins are called hepatic portal veins. Hepatic portal veins then come in close contact of the liver and proceed transversely. The hepatic portal vein then divides into two branches and enters into two parts of the liver. There they divide into capillaries.

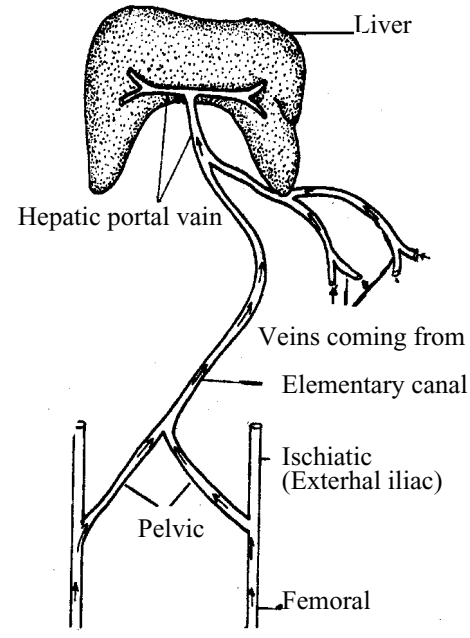


Fig. 8.30 : Hepatic Portal system of toad

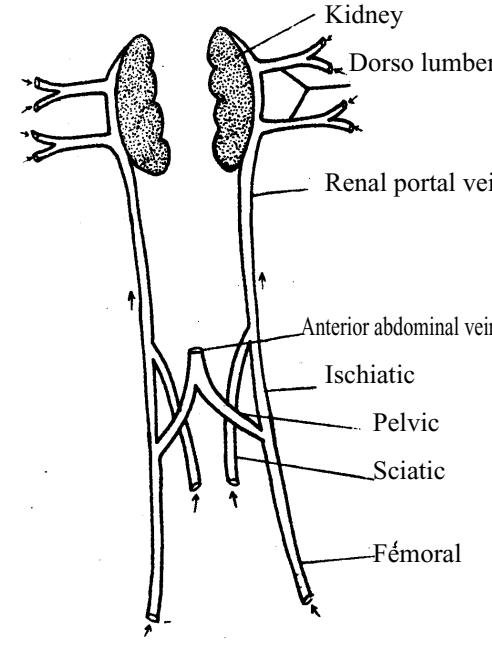


Fig. 8.31 Renal porat system of toad

B. Renal Portal System: The femoral vein coming from the hind limb and the sciatic vein coming from the pelvic region meet together and approach towards the kidneys. This united vein is called renal portal vein. Before entering the kidney some other smaller veins also join. These are called dorsolumbar veins. Later the renal portal vein enters the kidney and divides into capillaries. The

function of this system is to eliminate excretory materials from the blood collected by the kidneys.

Differences between hepatic portal and renal portal system and its significance are given below :

Differences between hepatic portal system and renal portal system

	Hepatic portal system	Renal portal system
Origin	Different parts of the digestive system such as stomach , intestine, pancreas,, spleen etc and veins come from hind limb are united together and enters into liver and breaks into capillaries instead open to heart	The femoral and sciatic vein united together to form renal portal vein this vein open into kidney and breaks into capillaries.
Destination	Liver	Kidney
Function	Absorbed food of alimentary canal and transport into liver. This food is differentiated into the liver and sends them to the place of necessary and store the excess food.	By the system filtration of metabolic waste and excretion of these materials of the blood by the kidney is done.
Significance	The absorbed food is stored into liver not circulated meaning lastly into the body and food is distributed when in need.	To separate the waste materials from the blood before entering the heart while brings into the kidney to filter and purify.

Respiratory system: Energy is necessary for different metabolic activities. Usable energy is produced inside cells by oxidation-reduction of glucose with the help of mitochondria. Water, $C0_2$, generally ATP (Adenosine Tri Phosphate) and heat are produced by this process. Cells can not use heat energy, so it is lost. ATP instantly supplies energy when it is needed. It should be kept in mind that in extensive heat, protoplasm gets paralyzed. For these reasons the cellular respiration process takes place step by step with the help of various type of enzymes. This process of energy generation inside cells is known as internal or cellular respiration. For this oxygen is essential. The process of collecting oxygen from the environment to every cells of the body is known as external respiration. In this process body receives oxygen enriched air and expels $C0_2$ from the body.

Cellular respiration process of metabolic activities of all organisms is same, among these the main metabolic path is Kreb's Cycle. To live in different

habitats of environments, toads respire through different methods of external respiration.

To live in different environments, the toad respires in more than Generally, the process of external respiration in toad is of four types.

1. Cutaneous respiration

2. Bucco- pharyngeal respiration

3. Pulmonary respiration

4. Gill respiration

1. Cutaneous respiration : This type of respiration takes place through the skin. The skin of toad is very thin and enriched with blood capillaries. The skin of toad contains a large number of mucus glands. Mucus is discharged from these glands; as a result the skin remains moist. For this reason, exchange of oxygen and carbon dioxide take place through skin easily in the process diffusion. During hibernation the toad respires by this process.

2. Bucco-pharyngeal respiration: The membrane of buccal cavity and pharynx of toad is very thin and there are innumerable capillaries. When air enters the buccal cavity oxygen gets into the blood of the capillaries by diffusion. This oxygenated blood flows to different parts of the body through heart and at one stage takes part in the oxidation of food inside the cell. The carbon dioxide produced as a result of oxidation of food comes out through diffusion. The toad respires this way generaly during rest.

3. Pulmonary respiration: Lungs are the main respiratory organs of toad. The toad has a pair of lungs. The lungs are pink coloured hollow sacs. Each lung is formed of innumerable smaller chambers like balloons. Each of this balloon like chambers is called air sac or alveolus. Its wall is enriched with blood vessels. When the lungs expand the air sacs become, filled with air. Exchange of oxygen and

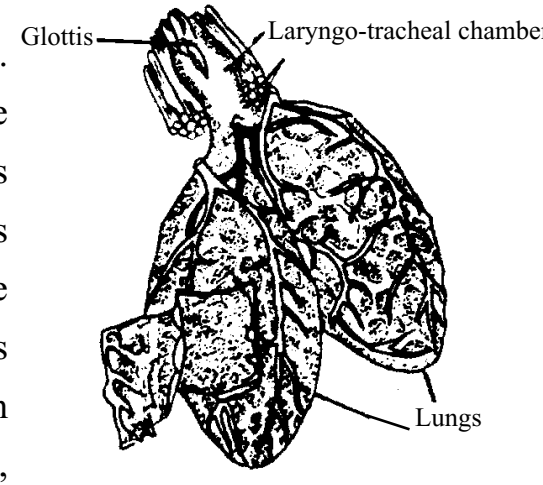


Fig :8.32 Pulmonary Respiratory system of Toad

carbon-dioxide taxes place through the air sacs. The fine air tubes with which the air sacs remain connected are called bronchioles. The two tubes which are formed one on each side by joining all the bronchioles of each lung are called bronchus: Right and left bronchi meet together and form a small trachea. Trachea and larynx or voice apparatus together form the laryngo-tracheal chamber. The lungs of each side joining with the larynx and glottis open through the nasal aperture. The adult and active living toad respires through pulmonary respiration. The pulmonary respiration is actually external respiration. External respiration is again divided into two sub stages such as, **Intake of air or inspiration and Release of air or expiration.**

Inspiration: At this stage oxygen along with the air enters the lungs from the environment. Inspiration occurs in two steps.

A. First step: At this time the nasal apertures remain open but the mouth aperture and glottis remain closed. Simultaneously the lungs contract and the floor of the buccal cavity are lowered. As a result, the volume of the buccal cavity increases. The oxygenated air from outside enters the buccal cavity. At this time exchange of oxygen and carbon-dioxide takes place in the blood of capillaries situated in the walls of the buccal cavity and pharynx.

B. Second step: At this stage the nasal apertures are closed and the floor of the buccal cavity is raised. As a result, oxygenated air enters the alveoli of the lungs. By the diffusion process oxygen from the cavities of the alveoli enters the blood capillaries close to the walls of the alveoli. In a similar process carbon-dioxide is released.

Expiration: At this stage from the alveoli carbon-dioxide comes out of the body. Expiration, occurs in two steps:

A. First step: At the first step of expiration the two lungs contract, external nasal apertures and mouth aperture remain closed and the floor of the buccal cavity is lowered. As a result volume of the buccal cavity increases and carbon-di-oxide mixed air returns to the buccal cavity.

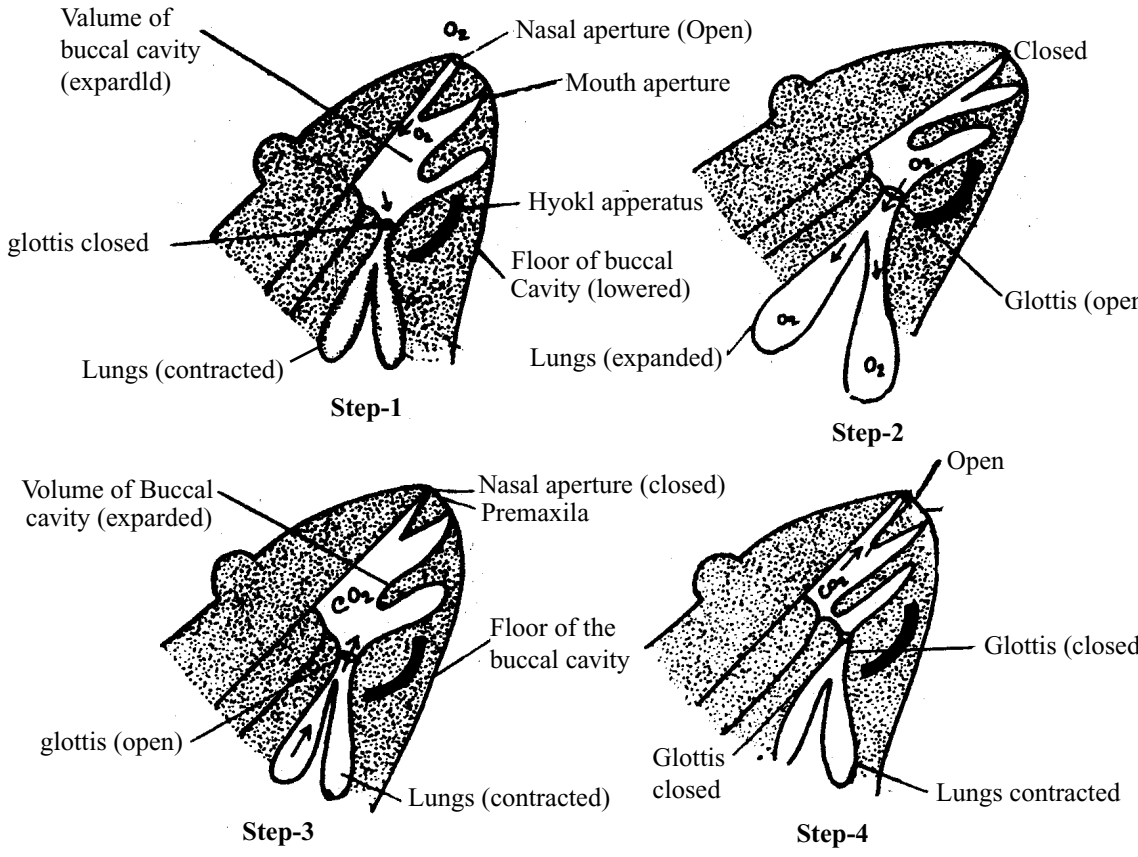


Fig: 8.38: Different stages of inspiration and expiration of toad

B. Second step: The floor of the buccal cavity is raised. The volume of buccal cavity reduce. At this time the glottis remains closed and the nasal apertures remain open. As a result through nasal apertures the carbon-dioxide enriched air comes outside.

Internal respiration: We have learnt earlier that internal respiratior basically cell respiration. In this process exchange of oxygen and carbon-dioxide takes place in the blood of capillaries. At the cellular level energy produced through oxidation of glucose.

Transportation of oxygen: As a result of the entrance of air inside the lungs the air of the lungs gets oxygen. The moist vapor that remains in this reaches to the interior part of the alveoli. Oxygen dissolves in watery drops a result the volume and pressure of oxygen increase. At this time the volt and pressure of oxygen in the blood of capillaries on the body walls of alvi remain less. As a result oxygen enters the blood through diffusion process. this time oxygen combines with the haemoglobin of blood, to form compound known as oxyhaemnglobin.

Haemoglobin + Oxygen → Oxy-haemoglobin.

This oxygen enriched blood reaches the body cells through the heart. The volume and pressure of oxygen remain less in the body cells, so breaking the oxyhaemoglobin the oxygen separates and enters the cells. This oxygen oxidizes the simple food (glucose) of the cells and produces energy.

Oxy-haemoglobin = Haemoglobin + oxygen.

Glucose oxidation and energy production :

This stage of internal respiration occurs in two steps.

1. Glycolysis

2. Kreb's cycle

Glycolysis: This process occurs in the cytoplasm of the cell. At this stage oxygen is required. At this time one molecule of glucose breaks into two molecules of pyruvic acid.

1 Molecule of glucose = 2 molecules of pyruvic acid.

Kreb's cycle: This process occurs in the mitochondria of the cell. The enting process is completed by certain steps and in the presence of some specific enzymes. At this stage oxidation occurs in the presence of oxygen. As a reesult carbon-dioxide, water and energy are produced.

Transportation of carbon dioxide: The transportation of carbon-dioxide exactly the reverse process of oxygen transportation. That is, carbon-dioxide enriched blood is transported from the body cells towards the respiratory organs.

Carbon-dioxide transportation happens in 3 ways.

(a) In the form of carbonic acid: A part of the carbon dioxide is mixed with the water and is transported as carbonic acid.

(b) In the form of bi-carbonate: Blood plasma carries carbon dioxide in the form of sodium bi-carbonate, and the red blood corpuscles in the form of potassium bi-carbonate.

(c) In the form of carbamino compound: Blood plasma and red blood corpuscles transport carbon-dioxide in the form of carbamino compound.

4. Gill respiration : The larva of toad is called tadpole. Tadpole lives in water. They have no lungs, so they respire with the help of gills like the fishes. In each gill there are numerous blood vessels. The dissolved oxygen of water

comes in contact with the smaller blood vessels of the gills and exchangcs oxygen and carbon-dioxide easily occurs.

Nervous system: This nervous system of Toad requires a central coordination arrangement to conduct different organs efficiently. The nervous system an endocrine or hormone system conducts controls and coordinates all the activities of the body of toad. The system through which the animal response to stimuli, maintains the connections of various organs, coordinates various activities and maintains relations with the environment is called the nervous system.

The nervous system of toad, can be divided into three main divisions based on the origin, structure, distribution and functions.

1. Central nervous system

2. Peripheral nervous system

3. Autonomic nervous system

l. Central nervous system: The central nervous system consists of the brain and the spinal cord.

2. Peripheral nervous system: The periphery or lateral nerve originates from the lateral sides of the brain and spinal cord formed of ten pairs of cranial nerves and ten pairs of spinal nerves.

3. Autonomic nervous system: In the body of animals there is a kind of nerve which is not directly- controlled by the central nervous system but control independently the activities of various organs. The autonomic Nervous system is formed with these nerves. This system is formed with a pair of sympathetic nerve cord with their branches.

Description of central nervous system: The central nervous system of toad formed of the brain and the spinal cord. The part of the central nervous system which is enclosed within the skull, is called the brain.

The brain of toad is elongated. The middle part is thick and two ends a n-arrow and bi-laterally syrumetrical. The brain is covered by two membrane The outer thick, hard, translucent and blood vessels enriched membrane called dura matter and the inner thin membrane is called pia matter. These two

membranes together are called meninges. Meninges cover the brain and spinal cord protects them.

The brain is formed of neurons or nerve cells. One neuron is joined with the other neuron by the synapse and form the nervous tissue. The outer part of the brain is formed of grey matter i.e. nerve cell bodies. The white part towards its inner side is called the white matter. This part is formed of nerve fibres.

The brain and spinal cord of vertebrate animals are not solid. In its inner Part there are hollow cavities or brain ventricles. The brain cavities remain filled up with a kind of fluid.

Structure of brain: The brain of toad is mainly divided into three parts, such as: fore brain, mid brain and hind brain.

1. Fore brain: It is the anterior most part of the brain. Brain is the fore brain. The fore brain is again divided into two parts:

a. Telencephalon b. Diencephalon

A. Telencephalon: It is the anterior most part of the fore brain. It is divided into two parts such as:

a. Olfactory lobe: It is a pair of out growth arising from the telencephalon of the fore brain. These growths are called olfactory lobes. It is the centre of smell of toad.

b. Cerebral hemisphere: Behind the olfactory lobes there are two cerebral hemispheres. Their function is to move the muscles and control intelligence.

B. Diencephalon: The comparatively small region situated behind telencephalon is the diencephalon. Its sides are swollen and there is a narrow raised portion on the dorsal side. Hormone is secreted from the pituitary body situated here. This hormone is helpful in metabolic processes, growth, attaining maturity and nutrition of reproductive cells.

2. Mid brain: The midbrain is situated in between the fore and hind brains This region is comparatively wider than the other regions. A spherical region present on the two sides of this part. It is called optic lobe. Midbrain is the centre for vision of the toad.

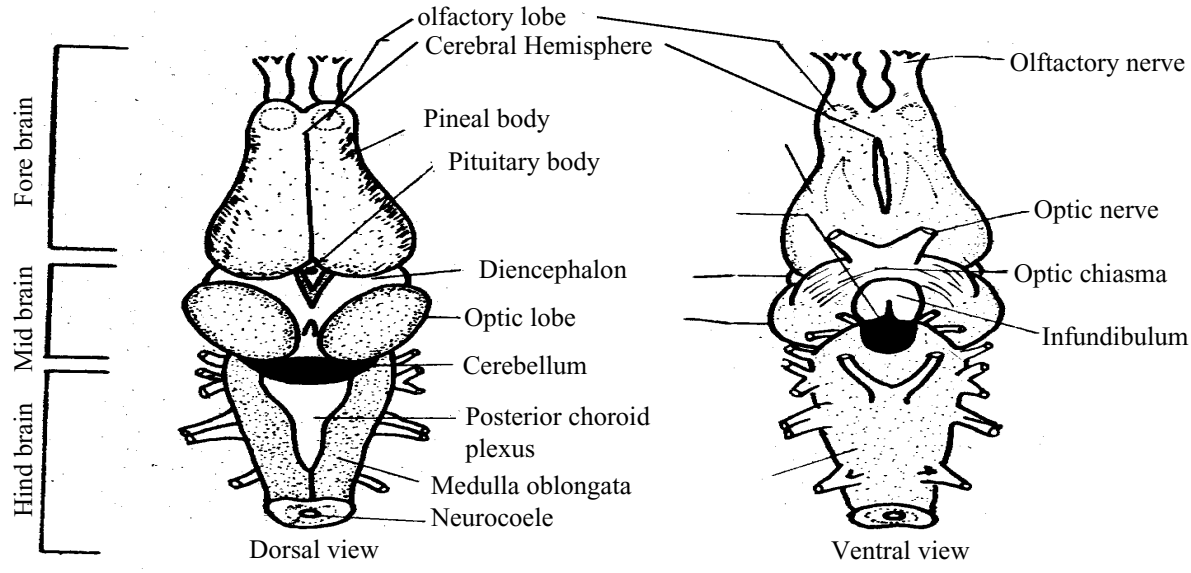


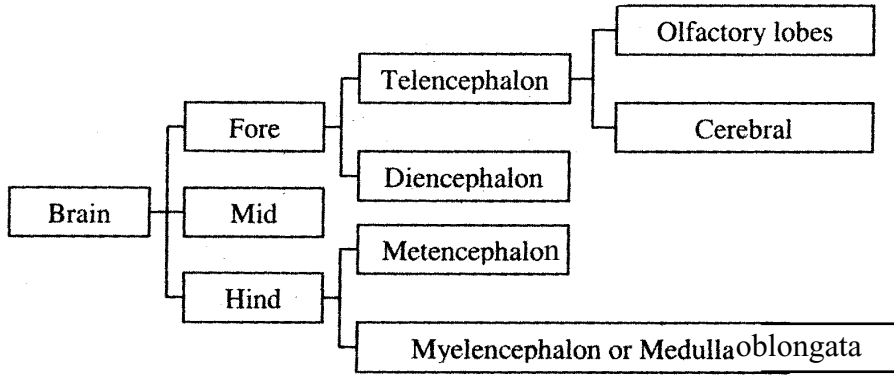
Fig:8.34 Brain of toad

3. Hind Brain : The hind brain occupies the posterior position of the mid brain. This part extends up to the root of the spinal cord. This region of the brain is divided into two parts. **Metencephalon** and **Myelencephalon** or **medulla oblongata.**

a. Metencephalon : The narrow part just behind the optic lobes is the metencephalon. This part controls the voluntray movement of toad.

b. Myelencephalon or Medulla oblongata : It is the posterior most part of brain which gradually narrows and meets with the spinal cord. There is an aperture behind the cranium. The medulla oblongata comes out through this aperture and meets the spinal cord. Medulla is an important region of brain. It assists in physiological functions including capturing of prey, respiration, producing sound; taking food by tongue, heart beat etc.

The sub-divisions of the brain are given in the following table:



Cranial nerves

Ten pairs of nerves coming out from the brain of the toad extend up to the peri. pheral region of the body. These nerves are called cranial nerves. Some of these nerves conduct stimuli from outside the body to the inner side, some carry directives to some definite organs from inner side of the body. Again some carry out both the orders and the stimuli.

According to the nature of work the peripheral nerves can be divided into three divisions, such as Sensory nerves, Motor nerves and Mixed nerves.

A. **Sensory nerves:** The nerves which carry stimuli from the peripheral organs of the body to the central nervous system are called sensory nerves. For example, the optic nerve of the eye, the olfactory nerve of the nasal aperture and auditory nerves of the internal ear.

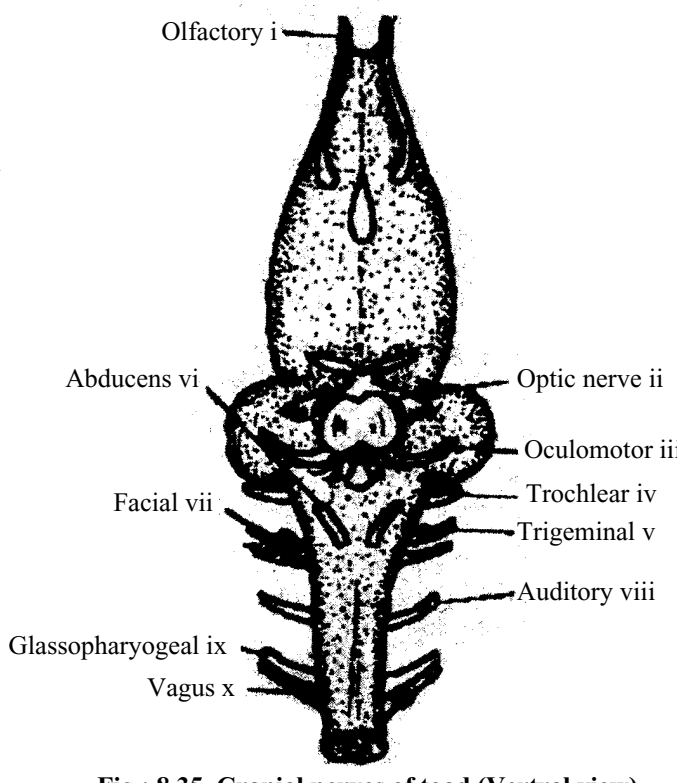


Fig : 8.35 Cranial nerves of toad (Vertral view)

The cranial nerves of toad originating from definite locations of the brain come out through the apertures of the skull and communicate with the various parts of the head. The origin, passage, distribution and functions of the ten pairs of nerves are given in the table.

Table: Summary of the cranial nerves of toad.

Name of the nerve	Origin	Branches and their extensions	Nature of work	Function
Olfactory nerve	Olfactory lobe	Surface wall of the nasal apertures	Sensory	To smelling
Optic nerve	Optic lobe	Retina of the eye ball	Sensory	To assist in vision
Oculomotor nerve	Ventral side of mid brain	Four muscles of the eye ball	Motor	To control the contraction and expansion of the eye muscles
Trochlear nerve	Back side of the optic lobe	Oblique muscles of the eye ball	Motor	To control the movement of the eye ball
Trigeminal nerve	Lateral side of medulla oblongata	1. First branch: eyelid, nasal aperture and frontal part of head 2. Second branch: Integument of the lower of the lower jaw of the mouth and muscles of the buccal cavity	Mixed nerve	1. To move the muscles of the upper side of the head. 2. To control the movement of the jaw 3. To move the tongue
Abducens nerve	Lateral side of medulla oblongata	Muscles of eye-ball	Sensory nerve	To control the movement of eyeball
Facial nerve	Lateral side of medulla oblongata	1. First branch: Upper surface of the mouth cavity. 2.Second branch: Lower surface of the mouth cavity.	Mixed	To perceive taste, to move muscle of neck and to help in chewing
Auditory nerve	Lateral side of Medulla oblongata	Different parts of inner ear	Sensory	To hear and to keep balance
Glosso pharyngeal nerve	Lateral side of medulla oblongata	Posterior part of tongue, muscles of pharynx	Mixed	To perceive taste, touch, to move tongue
Vagus nerve	Lateral side of medulla oblongata	1. First branch: Goes to pharynx and oesophagus 2. Second branch: Goes to lungs 3. Third branch: Goes to stomach. 4. Fourth branch: Goes to heart	Mixed	To control the functions of the pharyngeal region, to contract the lungs, stomach and heart.

Spinal cord: Spinal cord is the extension of medulla oblongata through the neural canal of vertebrae it extends up to the urostyle. Like the brain, the spinal cord is also covered by meninges. Towards the inner side of the spinal-cord remains the grey matter and towards the outer side there is white matter. From the spinal cord of toad comes out ten pairs of nerves.

Functions of spinal cord

1. It contains the nerves originating from the spinal cord and exchange information and directions of the brain.
2. It assist to perform instant work.

Excretory system : During metabolism in the body of toad various types of nitrogenous excretory products are produced. These substances are of no use to the body, but may cause harm if remain inside the body for a long time. So it is essential to remove these nitrogenous waste products from the body. The process through which nitrogen enriched excretory products, produced due metabolism is eliminated from the body is called excretion. Kidney is the main organ of excretion.

Excretory system and Excretion process

The excretory system of toad is formed by the following organs.

A. Kidney
B. Ureter or Urinogenital duct
C. Urinary bladder
D. Cloaca
E. Cloacal aperture.

Kidney: The two kidneys of toad are located in the abdominal region on the both sides of the backbone. The kidneys are elongated, deep red coloured with the anterior and posterior ends slightly pointed. The outer part of the kidney convex and wavy and the inner side smooth. Each kidney remains covered by a thin is membrane called peritoneum.

Functions:

1. To assist in the removal of nitrogenous waste products and other unwanted materials.
2. To control the balance of water in the body.

Structure of Kiney

The kidney can be divided into two parts :

i. Renal wall

ii. Renal cavity.

i. Renal wall: It is the outer part of the kidney. This wall is divided into two parts.

1. Outer part or cortex, and
2. Inner part or medulla.

The renal wall encircles a cavity in the middle portion of the kidney.

ii. Renal cavity: The renal cavity is surrounded by the renal wall. This, cavity remains connected with the Ureter.

Microscopic structure of kidney:

Each kidney of toad is formed by the combination of numerous fine coiled renal tubules. In each kidney there are about two thousand such coiled microscopic tubules. These tubules are called nephrons. Each nephron is divided into two portions.

a. Malpighian body or organ

b. Renal tubules.

a. Malpigbhian organ: It is the anterior rounded part of the nephron. This organ is again formed of two parts, such as: Bowman's capsule and Glomerulus.

1. Bowman's capsule and Glormerulus

At the free end of each renal tubule there is a closed cup-like part called the Bowman's capsule. The wall of this cup is formed of an epithelial cell layer. branch of the renal artery enters the cavity of the Bowsman's capsule. This branch of the artery is known as afferent artery. Inside the cavity of Bowmans capsule the afferent artery form a cluster of blood capillaries.

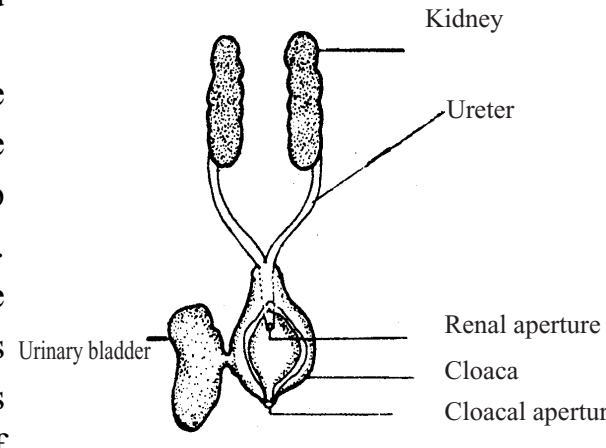


Fig : 8.36 Exeretary system of toad

This cluster is called glomerulus. Joining together these blood capillaries form an efferent artery. Glornmerulus and Bowman's capsule

together are called Malpighian body or Malpighian Organ. This part of the kidney is situated in the cortex or wall of the kidney.

b. Renal tubules: The duct like tubule behind the Bowman's capsule is called the renal tubule. This tubule being turned into coil opens into the collecting duct. The collecting duct ultimately opens into the ureter. The tubule is surrounded by the branches of efferent artery.

Ureter: From the outer end of each kidney a whitish elastic duct originates and goes towards the posterior part of the body. This duct is known as ureter. The ureters of the two sides meet and form a common renal duct and opens into the cloaca through a common renal aperture.

Urinary bladder: The thin, incompletely divided sac situated on the ventral side of the cloaca is called urinary bladder. Urine is stored here temporarily. The urinary bladder opens into the cloaca through an aperture.

Cloaca: The cloaca is situated behind the rectum. It is a narrow chamber. The urinary bladder opens into the cloaca through the renal aperture. Through it urine passes towards the cloacal aperture.

Cloacal aperture: The cloacal aperture is situated at the posterior end of the body. Through this aperture stool, urine, sperms and ova are discharged outside.

Excretion process

Amino acid is produced due to digestion of protein. This amino acid is used to perform various Biological functions. Excess and unused amino acid under the influence of enzyme named de-aminase takes part in de-amination process. In this de-amination process amine reacts with water to produce ammonia, thus ammonia is separated from the amino acid. Ammonia is a harmful substance for the body of the toad.

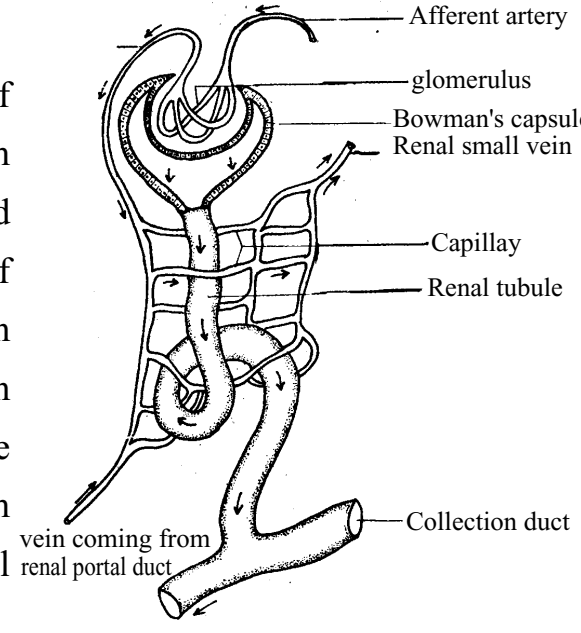


Fig: 8.37: Stmucluse of nephrone and filtration system

Along with blood, ammonia reaches the liver. There under the influence of an enzyme, urginase, ammonia by reacting with carbon dioxide produces urea and water.

In kidney

$$\text{Excess amino acid} \xrightarrow[\text{Enzyme}]{\text{Deaminase}} \text{Ammonia}$$

$$\text{In Liver Ammonia} \xrightarrow[\text{Engyme}]{\text{Urginase}} \text{Urea+Water}$$

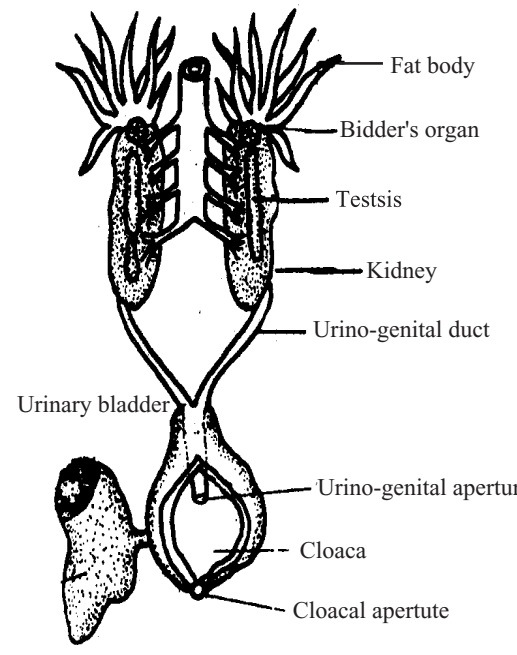


Fig : 8.38 Male Re-productive system (Urino-genital system)

You have learnt earlier that the afferent branches of the renal arteries dividing into numerous fine blood capillaries form the glomerulus. Through these afferent branches blood enters the **glomerulus** and passes through the **capillaries.** Due to high blood pressure, urea, glucose, and other soluble substances of blood enter the **renal tubules** crossing by the delicate walls of glomerulus and **Bowman's capsule.** Refined blood leaves the Bowman's capsule through different arteries. By the cells of the walls of renal ducts water, glucose, sodium chloride and other substances are absorbed from the solution inside these ducts. Residues are discharged with urea from the body by uretor.

Reproductives system

Reproduction is a physiological function. It is necessary for the continuance of species, so that it does not become extinct. This process can be accomplished asexually or by sexual process with the help of the opposite sex of the same species. The offsprings produced as a result of reproduction get mature and the process is repeated. In this way the continuance of a species is maintained with the help of the opposite sex of the same species. Those organs which take direct part in reproduction are called reproductive organs and the system is known as reproductive system. Toad is a unisexual animal. Male reproductive organs are present in the male toad and female reproductive organs are present in the female toads. Below is a description of the male and female reproaductive systems.

Male reproductive system : In the male toad the organs which take direct part in reproduction are-

1. A pair of testis
2. A pair of vasa efferentia
3. Urino-genital duct or vas deferens
4. Cloaca
5. Cloacal aperture.

1. Testis: In the male toad on the dorsal side of the abdominal cavity two elongated, slightly yellowish testes are present. These are attached with the kidneys. Sometimes they are divided in pieces. The testis remains attached with the kidney by a thin membrane called mesorchium. Each testis is formed of innumerable seminiferous tubules. Sperms are produced from the inner walls of these tubules.

2. Vas efferens: Some smaller ducts coming out from the testis remain directly connectd with the collecting ducts of the kidney: These fine ducts are called vasa efferentia. Sperms from the testis enter the urino-genital duct through these ducts.

3. Vas deferens or Uriono-genital duct: A duct comes out from the convex surface of each kidney. It is the sperm duct or vas-deferens of male toad. Urine and sperms both flow through this tube. So it is also called urino genital duct. Each duct becoming dilated forms the seminal vesicle below the kidney.

4. Cloaca: Behind the rectum the common chamber where the rectum and urino-genital duct opens is called cloaca. Through this sperms can pass towards the cloacal aperture.

5. Cloaca aperture: The aperture situated at the extreme posterior end of the body is called cloacal aperture. Sperms are discharged outside through this aperture.

Bidders's organ: This red coloured organ is situated at the anterior part of each testis. It is an inactive organ in male toad and in female toad it remains in immature condition. It vanishes in mature female toad but persists in mature male toad with small size. Its function is not yet known.

Fat Body: Finger like yellow coloured organs are situated at the anterior ends of the kidneys of both the male and female toads. Fatty substance remains stored in it and hence it is called fat body. The reproductive cells get nourishment from this fat body and they also provide nourishment to the toad during hibernation.

Female reproductive system

The organs which form the female reproductive system of toad are

1. A pair of ovaries
2. A pair of oviducts
3 A pair of uteri
4. Female genital aperture.

1. Ovary: The female toad has two ovaries. These are situated on the dorsal side of abdominal cavity. They have no definite shape; they grow during the breeding season. Within the ovaries innumerable ova are produced. Matured ova are black and spherical. At this time the two ovaries burst and the ova become scattered.

2. Oviduct: The toad has a pair of narrow, whitish, coiled oviducts. At the anterior end of each duct there is a funnel and the posterior end widens to form the uterus. The ova enter the oviducts through the funnels.

3. Uterrus : The posterior part of each oviduct becomes dilated to form a sac like structure. This is uterus, where the ova remain stored temporarily. Later the two uteri meet together and open into the cloaca. The urine and ova of the female toad pass into the cloaca through two separate ducts. Later through cloacal aperture they are discharged from the body.

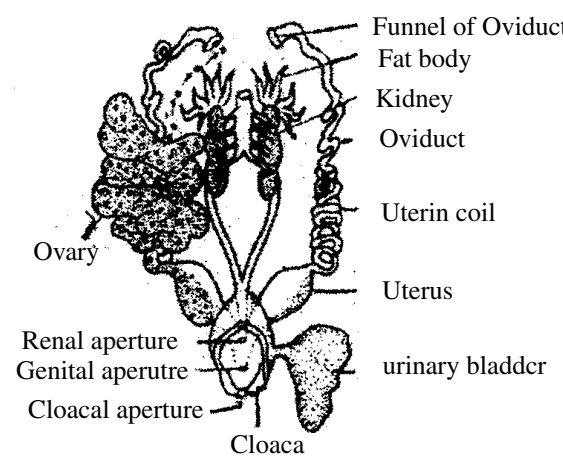


Fig : 8.39 Femele Reptoductive System (urino-gerital systemy)

Life cycle and metamorphosis :

The life cycle of toad is very complex. Rainy season is the breeding season of toad. At this time they become very active. The male toad croaks to attract the female toad. Sexual union occurs between a matured male and a female toad. This sexual union is called mating. During mating the female toad releases eggs in shallow water. The male toad simultaneously releases sperm over the ova. Zygote is formed by the union of sperm and ovum. The zygote is then transformed into an embryo and after passing through various stages, it becomes a mature toad.

Structure of ovum and sperm:

Egg: The ovum is often called an egg. The eggs appear as mustard-grain and can be seen in naked eyes. The shape of the ovum of toad is rounded, one end is blackish and the other end is whitish in colour. At the blackish end of ovum remains the cytoplasm and nucleus and in the whitish end portion remains the yolk. The amount of yolk in the ovum of the toad is plenty. Each ovum remains covered by a thin membrane. The egg having the yolk side is called a "Telolecithal' egg.

Sperm: The sperm of toad cannot be seen with naked eyes. The sperm cell is divided into three parts, such as:

Head part, middle part or neck, Tail part

A. Head: The head of the sperm is oval shaped Inside it lies the nucleus. Where remains the haploid number of chromosomes.

B. Neck or Middle part: The middle small portion between the head and tail of sperm is the neck. In this part of the cell remain centrosome and mitochondria.

C. Tail: The narrow, elongated and motile part of the sperm is called tail. With the help of this narrow tail the sperm swims in water.

Fertilization and development:

After the formation of ova in the ovaries of female toad, they pass towards the outer side through the oviducts. At this time the ova are surrounded or covered by albumin and take the shape of transparent ribbon. Inside this ribbon like part ova or eggs are arranged one after another in a row. In contact with water this ribbon like part swells and floats on water with eggs. In this condition union of sperm and ovum takes place. This union of sperm and ovum is called fertilization. The process of fertilization takes place in water outside the body of toad**:** This type of fertilization is called external fertilization.

Each sperm has a tail. When the sperm meets an ovum its tail is dropped. Zygote is formed when the ovum is fertilized by the sperm. Within a few hour of fertilization, the division of zygote begins. Zygote being divided by mitosis process forms an embryo. In this cell division at first a cell divide into two. Then from two, the number of cells becomes four. Soon from four the number increases in a rate of eight, sixteen, thirty two, etc. This change of the zygote is called embryonic development. At this time the embryo passing through many stages or steps becomes transformed into a three-layered embryo. These three layers are **Ectoderm, Mesoderm and Endoderm.**

1. Ectorderm: The outer layer of the embryo is called ectoderm. This forms the integument, nervous system and sensory organs.

2. Mesoderm: The middle layer of the embryo is mesoderm. This layer forms connective tissue, Vascular tissue, muscular tissue, sex organs etc.

3. Endoderm: The innermost layer of the embryo is endoderm. It forms the epithelium of the alimentary canal, liver, lungs, pancreas and other organs.

Within two weeks of the fertilization the formation of embryo from zygote is

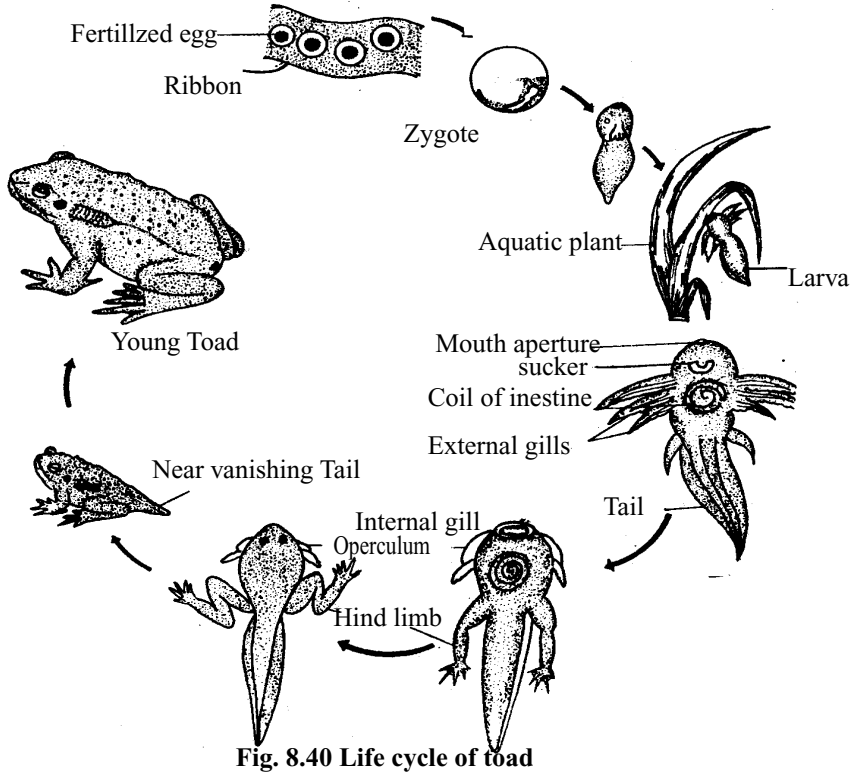


Fig. 8.40 Life cycle of toad

completed and it comes out breaking the covering of the egg. This stage is called larva or tadpole. The tadpole looks like a fish fry. The body of a tadpole is divided into three parts, a rounded head, a small narrow trunk and a flat tail. On the ventral side of tadpole and at the junction of the trunk and the tail the cloacal aperture is located. Initially the tadpole does not have mouth aperture, limbs and eyes. Instead of mouth aperture there remains a sucker on one side of the mouth. With the help of this sucker the tadpole keeps itself attached to algae or any other aquatic plants. At this time the tadpole does not takes any food; lives by taking nutrition from the yolk of the egg. There remain three pairs of external gills on two sides of the head. with the help of gills the tadpole performs respiration. In later stage mouth is formed at.the side of the sucker. Fins are formed on the upper side of the tail in the form of folds. External gills disappear and internal gills are formed inside the body: Coiled alimentary canal is seen indistinctly from the upper side of the body. In the mean time strong jaws are formed in the anterior part of the head. The gills of tadpole remain covered by an operculum like the fish. Oxygen dissolved in water, comes in contact with gills and respiration is performed.

After some days these gills disappear within the body and lungs are formed. In the meantime, first the hind limbs and then the fore limbs are formed. The tail gradually disappears within the body. The alimentry canal is small in size. The sharp parts of the jaws of the mouth are dropped and the mouth aperture widens. At this time the tadpole is transformed into a tiny toad and leaves water. By eating small worms and insects it gradually grows larger.

At one time the tail of the toad completely disappears. The organs of the toad after being well formed, the baby toad is transformed into a full grown toad When the life cycle of the toad is observed it is seen that there are many physical differences between a tadpole and a baby toad. At the time when the tadpole gradually transforms into the future toad, it passes through such intermediate stages with which the body-shape of a full grown toad has no similarity. Such changes of the life cycle of the toad are called metamorphosis The metamorphosis of the toad is controlled by the hormone named Thyroxin.

Toad

Excrcise

Multiple choice questions

1. Which one is the triangular cartilage of Toad?

a. Ischium Pubis
b. Supra-scapula
c. Pubis
d. Sternum

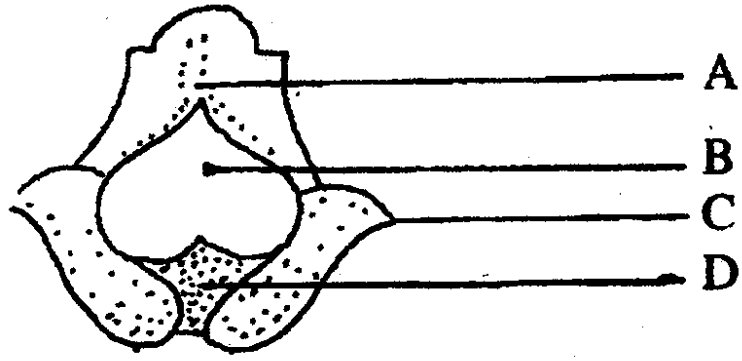
2. In the body of the Toad the food stores-

i. glucose as glycogen
ii. protein as amino acid
iii. fat as fat bodies

Which one of the follwing is correct?

a. i
b. i & ii
c. i & iii
d. ii & iii

Give answer to the question No. 3 & 4 in support of the following diagram.



3. Which part of the diagram has similarity with typical vertebrae?

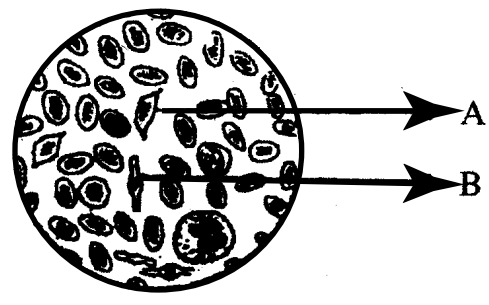
a. A
b. B
c. C
d. D

4. How many parts are necessary in the figure to be called an ideal vertebra?

a. One
b Two
c. Three
d. Four

Creative questions

1. While Gulib, an SSC examinee, was dissecting a Toad at his residence as a preparation for practical exam his grandmother was sitting beside him. Seeing the red blood of toad his grand mother asked him whether Toad's blood can be injected in human body when needed. Gulib said no in answer to this question. Moreover he gave some idea about the plasma and blood corpuscles showing the following figure from the book.



a. What is plasma?
b. Describe a single role of leucocytes in the body.
c. What was the scientific explanation of Gulib about not to inject Toad's blood into the human body.
d. What type of problems may arise with the shortage of the corpuscles labelled A & B in the diagram.

CHAPTER-NINE

Physiological Activities in Plants Nutrition

Plant Nutrition And Nutrient Elements :

Green plants manufacture carbohydrate foods by the process of Photosynthesis. These foods again break down to water, CO_2 and energy. That energy is used in plants growth and other process. But only Carbohydrate is not sufficient for healthy growth, physical development and regenerations of the plant body. Beside these, for normal completion of other physiological functions plant absorb different kinds of inorganic minerals from nature. The process of absorption of necessary minerals for healthy growth of the body; physical development and regeneration is called Nutrition or mineral nutrition of plant.

Nutrition and its Components:

Several nutritionists proved that, there are 16 inorganic elements necessary for normal growth and development of the plant. They are so important that they are called essential elements. Their characteristics are as follows: -

* They are essential for normal development and reproduction or the plant.
* For shortage of any one of them, deficiency symptoms shows in the plant body.
* Function of one element cannot be done by another one.

Mineral nutrients are divided into two groups, depending on how much of it is required for normal growth and physical development.

1. Macronutrients: Comparatively they are needed in large quantities. 10 minerals are macro nutrients, they are: - Nitrogen (N), Potassium (K), Calcium (Ca), Iron (Fe), Magnesium (Mg), Carbon (C), Hydrogen (H), Oxygen (O), Phosphorus (P), and Sulphur (S).

These 10 macronutrients can easily be remembered by the following sentence -Mg.K. CaFe for Nice CHOPS = Mg.K Cafe for good chops. Here

Mg for Magnesium, K for Potassium, CaFe for Calcium and Iron, CHOPS for Carbon, Hydrogen, Oxygen, Phosphorus and Sulphur.

2. Micronutrients: They are needed in minute amount. Following six elements are micronutrients: Zinc (Zn), Manganese (Mn), Molybdenum (Mo), Boron (Bo), Copper (Cu), and Chlorine (Cl). Beside these Sodium (Na), Aluminum (Al). Silicon (Si). and Cobalt Co) are also needed.

Source of Nutrients :

Among all the nutrients the plants from atmosphere absorb only Carbon and Oxygen. Other elements are absorbed from soil by root. These elements are present in the soil as different salts, but plant cannot intake them directly They absorb as different ions.

Action of different mineral nutrients in plant nutrition:

Actions of different elements are very acute in plant nutrition. For these elements are termed as essential elements. Formation of chlorophyll is hampered for the deficiency of Nitrogen. If chlorophyll is not formed manufacturing of food is hampered. If manufacture of food is seized it hampered the process of respiration and causes less production of energy. Magnesium is one of the elements of chlorophyll. As a result for deficiency of it will seize the formation of chlorophyll and manufacture of food by photosynthesis. Potassium acts as a catalyst in many biochemical reactions in plants, for this it is necessary in plant nutrition. The development of plant by cell division is also control by potassium. So without it plant nutrition is not at all possible. We use Nitrogen (Urea), Potash (Murrate of Potash), Phosphorus (Triple supper Phosphate) ect. for crops as it play valuable role in nutrition.

Deficiency Symptoms of Nutrients :

Plants show special symptoms in case of deficiency of any element. These symptoms are called Deficiency Symptoms or deficiency disease. We can ascertain the deficiency of any element by observing these symptoms. Deficiency symptoms of some elements are stated below:

Elements	Deficiency Symptoms
Nitrogen (N)	Formation of chlorophyll hampers for its shortage, as a result leaves become yellow. Young leaves become yellow at last. This process of becoming yellow is called Chlorosis. It reduces the development and rate of cell division, so reduces the growth of plants.
Phosphorus (P)	Deficiency of Phosphorus causes the leaf to tern violet. Necrotic area develop on the leaf, reduces the growth of root, may cause root, leaf or flower fall.
Potassium (K)	Leaf apex and margin becomes yellow and forms necrotic areas for the shortage of Potassium.
Iron (Fe)	Due to the deficiency of Iron at first the young leaves become fade in colour, the middle of the narrow veins become fade first. Some times the whole leaf become discolour.
Magnesium (Mg)	Older leaves become yellow first. Chlorosis develops at the intervenial spaces Necrotic area . develops on the leaf.
Boron (B)	Deficiency of Boron reduces the growth of root. Top of the shoot dies and hamper the production of flower bud.

Exercise

Multiple Choice questions

1. What are the nutrient elements plant directly receive from the atmosphere?

a. N,H b. C,O

c. O,Cl d. C,N

2. The mineral elements of the plants are regarded as essential elements because of its deficiency in plants-

i. normal growth is hampered.

ii normal reproduction is hampered

iii. lose resistance power.

Which one of the following is correct?

a. i b. ii

c. iii d. i, ii & iii

Answer the question no 3 & 4 in support of the following diagram.

Goni Mia is conscious farmer. He knows what would be the damage of crops for the wants of different manures. So he regularly uses urea. Potash & TSP and gets good harvest. For want of these different deficiency symptoms are developed.

3. Purpose of using TSP in the land of Goni Mia is to the plant-

i. provide RNA

ii. provide $C_6H_{12}O_6$

iii. provide ATP

Which one of the following is correct?

a. i b. i & ii

c. ii & iii d. i, ii & iii

4. What symptoms would be seen if potash would not be used in the land of Goni Mia?

i. Reduction of plant growth

ii. Necrotic area would be formed in the leaves.

iii. production will be less

Which one of the following is correct?

a. i b. i & ii

c. ii & iii d. i,ii & iii

Creative questions

1. Lipica used to irrigate, weed out etc. in her flower garden regularly. One day she observed leaves of some flowering plants turned yellow, some leaves become discolour and leaves, flowers and buds of some other plants fall down. She went to a horticulturist as nothing was known to her about the cause. The horticulturist, told her like animals the plants also need much balanced mineral nutrition. So he advised to supply essential nutrients in the garden.

a) What do you mean by mineral nutrition?

b) What is the cause of discolour the leaves of some plants of Lipica's garden?

c) What may be the correct explanation of the leaves being turned yellow and falling down of leaves, flower and fruits of the plants of Lipica's garden?

d) Analyse the way to solve the problem of Lipica's garden according to the the advise of horticulturist.

Imbibition, Osmosis, Ascent of Sap And Transpiration

Imbibition

If one side of a piece of blotting paper is touched water surface, the blotting paper will gradually absorb water and becomes wet. We can do this experiment with a piece of newspaper too. Imbibition is also a process of water absorption. Absorption of water by dry, semi-dry colloidal substances called **Imbibition.** More easily it can be said that the process of absorption of water by plant cell wall, protoplasm etc. is called imbibition. The amount of water absorbed by dry seeds during germination is done by imbibition.

The substances, which absorb water, are called Hydrophilic (water loving) substances. Hydrophilic substances contracted for shortages of water, again when it gets water become swollen by absorbing it.

It is seen that in winter the wooden doors and windows make gaps for contraction and in the rainy season they swells up by absorbing water and it become harder to open the doors and windows. It is a result of imbibition.

Diffusion

If a spoon of sugar dissolves in a glass of water, the sugar molecules spread throughout the whole glass of water; as a result the whole water becomes equally a sweet. If a spoon of salt is dissolved in a glass of water, it is seen that whole water becomes equally salted. Let us see what happens if some crystals of Potassium permanganate ($KMn0_4$) is dropped into a glass of water. After some times it will be seen that the whole water in the glass becomes violet. Dropping a drop of ink in the glass may do this experiment.

Actually in a crystal of sugar, salt or potassium permanganate there are any molecules compactly combined together. When the crystal is dropped in water the water molecules attract its molecules very strongly. As a result the crystal is completely dissolved in water and its molecules are spread throughout the water evenly. The molecules of sugar, salt or potassium permanganate distributed throughout the water by the process **diffusion**.

At a constant temperature and atmospheric pressure movements of the molecule

of a substance from a region of high concentration to a region of low conecentration is known as diffusion. The term diffusion means to distribute throughout.

Diffusion Pressure :

The potential ability of a substance to move from a region of high concentration to a region of low concentration at a constant, temperature end atmospheric pressure is called diffusion pressure. The diffusion pressure of gas is a gas balloon is higher than the diffusion pressure of its surrounding air. So when the balloon bursts, the gas inside the balloon spread throughout the surrounding air due to its higher diffusion pressure.

Factors Affecting Diffusion:

Diffusion of a substance depends on temperature, atmospheric pressure. Concentration of molecules of that substance and concentration of the medium.

Temperature: with the increase of temperature diffusion usually increases.

Concentration of the substrate: The rate of diffusion will be higher if the concentration of molecules of the substrate is higher; if the concentration is less, rate of diffusion will be less.

Concentration of the medium: If the concentration of the medium, like water or air, is more, the rate of diffusion will be less; and if the concentration is less the rate of diffusion will be high.

Atmospheric pressure: Increase of atmospheric pressure will reduce the rate of diffusion and decrease of atmospheric pressure will increase the rate. Usually temperature and pressure at a certain place remain same at a certain time, in that case the concentration of the substance and the concentration of the medium become the factors to control diffusion. If the medium and the diffusion substance are same (as in the balloon and the surrounding air) then diffusion will continue till the concentration of the two become same.

Diffusion through membrane :

If two solutions (mixture) of different concentrations is separated by a membrane then the rate of diffusion between two solutions will depend on the nature of the membrane. Usually we find three types of membrane in plants: -

) **Permeable Membrane:** Molecules of both solute and solvent can be diffused through this membrane. Cell wall, made of cellulose, is of this type.

) **Selectively permeable (Semi permeable) membrane:** Only the solvent molecules can diffuse through this membrane, not the solute molecules. Cell membrane is a semi permeable membrane.

) **Impermeable membrane:** molecules of both solute and solvent are impermeable (can not pass through= can not diffuse) through this membrane. Cell wall coated with cutine or suberine is impermeable membrane.

Importance of diffusion :

Diffusion plays a great role in plant life. CO_2 - necessary compound for photosynthesis is absorbed from air (atmosphere) by diffusion process. The process happens in the spongy parenchyma of leaves. Oxygen - necessary for respiration, is also intakes from air by diffusion. Movement of water and mineral salts in the plant body takes place by diffusion. Diffusion also responsible for loss of water from the aerial shoot of the plant.

OSMOSIS

If a raisin is kept in a cup of water for some times it will be shown that the raisin will absorb water and become full and flashed. The outer covering of the raisin is a semi permeable membrane. Out side this membrane there is water in the cup, and inside the membrane there is sweet juice of raisin. The amount of water in the cup is more (actually whole amount is water) but that inside the raisin is very little. In this condition water from the cup enter into the concentrated region inside through the semi permeable membrane of raisin. As a result the raisin swollen and filled with juice. It is happened by a special process known as **Osmosis.** Osimosis may be defined as -a process by which solvent (water) diffuse from an area of high concentration through a semi permeable membrane to a area of low concentration solution is termed as Osmosis. The process continues till the concentration of two solutions become same. Osmosis is a special type of diffusion.

We know solution is a mixture of solute and solvent, for example mixture of sugar and water is a solution. Here water is the solvent and sugar is the solute and the mixture is the solution. In osmosis diffusion of solute never takes place, only solvent diffuses that is in case of plants only water diffuses.

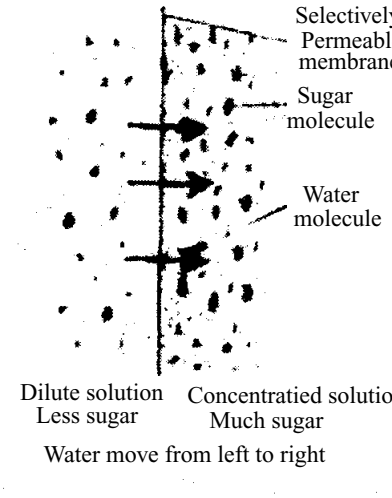


Fig. 9.1 Osmosis

Two types of Osmosis:

*** Endosmosis:** osmosis in which solvent (water) from outside enter inside the cell, is called **endosmosis**. Concentration of cell sap is more than the concentration of the outer solution. Put some raisins in water Water will enter inside the fruits (raisin) and the raisin will swell up like a grape being filled with juice.

*** Exosmosis:** Osmosis in which water (solvent) comes out from inside the cell is called exosmosis. Exosmosis takes place when the concentration of external solution is more than the concentration of cell sap.

Put some grape in salt solution and observe it. Water will come out from the grape and it will contract.

Condition of Osmosis: The process of smosis may occur under the following conditions:

***** There should have two solutions. One concentrated and other dilute.

0. A semi permeable membrane should separate the two solutions of different concentration.

***** The two solutions must be of same solvent.

***** Temperature and atmospheric pressure should be same.

Osmotic Pressure: = OP:

In the process of osmosis pressure required from higher concentration area to stop the movement of solvent from lower concentrated solution to higher concentrated solution when a semi permeable membrane separates the

two solutiions, is called **Osmotic Pressure (OP).** More the difference of concentration of two solutions more the OP, and less the difference of concentration, less will be the OP. if the concentration of two solutions is same there will have no OP and osmosis will not run.

Turgor Pressure

Due to endosmosis water enter into the cell and the cell become swollen. This swollen condition of the cell is called turgidity. Due to turgidity the protoplasm exert a pressure on the cell wall; this pressure is called Turgor **Pressure.**

An Experiment of Osmosis:

Osmosis can be observed by putting a Potato Osmoscope.

Requirements: A large Potato, A Bowl, Water and Sugar solution.

Procedure: Take half bowl of water. Cut two ends of the potato and make a hole at one end. Now fill up half of the hole of the potato by sugar solution and keep the potato (Potato Osmoscope) in the bowl's water. Care should be taken so that water level should be below the top of the potato cup.

Observation: After some times it will be seen that the level of the solution in the potato cup is increased.

Conclusion: Outside surrounding the potato there is water and inside the hole there was sugar solution. Cell walls of potato is permeable and the cell membrane is semi permeable (selectively permeable). So the water from the bowl enters through the cell wall and cell membrane to the solution in the hole of the potato. As water enters to high concentration solution through semipermeable membrane so other process is osmosis.

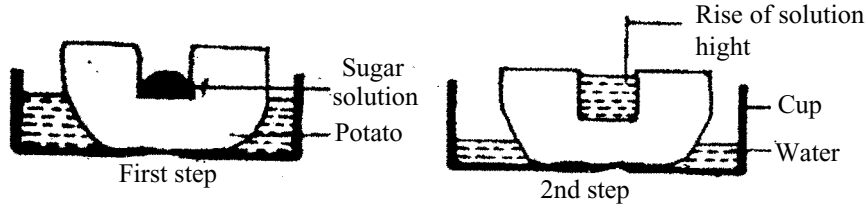


Fig: 9.2 Demonstration of Osmosis by potato Osmocope

Necessity of Osmosis in Plant Life:

Necessity of osmosis in plant life is unlimited. A short description about this is given bellow:

* **Absorption of water:** Plant absorbs water by root hairs in the process of osmosis.

* **Movement of water:** Water moves inside the, plant body by cell-to-cell of osmosis.

* **Opening and closing of stomata:** Opening and closing of stomata is controlled by osmosis. So osmosis also controls the rate of transpiration.

* **Swelling and growth of cell:** For normal growth and expansion of the cell it needs to swell. Cells become expanded by absorbing water through osmosis. This osmosis plays an important role for the growth of the cell and maintains its normal shape and size.

* **Equal distribution of water:** Water is essential for almost all the organic activities. These activities are going on in the living cells. Osmosis is very active to reach water to every living cell from root to leaf.

* **Turgidity of the cell:** Soft cells become turgid by absorbing water. Cell absorbs water by osmosis.

* **Germination of seeds:** The success of germination depends on the process of osmosis.

Absorption of water & minerals by the plant :

Both water and minerals are essential for plants. Plants absorb water and minerals from soil. The process of absorption of water and minerals is described very briefly :

Absorption of water:

The higher plants absorb water from soil by their root hairs. Root hair region is termed as absorption region. Unicellular root hairs are specially modified epidermal cell for absorption of water. Cell walls of root hairs are made of cellulose and thus it is permeable. Beneath the cell wall, there is the cell membrane, which is selectively permeable. Inside the root hair the cell sap is concentrated and in the outside there is water in between soil particles. So water from soil enter into the cell through permeable cell wall and selectively

permeable cell membrane by osmosis. Afterwards this water from root hair reaches the vessels of xylem tissue by cell-to-cell osmosis (shown in fig; 9.3). From vessels the water moves to leaves.

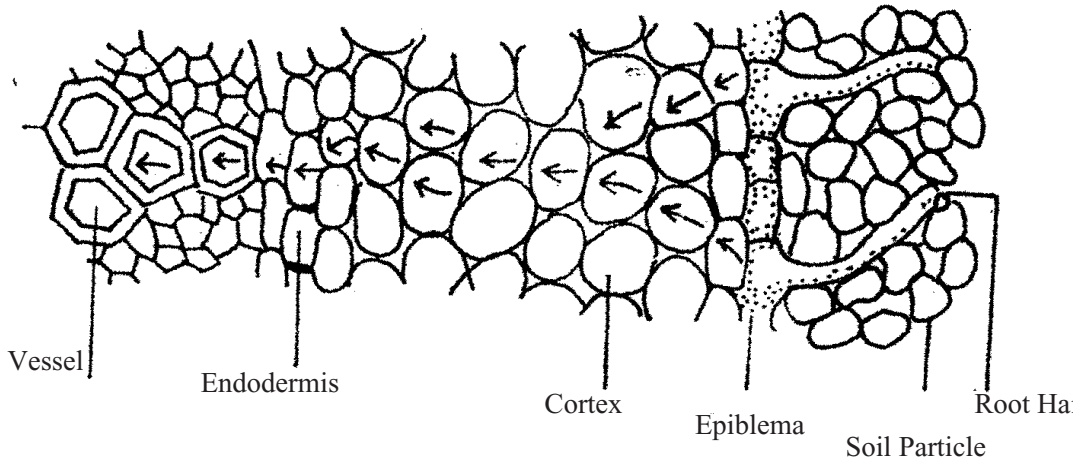


Fig. 9.3 Absorption of water from soil by Root hair and movement through xylem vessel

Absorption of minerals :

Cell division region at the top of the root is known as mineral absorbing area, some salts also absorb by root hair. Plant cannot take solid salts. The salts (minerals) dissolve in soil-water and converted to Cation (+) and Anion (-), root absorb them as ions. Na^{+} is a Cation Cl^{-} is an Anion. K^{+}, Ca^{++} are Cations; NO_3^-, PO_4^-, SO_4^- are Anions.

Difference between Absorption of Water and Minerals:

Water absorbed directly and minerals are taken as ions. Water absorbed by root hairs and minerals are taken by cell division region at the top of the root. Water is absorbed by osmosis and some portion of minerals is taken by diffusion.

ASCENT OF SAP:

Water with dissolved mineral salts inside a cell is called **Cell Sap** or **Sap.** The apical region of root (Meristamatic region and root hair region) absorbs water and mineral salts from soil. The process by which the cell sap raises from absorption region to the leaf and other parts is called **ascent of sap.** This raising of sap takes place through Vessels and Tracheids of Xylem tissue. The root hairs are spread in the spaces between soil particles. In the spaces there are capillary water. The concentration of cell sap in the root hairs

is more than the water and dissolved mineral salts in the soil. Thus water enters into the root hairs by osmosis. When water enters into the root hairs the concentration of its sap become less than the concentration of the sap of the adjacent cell. As a result water from root hair moves to adjacent cell by osmosis. In this way water moves from one cell to another and ultimately reaches the vessels of xylem tissue crossing the endodermis placed at the central region of the root. The vessel cells are tubular and are placed end to end forming a continuous tube from root to leaf. Water molecules are attached one another in such a way that is called Cohesion. Water molecules are also attached with the vessel walls this attachment is called Adhesion. Due to cohesion and adhesive force of vessels, and the pulling force (drawing force) of transpiration, the stream of water remain continuous. In this way water and dissolved mineral salts from root reach up to different organs like branches, leaves and flowers etc.

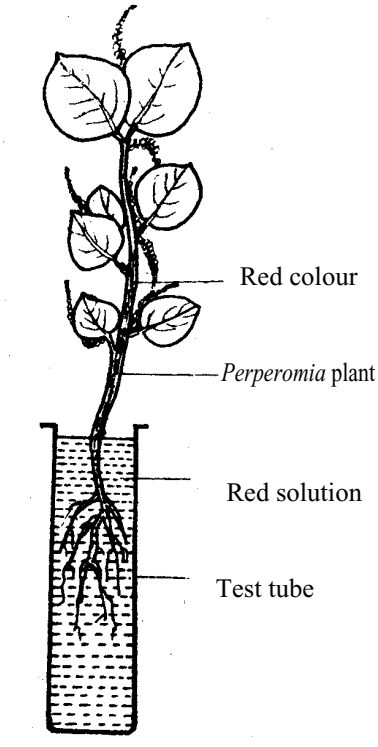


Fig : 9.4 Experiment to show ascent of sap

We can observe ascent of sap by a nice experiment in the laboratory. It will require a fresh *Peperomia* plant. The stem of *Peperomia* Plant is transparent.

Partly fill up a beaker with water and make it red by mixing a small amount of safranin. Put the plant in the coloured water in such a way so that its roots remain submerged in coloured water. After few hours it will be seen that the stem of *Peperomia* plant become red because of gradual up rise of red water through the xylem tissue of the stem.

TRANSPIRATION :

Transpiration is a physiological process. In this process plant loose water in the form of water vapour through their aerial parts mainly through the leaves. So it may be defined as "Loss of water in the form of water vapor from leaves and other aerial parts of a plant is called "transpiration." Plant absorbs water by their roots. This water conducted to all aerial parts like stem branches and leaves. So the water vapour that comes out from the plant is of water.

Types of Transpiration:

Internal water of plants usually comes out by three ways. Depending on these ways transpiration is of three types :

1. Stomatal transpiration: There are pores with two guard cells in leaves, young stems, in calyx and corolla of flower. These pores are called stomata (sing: stoma). Number of *stomata* is found more in leaves than other parts. For this reason in Bengali stomata are called pores of leaf. About 90% to 95 % of transpiration of plant takes place through stomata. Transpiration that takes place through stomata is called stomatal transpiration.

2. Cuticular Transpiration: There are Cutine coatings in young stems and leaves. This cutine coating is called **Cuticle.** Usually vapour does not come out through cuticle. But if the cuticle is thin and if the stomata are closed then a small part of transpiration takes place through cuticle. As transpiration take place through cuticle, it is called **Cuticular** transpiration.

3. Lenticular Transpiration: Due to secondary growth in stem, there develops small pore by rupturing the epidermal layer at places. These pores are called **Lenticels.** Some portion of transpiration takes place through these lenticels. As transpiration takes place through lenticels, it is called **Lenticular transpiration.**

STOMATA:

Stomata are present in leaves, young stems, calyx and corolla of flower etc. a small pore encircled by two guard cells is called a *Stoma.* Cell walls of guard cells adjacent to stomata are thick but the walls on opposite side are thin. There present a large nucleus and many chloroplasts. The swelling and looseness of the guard cells regulate the opening and closing of stomata. When the guard cells swell up the stomata opens and when it looses the stomata closes. The ventral surface of dorsiventral leave bears more stomata.

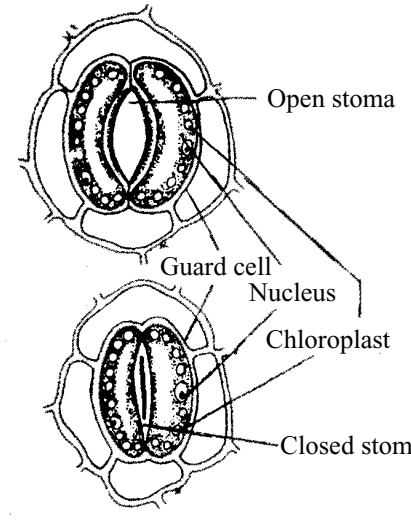


Fig. 9.5 An open and a closed stomata

Process of Stomatal Tranpiration :

Stomata are present on the leaf, usually on the ventral surface. At the upper epidermis of dorsiventral leaves there are palisade parenchyma and at the lower epidermis there are spongy parenchyma. In spongy parenchyma there are many air spaces. Stomata are present near the air space and placed on the lower epidermis. Usually vascular tissues i.e. xylem and phloem are present at the connecting zones of Palisade and Spongy parenchyma. Root hairs absorb water from soil and reach to the leaf through stem by vessels and Tracheids of xylem tissue. On reaching leaf the water come out of the xylem tissue and spread throughout all the cells of the leaf. The outer walls of the spongy parenchyma always remain wet to absorb carbon dioxide (CO_2), necessary for photosynthesis. The air inside the air space of spongy parenchyma come in contact with water of spongy parenchyma and absorb water vapour and store in the air spaces behind the stomata. Later on the vapour come out to the atmosphere through the open stomata. Air, O_2 and CO_2 also moves through open stomata. In most plants stomata remain open during daytime and closed in night. In succulent plants stomata remain open at night and closed in daytime. As a result of photosynthesis the carbohydrates inside the guard cells converted to soluble glucose and the guard cells absorb water from adjacent cells and become turgid and the stomata opens. During night. the soluble glucose converted to insoluble carbohydrate, the guard cell loose water to the adjacent cells by exosmosis and become flaccid. As a result the stomata closes. For this reason transpiration takes place in daytime.

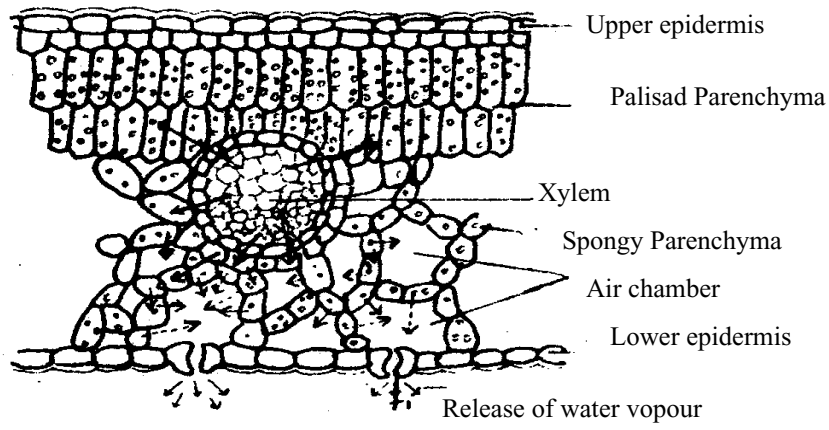


Fig: 9.6 Path of release of water shown in a transverse shown of a dorsiventral leaf

Factors affecting Transpiration :

Affecting factors of transpiration are of two types; External and Internal.

External Factors:

Light: Photosynthesis takes place in presence of light and as a result stomata opens. So light is the main factor, which influence transpiration

Temperature: With the increase of temperature water vapourises rapidly and increased the humidity in the atmosphere. So temperature controls the rate of transpiration.

Relative Humidity: If relative humidity is less the water vapour holding capacity of the air decreases, therefore rate or transpiration decreases.

* **Air Current:** The air current disposes the saturated air (as a result of transpiration), away from the plant and thus increases the rate of transpiration.

* **Atmospheric pressure:** Under low pressure water vapourise at low temperature. So if pressure decreases the rate of transpiration increases and if pressure increases the rate of transpiration will decrease.

* **Soil water:** If availability of soil water is less the rate of transpiration will decrease.

Internal Factors:

* **Root-Leaf Ratio:** If the number and total surface area of leaves become much less in comparison with root region (absorption region) the rate of transpiration will reduce.

* **Leaf area:** The greater the leaf area, greater will be the rate of transpiration, and lesser the leaf area the lesser the rate of transpiration.

* **Internal surface of leaf:** Thin cuticle, thin cell walls, exposed stomata, and well-developed spongy parenchyma favour transpiration. On the other hand leaves those possesses thick cuticle, thick cell walls, well-developed palisade parenchyma, Sunken stomata etc. will reducd the rate of transpirations.

Importance of Transpiration :

Transpiration is important to plants. The importance of transpiration is discussed briefly: -

* **Ascent of water and cell sap:** Transpiration creates a pull on the water column in the xylem vessel (which is called transpiration pull); as a result the water absorbed by the root and cell sap goes upwards.
* **Conduction of water and minerals to leaves:** water and minerals conducted to the leaves by transpiration pull. So water, necessary for photosynthesis and Mg, necessary for production of chlorophyll, conducted to leaves by transpiration. So it can be said that transpiration plays an indirect role on manufacturing food by photosynthesis.
* **Maintaining proper temperature and release of energy in leaf:** Leaves are taking energy from the sun every moment. Only 1 % of this energy is utilized in different reactions. The rest heat energy released by transpiration. If the temperature in leaf does not remain in optimum condition, all the organic activities would have been seized. So this is also a good aspect of transpiration.
* **Cell division and physical growth:** Transpiration indirectly maintains osmosis and thus keeps all the cells rigid. As a result it enhance cell division and development of the organ.
* **Resistance to Fungal infection:** Due to transpiration there deposits certain hygroscopic salts on the leaf surface, which resists fungal infection.
* **Absorption of $C0_2$ for photosynthesis:** Spongy mesophyll cells of leaves receive $C0_2$ from air present in the air spaces, by diffusion. For this the outer layer of the spongy mesophyll should always be wet. The air inside the air spaces absorbs water from here and transpires through stomata.

Excess of transpiration may cause shortage of water in plant. So excess of transpiration is harmful to plants.

Exercise

Multiple Choice questions

1. Which one is related, with the Ascent of Sap?

a. Xylem vessel b. Sieve-tube

c. Xylem fibre d. Companion cell.

2. Condition of osmosis?

i. Two solutions of different concentrations

ii A semi-permeable membrane

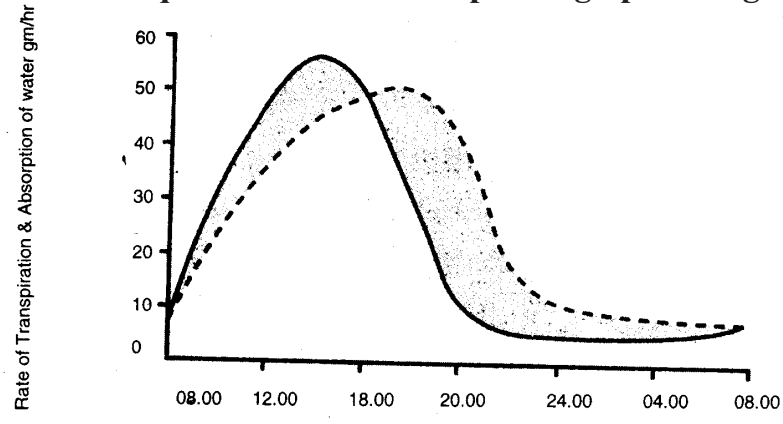
iii. A non-permeable membrane

Which one of the following is correct?

a. i b. ii

c. i & ii d. ii & iii

give answar to the question no. 3 & 4 depending upon the graph given below:



Time 24 hours (08.00 to 08.00)

The graph shows the transpiration rate & absorption of water in a plant for the duration of 24 hours.

3 When was the tranpiration rate higher than of the rate of water absorption in the plant?

a. At 8.00 b. At 12.00

c. At 16.00 d. At 20.00

4. The transpiration rate was changed from 8am to 2pm more possibly :

a. because of increase of water absorption rate of plants.

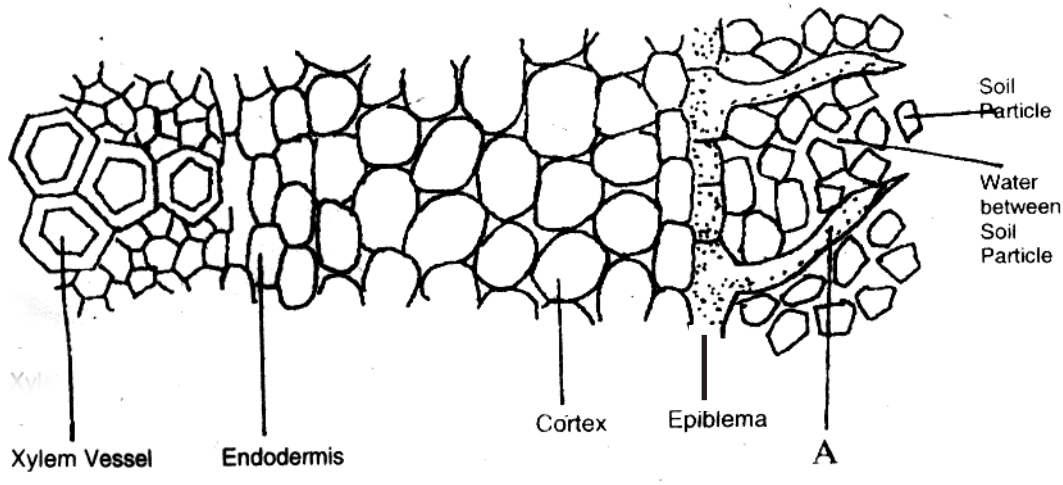
b. because of increase of photosynthesis rate of plants.

c. because of the increae of air flow.

d. because of the increase of air temperature.

Creative questions

1. See the diagram and answer the following questions.



a. What is the name of the part labelled A in the diagram?

b. What idea has been given by the drawn diagram?

c. Draw a motion diagram of the water absorbtion up to xylem vessel and explain the causes.

d. What type of problems would be arisen if the diagram A is damaged analyse.

Photosynthesis and Respiration

Photosynthesis is a biochemical process. In this process green parts (specially leaves) of plants manufacture carbohydrate food by CO_2 and water with the help of energy obtained from sunlight. Here light energy is converted to chemical energy. Plants absorb CO_2 and release O_2 as bi-product in the process of photosynthesis. The components required for this process are: - (i) Light, (ii) Chlorophyll, (iii) Water and, (iv) Carbon dioxide (CO_2).

Chlorophyll pigments are present in the chloroplasts of plant cells. Water absorbed by roots reaches to the mesophyll cells in the leaves. The process of photosynthesis is shown by the following reaction:

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

"Photosynthesis is such a biochemical reaction by which chloroplast, in the plant cell, uses the energy, received from the photon of sunlight, manufactures carbohydrate food by CO_2 of the atmosphere and water and other organic substances in the CO_2 cell.

Process of Photosynthesis:

Photosynthesis is a complex and lengthy process. In 1905 A.D. Blackman divides the process into two phases namely: 1. Light Phase and 2. Dark Phase. Both the phases are described here: -

1. Light Phage: Light is essential for this phage. In this process water breaks down to O_2, e- (electron) and Hydrgen (proton = H^+) by the help of energy obtained from sunlight. Such break down is called as **Photolysis** or **Photolysis of water.** Large amount of light energy is assimilated in chemical compound named ATP (Adenocine Tri Phosphate) and $NADPH_2$ (Nicotinamide Adenocine Dinucleotide Hydrogen Phosphate) as chemical.

energy. ATP and $NADPH_2$ are called assimilatory Power. This process of formation of ATP by using light energy is called *Photophosphorilation.* Photophosphorilation may be of two types - Cyclic and Non-cyclic. Two pigment systems (Pigment system-1 and Pigment system-2) control the light phase of photosynthesis.

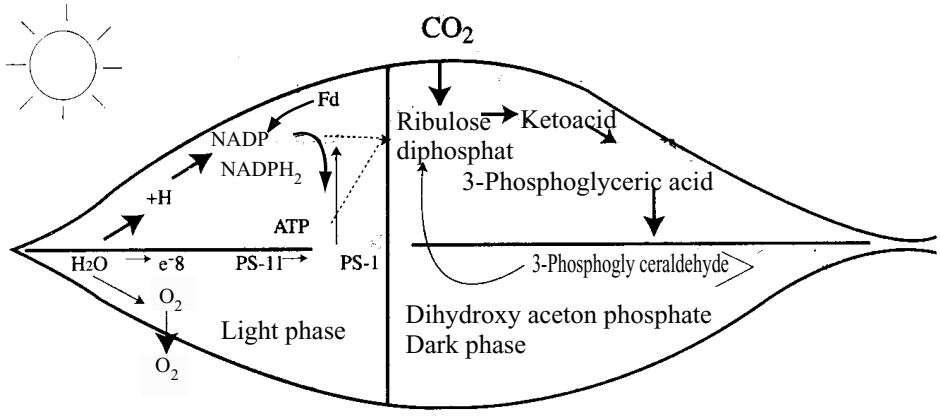


Fig:9.7 A short representation of the process of photosynthesis

2. Dark Phase: Light is not required in this process. ATP a $NADPH_2$, produced in light phase, are utilised in this process to manufacture carbohydrates. The process of manufacture of carbohydrate is as follows: -

CO_2, from atmosphere enters inside the leaf thus in the cell, through stomata. CO_2 combined with Ribulose 1,5 Diphosphate, present in the ccll produces an unstable compound named Keto acid. This Keto acid later on break down into two molecules named a 3 -Carbon compound named 3-Phosphoglyceric acid (first stable compound). This Phosphoglyceric acid then converted to 3-Phosphoglyceraldehyde and Dihydroxy Acetone Phosphate utilising ATP and $NADPH_2$, produced earlier in light phase. By several successive reactions these 3-Phosphoglyceric acid and Dihydroxi Aceton Phosphate ultimately produce Carbohydrate (Sucrose-Sugar) in one side and Ribulose 1,5, Diphosphate on the other side.

Prof. Calvin and Bassham of California University discovered this cylce of producing carbohydrate by utilising CO_2 of the atmosphere. Thus this cycle is named as Calvin and Bassham cycle. First stable compound of this cycle 3-Carbon compound thus these types of plants are called C_3 plants.

Another cycle of producing carbohydrate has discovered. It is called Hatch and Slack Pathway. In this process the first stable compound is a 4- Carbon compound, named oxalo-acetic acid. These types of plants are called C_4 plants. Sugarcane, Maize, *Cyprus* grass etc. are examples of C_4 plants. You will know more detailed in higher classes.

Organ of Photosynthesis:

Photosynthesis occurs in green parts in leaves. Various types of tissues are present in the leaf, such as upper epidermis, lower epidermis, vascular tissues and mesophyll tissue. Mesophyll tissue again are of two types-compactly, arranged elongated cells at the upper epidermis are the palisade parenchyma tissue and loosely arranged cells at the lower epidermis is the spongy parenchyma tissue.

Usually photosynthesis occurs in palisade parenchyma cells of the leaf. Palisade parenchyma contains innumerous chloroplasts. The process of photosynthesis completed in these chloroplasts. The portion of palisade parenchyma in a dorsiventral leaf is shown in diagram (Fig: 9.8).

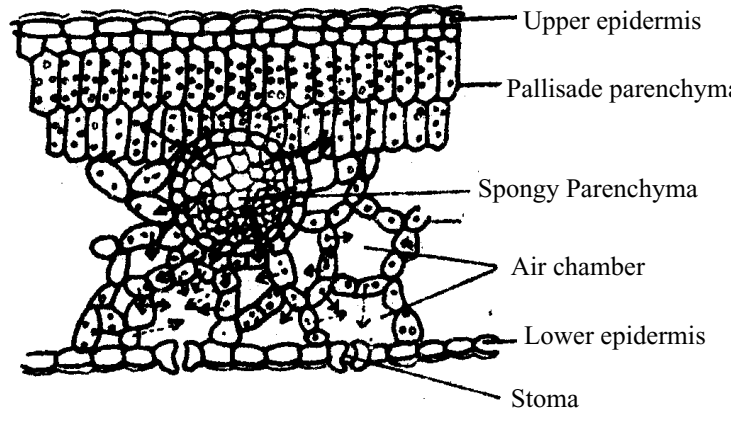


Fig. 9.8 Transverse section of a dorsiventral leaf showing Palisade parenchyma tissue.

Factors Affecting Photosynthesis:

Factors involved in photosynthesis are of two types - External and Internal factors.

External Factors :

0. Sunlight: Sunlight is essential for photosynthesis. The high-energy compound - ATP and $NADPH_2$ are formed utilising the Sunlight which help carbon reduction in dark phage. High intensity of light reduces the rate of Photosynthesis.

0. Carbon dioxide: Manufacture of carbohydrate is not possible without carbon dioxide. Thus if the amount of CO_2 reduces in air (in air there is 0.03% of CO) the rate of photosynthesis reduces.

0. Water: Water makes the guard cells turgid and the stomata opens. on the other hand water is utilised as a raw material in dark phase of the process.

0. Temperature: Photosynthesis seized near 0¡C and above 45¡ of temperature. Optimum temperature for photosynthesis is 22¡C- 35¡C. Below 22¡C and above 35¡C rate of photosynthesis decreases.

0. Oxygen: If density of oxygen increases in atmosphere the rat of photosynthesis will decrease.

Importance of Photosynthesis:

The importance of photosynthesis is unlimited. A short description is given regarding this: -

0. Manufacture of plant food: To live food is essential. Green plants manufacture food by the process of photosynthesis. If the green plant would not be able to manufacture food, then no plant could live in this world.

0. Supply of food for Animal Kingdom: Only green plants manufactures food by the process of photosynthesis. No animal, even man can manufacture their food. Rice, Bread, Fruits Fish Meat, Milk etc. whichever we eat all we get directly or indirectly from plants. So the Animal Kingdom is completely dependent on green plants, and the green plant manufacture these food by the process photosynthesis. So it can be said, the process of photosynthesis prepares of all the foods for both plants and animals.

0. Source of Energy: Much energy is exhausted in our works and movements. Source of this energy is food. Green plants manufacture food by the process of photosynthesis. Energy comes to food from the Sun light energy trapped as chemical energy in foods manufacture by photosynthesis. Food breaks down in every living cell producing energy. Source of our all energy is food and source of energy of food is the sun. So Sun is the source of all energy. Energy that needs in metabolic activities in plants and animals come from food too.

0. Ecological Balance: In maintaining Ecological Balance particularly balancing the ratio of O_2 and CO_2, photosynthesis plays a special role. The amount of oxygen gas in the airs 20.946% and that of carbon dioxide is 0.033%. This is the normal amount of oxygen and carbon dioxide gas in the atmosphere. For normal growth and living of plants and animals in this world, amount of these gases should be within normal range. On variation of the normal ratio the atmosphere will be imbalanced. We know respiration goes on in every living being (plants and animals). In respiration O_2 gas is taken in and CO_2 gas is driven out. Plants and animals both are taking O_2 and releasing CO_2 during respiration. If this system goes on successively there would have shortage of O_2 and excess of CO_2. But as green plants absorb CO_2 and release O_2 during Photosynthesis, so the ratio of O_2 and CO_2 in the atmosphere is still all right. Due to excessive deforestation the ratio of these two gases in the atmosphere is being destroyed. **Therefore, we should have to plant trees more and more.**

0. Contribution of Photosynthesis in Human Civilization: Men survive only because photosynthesis is present in green plants. But apart from the survival, the contribution of photosynthesis is unlimited in the arena of human civilisation. Coal, Petrol, Rayon, Cellophane, Paper, Rubber and Medicines etc. all are the gift of plant's.

Some Experiments on Photosynthesis:

L. Experiment to demonstrate that Oxygen is evolved during Photosynthesis:

Requirements: A large Beaker, Some *Hydrilla* Plant, One Funnel, One Test tube, water and a glowing splinter of wood.

Procedure: The Hydrilla plant should be kept in the beaker and covered with the funnel. *Hydrilla* plant be placed in such a way that its cutting ends remain towards the stem of the funnel. Water should be poured in the beaker in such a way that the stem of the funnel kept beneath the water level. A test tube completely filled with water should be inverted over the stem of the funnel. At this position the experimental set should be placed in Sunlight (or under electric light in the laboratory). **Observation:** After sometimes it will be seen that bubbles are coming out from the *Hydrilla* plant and are accumulating in the test tube. After accumulation of some gas the test tube should be taken out carefully and a glowing splinter of wood be thrusted into the test tube, it will burst into flame.

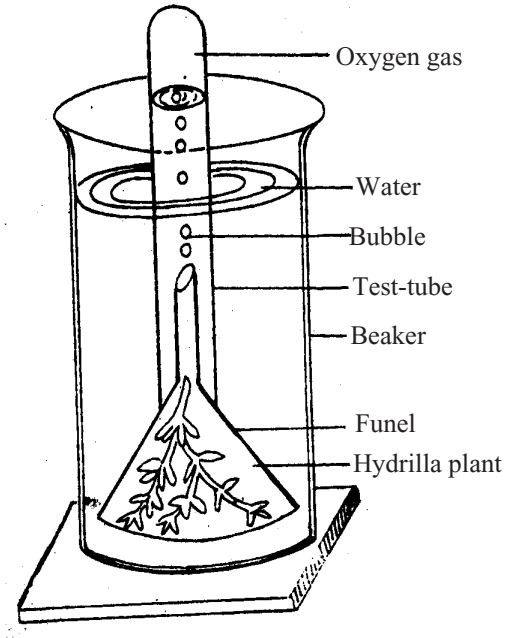


Fig 9.10 Experiment to show that O_2 is evolved during Photosynthesis

Conclusion: As the gas helps the glowing splinter to flame so the gas is Oxygen, because Oxygen does not flame itself but helps other to flame.

0. **Experiment to show that photosynthesis do not occur without chlorophyll:**

Requirements: A Variegated leaf of an Ornamental plant, Alcohol, Iodine solution, and a Beaker.

Procedure : A variegated leaf of ornamental plant should be collected at noon and its green portion be marked, then it should be boiled in alcohol and then immersed in Iodine solution.

Observation: After immersing in the Iodine solution it will be seen that only the green portion of the leaf become blue (deep violet or black).

Conclusion: Due to presence of chlorophyll only the green portions manufactured carbohydrate by photosynthesis. Having no chlorophyll orange or yellow regions did not manufacture carbohydrate. As there was carbohydrates in green portion, that portion become blue (deep violet or black).

3. Experiment to show that light is essential for Photosynthesis:

Requirements: A potted plant with green leaves, Black paper, Alcohol, Iodine solution, and clips, (the plant should keep in dark for a long time before experiment).

Procedure : Cover both side of a leaf with black paper and clip so that Sunlight cannot reach inside. Then let the pot with the plant be kept in Sunlight. After one hour tear the leaf and boil in alcohol so that the leaf becomes chlorophyll free. Now let the leaf be immersed in iodine solution.

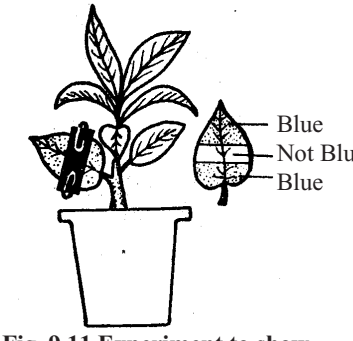


Fig. 9.11 Experiment to show that light is essential for photosynthesis.

Observation : On taking out from the iodine solution it will be seen that all the area except the covered area became blue (deep violet or black).

Conclusion: Carbohydrate react with iodine solution turns to blue (deep violet or black).

Conclusion: Carbohydrate react with iodine solution turns to blue (deep violet or black). Sunlight did not reach the area covered with black paper photosynthesis did not occur there, that is carbohydrate did not produce. As carbohydrate did not produce there the area did not turn blue (deep violet or black). Thus it is proved that Sunlight is essential for photosynthesis so to say for manufacture of carbohydrate.

4. Experiment to show that photosynthesis cannot occur without CO_2 :

Requirements : A potted plant, a wide mouthed glass-bottle, a splitted cork, caustic potash (KOH) solution Alcohol, Iodine solution and Vaseline.

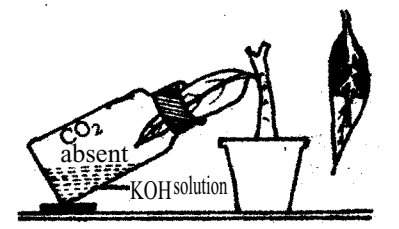


Fig. 9.12 Experimet to show that without CO2 photosynthesis cannot occur.

Procedure: The potted plant should be kept. 48 hours in darkness so that the leaves do not have any starch. One-fourth of the wide mouthed bottle should be filled with caustic potash solution.

Now take out the potted plant from darkness and insert half of a leaf in the bottle through a splitted cork, and fix tightly the cork to the bottle. Care should be made taken that a part of the leaf is placed inside the bottle. The bottle should be air tight with vaseline so that no air from out side can enter into the bottle. The CO_2 present in the air inside the bottle will be absorbed by caustic potash (KOH) solution. Now the experimental set should be placed in Sunlight. After 34 hours take that leaf and after boiling in alcohol immerse it in iodine solution.

Observation: On taking out of the iodine solution it will be seen that the portion of the leaf that was out side the bottle become blue (deep violet or black, and rest portion becomes yellow or brownish yellow.

Conclusion: The outside portion of the leaf absorbed CO_2 and manufacture carbohydrate by photoynthesis. Carbohydrate turns blue in iodine soulution. The portion of the leaf kept inside the bottle did not manufacture carbohydrate, as there was no CO_2. (CO_2 present inside the bottle was absorbed by KOH solution). Thus it is proved that CO_2 is essential for Photosynthesis. The portion of the leaf inside did not get both CO_2 and Light so it could not take part in photosynthesis.

Evolution of O_2 during photosynthesis :

In non-cyclic stage of photosynthesis in the light phage, O_2 evolved from splitted water. If O_2 was not relesed in the atmospher in the photosynthesis process, then there would be a great scarcity of O_2 in the

atmosphere. As a result the entire living creature would have perished because our respiratory system stops functioning for want of O_2.

Production of Carbohydrate during Photosynthesis:

Carbohydrate is produced during photosynthesis. Plant reserved the excess carbohydrate after their requirements. For example: Paddy, Wheat, Maize, Barley, Potato, Sweet Potato, Sugarcane etc. We took these as food. If green plants do not manufacture carbohydrate in photosynthesis, then for want of food all of the members of Animal Kingdom including human beings would have been destroyed.

What would happen if there were no Sunlight

If there were no Sunlight on the Earth there will have no Photosynthesis. Without photosynthesis there would be no movement of energy. The earth would become motionless. Without Sunlight no living being could exist.

RESPIRATION:

Every living being (Plants and Animals) have organic activities. Any work/function outside or inside the body there need energy. The main source of this energy is the Sun. Green plants trapped light energy in carbohydrates (and others) food. This food successively being oxidised release energy. Using these energy living world performed all functions and reactions. O_2 is needed to oxidize these organic compounds. As a result of oxidation CO_2 is formed inside the living body. Therefore it is revealed that organic compounds oxidize by the reaction with O_2, which is absorbed from the atmosphere. As a result of oxidation energy and CO_2 are releases. Living bodies utilize the energy but release CO_2 to the atmosphere. The process ran in both plant and animal cells. The process, by which energy and CO_2 are produce by oxidation of food materials combining with O_2, is called *Respiration.*

In respiration carbohydrate, protein, fat, organic acid etc. are oxidize and produce energy. The substances which take part in respiration are known as **Respiratory substrate.**

Respiration occurs in cytoplasm and mitochondria of a living cell. There is no definite time for respiration. This process runs 24 hours throughout the day and night. Though respiration occur in all the cells yet the rate of respiration is more in developing region like flower and leaf buds, germinating seeds, apical region of root and stem. The process of respiration is explained by the following reaction.

$$C_6H_{12}O_6 + 6O_2 \xrightarrow{\text{Enzymes}} 6CO_2 + 6H_2O + 38ATP$$

Glucose — Oxygen — Co-Enzyme — Carbon dioxide — Water — Energy

Types of respiration

Respiration is of two types . (1) Aerobic Respiration and (2) Anaerobic Respiration. The respiration where O_2 is essential called aerobic respiration The respiration that does not require O_2 is called anaerobic respiration. Aerobic respiration occurs in all higher plants. Only few lower plants (some Bacterial and Fungi) have anaerobic respiration. The processes are discussed below:-

1. Aerobic Respiration: Aerobic Respiration is the normal respiration in plant and animals. In this process Carbohydrates break down and produce CO_2 water and energy. Usually aerobic respiration is completed in four steps. the steps are as follows: -

Step - 1: Glycolysis: In this step one molecule of glucose, a 6-Carbon compound, after 9 successive reactions produces two molecules of Pyruvic, Acid, a 3- Carbon compound. In this step 4 molecules of ATP (2 molecules utilised) and 2 molecules of $NADPH_2$ are produced.

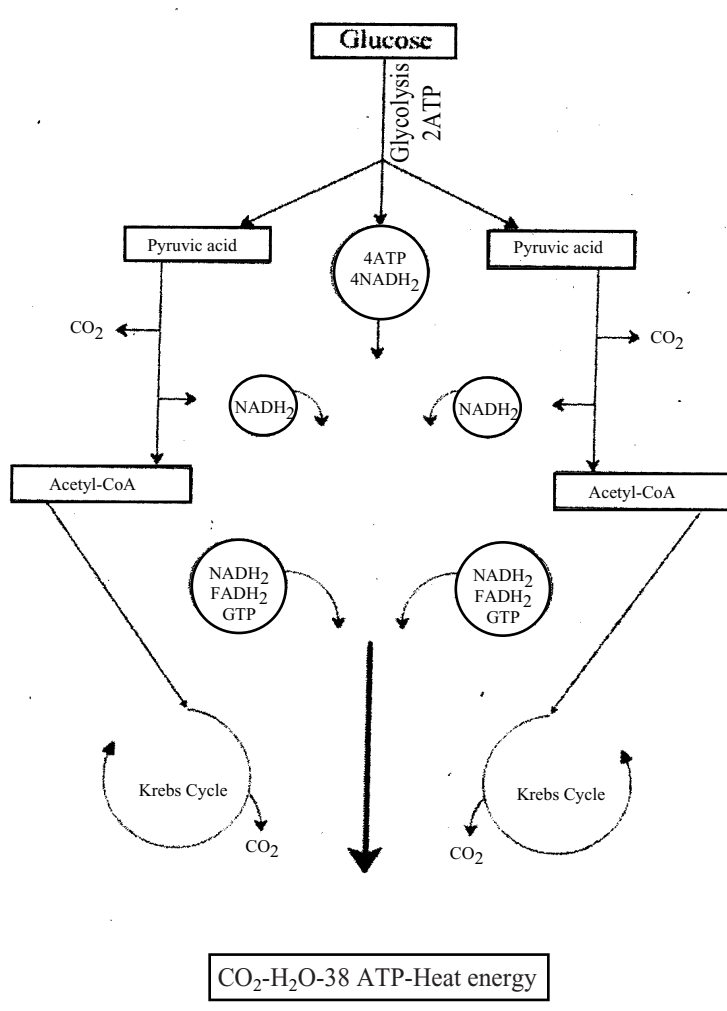


Fig. 9.13 Process of Respiration

Step - 2: Formation of Acetyle CO-A: Each molecule of Pyruvic Acid produce during glycolysis after four successive reactions produces, one molecule of Acetyle Co-A, a 2-Carbon compound, one molecule of CO_2 and one molecule of $NADH_2$. [From 2 molecules of pyruvic acid there produces 2 molecules of Acetyle CO-A, 2 molecules of CO_2 and 2 molecules of $NADH_2$]

Step - 3: Krebs Cycle: Every molecule of Acetyle Co-A enter Krebs Cycle and after 10 successive reactions produces 2 molecules of CO_2, 3 molecules of $FADH_2$, and I molecule of GTP (=ATP). From two molecules of Acetyle CO-A there produces 4 molecules of CO_2, 6 molecules of $NADH_2$, 2 molecules of $FADH_2$, and 2 molecules of GTP (=ATP).

Step - 4: Electron Transport System: $NADH_2$ and $FADH_2$ produced in the first step, being oxidized produce ATP and water.

In aerobic respiration the complete oxidation of one molecule glucose totally produces 6 molecules of water and 38 ATP (686 K. Cal. Energy). First two steps occur in cytoplasm and next two steps occur in mitochondria. Every reaction of respiration is completed with the help of special types of Enzymes.

2. Anaerobic Respiration: Anaerobic Respiration does not require any O_2. It occurs in two steps, they are: -

Step - 1: Glycolysis: In this step from one molecule of glucose there produces 2 molecules of Pyruvic Acid, 4 molecules of ATP (2 molecules utilised) and 2 molecules of $NADH_2$.

Step - 2: In this step from each molecule of Pyruvic Acid there produces one molecule of Ethanol (Alcohol) and one molecule of CO_2. Or from each molecule of Pyruvic Acid there produces only one molecule of Lactic Acid.

Importance of Aerobic Respiration:

1. Energy produced in this process is utilised by living beings to perform all sorts of reaction and other functions.
2. CO_2, released in this process is utilised directly or indirectly in photosynthesis and produces carbohydrate food.
3. This process helps plants in absorption of water, which indirectly keeps running growth and other organic processes.
4. Organic acid that produces in respiration is necessary for other organic activities, Respiratory energy also heps cell divinion.

Importance of Anaerobic respiration :

1. Some Bacteria cannot live in presence of oxygen. Among them the only process of producing energy is anaerobic respiration.
2. In this process Ethyl alcohol is produced, industries, which is used in different industries.
3. The process is utilised in Lactic Acid fermentation.

Factors Affecting Respiration:

Affecting Factors may either be external or internal: -

(a) External Factors:

1. Temperature: Below 20¡C and above 45¡C the rate of respiration reduces. The optimum temperature for respiration is 20¡C - 45¡C.

2. **Oxygen:** If the amount of oxygen is reduced the rate of respiration will reduce.

3. **Water:** Optimum supply of water maintains the rate of respiration normal. Rate of respiration reduces for scarcity of water.

4. **Light:** The stomata opens in light, so rate of respiration comparatively high in day time.

5. **Carbon dioxide:** With the increase of CO_2 in air, rate of respiration decreases slightly.

(b) Internal Factors:

1. **Food materials:** During respiration food materials break to release water and CO_2. So the quality and quantity of food materials in the cell regulates the rate of respiration.

2. **Age of cell:** Rate of respiration is maximum in young cells especially in meristamatic cells (as there is much protoplasm).

3. **Enzymes:** Different reactions of respiration need different kinds of enzymes. The process completely depends on their presence.

4. **Inorganic salts:** Rate of respiration increases if there is more inorganic salts in the cell.

Four Main Differences Between Aerobic And Anaerobic Respiration.

Characteristics	Aerobic Respiration	Anaerobic Respiration
1. Oxygen	1. Require Oxygen	1. Do not require Oxygen
2. Pyruvic Acid	2. Pyruvic Acid oxidized compllletely .	2. Pyruvic Acid oxidized incompletely.
3. Production of ATP	3. From one molecule glucose there produces 38 ATP	3. From one molecule of glucose there produces 2 ATP
4. End products	4. From each molecule of glucose there produces 6 molecules of CO_2 and 6 molecules of water.	4. From each molecule of glucose there produce 2 molecules of ethanol and 2 molecules of CO_2, or only 2 molecules of Lactic acid. No water is produced there.

Experiment to prove that Heat is evolved during Respiration:

Requirements: One Thermo flask, some germinating Gram seeds and a thermometer.

Procedure: Some germinating gram seeds are taken in the Thermo flask and closed its mouth tightly with a cork. A thermometer is introduced through the cork so that its bulb rests among the gram seeds. Note the mercury reading of the thermometer.

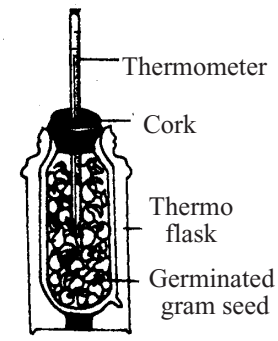


Fig. 9.14 Experiment to show that heat is evolved during Aerobic respiration

Observation: After some time an increase in the reading of mercury in the thermometer will be observed.

Conclusion: Rise of mercury indicates the rise of temperature. And this temperature is produced by the respiration of the germinating seeds.

Experiment of Anaerobic Respiration

Requirements: One small beaker, one test tube, a stand with clamp, mercury, some gram seeds, a piece of caustic potash and a pair of forceps.

Procedure: Partly filled up the beaker with mercury. Fill up a test tube completely with mercury and invert it with the help of the thumb and put it over the beaker containing mercury. Now keep the test tube upright by clamping with a stand in such a condition as if the mouth of the test tube remain in the mercury but not touched the bottom of the beaker. Now introduce some germinating gram seeds into the test tube with the help of a pair of forceps. As the seeds are lighter than mercury, they will float over Mercury. Leave the experimental set for observation.

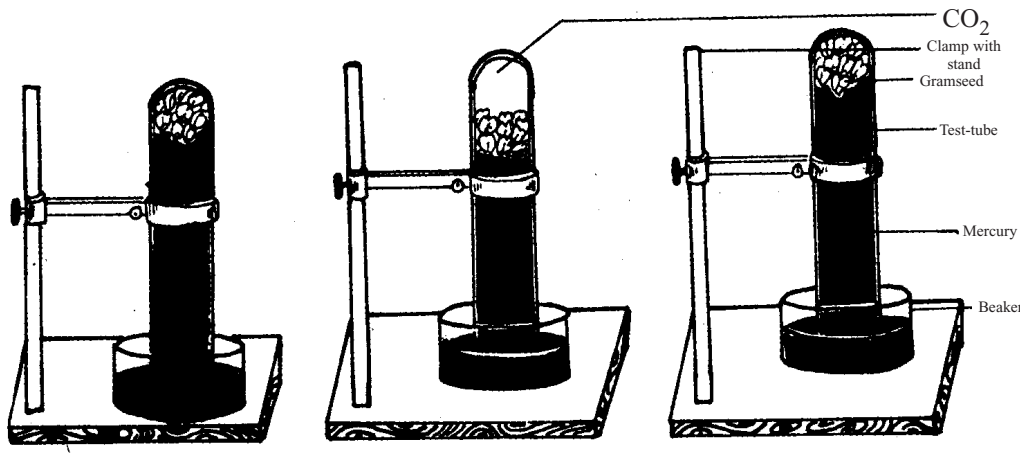


Fig. 9.15 Experiment of Anaerobic Respiration

Observation: After several hours it will be seen that the mercury at the top of the test tube has displaced downwards by a gas released by germinating gram seeds. Now introduce the caustic potash stick into the test tube with the help of a pair of forceps. It will be observed that the test tube is completely filled up with the displaced mercury as the gas is absorbed by caustic potash stick.

Conclusion: The gas is absorbed by caustic potash so it was CO_2 and respiration of gram seeds released the gas. Air cannot be present in the mercury and the gram seeds were present in mercury. So the respiration of gram seeds was anaerobic. Therefore in anaerobic respiration O_2 is not required.

Exercise

Multiple choice-questions

1. Generally how many steps are there to complete the aerobic respiration?

a. One b. Two

c. Three d. Four

2. In a jackfruit tree biological energy of action reaction comes-

i. through aerobic respiration

ii. through anaerobic respiration

iii. through photosynthesis

Which one of the following is correct?

a. i b. iii

c. i & ii d. i & iii

Answer the question no 3 and 4 in support of the following diagram.

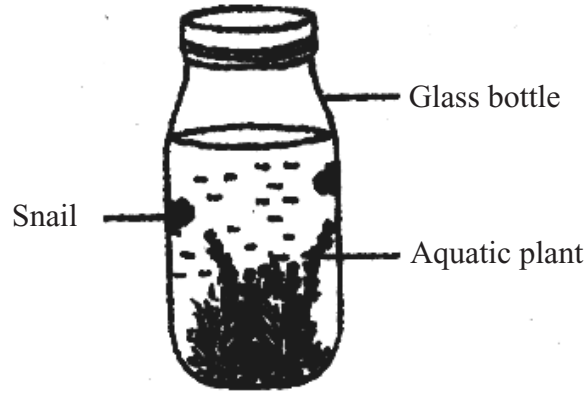


Fig.

3. Which component does require continuous supply in the above environment of the organism for living long?

a. Light b. Water

c. Oxygen d. Carbon dioxide

4. In the inside environment of the bottle releases

i. carbon dioxide from the Pila

ii. oxygen from the aquatic plant

iii. oxygen and hydrogen from the water

Which one of the following is correct?

a. i b. ii

c. i & ii d. i, ii & iii

Creative questions

One day a Biology teacher went to the bank of the school pond along with his students of class X as a part of teaching lesson on photosynthesis at noon on a sunny day. Pointing at the bubbles settled on the submerged Algae (Spirogyra) in the water near the bank, he asked the cause of their creation. Then different students answered in a different way. He collected some Algae to make all the students to realise the fact. Afterwards a scientific experiment was done on the Algae with the students in the veranda of the laboratory in the sufficient light and ensures the matter.

a. What is photosynthesis?

b. Why was the experiment done in the sufficient light on the Algae?

c. Explain the cause of creating bubbles from the Algae with the description of the mentioned scientific experiment.

d. Analyse the contribution of creating bubbles from the Algae for the well being of the biological world.

Growth and Development of Plant

We know seeds give rise to seedlings, from seedlings there develops a large plant. Plant produces flowers and fruits. These are all the results of growth and development of the plant. Embryo is present in the seed. Growth of embryo is the germination. So without the growth of embryo germination of seed will not take place. Without germination seedlings will not produce. Without growth of seedlings a large plant will not develop. Without development of a large tree we shall not get flowers, fruits, seeds, wood, crops, or the forest and nothing of this sorts. So growth and development of plant is essential for them so that they can again produce seed to maintain their growing by reproduction. Again the growth and development of plant is essential for all animals including human beings, because with growth and development of plant we will not get anything like - food, medicine, cloths, house building materials and a habitable environment. Growth is a fundamental characteristic of all living organisms. Growth means a permanent increase in shape, size weight and in bulk of a plant or its organ.

Region of Growth: The ideal growing region of plants are its root and shoot apex. In root or shoot apex there are apical meristems. This region is also known as primary meristamatic region or primary growth region.

Growth in length: The apical Meristamatic tissue by successive cell division creates new cells. The new cells later on increase in size. In this way by the formation of new cells and their increase in size, the apical parts successively increase in length. Formation of young leaf and bud is also the function of these tissues.

At the top of the root there present a cover like structure, which is called root cap. The cell division region is behind the root cap region. The cell of this region divide rapidly and forms many new cells. Behind the cell division region of elongation. Cells of this region increase in size and volume especially in length, as a result length of root increase. Behind the region of elongation lies the permanent region. Cells of this region are mature and are different is shape and size.

At the top of stem there is a bud called apical bud or shoot apex. Cells of apical bud are meristamatic cells. Therefore this is the cell division region, because cells of this region divide rapidly and increase in number. Behind this region is the region of elongation, as cells of this region rapidly increase in length. Behind this region is the permanent region, cells of this region is mature and are different in shape and size.

Growth in breath:

The breath of a one-year-old mango tree increases after one year. In this way with the increase in age its breath also increase. Breath of a mature root and stem is increased by secondary growth (lateral growth). Usually secondary growth occurs in gymnosperms and dicot plants. So all the broader plants of the world either gymnosperm or dicot plant. Examples of gymnosperms are Cycas and Pinus. Mangos, Jamboline, Litchi, Shaal, Garjan, Sundary, Teak, Gamari, Karai etc. are examples of dicot plants.

How increase in breath take place?

Increase in breath takes place in root and stem by their secondary growth in intrastellar or extrastelar region. First in the intrastelar region of vascular bundles there develops a cambium ring. This cambium ring produces secondary xylem tissue towards the center and secondary phloem tissue towards the periphery. As many secondary xylem and secondary phloem is formed from the cambium ring so much increase the breath. Secondary growth also takes place in extrastelar region (out side the pericycle).

Apical Dominance:

We came to know that apical region of stem is the ideal region of growth. During apical growth there develops young leaves and sometimes axillary bud. Always the rate of development of axillary bud is lesser than that of apical bud. It is observed that if the apical bud is removed the growth of axialiary bud expedite. For production and better growth of buds at the lower region in many cases the apical bud is removed. In Tea plant if apical bud is removed many axillary buds produces. In this way the tree characterstics of tea plants changes to shrubby nature, and production of bud therefore, the production of tea increases. By the influence of apical bud usually the production of axillary bud seized, or if produce always the growth of axillary

bud is dominated by the growth of apical bud. The dominating tendency of apical region of stem is called apical dominance.

The growth regulatory substance named Auxin mostly present at the shoot apex, for which growth rate is higher at this region. When apical bud is removed Auxin flows downwardly, thus produces axillary bud or accelerate their growth.

You can demonstrate the apical dominance very easily. Cut the apical bud of a potted chili or ornamental plant. Then it will be observed that the axillary buds developed to branches. Without cutting the apical bud not much branching will occur.

Growth regulatory Substances: Growth Regulators

There are some biochemical substances, small amount of which regulate the growth of plants. These substances are produced in the plant bodies. As they regulate the plant growth so they are called growth regulators. Earlier they were called Hormone. As they are produced in plants they are now named phytohormone. Phyto- means plant.

Growth regulators are divided mainly into two types: -

(1) Growth promoter and (2) Growth inhibitor.

Growth promoters are Auxin, Gibberellin, Cytokinin and Flowering hormone. And Growth inhibitors are Dormin or absecic Acid.

Influence of Auxin :

(i) Auxin increases the length of the cell, (ii) Produce apical dormancy (iii) Initiates the formation of root, (iv) Help to produce seedless fruits.

Uses of Auxin: (1) Used for germination of seeds (2) As Auxin Initiate root formation so it is used in grafting of mango, litchi, *Psidium* etc. plants. (3) It used in case of early fruit fall. (4) Auxin also used in production of seedless fruits, in floriculture, tissue culture and in management of weeds.

Influence of Gibberellin: (1) Gibberellin increases the length of stem. Breaks the dormancy of seeds and buds (3) Help to bloom the flower.

Influence of Cytokinin: Cytokinin accelerates cell division.

Uses of Cytokinin: (1) Used for production of seedless fruits (2) In tissue culture.

Abscisic Acid: Leaves and buds droped by its influence. inhibit growth of bud.

Tropism

When one look at the Banyan tree it will be seen that the branches and sub-branches are growing towards the light, but the Prop roots originated from the branches growing towards the earth. If a gram seed is kept on wet soil it will germinate within a few days. It will be seen that its radicle gradually develop and goes into the soil and plumule goes upwards against the soil. The movements of plant organ towards certain direction like light; earth or water is called tropism. The tropism maybe towards stimulant like light, earth or water or may against to those. Movement of plant organ towards the stimulant is called positive tropism. On the other hand movement against the stimulant is called negative tropism. Tropic movement towards light, earth, water and any chemical is described briefly:

(a) Phototropism : The stem and branches of plants always expanded towards light but root and its branches expands against the light. Movement of stem towards light is called positive phototropism and movement of root against light is called negative phototropism.

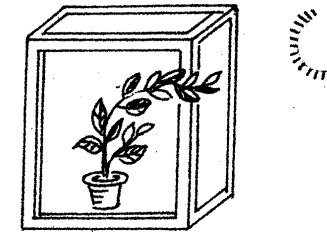


Fig. 9.16 Experiment on phototropism

A seedling of gram or chili may demonstrate phototropism. Take a glass bottle with cork. Fill up the bottle with water. Insert the plant into the bottle through the cork so that the stem remains outside the cork and the roots remain inside being immersed in water. Place the bottle at a place where it gets light from one side. After one day it will be seen that the stem bends towards light but the tip of the root bends against light. Phototropism may also be demonstrated by putting a potted plant on a perforated wooden box. Leaves of plant manufacture food by using energy from sunlight and both plants and animals world depends on this food.

(b) Geotropism : Movement of root is towards the earth and movement of stem is against the earth. A movement towards the earth is negative geotropism. Put a germinating gram seed on soil in a pot and keep the pot in such a closed room so that light cannot come from any direction. After one day it will be seen that the root of germinating gram seed bended and enter into the soil and the stem bended against the soil.

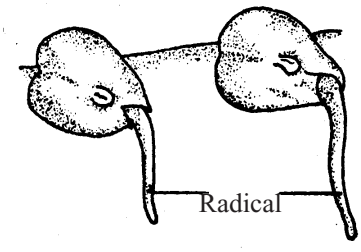


Fig. 9.17 Root's Geotropism

Majority of food for plants remain in earth. Root absorbs these foods. So the movement of root towards earth is quite significant.

(c) Hydrotropism: The movement of root is towards water and expansion of stem is against water. The movement of root towards water is positive hydrotropism and expansion of stem against water is negative hydrotropism.

(d) Chemotropism: Earth contains more organic manure thus the root and its branches expanded towards that direction. Movement towards chemical substances is **Chemotropism.**

EFFECT OF LIGHT AND TEMPERATURE ON PLANT GROWTH AND YIELD

We know all the fruit yielding plants like Aam, Jaam, and Boroi etc. plants are planted at almost every home in Bangladesh. It will be seen if you observe carefully that all the plants does not flowers in the same time. Mango tree flowers in winter and its fruits ripe in summer. But Boroi flowers in autumn and fruit ripe in winter. Let we have another example. Bean is a winter vegetable. Cultivated almost at every home in Bangladesh. Its seeds are sown in rainy season and the plant flowers in winter. At the end of winter it's flowering stops and in the next winter after the year it flowers again.

We know the length of daytime is short (long night period) is winter in Bangladesh and in summer and rainy season length of day is longer (Night time shorter) A short day time is required to product flower in bean plants. So it flowers in winter. As the daytime is longer in summer so bean plants does not bloom in summer. Therefore it is observed that in Bean plants vegetative growth takes place in longer day period and in shorter day period it flowers i.e starts yielding. Thus it is understand that in growth and development of plant (Bean is only one example), there is influence of light.

The influence of length of daytime on flowering of plants is called Photoperiodism. In 1920 Garner and Allard observed the affect of photoperiods in Maryland Mammoth a variety of tobacco plant. According to effect of length of day and night (photoperiods) upon the flowering time Garner and Allard classified the flowering plants into three classes:

1. Short day Plant: These plants flowers when day length is short. *Dahlia,* Tobacco, *Chrysanthemum* are short day plants. They may also call long-night plants. Two species of jute are short - day plants. In 10 - 12 hours photoperiods plants flower in 30 days. More than $12\frac{1}{12}$ hours of photoperiods delayed flowering.

2. Long day Plant: These plants give flower, when day-length is longer. Sponge guard *(Luffa)* Lettuce and *Beta palonga* (Palong) is long day plants. They may also call short night plants.

3. Day-Neutral Plants: Flowering time of these plants does not depend on the duration of daylight. They flower when necessary vegetative growth is completed. Day-neutral plant can be grown in both winter and summer. They flower in both the seasons. Sunflower is a plant of this type. Aus paddy usually a day-neutral plant.

Leaves receive the stimulation of photoperiods.

Importance of photoperiodism:

If all the plants were short-day plant or all long - day plant, then we would get only one crop in a year. There would be problem in preservation of crops, again in a certain time in the year there will be scarcity of various fruits. As there are short day plants, long-day plants and day-neutral plants in nature, thus we get some one or other crops, vegetables or fruits throughout the year.

Like light, temperature and cold also have effects on plant growth and flowering. It was seen, that in many germinating seeds when treated with cold cause early flowering. Application of cold treatment to germinating seeds to effect early flowering is called *vernalization.*

In 1920 AD Russian scientist T. D Lysenko invented this method of acceleration the ability to flower by cold treatment and named as Jarovization. Later the term Jarovization was renamed in Latin as vernalization.

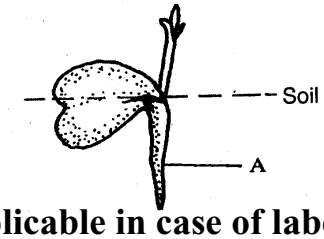
Vernalization is induced on germinating seeds or young seedlings. They are kept in low temperature (usually 13¡ - 15¡C) for some days thus cold treatment completed. The apical meristamatic cells of the plumule or seedling receive stimulation of *vernalization.*

Importance of Vernalization: In Russia Biannic wheat is converted to annual one by vernalization treatment. In our country large amount of paddy is being destroyed by flood. If the flowering time of paddy be accelerated by 5 - 10 minutes then it will be possible to protect paddy of Crores of Taka.

Excercise

Multiple choice questions

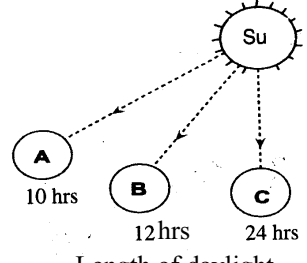
1. Which one is used as weed killer?
   a. Auxins
   b. Gibberellin
   c. Cytokinins
   d. Abscisic Acid



2. Which one is applicable in case of labelled A?
   i. Positive geotropism
   ii. Positive phototropism
   iii. Postivie Hydrotropism

   Which one of the following is correct?
   a. i
   b. iii
   c. i & ii
   d. i & iii

Answer to the question no 3 & 4 on the light of the following diagram.



3. Which plant gives flowers and fruits in the situation of labelled A, B and C?

a. Tobacco b. Palongsak

c. Bean d. Sunflower

4. What would be happened if you cultivate Jhinga at the duration of labelled A ?

i. Rapid growth of the Jhinga tree

ii. Jhinga production would be less.

iii. Would be economic loss.

Which one of the following is correct?

a. i & ii b. i & iii

c. ii & iii d. i, ii & iii

Creative questions

Hilmun planted a few number of Gourd seedlings in the corner of his house premises and kept intensive observation. He observed the seedlings grow rapidly but growth in length was higher then the lateral growth. After a few days he lifted up the plant on a platform then cut their apical buds.

a. What is apical bud?

b. Why in Gourd lateral growth is less than the growth in length?

c. Explain why Hilmun cut the apical bud of the Gourd plant.

d. Analyse with an example how much it is reasonable to cut the apical bud of other plants like Hilmun's Gourd plants.

CHAPTER- TEN
FLOWER

Flowers are the most beautiful and charming creation of thenature. we all love flowers; trees full of red Shimul, Palash, Madar, or Krishnachura, field full of yellow mustard, beels and Jheels full of violet Kalmilata, hedges full of blue Aparajita, gardens full of roses, China-Roses, Gandhoraj, Kamini, Shephali, Bokul etc. are all dear to us.

Are all these flowers around us are alike? No, if you observe carefully, it will be seen that among them some are red, some are yellow, some are blue or some are white. Again some one of them has strong smell (Hasnahena), some one has sweet smell (Rajanigandha, Chapa, Gandharaj). Again some has no smell at all (Jaba). As There are diversity in colour and smell among them they also differ in structure.

Different Parts Of A Flower:

A flower has several parts. Different parts have several functions. Taking a flower in hand we can observe its different parts. Let us see what parts are there in a'datura [Dhutura] flower. Different parts of Datura flower from out side are:

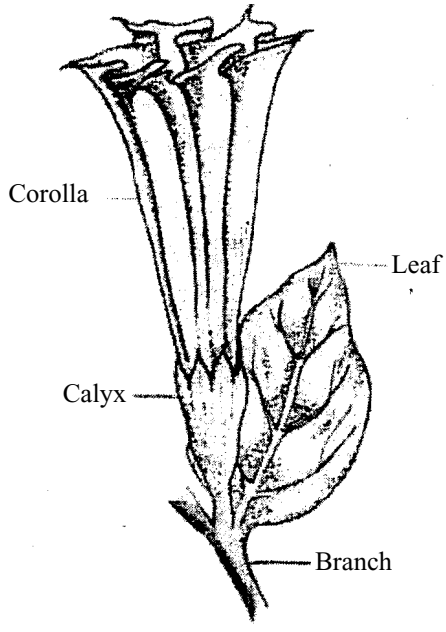


Fig. 10.1 A branch with a flower

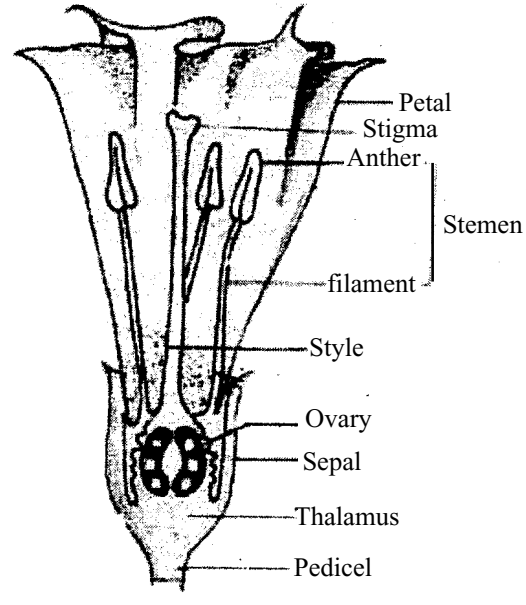


Fig. 10.2 Different parts of a Datura flower

1. There is a green slender stalk (Pedicel) at the base of the flower the pedicel is swollen. On this swollen part other whorls of the flower are arranged. This part is called thalamus. Thalamus is present in all flowers but all flower not have pedicel. Flower with pedicel is called pedicelate (e.g. Datura, China-rose) and flower without pedicel is called sessile [e.g. Colocasia (Kachu), Polianthus (Rajanigandha)]

Function: To hold other parts of the flower and to attach a sessile flower with stem.

2. Out side the flower there is a green tubelike structure at the base. Top of this tube is splitted into five,segments. From this it is understood that these five segments are combined together to form the tube. This outer green whorl of the flower is called the **Calyx.** Each of the five parts that comprises the calyx is called a sepal. Sepals may be united together (as in Datura) or may be separated (as in Brassica). In China-rose (Jaba) outside the calyx there is another whorl like the calyx called Epicalyx.

Function: To protect other internal parts in the bud from adverse external environment

3. Next to, petals combined together, to make the corolla. Usually corolla is the show part of the flower. Petals may be united (as in Datura). or may separate from each other [as in Brassica (Sharisha)].

Function: To attract insects and to protect internal parts of the flower.

4. Inside the corolla there is five rod like organ attached at the base. Each of these organs is called Stamen. Each stamen is divided into two parts the slender part is the filament and swollen part at the top is the anther. Inside anther there lies pollen grains. The total stamens of a flower collectively form a whorl, which is called the Androecium.

Function: Main function of the Androecium is to produce pollen grains.

5. The central part of the flower is the Carpel. Swollen part at the base of carpel is the Ovary, long slender part at the middle is the Style and lobbed part at the top is the Stigma. Inside the ovary there are small round parts call Ovules. Ovules later develop to seeds. In Datura flower there are two carpels united together. The whorl of a flower that is formed by one or more carpel called the Gynoecium. The ovary of a flower develops to a fruit. In china-rose five carpels are united to forms the gynoecium.

Function: Functions of the gynoecium is to produce fruits and seeds.

From the above discussion it is understood that a Datura flower has five parts namely: l.thalamus, 2. calyx, 3. corolla,4. androecium or male whorl and (5. gynoecium or female whorl. Among these thalamus is an axis on which other four whorls are arranged.

Datura flower has five parts. But some flowers may have thee or four parts. The flower, which has five parts, is called an ideal flower.

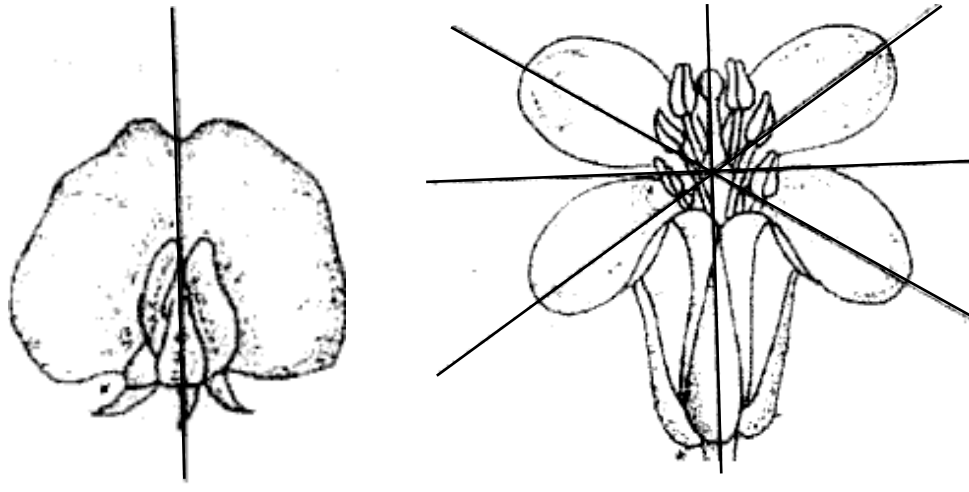
Function of flower: The main function of a flower is to produce fruits and seeds for reproduction of the plant. Androecium and gynoecium are directly involved in seed production, thus they are called essential whorls. Calyx and corolla are called accessory whorls.

Different kinds of Flower:

If we examine various flowers surrounding us it will be seen that all the flowers are not alike. Like colour and smell they have many variations in their structure too. A description about this is given below:

(A) According to completeness:

1. Complete Flower: A flower that possesses all the five whorls is said to be a complete flower. Datura, China-rose etc. are complete flowers.



Zygomorphic Asymmetric **Actinomorphic, Complete, Bisexual, Symmetric**

Fig. 10.3 Zygomorphic and Actinomorphic Flower

2. Incomplete flowre : A flower is said to be an incomplete flower that does not have all the five whorls. Lau, Kumra, shasha, jhinga etc. are incomplete flowers. In these flowers either male or female whorl is absent.

(B) According to sex argan :

1. Bisexual flower: Flowers, which bear both male and female whorl (Androecium and Gynoecium), are called Bisexual flowers. Datura China-rose, Brassica (Sharisha) etc. are bisexual flowers.

2. Unisexual flower: Flowers, which have either male or female whorl, are called unisexual flowers. Flower that bear only female whorl is called female flower and flower that bears only male whorl is called male flower. In plants like lau (Bottle Gourd), Kumra (Gourd), Jhinga (Luffa) etc. male and female flowers are grown separately in the same plant.

(C) According to Regularity of Organ:

1. Regular Flower: Flowers in which the members of each whorl are similar in shape and size called regular flower. e.g. Datura, Brassica, Hibiscus (China-rose) etc.

3. Irregular flower: A flower having member of each whorl (especially calyx and corolla) dissimilar in size and shape is called irregular flower. pisum (Motor), Clitoria (Aparajita), Beans (Shim), etc. are irregular flowers.

(D) According to Symmetry:

1. Symmetric Flower: A flower, which may be cut into two equal halves by one or more vertical plane passing through the center of the flower is called a smymetric flower. Symmetrical flowers are of two types: -

(i) Zygomorphic: Flowers, which may be cut into two equal halves by only one vertical plane passing through the center of the flower is called Zygomorphic flower e.g. pisum, Beans, Clitoria etc.

(ii) Actinomorphic : Flowers, whcih may be cut into two equal halves by more than one vertical plane passing through the center of the flower, is called actinomophic flower. e.g Datura, Hibiscus, Brassica etc.

2. Asymmetric Flower: Flowers, which cannot be cut into two equal halves by any vertical planes is called asymmetric `flower. Canna (Kalabati) flower is an asymmetric flower.

(E) According to Presence of Bracts:

1. Bracteate Flower: Flowers, which have bract or bracts at its base is called bracteate flower, e.g. Crotalaria (Atoshi).

2. Ebracteate Flower: Flowers, which have no bract at the base is called ebracteate flower. In Brassica flower there is no bract.

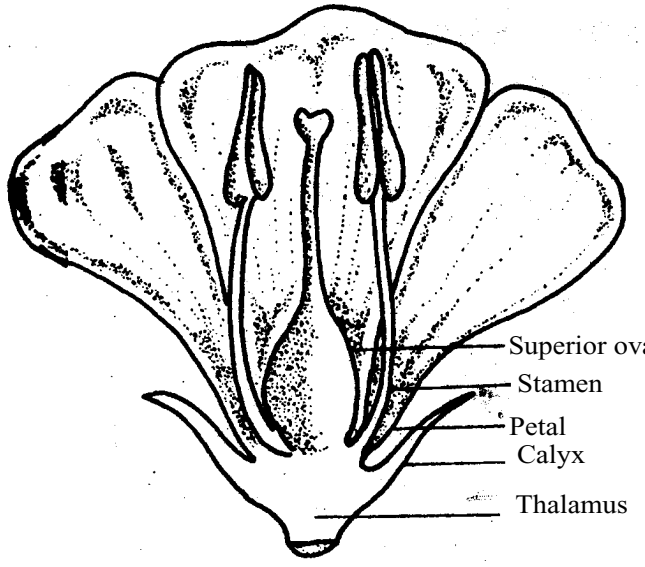
A bract is a small leaf or leaf like organ in the axils of which arise flowers.

(F) According to the position of Ovary:

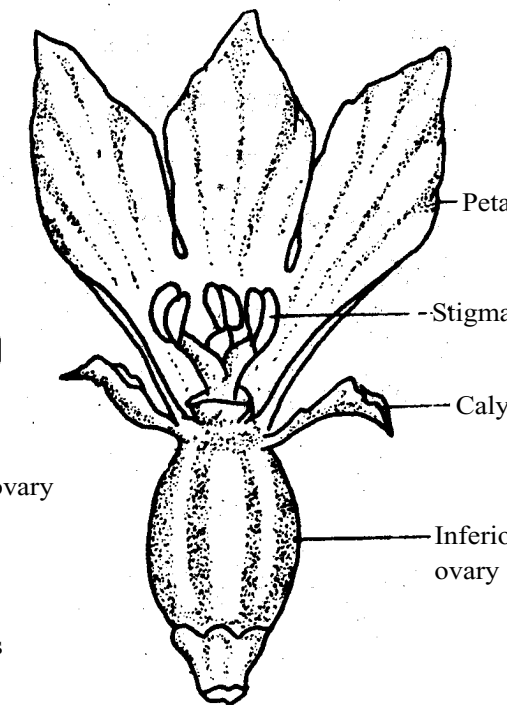
1. Hypogynous flower: A flower in which Calyx, Corolla and Androecium lies beneath the ovary is called hypogynous flower. Flowers of Datura, Hibiscus, Brassica, Solanum, and Chili etc. are hypogynous flowers.

2. Epigynous flower: A flower in which Calyx, Corolla, and Androecium are placed above the ovary is called epigynous flower. Flowers of lau (Lagenaria), Kumra (Cucurbita), Jhinga (Luffa) etc are examples of epigynous flowers.

3. Perigynous flower: A flower in which Calyx, Corolla and Androecium are placed around the ovary is called perigynous flower. The thalamus of perigynous flower is cup shaped and the ovary is placed in the concave center of the thalamus, e.g. Rose. ovary is placed in the concave center of the thalamus, e.g. Rose.



10.4 A Hypogynous Flower



10.5 An Epigynous Flower

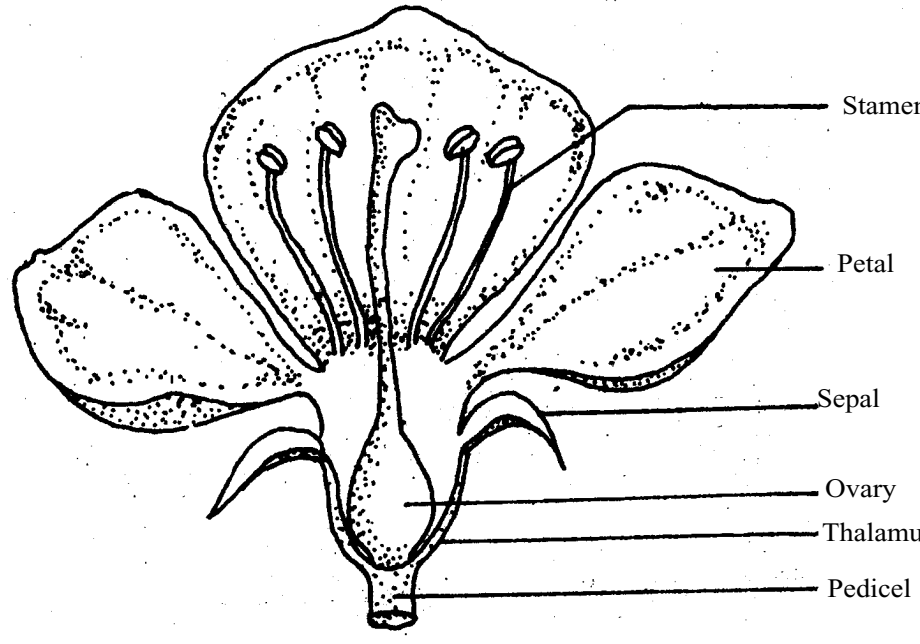


Fig 10.6 A Perigynous Flower

Exerise

Multiple Choice questions

1. What is the function of the part labelled A in the diagram?

a. To help fertilization
b. To attract insects
c. To produce fruits
d. To produce seeds

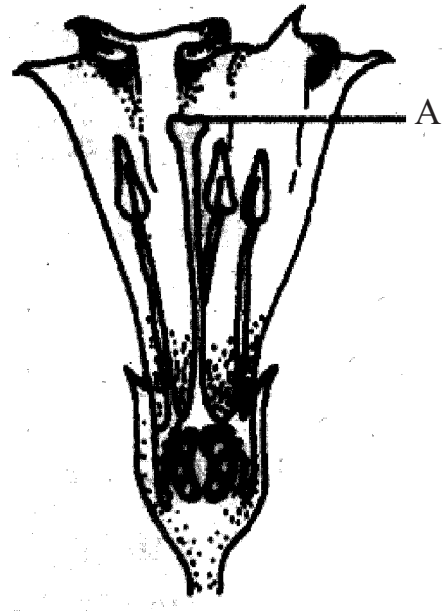


Fig.

2. Jaba is a-

i. Hypogynous flower
ii. Actinomorphic flower
iii. Unisexual flower

Which one of the following is correct?

a. i & ii
b. ii & iii
c. i & iii
d. i, ii & iii

Give answer to the question 3 &4 in the light of the following diagram.

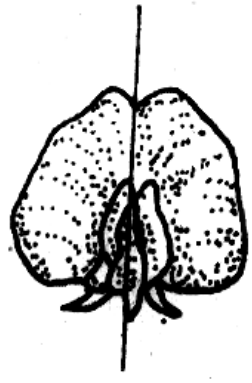


Figure A

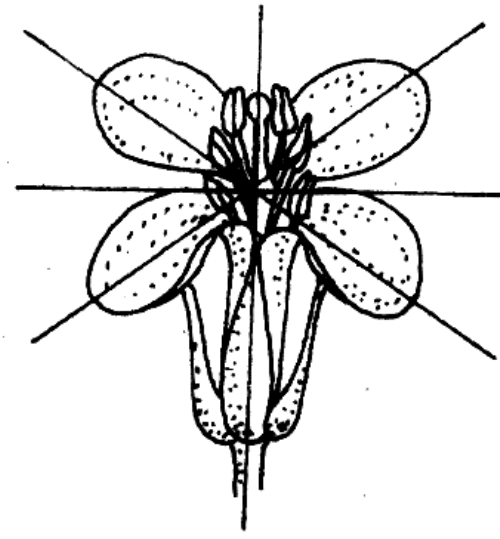


Figure B

3. Which one is applicable in case of diagram A?

i. Zygomorphic and Irregular

ii. Zygomorphic and Regular

iii. Pea and Bean type flower.

Which one of the following is correct?

a. i & ii b. i & iii

c. ii & iii d. i, ii & iii

4. The flower of the diagram no. B is-

i. Actinomoraphic and Regular

ii. Complete and Bisexual

iii. China rose and Mustard type flower

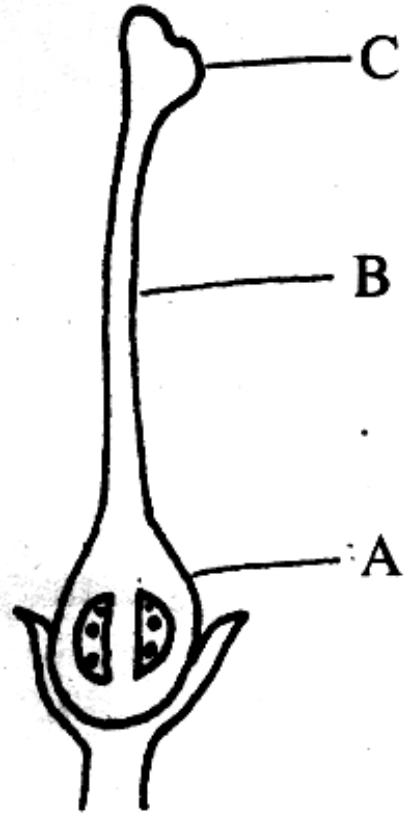
Which one of the following is correct?

a. i & ii b. ii & iii

c. i & iii d. i, ii & iii

Creative questions

See the following diagram and answer the questions.



a. What is the name of the labelled part C of the diagram?

b. Explain the importance of the labelled area A.

c. Draw a complete flower using the given diagram and label different parts.

d. Mention the similarities and dissimilarities of Megasporophyll of the cycas plant with that of the shown diagram.

CHAPTER - ELEVEN

Pollination, Fertilization, And Dispersal of Fruits and seeds

Pollination:

Every fertile stamen contains an anther. Inside the anther develops the pollen grains. At one time the anther bursts and pollen grains are carried and attached to the stigma (of same flower, or flower of the same plant or flower of the same species of a different plant), by insect, air or any other agent. Process by which pollen grains are transferred from anther to the stigma is called pollination.

Pollination of two types: 1. self-pollination and 2. cross-pollination.

1. Self-pollination: When pollen grains from the anther are transferred to the stigma of the same flower or a flower of the same plant is called self-pollination. In self-pollination the genotype (factors those control the characteristics of living beings) of two flowers remains alike. Self-pollination occurs in a small numbers of plants in nature. Self-pollination takes place in flower like Bean, Tomato, *Commelina* etc.

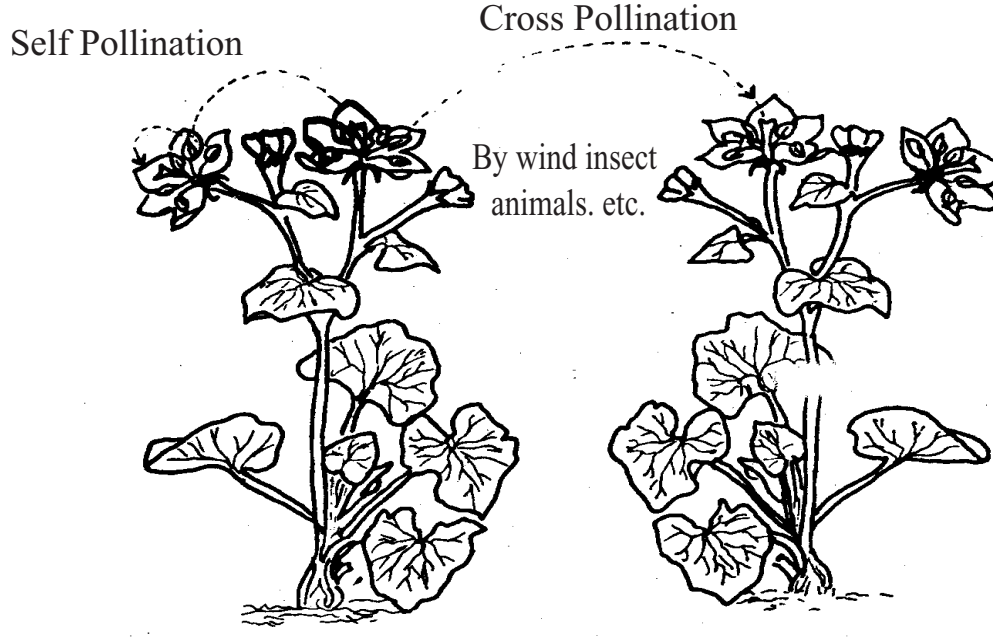


Fig. 11.1 Self-Pollination and Cross-Pollination

2. Cross - Pollination: When pollen grains are transferred from the anther to the stigma of flowers of same species of a separate plant is called *cross-pollination.* In cross-pollination the genotypes of two plants have some variation, in nature, cross-pollination occurs in most of the plants. Examples of cross - pollinated plants are Paddy, Wheat, Maize, Mustard, Silk Cotton (Shimul), Madar, Mango etc.

Significance of self-pollination: As this type of pollination takes place between two flowers having similar genotype, the genotype of the produced seeds remains unchanged. So the plants that produce from these seeds have got the character just like the mother plant. In this way the hereditary character remains similar i.e. it maintains the purity of species. This is most significant in self-pollination.

Merits of Self -pollination:

1. Pollination is ascertained. 2. Very few pollen grains are lost.

3. Maintains the purity of species. 4. Less dependent on external agent.

Demerits of self-pollination:

1. No new variety is produced as there is no combinations of new characters.

2. Produce weaker progeny with less vitality.

3. New progeny are borne with less adaptability.

4. The species may extinct in future.

Significance of Cross -pollination :

Pollination occurs between two flowers having difference in genotype. Thus the seed that is produced from this have variation in genotype. Therefore the new plant grown from this seed is not identical with the mother plant. New variation may produce even a new species. Due to combinations of the most plants their adaptability increase so natural calamity (disaster) cannt extinct them easily.

Merits of cross pollination:

1. Combination of new character occurs.
2. New varieties may be originated
3. Seeds become more viable and more tolerant.
4. Adaptability of new plants increases.

Demerits of Cross - Pollination:

l. Depends on external agent.
2. Pollination is uncertain.
3. There is loss of a large amount of pollen
4. Purity of species is lost/destroyed

Difference between Self - Pollination and Cross - Pollination

Self pollination	Cross pollination
1.Occurs in the same flower or between two flowers of the same plant. 2. Pollination usually occurs before blooming. 3.Does not need the presence of other plants of the same species nearby. 4.Depends little on pollinating agents 5. Purity of species preserved 6. No new variety develops.	1. Occur between two flowers of two different plants. 2. Pollination occurs after blooming. 3. Needs the presence of other plant of the same species nearby. 4. Depends completely on pollinating agents. 5. Purity of species is not preserved. 6. Possibilities of origin of new varieties.

Pollinating Agents

Pollination, especially cross - pollination takes place by four different agents like insects, wind, animal and water. A short description about this stated below:

1. Pollination through insects: In most.cases at the time of collection of Vnectar pollen grains from one flower is transferred to another flower by insects. Flowers in which pollination occur through insects are known as entomophilous flowers. Mustard, Basils, Orchids, Roses, Cucurbita, etc. are entomophilous flowers.

Characteristics of entomophilous flowers:

a) Flowers are bright coloured.

b) Most of the flowers are sweet scented.

c) Flowers contain nectar at the base.

d) Pollen grains are sticky.

e) Stigmas are sticky.

2. Pollination through wind: In many plants Pollination occurs through wind. Flowers in which pollination occur, through wind are known as Anemophilous flowers. Paddy, Wheat, Maize. Sugarcane, Palm etc, are Anemophilous or wind pollinated flower.

Characteristic of Anemophilous flowers:

a). Flowers are usually unattractive and have inconspicuous colour

b). Flowers usually are without sweet scent and nectar.

c). Pollen grains are very light and are produced in large numbers.

d). Stigmas are large, feathery and sticky, so that pollen grains carried by wind may attach very easily.

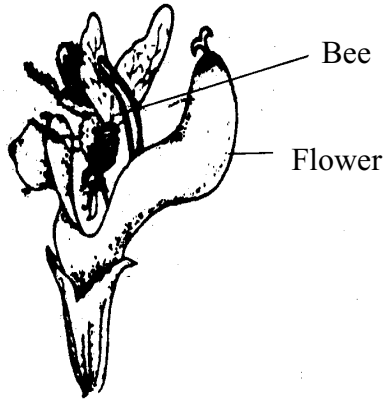


Fig 11.2 Entomophilous Flower

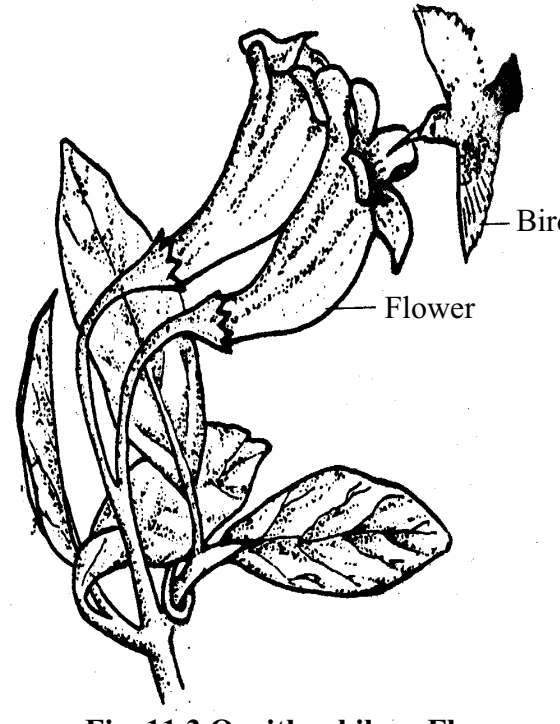


Fig. 11.3 Ornithophilous Flower

3. Pollination through Animals: In many flowers pollination occurs through Birds, Bat or Snails etc. Flowers which are pollinated by animals, are called zoophilous flowers. Madar, Shimul, Kadam etc. are zoophilous flowers.

Characteristics of zoophilous flowers

(a) Flowers are usually large.

(b) Flowers have bright colour,

4. Pollination through Water: Many aquatic plants are pollinated by water. When pollination is accomplished by water the flowers is said to be hydrophilous flowers. *Vallisneria, Urticularia* etc. are Hydrophilous flowers.

Characteristics of hydrophilous flowers:

a) Flowers are usually unscented.

b) They grow under water.

c) Female flowers are solitary and with long stalk.

d) Male flowers are light, transferred by water through floating.

Fertilization:

We know there are small organs named ovules in the ovary of a flower. These ovules later on develop to seeds. The seeds we see in the fruits like Mango, Jambolina (Jaam), Lichi, Jackfruit etc. all are the developed ovule. When the ovule gradually develops to seeds at the same time the ovary of the flower gradually develops to a fruit. Ovules are developed to seed as a result of fertilization. Usually without fertilization ovules cannot be developed to seeds Again fertilization also causes the ovary to form a fruit. For fertilization it is necessary to originate male and female gametes. In flowering plants union of male and female gametes is called fertilization.

Formation of male gamete: Inside the anther there are pollen mother cells. By meiosis four pollen grains are produced from each pollen mother cell. Each pollen grain contains two coverings, the outer coating is called exine and the inner one is called intine. In the exine there is a pore named germ pore Nucleus of the pollen grain undergoes mitotic division and forms tube nucleus and generative nucleus. Usually pollination occurs at this bi-nucleated condition.

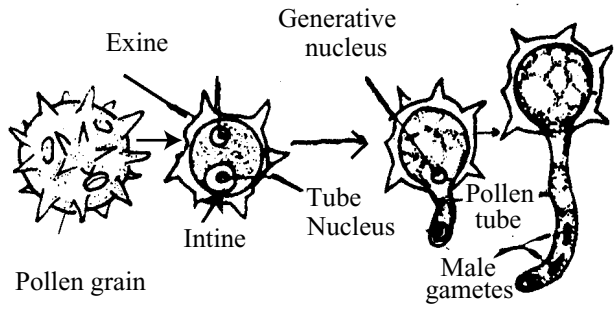


Fig. 11.4 Stages of development of male gametes

As a result of pollination, the pollen grains become attached to the stigma and a pollen tube is developed from the pollen grain. The tube gradually makes its way down into the ovary through the style. The tube nucleus enters the pollen tube followed by the generative nucleus. The generative nucleus undergoes mitotic division and form two male reproductive cells or male gametes or sperms. The male gametes are haploid.

Formation of female gamete:

Inside the ovary of a flower there lies the ovules. In each of these ovules one megaspore mother cell (female reproductive mother cell or egg mother cell) is produced. This cell undergoes meiotic division to give rise to four haploid megaspores. In most of the cases three out of four degenerate and only one cell survives. The nucleus of the survived large cell divides mitotically to give rise to two at first, next from these two forms four and then from four to eight nucleus. These eight nucleus remains at two poles of a sac like structure. The sac like structure is called **embryo sac.** One nucleus from each pole moves to the centre of the *embryo sac* and fuse together to form a secondary nucleus. The three nuclei remaining at the micropyler end of the embryo sac are called egg apparatus. The central one of these three is larger one and it forms the egg or ovum, and the other two besides the ovum are synergides. **Ovum** is the female reproductive cell or female gamete. The rest nuclei of the embryo sac are called antipodal cells. The ovum is **haploid.**

Union of female and male reproductive cell: The pollen tube gradually proceeds and moves downwards and ultimately reaches the embryo sac. When the pollen tube reaches the embryo sac the tip of the pollen tube bursts and the

two male gametes are released. One of the male gametes. (sperm cells) unites with the egg and complete the process of fertilization. The other male gamtees unite with the secondary nucleus. This union is called **triple fusion.** This process is known as **double fertilization.**

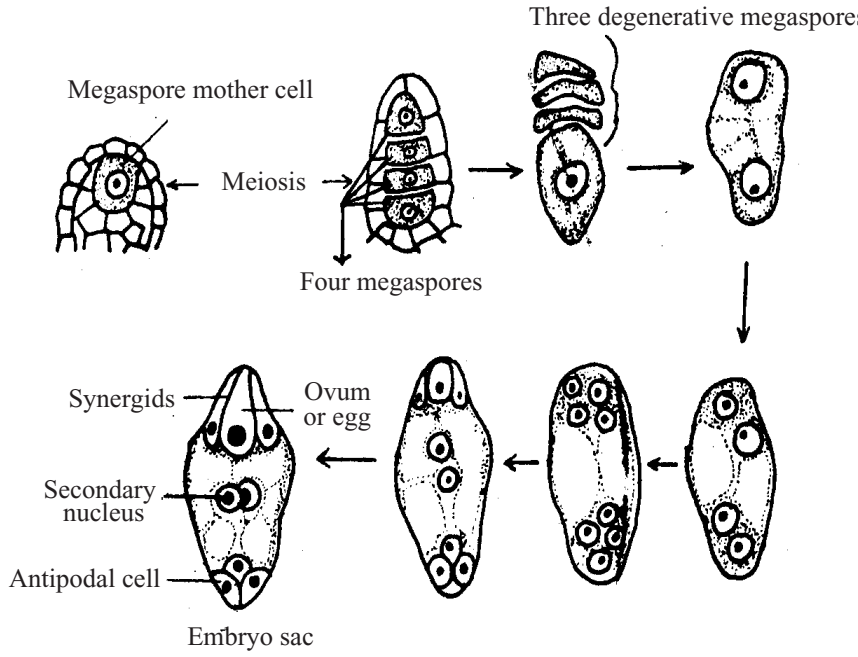


Fig. 11.5 Stages of development of female gametes.

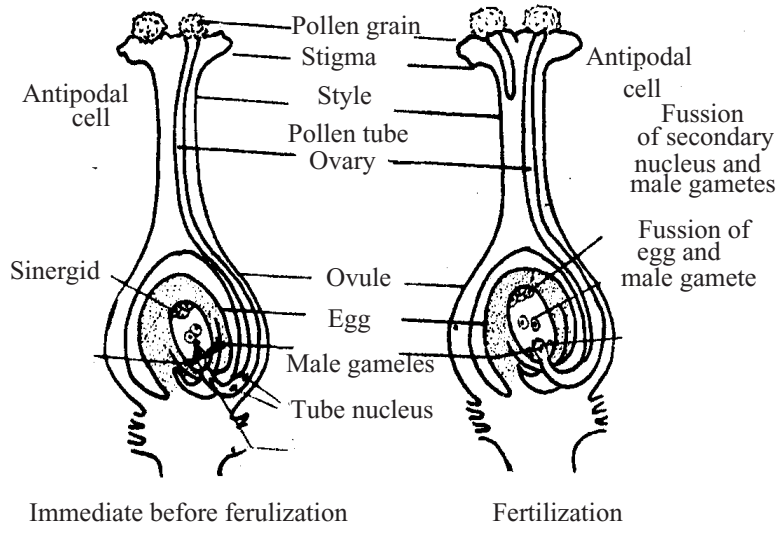


Fig. 11.6 Fertilization in Angiospermic Plant

Stages of Fertilization: From the above discussion it is understood that there are three stages in the process of fertilization, namely - 1. Development of male gametes, 2. Development of female gametes and 3. Union of male and female gametes.

Development of Embryo: Embryo develops after fertilization. A diploid zygote is developed as a result of the union of male and female gametes. It is also called a fertilized egg. The zygote remains in resting stage for sometimes (may be few hours, days or even months). After the resting period the zygote cell undergoes a transverse division to form a bi-celled pro-embryo. The pro-embryo then undergoes successive cell division at different plains to form an embryo. An embryo consists of cotyledon and an axis. The upper portion of the, axis is the plumule and the lower portion is the radicle. In a monocot seed there is only one cotyledon (e.g. coconut, paddy etc) and in a dicot seed there are two cotyledons (e.g. mango, bean, gram, pea etc.).

Development of Endosperm:

Endosperm is an essential constituent part of the seed. The food for developing embryo is preserved in it and the embryo absorbs food from the endosperm. The triploid cell originated from the union of secondary nucleus of the embryo sac and a male gametes, is the first cell of the endosperm. The triploid cell undergoes mitotic division repeatedly to give rise to a mature endosperm. The endosperm is triploid i.e. three nuclei fused together to form it.

In many plants endosperm is present in a mature seed. During germination, the embryo absorbs food from the endosperm. These types of seeds are called endospermic seed - e.g. Paddy, Wheat, *Ricinus* etc. In many other plants endosperm being absorbed and stored in cotyledon and is utilised during germination. This type of seeds are called non-endosperm seed e.g. Gram seed, Pea, Mango etc.

After fertilization the ovary is developed to fruit and the ovule developed to seed. Changes in ovary and ovule after fertilization is shown in the following table:

Development of fruits from ovary		Development of seeds from ovule	
1. Ovary 2. Ovary wall 3. Ovule	1. Fruit 2. Fruit wall 3. Seed	1. Ovule 2. Integument 3. Egg 4. Endosperm Mother cell 5. Micropyle 6. Funiculus	1. Seed 2. Seed coat 3. Embryo 4. Endosperm 5. Micropyle 6. Seed stalk

Significance of fertilization:

As a result of fertilization the ovary of a flower develops to a fruit and ovules to seeds. Seeds maintain and increase the generation by reproduction. If there were no seed probably the plant would have perished. This may be said in other words as, if there was no fertilization the plants would have perished. Again animal world especially human being live on fruits and seeds of plants. If there was no fertilization seeds and fruits would not have grown. No animal life could exist without the food produced by plants. So the significance of fertilization is unlimited

Dispersal of Fruits and Seeds:

Usually a plant produces a large number of fruits and seeds. Some fruits are carried from one place to another by human beings for their own interest e.g. Litchi, Mango, Jackfruit etc. In some plants fruits and seeds remains just under the tree. Again in some plants fruits and seeds are taken away from the mother plant by various agents and are distributed to distant areas. This process of distribution of fruits and seeds to a distant area from its mother plant by several means is called dispersal of fruits and seeds. Usually dispersal of fruits and seeds take place by the following means. Here is a brief discussion.

1. Dispersal by wind: Seeds of many plants are carried away by wind and are distributed at distant places. These types of fruits and seeds are very light, small and provided with wings. So the wind may carry these seeds easily to different places. Fruits of sunflower have pappus, in Chhagalbati the style is

persistent and feathery, in Mehogany and Shajina there is flat appendage in the seeds. The seeds of Akonda and Chhatim are provided with hairs. Thus fruits and seeds of these plants can easily travel by wind and can be scattered to distant places. Occasionally we find seeds of Chhatim and Akonda are flying in the wind.

2. Dispersal by water: Shapla, Padma or even coconut float on water and moves to distant places. Fibrous or spongy tissues cover their fruits and seeds, thus they float on water very easily.

3. Dispersal by explosion of fruits: There are some fruits, which produce a vibration when it burst. By vibrating force the seeds are scattered to a good distance. Castor, pea, Dopati etc. are fruits of these types.

4. Dispersal by Animals: Fruits of some plants adhere to the body of animals and are carried away from one place to another. Fruits of Prem Kata *(chrysopogon Aciculatus),* Have Sticky Glands On Their Bodies, Khagra *(Xantiuun indicum)* has hooks on its body, etc. are dispersed by adhering to animal body even to clothing of human beings.

5. Dispersal by Birds: Some fruits are carried away by birds on their beaks to a great distance. Litchi is one of these types of fruits. Birds eat some fruits but its seeds cannot be digested and come out with stools and from that seedlings grow, e.g. Date-palm, *Pisum,* Tamarind, *Ficas* etc.

Besides these, man willingly carried many fruits and seeds from one place to another, even from one country to another.

Importance of Dispersal of Fruits and Seeds:

Without favourable conditions seed do not germinate. Again without favourable environment no seedling can grow big. If all the fruits or seeds of a plant fall directly under the mother tree, then many of them will fail to germinate, for want of space, water, light and air, many of the germinated ones may die because of the shade of the plants. The rest survivors will gradually perish. So for maintaining the existence and increasing of generation of plants in favourable environment dispersal of fruits and seeds is essential.

Exercise

Multiple choice questions

1. Which one is present in the Suflower for dispersal?

a. Wings b. Pappus

c. Spine d. Hook

2. Which one of the following is diploid?

i. Ovum

ii. Embryo

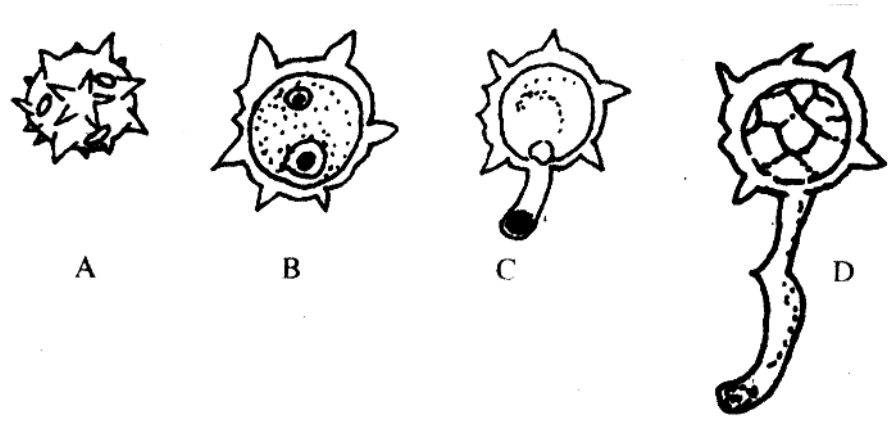
iii. Seed

Which one of the following is correct?

a. i & ii b. i & iii

b. ii & iii d. i, ii & iii

Answer to the question no. 3 and 4 depending upon the following diagram.



Diffrent stages of formation of male gamete are shown in the diagram.

3. Which stage in the diagram pollination is occurred?

a. A b. B

c. C d. D

4. Which statement is correct?

a. Stage A forms as a result of Mitosis

b. Stage B forms as a result of Meiosis

c. Stage C is haploid.

d. Stage D is diploid

Creative questions

Pollination is the primary process to complete the sexual reproduction of flowering plants. The matter of transfer of pollen grains between the two flowers are shown through arrow marks in the following diagram.

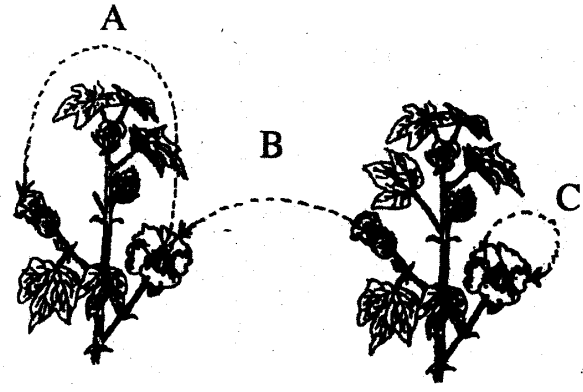


Fig. 1 Fig. 2

a. Where does the pollen grains lie in a flower?

b. The flowers of the figure no. 2 are of what sex and why?

c. Explain why for effective pollination C is much better than A.

d. Analyse as a result of the pollination indicated by C and B in the diagram what type of characteristics may observe in the next generation.

CHAPTER - TWELVE

REPRODUCTION OF PLANTS

If we want to plant a Jackfruit *(Artocarpus heterophyllus)* tree we sow a seed of a Jackfruit, because Jackfruit tree originates from Jackfruit seed. in this way we get Jaam (black berry) tree from a Jaam seed, Coconut tree from Coconut, Jute plants from Jute seeds, paddy plant from paddy seed. Again some time we can get new plants from stem cutting also. The process by which a plant gives rise to grow a similar new plant is known as reproduction. Reproduction is one of the most important features of living beings.

Types of Reproduction:

We can grow a new plant from seeds, or some other organ of the plant may give rise to grow a new plant. So the process of reproduction is not of only one type. Different types of reproduction is described below:

1. Sexual Reproduction: We have learnt from the chapter fertilization that the union of male and female gametes develop seeds. seeds are the product of sexual union. So the reproduction that takes place by Seeds is sexual reproduction. We get plants like Paddy *(Oryza sativa),* Wheat *(Triticum),* Maize, Jaam, Jackfruit etc. from their seeds.

2. Asexual Reproduction: Reproduction by any organ other than seed is called asexual reproduction. Asexual reproduction may be of two types: (a) by asexual spore and (b) by vegetative organ. Plants like Algae, Fungi, Moss, Fern etc. reproduce by asexual spores.

3. Vegetative Reproduction: Reproduction that takes place by vegetative organ is called vegetative reproduction. Vegetative reproduction usually takes place by organs like root, stem or leaf etc. Vegetative reproduction again are of two types: (1) Normal and (2) Artificial.

Normal Vegetative reproduction: If we sow a potato or sweet potato, a root of Kakrol or a branch of Madar it will naturally gives rise to grow a new plant. But if we plant a branch of Mango tree it will not give rise to grow a new planty rather it dies. When any part or organs of a plant naturally give rise to

to grow new plant is called natural vegetative reproduction. natural vegetative reproduction may occur by following means:

By Roots: Plants like sweet potato (a modified root), *Dahlia,* Kakrol, and Patol etc. reproduce by roots.

By Stem: Plants like Zinger, Turmeric, Shati, potato, Olkachu, Onion (these are modified stems) etc. reproduce by stems. Banana, Pudina, Pineapple, *Chrysanthemum* etc. reproduce by sucker (a modified stem). Shajina, Madar, Chhatim, and Jiga etc. give rise to grow new plants by planting their branches. New plant also originates from young Bamboo shoots.

By leaf: Reproduction of Pathharkuchi *(Bryophyllum)* takes place by its leaf. When a leaf is left on the earth new buds originates from every notch of its margin and gives rise to a new plant.

Artificial Vegetative Reproduction: Branches of mango tree do not give rise to grow a new plant rather the branch become sapless. But if a bandage layering is made by the branch and plants it, it gives rise to a new plant. Artificial vegetative reproduction is being done in various methods by human beings. Various methods of vegetative reproduction are: Cutting, Layering, Budding, and Grafting etc. artificial vegetative reproduction may be done in plants like Mango. Lichi, Boroi etc.

Merits of Vegetative Reproduction:

1. The flowers and fruits of new plants bear the similar characteristics as those of its mother plant.
2. The new plants give early flowers and fruits.

Exerscise

Multiple choice questions

1. By which Pineapple reproduces?

a. Root b. Stem

c. Sucker d. leaf

2. Which is reproduced by seeds?

i. China rose

ii. Acacia

iii. Dhutura

Which one of the following is correct?

a. i b. ii

c. i & ii d. ii & iii

Answer to the question no 3 and 4 in the light of the following paragraph.

Mrs. Etikana Chowdhury collected a stem of Sajina from one of her neighbours tree planted in her own land and after a year the tree grown with Sajina.

3. In this case the tree-

i. occurred asexual reproduction

ii. occurred vegetative reproduction

iii. occurred artificial vegetative reproduction

Which one of the following is correct?

a. i b. i & ii

c. ii & iii d. i, ii & iii

4. What was the motive of Mrs. Chowdhury for cutting and planting a branch of the Sajina tree?

a. To get a good variety.

b. To set Sajina rapidly.

c. To minimise expenditure of Sajina.

d. To distribute among the relatives.

Creative questions

Generally the cereal producing plants like paddy, wheat, mustard etc. are reproduced sexually and that is the proper system. On the other hand in the woody plants like Lichi, Mahogany, Mango, Jackfruit etc. sexual or asexual or both systems are found. Mr. Hakim follows sexual system during Mahogany plantation and asexual system during Lichi plantation.

a. What is reproduction?

b. Why does Mr. Hakim follow sexual reproduction during the plantation of Mahogany?

c. Explain the asexual process followed by Mr. Hakim during the Litchi plantation.

d. In the Corn Producing plant only sexual reproduction is the proper system-analyse the statement.

CHAPTER-THIRTEEN
ORGANISM AND ENVIRONMENT

Everything surrounding us forms our environment. There are two types of environment which are recognized, the non-living environment and the living environment. The relation between these two environments is very intimate. The main factors of non-living environment are soil, water and air which provide food and shelter to the living organisms.

The environment influences our life deeply. We get all kinds of things from the environment that helps us to stay alive. Different types of animals grow in different environments, e.g. rivers, canals, lakes, ponds etc., which are able to meet the requirements of different aquatic animals but the terrestrial animals cannot live in this type of environment. There is scarcity of water in the desert, so the number of plants growing in the desert is very limited. In this type of environment, plants are rarely seen. Aquatic animals and plants are almost rare.

If we observe, we will notice that both plants and animals living in the saline soil of the Sundarbans are not found in the forests of Sylhet and Chittagong Hill tracts. From this, it is understood that the organisms, which grow and live in some particular natural environment have their own individuality. In this way, different organisms (plants or animals) together form a biotic community. Each community consists of plants, animals and micro-organisms. They live together in co-operation with one another. The climatic condition of a particular geographical region depends upon the topography and configuration of that region. The animals and plants of a particular region are influenced by the climate of their habitat.

Besides, the animals of that region also have influence upon the plants. In this way the inseparable relation between the environment and the biotic community of a particular region is formed. The biotic community and its non-living environment are dependable on each other.
You have learnt before that the size and nature of the plants and animals depend on their environment. All the regions of the world are not similar. Sundari, garan and gewa plants are found in the Sundarbans. The rivers of this forest have crocodiles, Royal Bengal Tiger and spotted deer are found on this land. These animals and plants are not found in the forests of Sylhet and

Madhupur. Why is this so? It is very natural to ask such a question. All these happen due to the diversity of a particular environment.

The organisms return all the elements that they have taken from the environment. It becomes difficult to survive for the plants and animals if the environment lacks any biological or physical factors. The plants absorb nutrition from the fertile soil. The animals in turn get their food from the plants. Through this mutual co-operation the plants and animals grow.

Due to overpopulation, human habitation and number of industries have increased. For this reason the areas of traditional cultivable land and natural forests have decreased. Sound, smoke, industrial waste, garbage and bad smell of the factories etc. are polluting the environment. As a result the balance of environment is being disrupted.

The different animals of the world are not only dependable on one another, they are also dependable upon the physical factors of the environment e.g. soil, water, air and plants. For this reason, living beings cannot be separated from the nonliving. There is an intimate relationship between the living community and the non living environment for survival. The inter relationship between organisms and their environment is ecology.

Components of Ecology

We understand from the discussion above that ecosystem has two components. One is biotic community and the other is non living environment. It is the non-living environment, which holds the biotic community. In any particular environment of a geographical region, the relation and interactions between living and nonliving objects are collectively known as Eco-system.

Non living components

We have learnt before that the non living elements influence the living elements. Inorganic, organic and physical components are included in non-living components.

1. Inorganic components: Water and mineral salts are inorganic components of eco-system. In addition to these there are other gaseous elements like O_2 (oxygen), N_2 (nitrogen), CO_2 (carbon dioxide) etc., which are necessary for the nutrition of the plants and respiration of organisms.

2. Organic components: It is the rotten parts of the dead body of plants and animals. The dead body of plants and animals after being decomposed forms urea and humus. These constitute the organic elements of the soil. Saprophytic fungus and bacteria acting on dead plants and animals form the organic components. Some of its parts are converted into inorganic salts. These inorganic salts are taken as nutrients by the green plants. Now you have understood, how the organic components maintain link between the biotic and abiotic parts of the environment.

3. Physical components: The environment is largely dependent on certain physical factors. They are:

i. Climate: The climate of a particular environment depends on rainfall, air movement, temperature, humidity, amount of sunlight, snow fall etc.

ii. Soil factor: Condition of soil in any place influences the animals and plants living there.

a) Soil composition: The relative amount of sand, clay and silt etc, determines the quality of the soil. The quality of the soil has a special influence over the animals and plants of that particular area.

b) Humus and Mineral salt: The rotten manure, produced from the dead plants and animals is the humus. In humus there is a large amount of mineral salt. Plants absorb this mineral salt with the help of their root hair.

c) Soil water condition: The life of animals and plants also depend on the quantity of the water, the level of underground water, drainage of excess water and also on the porosity of soil.

1) Topographic factor: The topographic factor of a particular region influences the animals and plants living there. Weather, soil factor and topographic factor are the inorganic components of eco-system. The main source of energy is the sun. The green plants with the help of chloroplast, inverts the solar energy into organic component and stores it in the body. indirectly this solar energy is flowing within the living community. Thus the life process and energy flow on this earth is maintained.

B. Living components: Every organism is a part of the eco-system. In eco-stem the non-living and living components are interdependent. Absence of one affects the other in maintaining their natural activities. The habits of plants influence the animals characters of eco-system. Every living being takes food for its physical growth, reproduction and existence. Every organisms gets energy from food. We have learnt before that the source of energy flowing in biotic community is the sun.

Food chain: We know that it is the green plants which manufacture their own food by using the solar energy. As the green plants can prepare their own food, they are autotrophic. Green plants in the presence of sun light react with the inorganic substances (CO_2 and water) and make their own food. The plant's body preserves the solar energy in the form of potential energy. Of the food manufactured by the plants, only small portion is used for its own requirement while the major portion is stored in its body. The herbivorous animals eat this stored food and the carnivorous animals eat these herbivorous animals. They are consumers. The decomposers (bacteria, fungus) use plants, herbivorous, carnivorous animals etc. as food and transforms those into humus. From inorganic components of soil the green plants again produce their food with the help of solar energy. It is now clearly understood that starting with plants, through various types of animals and decomposers, step by step, the food substances are transferred from one to another and finally return to the green plants. This cyclic transfer of food and the relation of food and its consumer are known as the food chain.

Depending on producer and different levels of consumers some examples of food chain are given below:

Producer	Primary consumer	Secondary consumer	Tertiary consumer	Highest or top consumer
1. In Terrestrial Eco-system				
Terrestrial Plants	Man			
Grass	Cattle Sheep, Goat	Man		
Crop	Rat	Snake	Eagle	
Grass	Insects	Frog	Snake	Peacock
2. In Aquatic Eco-system				
Aquatic plants	Aquatic insects	Small fishes		
Algae	Amoeba	Hydra	Small fishes	Large fishes
Phytoplankton	Zooplankton	Whale		

From the examples given above, we can understand that how the food material forms consumers of different levels of the food chain based on producers. In one food chain there may be one producer and three to four consumers.

Generally the final consumer is not eaten by any other animal. His death occurs due to disease, normal or abnormal causes.

In an eco-system there maybe different types of food chains. Usually two types of food chain are found in nature.

1. Grazing food chain or Predator food chain.
2. Saprophytic food chain or Detritus food chain.

1. Grazing or Predator food chain: The food chain starts from the green plants, goes to grazing herbivores and gradually moves from the smaller carnivores to the bigger. It is known as predator grazing food chain. e.g. deer eats grass, tiger eats the deer (this is a predator grazing food chain).

2. Saprophytic or Detritus food chain: Different micro-organisms or fungus splits up dead body of plants and animals into organic components. The splitting organisms are decomposers. The splited organic compounds are taken as food by some animals and then the decomposers are converted into foods of other animals. Such as, Dead organism-Decomposer-Amoeba -Hydra Zooplankton-Fish.

Food web: Previously we came to know that any food chain cannot remain scattered in nature. One food chain is linked with the other. When in a given eco-system, more than one food chain exists, the food chain becomes very complex and in this case the members of different types of food chain become interrelated. The well organized interrelated arrangement of more than one food chains formed by various species together is known as the food web.

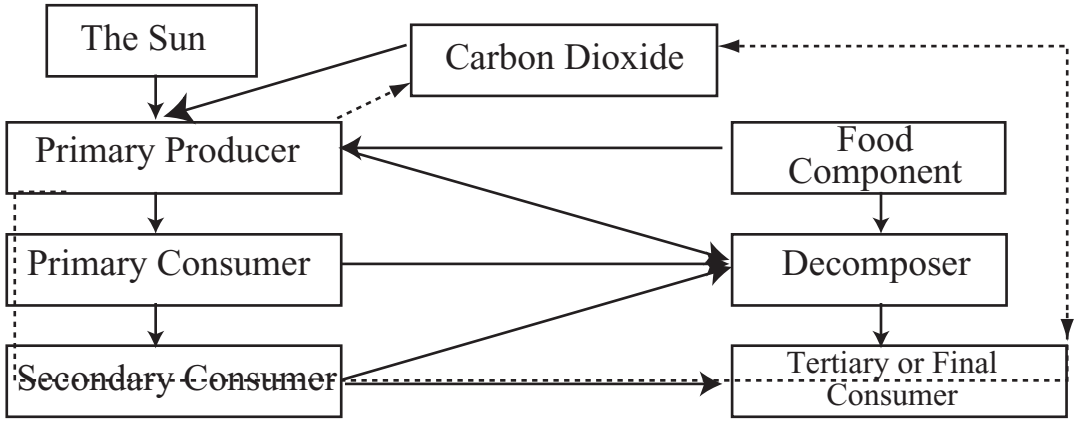


Fig- 13.1

Bird: **Brief Description of Different Stages or Steps of Food Chain and Food Web are given below :**

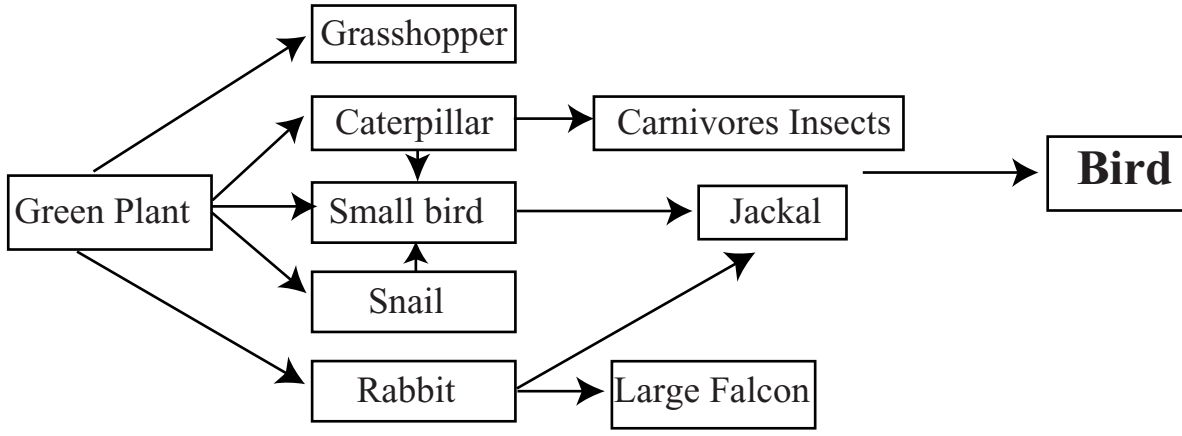


Fig - 13.2 Food

Producer: Solar energy is the main source of energy in the ecosystem. the green plants, in presence of sunlight react with carbon dioxide and water and produce carbohydrate and oxygen as excess. In this way, the solar energy stored in chemical compounds or food. Those who accomplish this significant function are known as producers. Green plants are the main producers in eco-system. Producers are autotrophic. The producers do not depend upon other organisms for nutrition.

Consumers: The living organisms which cannot manufacture their own food using the solar energy like the green plants and get their nutrition by eating other organisms are known as consumers. Most of the consumers of the living world are animals, e.g. mynas eat the insects, lion eats the deer, tiger eats men etc. So Myna, lion and tiger are **consumers.** As the consumer depends upon other living organisms for food or nutrition they are called heterotrophic. There are three levels of consumer's namely Primary consumer, Secondary consumer_ and Tertiary consumer.

(i) Primary consumer: Herbivores or Green plant eating animals are known as Primary consumers. Zooplankton. various types of insects, goats, cows etc dircetly denends on plants.

(ii) The secondary consumer : The animals which live on primary consumers are known as secondary consumers, e.g. frogs eat insects and tiger, jackal etc. eat herbivores animals.

(iii) Tertiary or highest consumer: Those who live on secondary consumer, are tertiary or highest consumers. e.g. vulture, falcon, crocodiles. sharks etc are, tertiary consumers because they live on secondary consumers.

There are many animals which live on food of more than one level e.g. when the peacocks live on plants, they are primary consumers and when they eat small insects, they are tertiary consumers. These sorts of animals are known as omnivorous animals. Man also consumes foods of different levels of the food chain to stay alive.

Decomposer: In an eco-system there is another type of heterotrophic organism which is collectively known as decomposers. This includes mainly the bacteria and fungi. From the body of the decomposers enzymes are secreted and that decomposes the dead body of the plants and animals to form simple chemical compounds. These chemical compounds are absorbed by the bacteria and fungi as nutrients. Besides this, the decomposers perform an important function which is to transform organic substances into inorganic ones. These inorganic substances are used by green plants for food preparation.

Nutrient flow in Eco-system: It is observed that plants accept inorganic substances and manufactures food by respiration the process of photosynthesis. A small portion of the food produced by the plants is used by them and the rest is reserved in the body. The herbivorous animals eat this and gradually

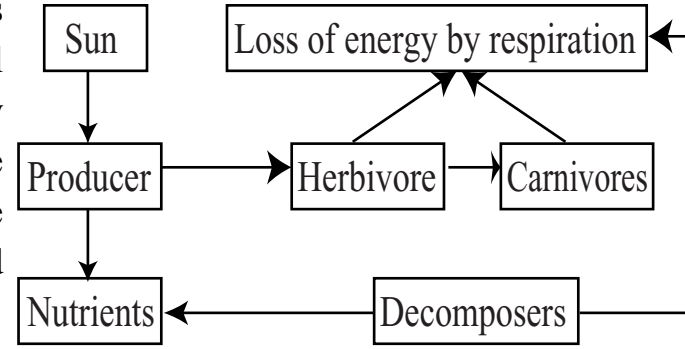


Fig- 13.3 **Flow of nutrients and energy**

herbivores are eaten by the carnivorous animals. The decomposers transform the plants, herbivorous and carnivorous animals into inorganic substances. Using the inorganic, substance the green plants can again manufacture food with the help of solar energy.

In an eco-system the transfer or flow of energy and nutrient from one trophic level to other is in succession. In each trophic level of food chain energy available decreases step by step, decomposers rot the dead body of the

organisms and inorganic nutrients are stored in nutrient storage of environment. The green plants again find inorganic nutrients from the storage environment. The cyclic flow of nutrients is known as nutrient flow. Food chain and nutrient flow are the important characters of ecosystem.

Energy flow in Ecosystem: Green plants. are the primary producers, which produce energy by using solar energy. Green plants hold solar energy as chemical energy from where it flows as energy or chemical compounds to the herbivorous animals and from the herbivorous animals to carnivorous animal Energy is spent in every step on the way to flow from the producer to the carnivorous animals. Almost all the energy is spent at the time of transfer of energy to the decomposers- from producers, herbivorous and carnivorous animals. This causes no energy to be transferred at the time of nutrient flow to inorganic nutrient storage. Inorganic nutrient materials are again transferred to producers from the nutrient storage. From this, it is understood that in eco-system the nutrient flows in a cyclic order with the eco-system. The energy flow is however, one way and not cyclic.

Decomposition and Transformation of Energy: We know that among the physiological processes of organisms, excretion is one of them. The animal excrete the nitrogenous waste products from the body through excretion. In this process some energy is spent. Besides this, the living organisms lose energy due to other physiological process. Living organisms come to an end through death and lose energy. This energy is called lost energy. The decomposers get necessary energy from the dead bodies and excretory products of different trophic level. In this way energy is transferred and the food chain remains effective.

Some examples of food chains are given below with which a human being is related in some way and they are the last level of the chain. It is seen that some of these food chains are very small and others are very large.

As for example

Grass, Paddy→ Cattle→ Man

Algae→ Aquatic insects→ Fish → Man

Algae→ Aquatic insects→ Small fish → Big fish→Man

Palddy→ Man

Living organisms spend a lot of energy in respiration and other biological functions. If the food chain is short, less energy is spent and if it is long then more energy is spent. From this rule it is understood that more the energy is transferred from producers to higher levels less the energy remains.

Major Eco-systems

According to the environment the ecosystem is divided into two parts, one *Terrestrial Eco-system* and the other one is *Aquatic Eco-systems.*

The Environment of a place depends on the topography, weather and climate of that place. The animals or plants of a particular region are dependant on some natural characteristics such as nature of soil, rivers, deserts, hills, mountains, climate etc.

1. Terrestrial Ecosystem: There are different types of terrestrial eco-system in different parts of the earth surface due to difference of rainfall, temperature, wind flow etc. There are many differences in ecology of agricultural land, grassland, desert and forest. Instead there are differences in ecology of mountain, hill, plain land, cold area, temperate area and tropical area. It is not possible to describe all types of eco-system in this chapter, so two of our known eco-systems are described here briefly.

A. Eco-system of paddy field: Due to cultivation, manure and irrigation the fertility of the land is increased. Paddy is the main plant of paddy field. Besides this there grow grass and many other weeds. They are the producers of the eco-system. Different types of insects infect the paddy. They are the primary consumers. Toad and different birds lives on the insect, snake lives on toad, the predator birds lives on small birds. When they die the saprophytic insect (ant, larvae of flies) and bird (crow, vulture) eat them. Besides these different types of bacteria and virus decomposes the dead bodies of plants and animals into organic compounds. In this way the eco-system of paddy field is formed.

Their analysis is found in the following list.

Producer: Paddy, grass and weeds.

Primary consumer: Insect and worm, cow, goat.

Secondary consumer : Toad, Insect eating birds, Man (man eats cow and goat).

Tertiary consumer : Snake, predatory birds.

Decomposer: Bacteria, fungi, saprophytic animals (crow, vulture, jackle).

B. Ecosystem of forest: The forest eco-system of Bangladesh is more or less same in nature. But the organisms of different food chains are different in different places.

Producer : Trees of forest, herbs shrubs.

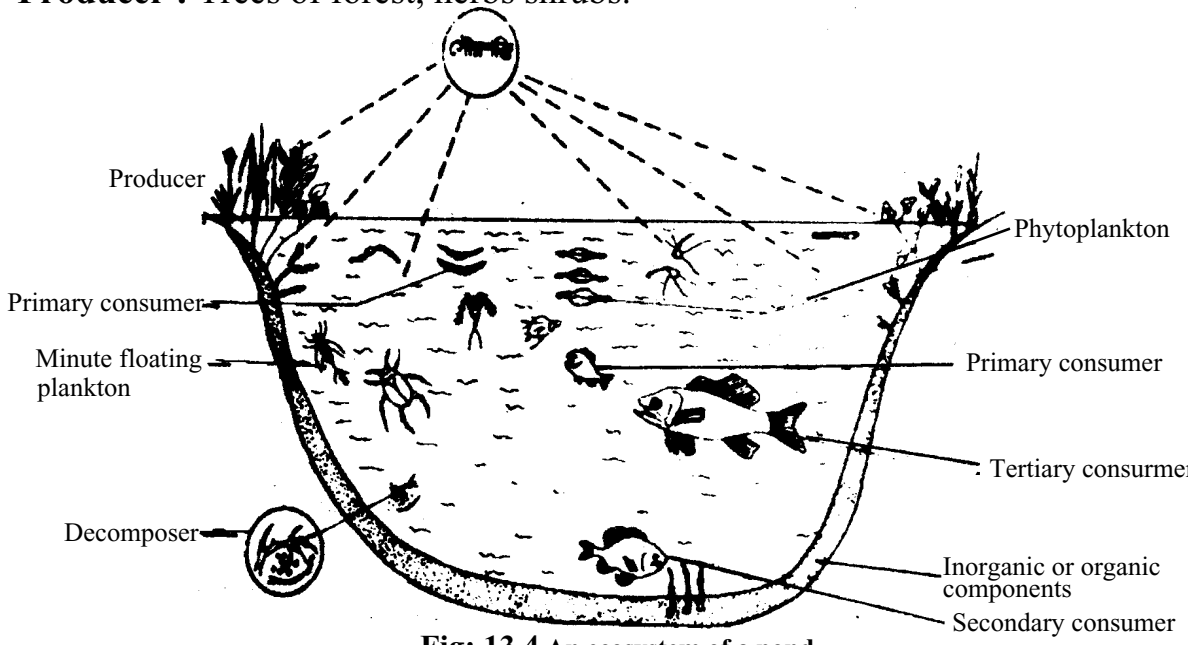


Fig: 13.4 An ecosystem of a pond

Primary consumer: Insects and worm, deer, monkey (omnivorous), *Hystrix* elephant, bats.

Secondary consumer: Toad, calotis, hoppers, bats, different types of birds, tiger.

Tertiary consumer: Snake, mongoose, kite.

Decomposer: Fungus, bacteria, saprophytic insects and worm, birds and wild beast.

(2) Aquatic Ecosystem: Aquatic eco-system is divided into three categories. (1) Pond ecosystem (2) River ecosystem and (3) Marine ecosystem.

A. Pond ecosystem: The mutual relation between the living organisms and non- living things of a particular area is known as ecosystem. In every ecosystem, every organism has a definite habitat and a definite life pattern. It is the main characteristics of an ecosystem.

A pond is a self-sufficient and an ideal example of ecosystem. In a pond, the intimate relation between the inhabiting living and non-living components is well understood. The non-living objects are various types of organic and inorganic substances such as water, sun rays, CO_2, oxygen, calcium, phosphorus, humic acid etc. The living components are producers, primary consumers, secondary consumers, tertiary consumers and various types of decomposers.

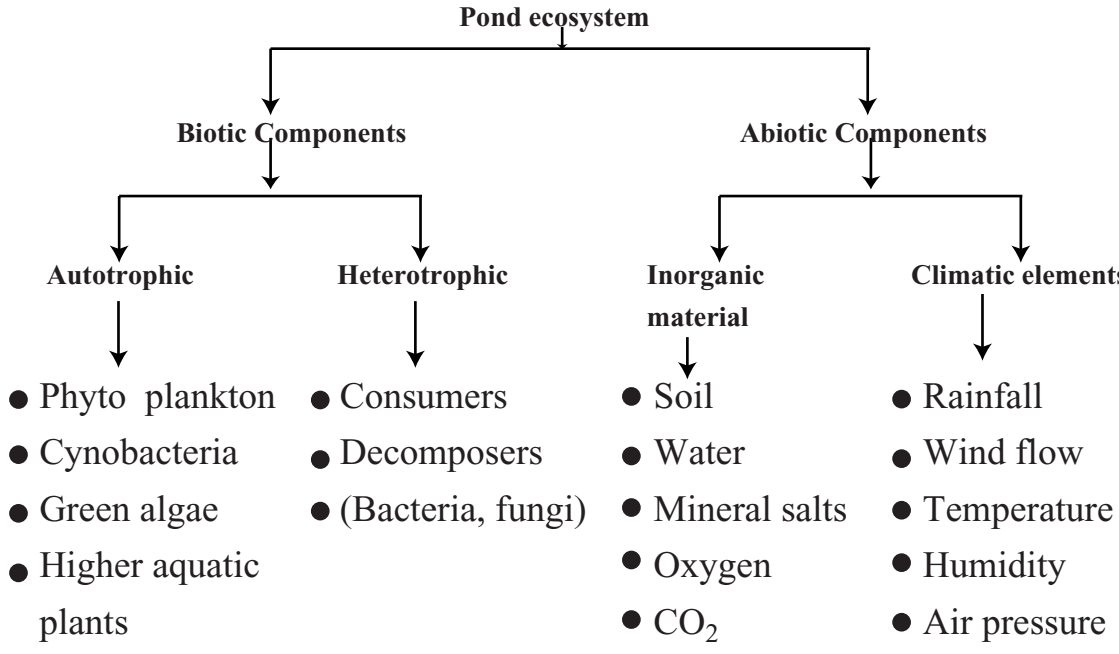
Producers: Various types of photosynthetic algae and shallow water plants living in the pond are the producers. The floating organisms are called plankton. The minute plants of plankton type are known as **phytoplankton.** Green aquatic algae and other aquatic plants can live by producing food by the process of the photosynthesis, so they are called producers.

Primary consumers: These are various types of floating minute insects, larvae of mosquito and other microscopic animals like zooplankton etc. Floating minute animals are called zooplankton. These consumers cannot manufacture their own food and they live on by eating the producers directly.

Secondary consumers: Small fishes, some aquatic insects, prawns, frog etc. are secondary consumers. They can neither manufacture their own food nor accept the producers as food. They live on by eating the primary consumers:

Tertiary consumers: Small fishes, prawn and all other animal that feeds, upon the secondary consumers are known as tertiary consumers. Large fishes like shoal, boal, vetki, stork and heron are the tertiary or highest consumers.

Decomposer: In pond water, various types of fungi and bacteria live as, saprophytes which are- known as decomposer. These decomposers can live by floating on water or live at the bottom clay. They attack living or dead consumers and help to rot. As a result, organic and inorganic chemical substances usable by the producers are fornmed again. The producer community of the pond use these decomposed elements. The flow chart gives an idea about the components of pond ecosystem.



B. River Ecosystem: water body often the rivers may have strong currents. For this reason, there is a noticeable difference between the environment and the living communities of rivers with those of the ponds. In river there are different types of algae fishes like Hilsha, Pungas, Chital, Boal etc. live in the rivers. The bodies of. these fishes are laterally compressed. For this feature of their body shape they are capable of moving easily in strong current. Near the bank of the river where the current is less, living communities like those of the ponds grow there. In the ecosystem of rivers the food chain is short e.g. Algae, Hilsa, Boal.

(iii) Marine Ecosystem: The water of the sea is saline. In the saline water the sea there lives numerous phytoplanktons and zooplanktons. Coral, Prawn Starfish, Snail, various types of small and large fishes, tortoise, dolphin, shark. whale etc. live in the sea. Phytoplankton and sea algae are the only producer in marine environment. Prawn, bivalve, zooplankton, minute pelagic animals and small fishes are the primary consumers. Large fishes, tortoises, whales etc. are the secondary ones. The sharks and various predatory fishes the tertiary ones. Generally the small fishes are herbivorous. The starfish, prawns, snails are detritus eating animals. The food chain of whale is also short like that of hilsa such as plankton, whale, plankton, small bivalve's and whale.

Ecosystem is a self-sufficient unit: Every ecosystem is more or less a self-controlled unit. In nature the number of a particular living being cannot increase too much. All organisms are interrelated with each other in the form of food and consumers chain. Any one of these systems cannot be completely eliminated easily. The proportionate number of different level of biotic communities always remains more or less unchanged.

In spite of various changes in the environments, the natural balance is maintained for a long time. By some reason, if the number of a particular animal of a place increases, the number of other living beings of that ecosystem will change in such a manner that the balance of the number of other living beings is maintained. If it is discussed with example, it will be easy to understand. Suppose in a forest, tiger, deer, cows, pigs etc. live. Deer and pig are the foods of tigers. If the number of deer and pigs increase, the tiger will have enormous quantity of food and consequently the tiger Production will increase and if the number of tiger's increases, large number of deer and pigs will be killed, as a result, the number of deer and pigs will be decreased. This will cause a dirth of food for tigers and the number of tigers will be decreased. On the other hand, if the number of tiger decreases the number of deer and pigs will increase. In this way, through decrease and increase of different animal population of the ecosystem of an area is automatically controlled.

The responsibility of man in maintaining balance of an environment: Starting from the producer up to the highest consumer there is a proportion of number of different tropical level in the ecosystem. Here the different processes of ecosystem are maintained nicely. It is called environmental balance. The relation between the inorganic and organic elements is very intimate in an ecosystem and the elements of an ecosystem maintain balance with each other. But different types of natural disasters, e.g. earthquake, tidal bore, draught etc. may destroy the balance. Besides these, man misuse natural resources for their own comforts. This affects the natural balance. For this reason there is a gulf of difference between the environment of ancient time and the present time.

Human beings are now facing two problems. The first one is the excessive population increase and food crisis. The second problem is the conservation of natural environment. Conservation of nature is one of the main steps to maintain the balance of the environment. In this way the components of environment can be saved. Climate, Solar energy, minerals, soil, plants, wildlife etc. are natural resources. Naturally very little of these resources decrease or being misused and nature herself always balance these. But soil, fresh water, forest, wildlife etc. are nature's perishable resources. Due to continuous use the quantity of these resources are becoming less. The goal of conservation is not to stop the use of these perishable resources and that is quite impossible. On the basis of knowledge from ecology, fresh water, soil, forest and wildlife can be conserved by definite plans. The main object of conservation is to use the natural resources by well planning to stop all types of misuse and dispotic use and in probable case revive the past condition.

Exercise

Multiple choice questions

1. **Which one of the following food chain would supply the least energy to mankind?**

a. Floating plant→ Floating animal→ Small fish→ Big fish→ Man

b. Floating plant→ Floating animal→ Small fish→ Man

c. Floating plant→ Big fish→ Man

d. Paddy→ Goat→ Man

2. **Which fact is corrtect in the role played by the decomposer in Eco-system?**

i. To decompose dead body turn into simpler chemical compounds.

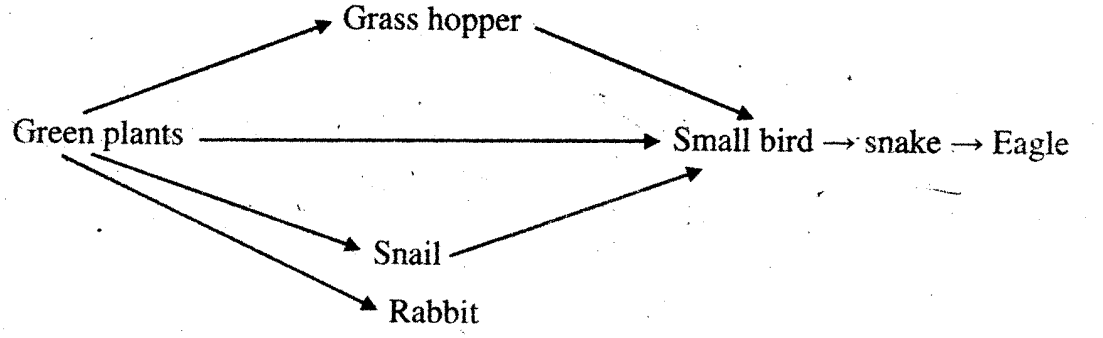
ii. The compounds, produced from the dead body absorbs as nutritive materials.

iii. Trasnsforms organic substances into inorganic ones.

Which one of the follwing is correct?

a. i b. iii

c. i & iii d. i, ii & iii



Answer to the question no 3 and 4 in support of the above diagram.

3. How many food chains are there in the diagram?

a. One b. Two

c. Three d. Four

4. Which are secondary consumers'

a. smallbird b. snail

c. Grasshopper d. Rabbit

Creative questions

Trina went to her maternal uncle's house for recreation during summer, vacaion. During her taking bath in the pond she saw the pond water is very green and in water Puti, Telepia, Soal and some aquatic insects were wandering on water. She saw a few numbers of herons and kingfishers in a tree on the bank of the pond. She wanted to know from her uncle the way of coexistence of those living organism and her uncle explained it.

a. What is aquatic ecosystem?

b. Prepare two food chains using the different living organisms in the pond.

c. Explain the energy flow among the different living organisms in the ecosystem.

d. Analyse what consequence in pond ecosystem may happen if the aquatic plants decrease gradually in pond water.

CHAPTER - FOURTEEN

POLLUTION AND CONSERVATION OF ENVIRONMENT

Now a days environment is taken into consideration extensively more than it was before. Conservation and long time management of the components of environment like soil, water, air, plants and animals etc. has now become the most important matter to us. Now a days man has come to realise that it is better to try to adjust with nature than to conquer it.

Soil pollution:

Soil is the upper layer of the earth crust which is soft and consisting of a mixture of various organic and inorganic substances. We live on the surface of the soil. We take different necessary elements from the soil. The remains of plants and animals return to the soil. Thus we can utilise repeatedly the different ingredients of the soil by rotation. So it can be said that our relation with the soil is very close. If soil is polluted it will have deadly effect on our environment.

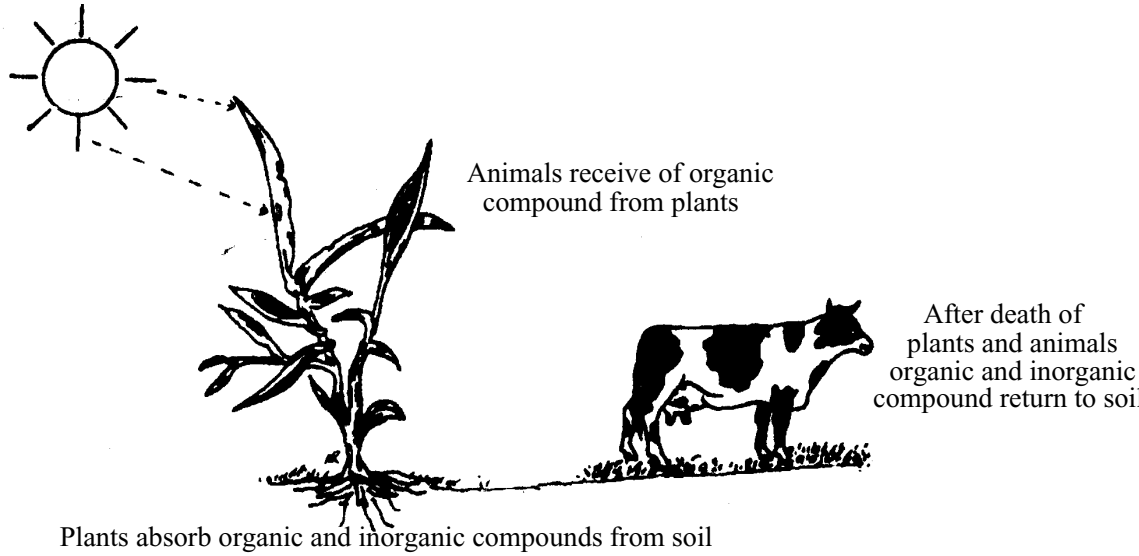


Fig. 14.1 cycle of organic and inorganic components

Soil is polluted by several means. Soil is eroded by different natural factors like flood, volcanic eruption, rainfall, and wind flow etc. Due to flood soil is eroded and become unproductive. Plant cannot grow on that soil. Rainfall and wind in the same way erode the upper layer of the earth and make the soil. barren.

Several activities of human beings,cause the soil to be polluted. Destruction of forests and plants, excessive cultivation and irrigation cause soil pollution. If there is no plant and cultivation is done in excess, it will erode the fertile layer of the soil surface and thus soil will become non-fertile. Excess irrigation causes waterlogging and makes the soil saline. Underground salt being dissolved in water come to the surface and make the soil non-fertile. Various types of waste materials are one of the causes of soil pollution. Harmful chemical substances and substances that is not absorbed by nature (e.g. polythene, plastic etc.) cause soil pollution. When soil is polluted no plants, insects or microorganisms can grow on it. As a result the soil becomes unproductive and unfit for human habitation. To keep the natural environment balanced a fertile and productive soil is necessary. Therefore, we all should take care so that the soil does not get unfertile and polluted. One of the ways to protect soil pollution is to plant more and more plants. There should have necessary laws so that industries do not leave their wastes here and there. If we all are careful against soil pollution it is possible to prevent the pollution.

Atmosphere

The gaseous layer that surrounds the earth from above the soil and water layer is the atmosphere. It is differentiated into three layers:

(i) Troposphere (adjacent to earth's crust): Above the Earth's crust this layer is extended from 10 K M. (at polar region;
to 16 K.M. (at equator).

(ii) Stratosphere: Above the troposphere this layer is extended up to 80 K.M. from the Earth's crust.

(iii) Ionoshpere : Above the stratosphere and extended up to 3500 K.M.

Fog mist, dust particles, clouds, and wind etc. are limited only in the Troposphere. In this layer the average ratio (depending on density) of different components are as follows: Nitrogen - 78%, Oxygen - 21%, Argon - 0.93%, Carbon dioxide - 0.03%, and a trace of water vapour, Methane, Helium and Krypton etc.

Beneath the Stratosphere (25 to 30 K.M. from Earth's crust) there is a dense layer of Ozone. It is called Ozone barrier. This layer protects the life from the harmful effects of the radioactive waves particularly the Ultraviolet Rays of the Sun. The density of air in the ionosphere is very light. Due to the effect of the radioactive rays of the Sun the components of the air remain in ionic forms.

Air Pollution:

Like soil air is also polluted by natural or human activities. Air is polluted by natural causes like sandstorm, forest fire, volcanic eruption etc. Dusts, smoke and poisonous gases mix with air and make the air polluted.

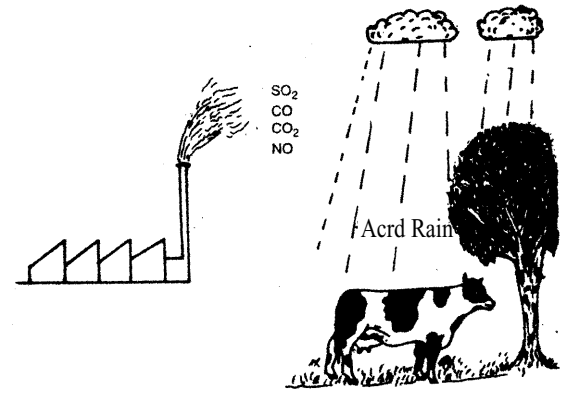


Fig. 14.2 Air pollution

Air is being polluted by smoke from mills and factories, automobiles and from bad smell of waste materials. In the smoke of industries and automobiles there are CO_2, CO, SO_2 and various other harmful gases. What will happen if the concentration of CO_2 increases in the air? The effect resulting the increase of CO_2 in the atmosphere is known as Green House Effect. This topic has been elaborately discussed in the next chapter. As a result of green house effect the temperature of the atmosphere increases. For this, there is a possibility of dissolving the ice of polar region and that may cause great flood. Many seaside and low-lying countries will be

submerged. When carbon monoxide mixes with blood, it totally destroys the Oxygen transport capacity of blood. Without Oxygen people will die. Sulphur dioxide and Nitric oxide, produced by Nitrogenous fertilizers, when mixed with rainwater causes acid rain, which is very much harmful for plants, animals, buildings, and instruments. CFC (Chloro-Fluoro Carbon) gas evolves from various materials used by human beings gets in the atmosphere. CFC gas is responsible for damages in the Ozone layer. Detailed discussion in this respect will come later.

The most effective way to stop air pollution is to increase the number of plants. This will maintain the balance of the amount of O_2 and CO_2. On the other hand it is necessary to take care so that no harmful gas can be mixed with the air. Condition will improve if filter is used in mills and automobiles.

Water Pollution:

We have so much water in our country that mostly we do not feel the effect of water pollution. Water is polluted by natural means like flood and rainfall. As a result of flood many impurities are mixed with water. Water is mostly polluted by man-made causes. Industrial wastes, household garbage, rainwater containing chemical fertilizer and insecticide, all these mixed with water make it polluted. Due to water pollution extreme harm is caused to aquatic plants and animals. The oxygen content of water becomes reduced and thus many fishes and aquatic animals die and float on the water surface. There are strict regulations against water pollution in European countries. All water transport vessels are to take necessary measures so that their oil and waste materials do not pollute water. There are provisions of severe punishment or heavy penalties if such measures are not taken. To prevent water pollution in our country primarily people should be motivated through different medias. Later regulations should be implemented very strictly and impartially.

Sound Pollution :

Sound is a constant companion of the city dwellers. Sounds of vehicles and vendors wake us up in the morning. All through the day sound pollution occurs with mixed sound of different machineries, telephones and loud voices of human beings in the offices and these have become very normal sound pollution. When a man comes back home and listens to Radio, T.V. or Tape recorder then there is also sound pollution.

If sound exceeds a certain limit (80 decibel). it reaches the stage of pollution. The effect of sound pollution is quite harmful to animals. It causes high blood pressure, insomnia (sleeplessness), loss of hearing capacity and extreme case of mental disorder.

Ozone layer :

Ozone is one kind of gas. Three oxygen atoms together constitute one molecule of ozone. The chemical formula is O_3, Certainly you know about the three layers of atmosphere Troposphere, and Stratosphere Ionosphere. A dense ozone layer exists in the stratosphere zone about 25 to 30 K.M. above the Earth surface. Ozone is also present in the troposphere zone. This layer of ozone surrounds the Earth from all sides. You have learnt that from time immemorial this ozone layer has been protecting the living beings of the earth from deadly ultraviolet rays radiated from the Sun.

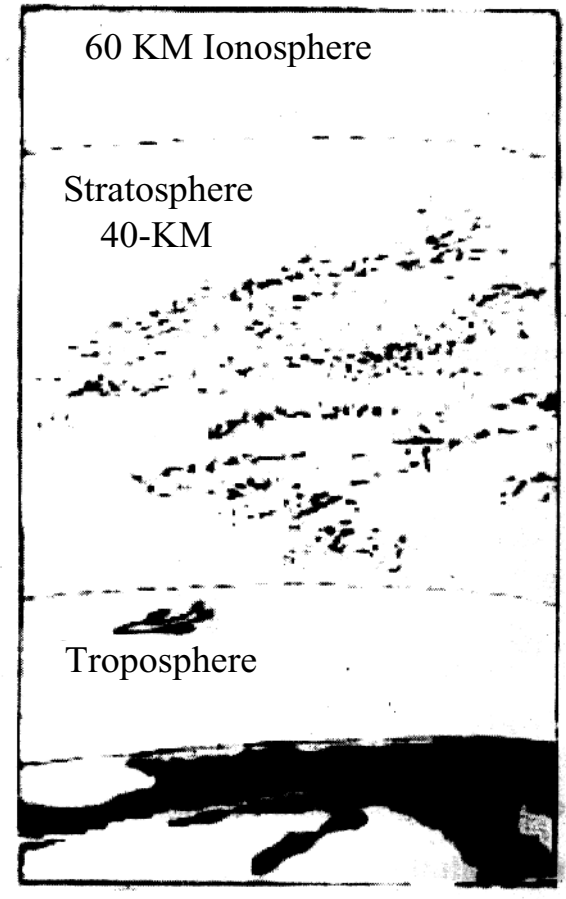


Fig. 14.3 Ozone Layer

Ultraviolet rays are of three types: UV-A rays consist of long wavelength.

Ultraviolt-B consist of medium wave length. And UV -C consist of short wave length. The ozone layer in the stratosphere zone prevents the total amount of the most dangerous UV -C and most part of less harmful UV -B. The rest amount UV -B is prevented from coming to the earth, by the troposphere zone and clouds.

Two American Scientists Maria Molina and Sherwood Ronald in 1974 AD first gave the idea that the chemical compound Chloro Fluoro Carbon (CFC) that is used in our daily life is responsible for the damage of ozone layer. CFC compound is used in the cans of Aerosol and in making of various foams. Getting release in to the atmosphere it moves to the higher atmospheric zone. The CFC compound does not break easily in the lower zone of the atmosphere. Reaching stratosphere CFC comes in contact with ultraviolet rays and releases chlorine after breaking itself. The free chlorine then acts as a catalyst and break the ozone molecule to an oxygen molecule and one oxygen atom. This process goes for years after years. Some other chemical compounds like Carbon Tetrachloride Trichloromethane and Helone also adversely affect the ozone layer.

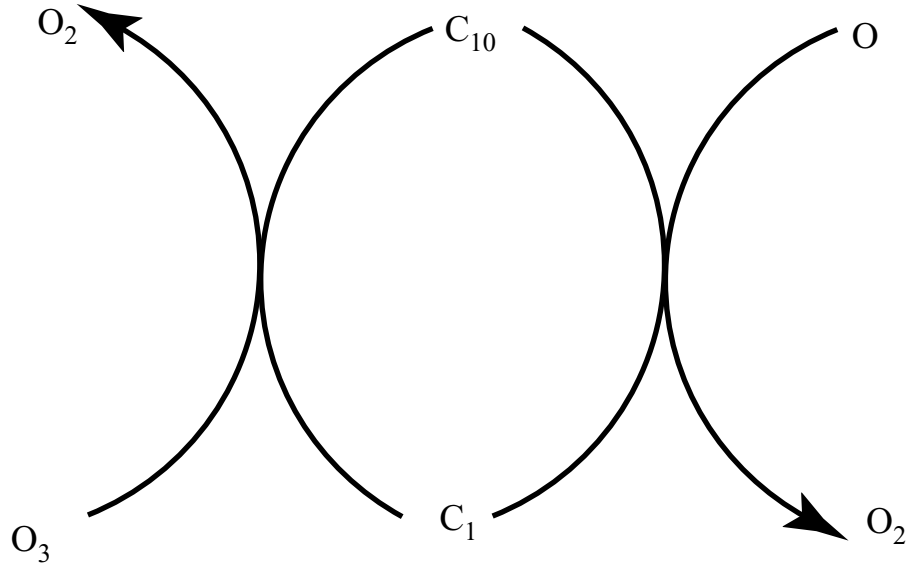


Fig. 14.4 Breaking down of ozone molecule by Chloringe

Ultraviolet rays are harmful to living bodies. It is proved that an increased exposure to UV -A and UV -B resulting an enhanced possibility of skin cancer. Besides, various eye diseases like formation of cataract, distortion of eye-lenses, and lose of eye-sight found in aged people, are due to the effect of UV -B. Due to the reduction of the power of disease resistance, contaminations of various infectious diseases increased.

Green House Effect

You know what is green house. cold countries plants are grown in a green house to protect them from external cold. Usually this house is made of glasses. As a result sunlight can enter inside. Inside the room plants live on carbohydrates manufacture through photosynthesis by the help of sunlight. With the help of sunlight the internal environment of the house remain warm. As glass is bad conductor of heat so external cold cannot reach inside nor internal heat can go out.

Carbon dioxide in the atmosphere acts almost like the glass of the green house. The earth is heated by sunlight. Much of this heat is lost to the space-by radiation through the atmosphere. As a result the temperature of the atmosphere remains more or less same. But if the amount of CO_2 is increased in the atmosphere, the condition becomes different. Some of the radiated heat is absorbed and retained by carbon dioxide; this results in the increase of atmospheric temperature. Scientists have calculated and found that the amount of CO_2 in the atmosphere has been increasing day by day. You must know why the amount of carbon dioxide is increasing. Large-scale deforestation is one of the main reasons. Another reason is the use of fossil fuel. Petrol, diesel, kerosene, coal etc. are mineral fuel. Its uses are increasing in factories, vehicles, and household purposes. As a result the amount of carbon dioxide in the atmosphere is increasing day by day.

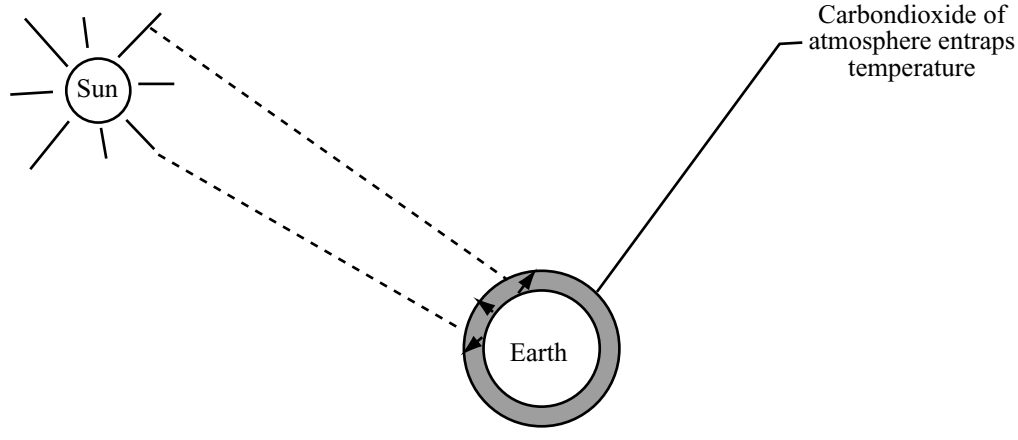


Fig. 14.5 Green House Effect

Fig 14.5 Green House Effect

Can you realise the effect of increased atmospheric temperature on the environment due to green house effect? You know that huge amount of ice is deposited in the two polar regions of the earth. With the increase of the atmospheric temperature this ice will start melting. As a result the water level of seas will increase. Many islands, seaside cities and countries will gradually go under water. Many areas of Bangladesh may submerge under the water of the Bay of Bengal.

Role of Human beings in conservation of Environment:

From above discussion you must have learnt that various activities of human beings are responsible for pollution of the environment. Men knowingly or unknowingly are polluting the environment. So attaining the knowledge about environment pollution and developing consciousness should be the primary responsibility for preventing environment pollution. If we are aware of pollution of the environment, have willingness and desire to prevent it then we will be able to do it.

Effect of Urbanization and Industrialisation on Environment:

For fair livelihood in a comfortable environment we need many things like houses, roads, schools and colleges, shops and markets, hospitals and post offices etc. A town or city develops with all these facilities. The system by which a town or city develops is called urbanization. To develop an ideal town some important aspects should be taken into consideration. Towns and cities of our country have not been developed in well-planned way as those of the developed countries of the world. Except the new part of Dhaka and some areas of Chittagong, our towns are developed absolutely without any planning. While establishing an ideal town some important aspects should be taken into consideration with great importance.

1. To establish a town primarily it is necessary to select a suitable site.
2. To live in comfort it is necessary to construct neat, clean and comfortable houses. In these houses there should have clean and pure water supply, electricity, gas supply and proper sanitary system.
3. For proper supply of daily necessities and fresh vegetables, fish and meat, there should have shops and markets.

4. For maintaining cleanness and healthy condition in these shops and markets, Public health department should supervise them regularly.
5. For treatment of diseases there should have dispensaries and hospitals, population control and family planning centers, maternities etc.
6. Along with schools and colleges for children's education there should have arrangement to establish libraries, recreation and health-care centers, including playgrounds, clubs, parks etc.
7. There should have suitable recreation center for aged people so that they can pass a life of ease.
8. There should have arrangements for prevention and treatments of various contagious diseases so that these may not turn into epidemics.
9. There should have necessary job provision for the town dwellers.

Due to gradual increase of population there develops undesired formation of slums in vacant places inside and around the towns. In these slums uproote people live in extremely miserable condition. This situation is gradually turning to be more acute. As a result various social and hygienic problems are being created. Unplanned urbanization results extreme deterioration of the environment.

The environment of the slums, developed for the new comers from the villages, is dirty and unhealthy. Because in these slums there is no water supply or drainage and sewerage system. There is no facility of collecting water from rivers, canals, ponds or pools like villages. As a result the slum dwellers often suffer from various water borne diseases. From these slums diseases spread to other areas of the town also. But in towns purified and chlorinated water is stored in big tanks at a high level. Water is then supplied to different areas of the town through pipelines. But for excess population the stored water is not sufficient. Consequently the inhabitants of the town suffer from water shortage.

The supply of fuel is a significant problem of unplanned urbanization Previously in town also, wood and dry cowdung were used for cooking. But at present natural gas is being used. Now a day, in many countries, Bio-gas is being used for cooking. Smoke originates from both wood and dried cow dung and pollutes the air. For unplanned urbanization supply of natural gas cannot be ensured to every corner and for all the time.

Because of rapid increase of population people from villages are rushing to towns in search of livelihood. The urbanization process must be planned for them. Otherwise there will be no comfort in life of the town dwellers and the environment will be polluted day by day.

Commercial establishment of mills, factories and machineries for the production of various necessary materials for the people is known as industrialisation. With the objective of industrialisation various types of industries have been established in the world.

Previously men were dependent more on articles available in the nature. But with the advancement of human civilization; industrialisation is also improving rapidly. In the recent past there was a balance between birth rate and death rate in the world, particularly in Bangladesh. At present number of death caused by natural calamities like cyclone, famine, different fatal diseases, aggression and bite of harmful animals, is much less than as prevaile in the past. Now a day there are preventive measures for protections against the disastrous effect of every natural calamity. For example the forecast of cyclone is available before hand and taking shelter in safe places people can save their lives. With the improvement of communications system famine do not occur as frequently as before, even if it occurs food can be supplied easily. Prevention of hunting wild animal and adopting defensive measures against their attack has made human life safer than before. Taking effective and preventive measures against severe diseases man has become able to recover from his illness and avoid inevitable death. Thus the average longevity of human being has increased. As a result with increased longevity people can give birth to children in greater number. Above all the general people of Bangladesh are reluctant to adopt family planning for which the population of this country is increasing rapidly. For this increase in population the cultivable land and forest areas are gradually decreasing. Thus the demands of agriculture as the main livelihood of our country can no longer be met from agriculture alone. For this reason it is necessary to establish industries in a well planned way. But our conventional industries are dependent on our natural resources. As the raw materials produced in our country are not sufficient for the need, thus necessary raw materials are to be imported from foreign countries.

Industrialisation is mainly of two types :

A. Such materials should be produced which are at present imported from abroad e.g. production of superior quality of cloth.

B. Such materials should be manufactured for which raw materials may be imported from abroad, and utilising cheap labour of this country, those items may be produced and exported abroad, e.g. garments and ceramic industries. Cloths being imported from outside and by utilising cheaper local labour garments are produce and exported. It is a profitable business.

Unplanned growth of industries deteriorates the environments in many ways. Mills and factories should not be established in human habitation. Because.

1. Industrial smoke pollutes the air of the locality.

2. If unused and excess raw materials and by-products are, not removed properly, these may often decompose and pollute both soil and air.

3. Often in the name of by-products the industrial wastes are thrown to the river or other water reservoirs. As a result the water of the reservoir become polluted and may cause harm to fishes and other aquatic animals living there. Use of this polluted water may also do harm to human beings. So industries should not be established here and there in unplanned way.

4. If industries, producing high sounds are established in human localities, people of those areas will become victim of soun pollution. In this way unplanned industrialisation directly or indirectly may affects the environment. Unplanned industrialisation deteriorates the public hygiene of environment. so before establishing any industry in an area the above factors should carefully be taken into consideration.

Excrcise

Multiple choice questions

1. Which gas is responsible for erosion of ozone layer?

a. Carbon dioxide b. Carbon monoxide

c. Chloro floro carbon d. Sulpher oxide

2. Which statement is correct in case of ultraviolt ray?

i. Increase the loss of eye sight of the olds by the effect of UV-A

ii. Distrotion of eye-lenses by the effect of UV-B

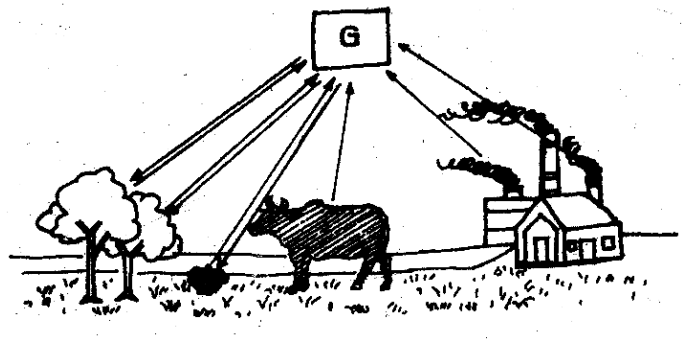
iii. Enhance possibility of skin cancer by the effect of UV-C

Which one of the following is correct?

a. i b. ii

c. i & ii d. i & iii

Answer the question no 3 and 4 in support of the following diagram.



3. What is the name of the gas labelled G in the above diagram?

a. Sulpher dioxide b. Oxygen

c. Carbon monoxide d. Carbon dioxide.

4. The labelled G gas is-

i. produced more in the Dhaka city.

ii. produced more in deep forests.

iii. used for the treatment of dying patient.

Which one of the following is correct?

a. i b. ii

c. i & ii d. i & iii

Creative questions

As a result of the gradual increase of green house gases the temperature of the atmosphere is increasing and the green house effect is also become acute. According to a statistics one molecule of CFC gas can absorb equivalent quantity of heat of 1000 (one thousand) molecules of Carbon dioxide. But 49% of the total green house effect of the earth is being happened by carbon dioxide. It is shown in the another statistics that urbaniztion is one of the many causes to increase the temperature of the earth. A green house effect is shown in the following diagram.

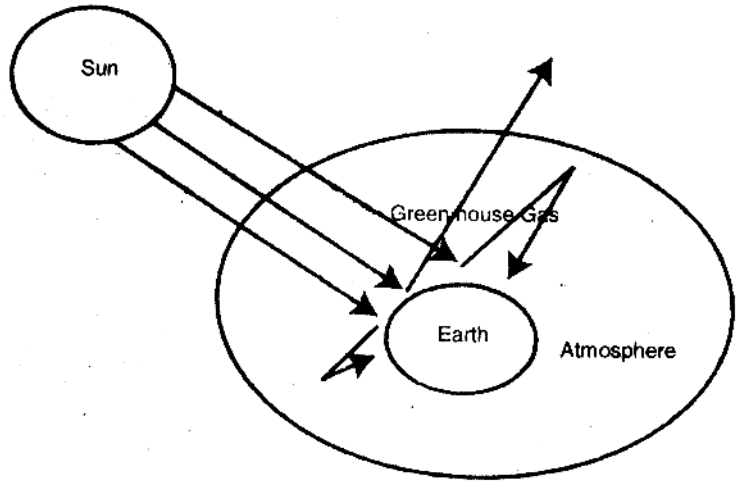


Fig: Green house reaction

a) What is Green house gas?

b) Why is the Carbon dioxide only responsible for almost half of the green house effect of the world though the capacity of Carbon dioxide is less than C.F.C gas?

c) Explain green house effect on support of the above diagram.

d) Analyse the responsibility of human being to reduce the influence of urbanization on creating green house effect.

CHAPTER - FIFTEEN

Natural Diversity of Bangladesh - Distribution of Plants and Animals

Bangladesh is a small country of an area of about 1,47,570 square kilometers. It'is situated in between 20û34¡ and 26û38¡ northern latitude and 88û01¡ and 92û41 eastern longitude. Though the country is small yet the plant and animal resources is not so little. River washed Bangladesh is the largest delta in the world, having characteristics of natural diversities. Growth rate of population in this country is very high. The density of population is increasing day by day. To meet the needs of this additional population, homesteads and furniture are being made, and cultivable lands are being procured by destroying valuable forests. As a result forestland is terribly destroyed. Many species of plants and animals are becoming extinct. Thus plant and animal resources are being lost. As a result the topography (land forms) of this country is being changed very rapidly.

The nature of any region is the combination of various inorganic components like topography, climate, rivers and canals, mountains and hills etc. The nature and natural flora and fauna of a particular region together form the natural environment of that region. The characteristics, which prevail in a particular natural environment, are known as natural characteristics of that region. The natural environment of a particular region is dependent on the topography and climate of that region.

Bangladesh may be divided into several regions on the basis of topography or landform. The environmental components, flora and fauna of this region are full of special characteristics.

Some of these are discussed below: Recent flood plain 2. Haor and marshy lands 3. Pleistocene uplands, 4. Tertiary hilly region 5. Coastal mangrove forest and 6. Saint Martin's Island.

1. Recent flood plain:

This region comprises of the vast plain land of Bangladesh. The land is formed by the alluvium carried by different rivers, particularly the Ganges, the Brahmmaputra and the Padma.

Environmental characteristics: The soil of this region is made of alluvium and is very fertile. In the rainy season many aquatic plants, by death and decomposition, converted to organic manure and thus make the soil more fertile.

Plants: Among the aquatic plants *Nymphaea noucheli* (Shapla) [our national flower], Lotus, *Ipomea*, Halencha, Shola, *Vallisnaria* (Pat Shaola) *Urticularia, Azolla, Lamna, Wolfia* (smallest flowering plant) *Eichornea* (Kachuripana), *Pistea* (Topapana), *Trapa* (Paniphal), *Polygonum* (Panimarich), and various types of grasses are the major plants. In this region there grows plenty of fresh water algae among which phytoplankton, a primary producer, serve as the food of fish and other aquatic animals.

In uncultivated lands, Kalkesunda *(Cassia)*, Shetodron *(Leucas)* Raktodron, Dhutura *(Datura)*, Hatishur *(Heliotropium)*, *Mikania*, Bhat *(Clerodendron)*, Muktajhuri *(Acalypha)*, Kachu *(Colocasia)*, Khagra *(Xanthiun)* etc. are the major plants. Around the houses betel nut, coconut, mango, jackfruit, banana, litchi, tamarind, plum, jamboline, bamboos, Barun, Pipul, Akondo *(Calotropis)* etc. are the main plants.

Among the crop plants paddy *(Oryza sativa)*, deep-water rice (a variety of paddy grown in deep water), and jute *(Chorchorus sp.)* are the main.

Animals: In this region there live different species of small and large animals. Among them, toad, frog, lizard, tortoise, different varieties of snakes, mongoose, sparrow, Shalik, Moyena, parrot, crow, kite, vulture, buffalo, cow, goat, sheep etc. are notable. Besides these, in the rivers of this region there is fresh water dolphin (Shushuk) and different species of fish. In ponds and other water reservoirs there are many species of small and big fishes, aquatic snakes, tortoise etc.

2. Haor and other Marshy lands:

These are formed by accumulation of water in the low-lying areas on the earth surface. Except rivers, ponds, and lakes the other marshy lands of Bangladesh may be classified into three categories: Haor, Baor and Beel.

A. Haor: Due to natural movements of the earth, beneath the earth crust, some times changes take place on the earth surface. As a result earth

surface become deepen to form a basin like area where plenty of water is reserved. This vast water reservoir is called Haor. The greater Sylhet district of Bangladesh is known as 'Haor Basin' region. The eastern region of Kishorganj and Netrokona are also included in Haor region. Some worth-mentioning Haors are Hakaluki, Tanguar Hayil, Dubriar Haor etc.

B. Baor : The horseshoe shaped water reservoirs, which are formed naturally due to the change of river route, are known as Baor. There are several Baors in the southwestern region of Bangladesh. Among these some big ones are: Baro Baisdia. Choto Baisdia. Baluhar. Marjat. Joidia etc.

c. Beel : Water reservoir that originates by the side of the old river route is called Beel. There are many Beels in the greater districts of Bangladesh namely Rajshahi, Rangpur, Bogra, Pabna, Faridpur and Khulna. Among these, Chalan Beel, Patrail, Manda, Parul, Raktodoha. Dakatia, Gopalgonj Bakhra are prominent.

Environmental Characteristics :

Almost throughout the year water remains present in the Haors, Baors and Beels, but in winter water become less and then paddy is cultivatad there. In some places there remain at least some water throughout the year.

Plants : Usually common aquatic plants are grown in aquatic environments of the Haor, Baors and Beels. Besides this, there grow specially reeds (Nalkhagra), Ikar, Hijal, Karoch, Gota, Gamar, Barun and wild roses. Thes are bushes of Hijal and Nalkhagra.

Animals : In these shallow water bodies there are different species of fishes like Lata, Meni, Baim etc. and various kinds of animals like toad, frog, tortoise, water snakes, heron, crane, Kadakhocha Pakhi, kite, eagle and Pankouri etc.

3. Pleistocene uplands : During Pleistocene era (25,000 years ago), many regions of the world became raised and formed uplands. These regions are called Pleistocene uplands. In Bangladesh, Barendro region, Modhupur Gorh and Lalmai hills are

parts of these uplands. The environmental characteristics and flora and fauna of these regions are almost similar. But the large area of Shaalbon is noticeable.

A. Barendro : The region occupies the north-western region of Bangladesh including Chapainowabganj, Rajshahi, Nowgaon, Jaipurhat and part of Dinajpur. The total area of this region is about 9300 square kilometers and situated at about 6 -12 meters (20-40 feet) above sea level. In some area of this region the soil is terraced in steps.

B. Modhupur Gorh : Modhupur Gorh includes Modhupur of Tangail district, Jamalpur, Gazipur, and parts of Dhaka and Narsingdi district. Total area of this land is about 4100-square kilometers and situated at about 15 -30 meters (50 - 100 feet) above the sea level. Long ago there was a continuous Shaalbon of 160 kilometers long from Jamalpur to Dhaka. Now this forest is scattered into pieces. Though Chandra, Rajendrapur or Bhawal is treated as separate forests but they are actually parts of Modhupur forest. Brahmmaputra and Shitalakshma rivers separate the eastern part of this forest from the main uplands. Egaro Sindhur, Shibpur, and Monohardi thana and part of Sonargaon are part of this separated region.

C. Lalmai Hills : Lalmai Hills is situated near Comilla town and is about 14.5 kilometers (9 miles) in length and 0.8 -2.4 kilometers (0.5 -1.5 miles) in breadth. This is also a part of Pleistocene uplands. This hill is about 6 -12 meter (20 -40 feet) in height. Its highest pick is more than 46 meters (150 feet). Probably the name 'Moinamoti Shaalbon Bihar' originates because of the presence of Shaal forest here.

Environmental Characteristics : Soil of Pleistocene uplands is unproductive, acidic and reddish or somewhere grayish. Rainfall is insufficient, less than 2000 m.m. in a year. Climate is to some extent extreme, high temperature in summer, dry winter, less humidity in air; these are the characteristics of this region. This climatic condition has contributed in creating deciduous forest. In Modhupur region forests develop in elevated land (Chala) and places in between raised lands (Chala) are known as BAID (Low land). In low land Areas paddy Is cultivated.

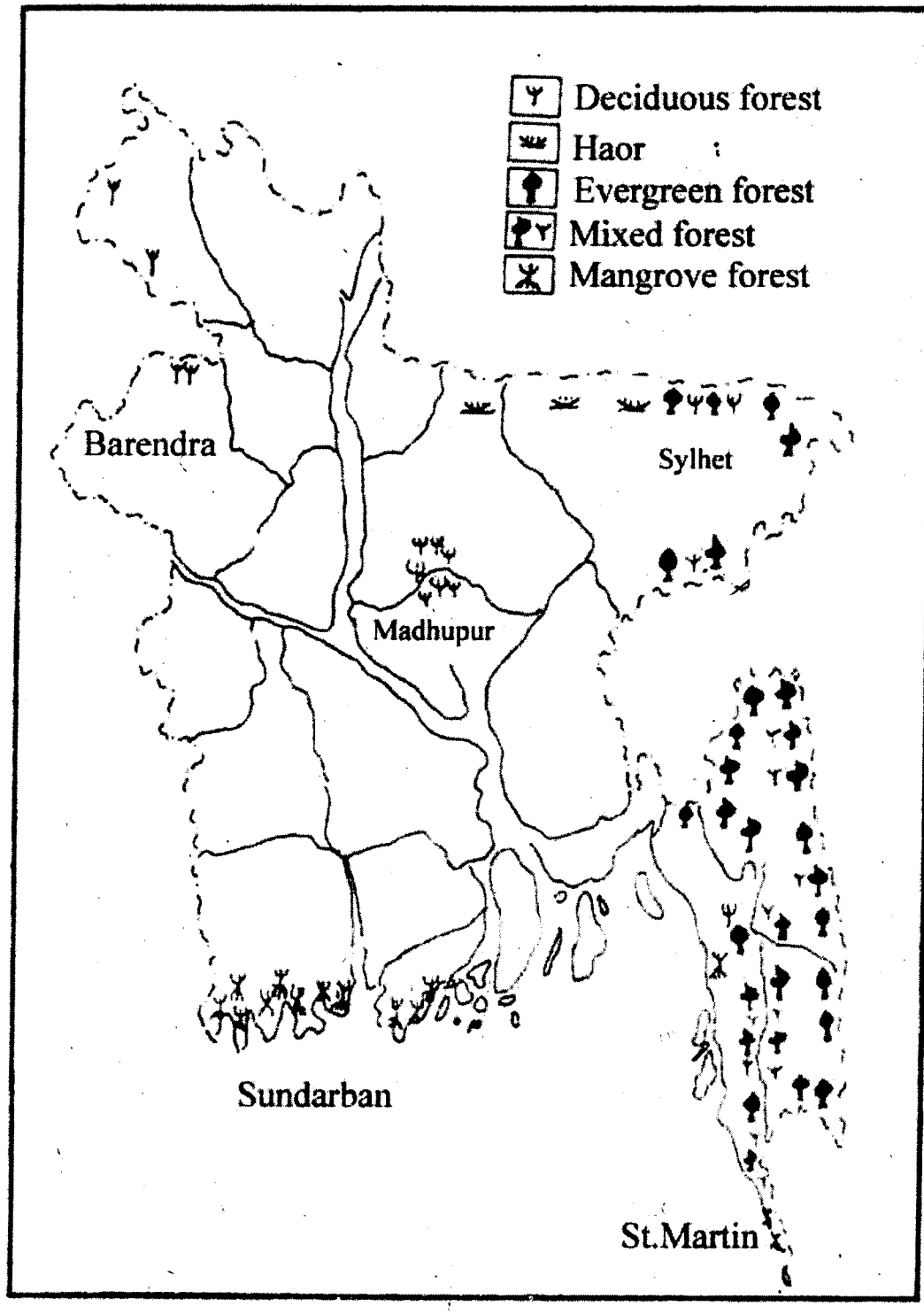


Fig. 15.1 Distribution of Forest areas of Bangladesh

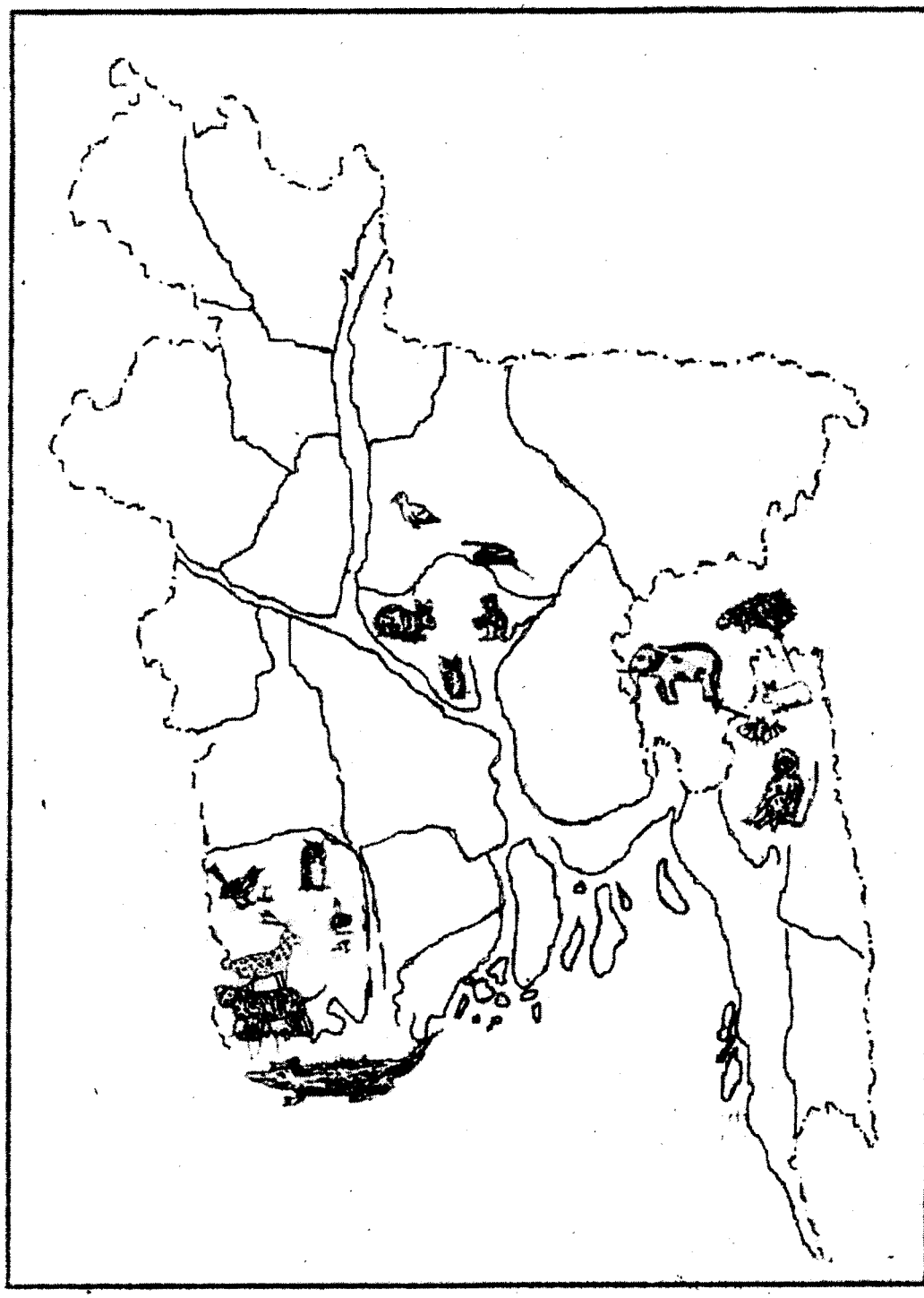


Fig 15.2 Distribution of Animals in Bangladesh

Major Plants : One of the characters of this upland is the presence of Shaal forest. Shaal forest is said to be a deciduous forest. Because in winter all the trees of this forest become leafless. In some places Shaalbon is also known as GAJARI GORH. 97% tree of this forest is Shaal tree *(Shorea robusta)* from which the name Shaal forest originates. Among other trees, there are wild Chalta, Gachhi Gajari, Koroi, Kumvi, Gamari, Palash, Vela, Bahera, Haritaki etc. Almost all of these are deciduous plants. Many jackfruit trees have been cultivated in Modhupur and Bhawal region. Shaalbon has reduced in large scale in Barendro region. There are still some Shaalbon in Phulpur and Ghoraghat of Dinajpur and Dhamarhat of Nowgaon. The Shaalbon of Dhamarhat is a continuous part of Indian Shaalbon. In Chapainowabganj and Godagari of Rajshahi, Shaalbon is almost nil. Besides a very few Shaal trees, some Pora-Shaal, Koroi, and Sinuri etc. are present here.

Major Animals : Monkeys, squirrel, jackals Langoor, several species of snakes, mongoose and different kinds of birds are the major animals of Barendra region. In Modhupur region the major animals are monkeys, entellus, jackals, lizards, woodpeckers, owls, kites, mongoose, water monitor, squirrels and tree frogs. Once leopard and deer were abundant here but now they are very scanty.

4. Tertiary hilly region : The hilly regions of north-eastern and south-eastern part of Bangladesh have originated during the elevation of the Himalayans in Tertiary period They are similar to Lusai of Asam and Arakan hills of Mayanmar. These hills are situated in greater Sylhet, Chittagong and Chittagong Hill Tracts.

A. Hills of Sylhet : In Moulavibazar, Habiganj and north-eastern part of Sylhet there are hills or hillock covered with grassland and trees. Usually these are situated at 30 -60 meter (100 -200 feet) above sea level. In these hills tea cultivated. The highest hill of Sylhet region is the Patharia Hill. Its height is 240 meters (800 feet).

B. Hills of Chittagong : In the northern region of Chittagong there are some small hills situated parallal with the seashore and are extended north to south The hills of Sitakunda and Chandranath are one of them. The highest peak here is 350 meters (1155 feet). In the south there are some small hilly range in between Cox's Bazar and Teknaf.

C. Hills of Chittagong Hill Tracts: There are many hills in the hilly district of Rangamati, Bandarban and Khagrachhari. These hills are extended from north to south. Normal height of these hills is not more than 600 meters (200 feet). Among the hills of Chittagong Hill Tracts the highest one is Tajingdong (Bijoy), which is 1231 meters (4039 feet) in height. Other high hills are: Moudok Muyal -about 1000 meters (3292 feet), Reng Tiyang -about 920 meters (3141 feet), and Pyramid hill -about 920 meter (3016 feet).

Environmental Characteristics: Hilly lands are elevated with heavy rainfall and it rains almost throughout the year. Air in this region is saturated with humidity. In Sylhet region the amount of rainfall is more than 5000 m.m. in a year, in Chittagong -about 3000 m.m. and in Chittagong Hill Tracts to 2500-2750 m.m.

Plants: Presence of forest is the characteristic features of hilly region. In these forests there grow various types of plants - climbers, bushes, bamboos, canes and grasses. Formerly this region was covered with dense forests. But due to overgrowth of population and collection of forest resources in excess these forests are decreasing gradually.

Management of forests of Bangladesh is of two types. (1) Reserve forest under the management of the forest department of Bangladesh and (2) Unclassed State forest under the management of Local district administration. The second type of forests has suffered much loss. Most of these areas are now barren.

The management of forest department causes the damage of most of the forest area. In natural forest there grow many species of plant. But for the production of more valuable timber, in many regions the naturally growing plants are being cut down and many trees of a single species have been planted. This is called monoculture. This type of forest is called *Plantation Forest.* In these forests valuable species of plant like Teak, Gamar, Rubber etc are planted, thus the diversity of plants in this forest is much lesser.

For Predominance of certain species, forests are given various names. Such as in cane forest mainly canes are grown. In the similar way in bamboo forest various types of bamboos are grown. Teak and Gamar are already

mentioned. Besides. in many treeless hills there grows different types of grasses, particularly Chhon grass *(Imperata cylindrica)* are grown. These are called Chhon forest.

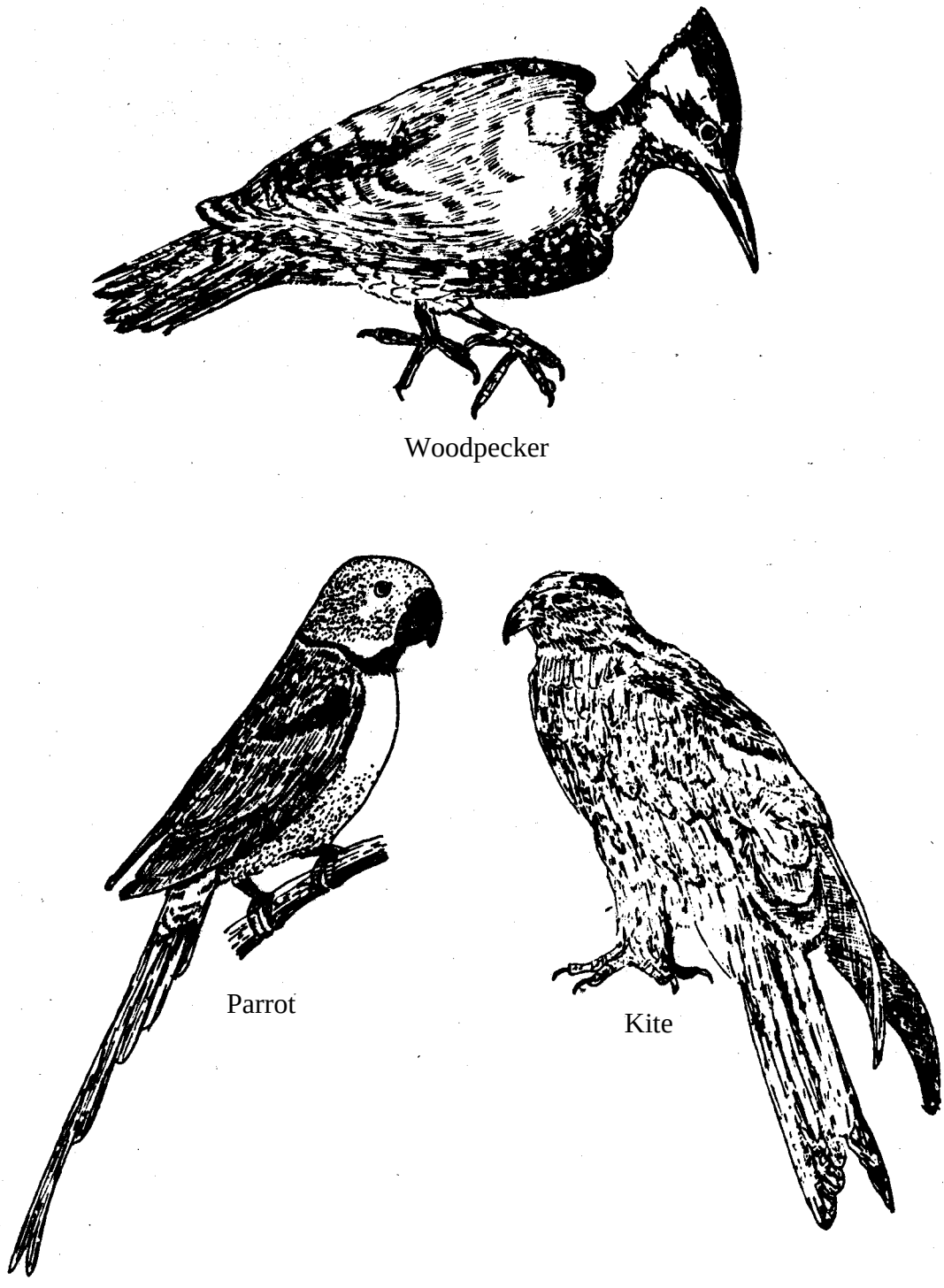


Fig 15.3 Different Birds of the Forest region

in Bangladesh the hily forests are of two types :

1. Tropical Evergreen Forest: In these forests the large trees do not shed their leaves in winter as the Shaal forest do. Thus their canopy or tops of the trees look evergreen throughout the whole year.

2. Mixed Evergreen Forest: Some of the plants of this forest are evergreen and some species shed their leaves in winter. As there is a mixer of evergreen and deciduous plants this forest is known as mixed evergreen forest.

Height of the trees of this forest is not equal. As a result their tops are seems to be arranged in 2/3 strata or layers. The tallest trees are up to 60 meters (200 feet) in height, e.g. Garjan, Chapalish, Civit. Telgu etc. They are said to be the first layer trees. Trees having a medium height make the second layer, e.g. Chikrashi and Gamar. Trees of the third layer are shorter than those of the second layer, e.g. Jarul, Uriaam *(Mangifera longipes)* etc.

Forest region of Sylhet: They are a combination of tropical evergreen and mixed evergreen type. Among the first layer trees, Chapalish, Deowa, Chamrata, Aamra, Padak and Banchalta are prominent. In the second layer Bhuikadam, Champa, Panidumur, Bandarhola, Chikrashi and Gamar are prominent. Among bamboos Muli, Khang, Parua are notable. There are some Garjan in Patharia region. In some areas some Teak, Ironwood, Malacca and Koroi have been planted. A large number of orchids, various types of *Colocasia,* ferns and epiphytes are found to grow in the forests of Sylhet. Canes also grow in Sylhet forest.

Forests of Chittagong region are evergreen and mixed evergreen type. Here among the first layer plants Garjan, Chapalish, Chandul, Koroi, and Coconut are prominent. Second layer is comprised of mainly Chikrashi, Jarul, Bahera, Toon, Dhenkijaam etc. Bamboos and Chhon grow in open forests.

Forest of Chittagong Hill Tracts comprises of evergreen, mixed evergreen, deciduous, canes and bamboo forests. The major plants of this region are Civit, Garjan, Chandul, Nageshwar, Batna, Taali, Pitraj, Punail, Koroi, Gamar, Vadi Bandarhola, Chapalish, Udal, Aamra, Shilvadi, etc. Among these Gamar Koroi Vadi, Shilvadi, Udal and Aamra are deciduous tree. Bamboo and Chhon forests are in abundance in this region. Canes are also available. There are many Teak but they are all planted.

Main Animals:

Sylhet Region: Among the mammals monkey and entellus (Honuman) are prominent. Besides these there are various kinds of birds.

Chittagong Region: Notable animals of this region are elephant, leopard, deer, gibbon and different kinds of snakes and birds.

Chittagong Hill Tracts: Amphibians like tree frog, toad, python, cobra, monitor lizard are found in the forests. Among mammals big rat, bat, monkey, entellus, leopard, gibbon, bear, elephant, gaur are found to live here. Elephant is the largest mammal amongst the terrestrial animals. In forest, birds like Moutusi, Doyel *(Copsychus saularis)* [the national bird of Bangladesh], parrot, woodpecker and some others.

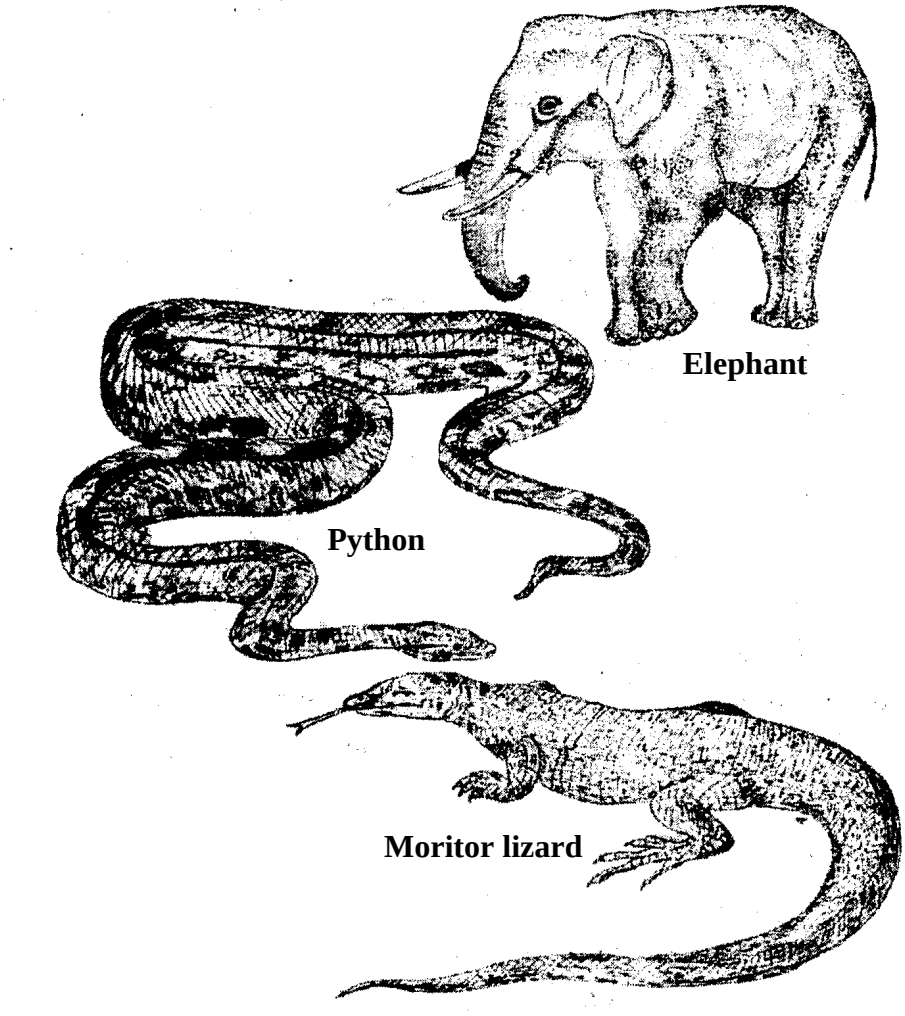


Fig. 15.4 (A) Few Animals living in the forest of Chittagong Hill Tracts

5. Coastal Forest or Mangrove forest:

Environmental Characteristics: In the coastal region of the Bay of Bengal the soil is saline, muddy and water logged. Besides daily high and low tides is an important factor. All these environmental factors are unfavourable for plants. To overcome these adverse conditions, plants, those grow here, develop certain adaptations such as: (1) Due to salinity of the soil their root cannot enter very deep in the soil. So to protect from wind and storm many plants (e.g. Sundari) develop root buttresses.

(2) Many plants (e.g. Boro) develop stilt roots.

(3) Due to inadequate oxygen supply in the soil many plants e.g. Sundari, Keora, etc. develop Pneumatophores or respiratory roots, originate from the underground horizontal branch roots lying parallel with the soil surface. There are air pores and air spaces in these respiratory roots, which help the exchange of gasses.

(4) As seeds are washed out by tides, in some plants there occurs viviparous germination. Hence seed germinates when it is in the fruits and fall on the earth when the root become elongated and heavy. Viviparous germination found in plants such as Boro, Khosi, Hargoja etc. Sundari and Geowa do not have viviparous germination.

Distribution of coastal forests:

Plants those are adapted in adverse coastal environment are known as *mangrove.* The forests, which develop by them, are called mangrove forest. In local language some times they are called 'Para-Bon' Sundarban in the southern part of Bangladesh and Chokoria Sundarban in the south-eastern region are natural forest. Besides these, for the protection of coastal area from cyclone and tidal bore many mangrove plants are planted along the seashore. This man made forest are termed as coastal afforestation. A description of these is given below:

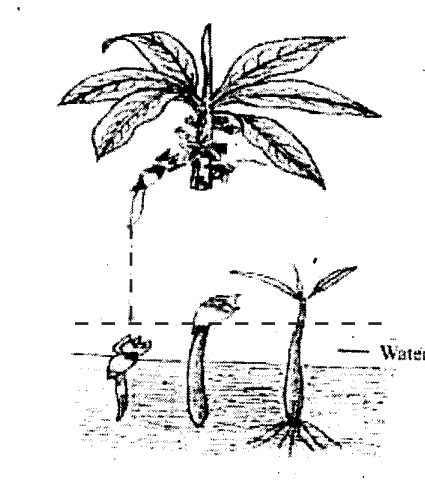
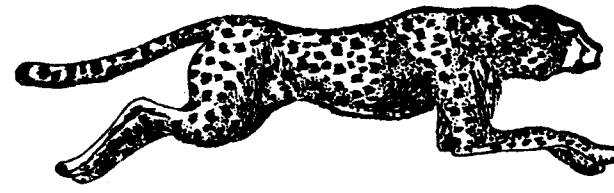


Fig. 15.6 Viviparous Germination

(1) Sundarban: Sundarban is the largest forest of Bangladesh. It comprises of land area of about 5100 square kilometer (2000 sq. miles), occupying the southern part of Khulna and south-western part of Potuakhali district. The river Baleshwar in the east, Raymongal in the west, country's main land in the north and the Bay of Bengal in the south surround the Sundarbans.

About 47% of the total forest area of the country, is occupied by the Sundarbans and more than 50% of the forest revenue is earned from the Sundarbans From this forest we directly get timber, fuel, fish, honey and wax. Every year 9,70,000 tons of Golpata (Leaf of *Nipa fruticans,* 220 tons of honey and 50 tons of wax are procured froms the Sundarban. Besides these the forest protect the locality from high waves of the sea.

Gibbon



Chita

Fig. 15.4(B) Few Animals living in Chittagong Hill Tracts

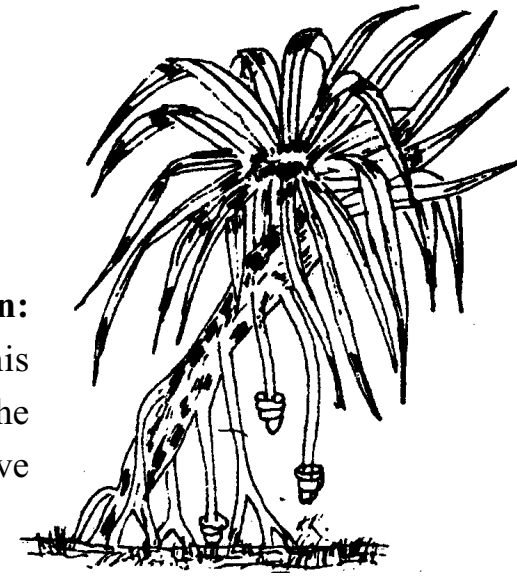
On the basis of the salinity the Sundarban is divided into three zones: -

Non-Saline Zone: Usually the area near the rivers, canals and channels are non-saline. Main plant of this area is Sundari *(Heritiera fomes).* Besides Geowa, Keora, Golpata, Amur, Hintal, Hargoja are also found to grow in abundance.

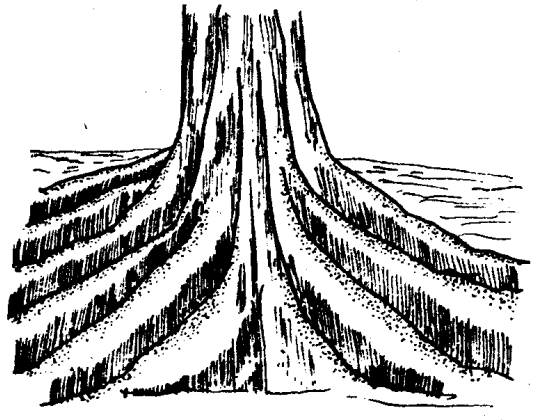
Mild Saline Zone: Main plant of this region is Geowa *(Excoecaria agallocha)* and among other plants there grow Pashur, Khapu, Kankra, Sada bain, Kala bain and Pakka Sundari.

Saline Zone: Major plants of this region are Garan, *(Ceriops roxburghiana),* Dhundal, Pashur, Kankra etc.

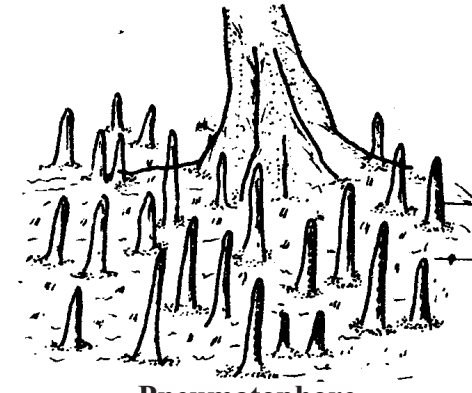
Major Animals Of the Sundarban: Differrent species of animals live in this forest. Many of them are found only in the mangrove forest region. Some animals live within aerial or respiratory root area.



Stilt Root



Root Buttress



Pneumatophore

Fig. 15.5

Abundant of red crab, shrimp and Chiring fish are found here. To move by jumping the pectoral fins of Chiring fish are specially developed. The notable animal of the Sundarban is the Royal Bengal Tiger *(Panthera tigris,* the National Animal of Bangladesh). This animal possesses as much strength as it is beautiful to look at. They are very brave and ferocious. Once this tiger lived throughout the whole continent of Asia. But this precious animal is now about to be extinct. Only about-200 tigers are now present in the Sundarbans. Besides this tiger, Otter, wildcat and cobra, pig, monkey and

spotted deer are found to live there. There are big crocodiles in the rivers flowing through this forest. Large number of beehives are found in the Sundarbans from which a good amount of honey and wax are procured.

(2) Chakoria Sundarban: The mangrove forest situated in the estuary of the river Matamuhuri in Cox's Bazar district is named as Chakoria Sundarban. It is now exists with less than half of its previous area.

Plants: Main plants of Chakoria Sundarban are Bain, Ora, Keora, Soilkata, Garan, Kankra, Hintal, Golpata, Hargoja, Kholshi, tiger fern Nonalata, Sundrilata and few Sundari (at present almost nil so to say). There is another mangrove forest on the bank of the Naaf River near Teknaf, but there is no Sundari *(Heritiera fomes)* tree.

Major Animals: Different species of fishes, snakes and birds are found there.

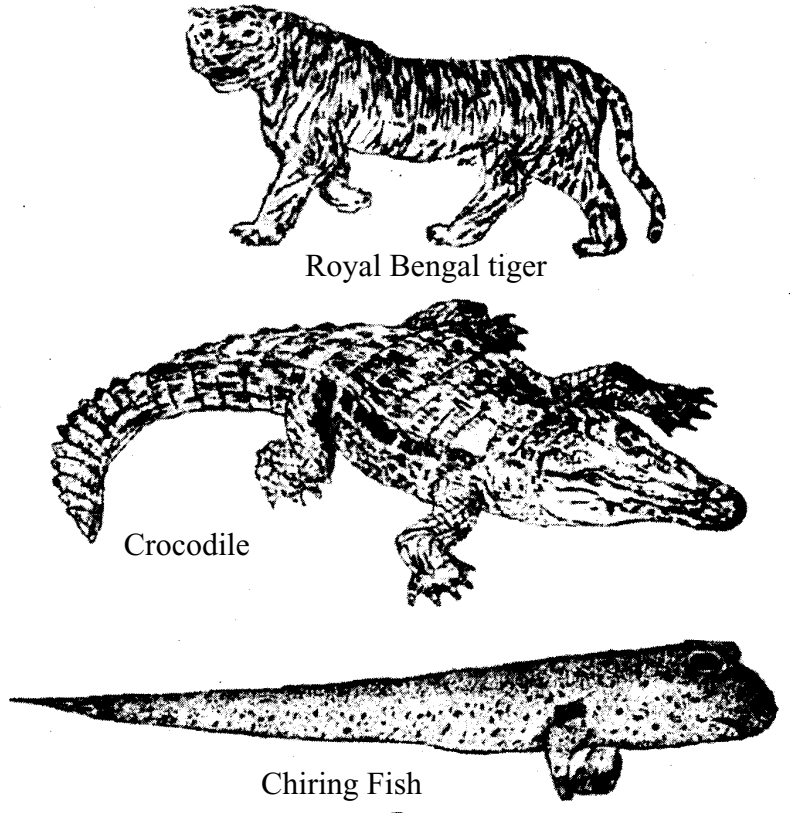


Fig. 15.7 (A) Few Animals of Garan or Mangrove Forest

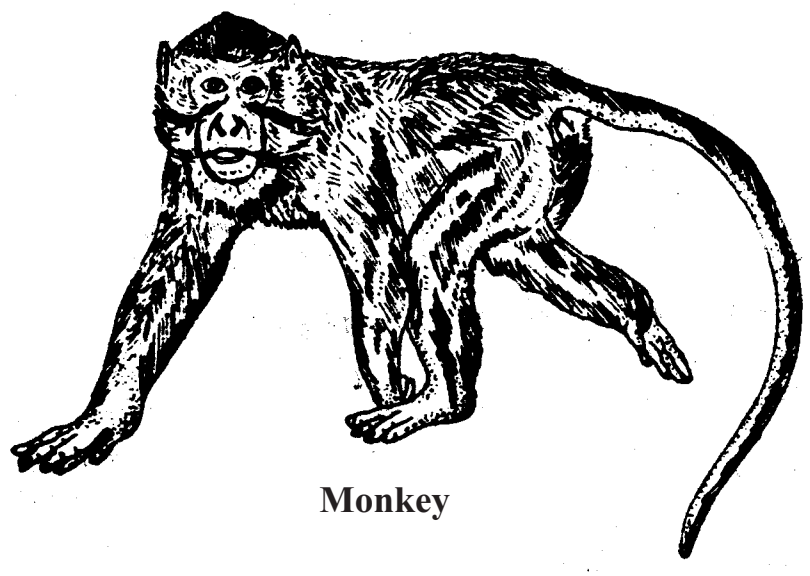


Fig. 15.7 (B) Monkey Of Mangrove or Garan Forest

(3) Coastal Afforestation: To protect the lives and properties from successive cyclone and tidal bore in the open coastal region seedlings of mangrove plants have been planted along the coastal region. As a result an attractive forest has developed. Within a short span of time the soil of the areas has changed its quality and has become cultivable.

Plants: In coastal afforestation usually Bain and Keora are planted. Bain is planted in the soil containing comparatively high salinity and Keora in the estuary region where saline water mix with river carried fresh water.

6. Saint Martin's Island:

Geologically Saint Martin's Island is a continental island. But many people take this island as a coral island as some corals are found to grow there. It is located about 12 kilometers off in the Bay from the main land of Teknaf. The island is about 5 kilometers in length and 600 meters in breadth at certain places and 100 to 200 meters at some places. There are some small island nearby the island, which are called by the local people as ***'Seradia'*** or separate islands. The northern part of the island is wider and known as Zinzira. There are inhabitants. In the south there is no inhabitants but there is mangrove forest. In Zinzira, there is a fresh water lowland.

Environmental Characteristics: Calcium enriched soil, moderate rainfall, and moderate temperature is the main environmental features. Saline water enters in the mangrove forest at the time of high tides and recedes at low tides.

Plants: In the sandy shore of the island Jhau *(Casuarina),* Nishind *(Vitis nigunda),* Bhat, Nata, Chhagalkhurilata are found to grow. They are the plants of sandy heaps. Around the island there are large varieties of screw pine *(Pandanus).* There are aquatic plants in the marshlands of Zinzira. There is a small mangrove forest in the south, but there is no Sundari tree. Crepa, Khalshi Shoilkanta, Hargoja etc. are found to grow here. Among the planted plants mango, jackfruit, Peyara, betel nut, pomelo (Jambura), plum (Kul) and at abundance of coconut are prominent. Around the homestead Chalta, Koroi *Ipomia,* Udal, fig etc. are found to grow. In the island usually Paddy Coriander, Onion, Chili, Garlic, Sweet potato etc. are cultivated. There are various brown and red alga growing on corals and stones. At presen afforestation process is going on in this island.

Main Animals: Large marine turtles are found in the island. They come on the land for laying eggs. They lay many eggs at a time. Besides, in the lowlying area of the southern part there are innumerable red crabs and abundant of marine birds. Around the island there are various kinds of marine fishes in the sea. Several corals, different species of marine snails, bivalves and poisonous snakes are present around the island.

The inhabitants of this island usually live on fishing. Population is increasing very rapidly in the northern part of the island. Children collect and sell stone and corals of sandy beach to the tourists. As a result soil is eroding from the entire coastal area. Thus hampering the environment of the island.

Importance of Forest Regions for the Conservation of Environment and maintaining the Ecological Balance: Plants, animals, water, light, air. temperature and soil etc. are the components of Natural Environment. These Factors collectively form the natural environment of a particular region. From the beginning the Almighty Creator has established a balance in these elements. Any single notable change in any element of nature of any particular area affects the established balance among the total elements. Ultimately it

causes adverse reaction on environment as a whole. As a result. the natural environment is destroyed and gradually it becomes inhabitable. The flora, particularly the forest of a region or of a country plays a direct role in maintaining the natural environment and protecting a balance because the plants are the *Primary Producer.* For example, if there is no plant in any water reservoir (or marshy land), then no fish will survive there and in absence of fish, the fish dependent cranes, other birds and snakes will not be able to live there. If the forests of an area are destroyed, the water holding capacity of soil will be decreased rainfall will be less, degradation of land will increase, rivers will be silted up, and in rainy season the area will be flooded easily. And due to the lowering of the water level in the dry season draught will appear. The yield of crops will decrease and deficiency will increase. Again all the inhabiting animals, birds, frogs, snakes will perish or they will come to the cropland or locality in search of food. If the number of plant is decreased the amount of CO_2 will increase in the atmosphere and the natural balance will be destroyed. So for leading a normal healthy life for ourselves and our next generation we shall have to give adequate protection to our present forest resources and raise more and more forests and fruit trees to increase the plant resources according to the additional demand of the growing population.

Conservation of endangered plants and animals: The land area is limited on the earth but population is increasing. New houses are being made for this additional population to live. Schools and colleges are being built for the education of their children, hospitals for treatment; new roads are being made for their movement. More cultivable land are being procured for producing additional food for them. For all these reasons forest land are being destroyed every moment. It is learnt from different survey report that at present in average 50 acres of forestland are being destroyed in every minute. Due to destruction of forest areas, many plant and animal species dependent on them have already been perished and many more species are on the way to be extinct. The endangered plants and animals are inseparable components of the environment. So to save the environmental balance they must be protected from the extinction, so that we can get valuable life saving medicine and

valuable gene for the development of the crops. By this time many plants and animals ar going to be perished. They must be protected from extinction. The endagered plants are Ashwagandha, Latakasturi, wild onion, and Montesia etc. and among the endagered animals are Ghorial, Green tortoise, Python, King cobra, hilly Moyena and stripped tiger. In order to save them the natural environment, where they grow, is to be conserved as it was before. The destruction of forest area must be stopped totally. No uncontrolled procurement of plant from nature will be allowed. The use of insecticides, fungicides or weedicides should be minimized as much as possible.

Exercise

Multiple choice questions

1. Which one of the following is the characteristic of pneumatphore?

a. To absorb water
b.To take oxygen
c. To release carbon dioxide
d. To protect the plants

2. To create deciduous forest the helpful environment isÐ

i. summer having high temperature

ii. without humid dry winter

iii. less humid air.

Which one of the following is correct?

a. i
b. iii
c. ii & iii
d. i, ii & iii

Answer the question no 3 and 4 in support of the following diagram.

3. What type of animal in the diagram is?

a. Mammal b. Pisces

c. Arthropod d. Cartilaginous

4. With the help of the organ labelled A the animal is-

i. swimming

ii. jumping

iii. breathing

Which one of the following is correct?

a. i b. ii

c. ii & iii d. i , ii & iii

Creative questions

The science teacher of Gubinda Guro High School- went to Sundarban for excursion with his students of class IX. While walking in the forest one of the students found some trees have upwardly directed roots. Out of curiosity the students asked his teacher about the cause of creation of this upwardly directed root. The Teacher explained the cause of formation of upwardly directed root and other adaptive-feature of the saline muddy plants of Sundarban area.

a. What is the other name of Sundarban?

b. Why the upwardly directed roots of the plants of Sundarban are called the adaptive feature?

c. Explain which process do you follow to identify this type of forest in the Cox's Bazar area.

d. Analyse how mucn it is-reasonable artificially to create this type of forest in your locality out of Sundarban area.

CHAPTER-SIXTEEN

ECONOMIC BIOLOGY (BOTANY)

Man needs food to eat, clothes to wear, house to live, medicine to recover from illness and beverages to drink. These are absolutely necessary for human beings to live on. These are the basic needs of mankind. These basic needs of us are fulfilled by various kinds of plants. Besides these, we get paper from plant, which is an important element of civilization. We get rubber without which the civilization cannot run. We get various kinds of dyes, gums, and essential fuel. We get raw materials for agriculture and industries. We get boat for river cruise. We get fresh air enriched with oxygen and what not. In short, the importance of plants is unlimited.

A brief description of the plants that produce our food, clothes, dwellings, medicine and beverages are given below.

A. Food producing plants:

Food gives us energy to work, fulfils the decaying of body and adds nutrition to our body. According to nature of nutrient compounds, human foods are divided into six categories. They are: l. Carbohydrates, 2. Protein,

3. Fats, 4. Mineral salts, 5. Vitamins and 6.Water. Every category of food contains some amount of water. Short introductions of 10 food-producing plants are stated here.

1. Paddy *(Oryza sativa):* Paddy is a grass like plant. The stem is hollow, leaves are elongated and with leaf sheath. Panicle of paddy grows at the apex of the stem. in Bangladesh three varieties of rice are cultivated - a) Aus (sown in Feb - April), b) Amon (sown in wet soil during June-July), c) Boro (sown in low land during . Nov.-Jan). Besides these high yielding varieties of IRRI and BRRI paddy also cultivated. IRRI and BRRI varieties of paddy may be sown as Aus, Amon or Boro.

Fig. 16.1 Paddy Plant

Uses: We get rice from paddy and boiled rice is our staple food. From paddy we also get flattened rice (Chira) and Puffed rice (Muri).

2. Wheat *(Triticum sp):* Like paddy wheat is also a grass in nature. The plant attains a height of 2-3 ft. Wheat plant also bears apical inflorescence.

Uses: We get Suji, Aata, (course flour), and Moida (flour) from wheat. in many countries (cold countries) wheat is the staple food.

3. Maize or Corn *(Zea mays):* Maize is an annual monocot plant. It attains a height of 3-6 feet. Its stem is solid and from the lower part of the stem there develops stilt roots. The plant produces two types of inflorescence - the male inflorescence is called **tassel** and the female inflorescence is called **Cob.**

Uses: Corn grains are eaten after roasting in fire, from corn grains cornflakes, corn oil, corn flour etc. are made. Corn oil cantains very less amount of cholesterol and it is good for our health. In many countries (mexico) corn is the staple food.

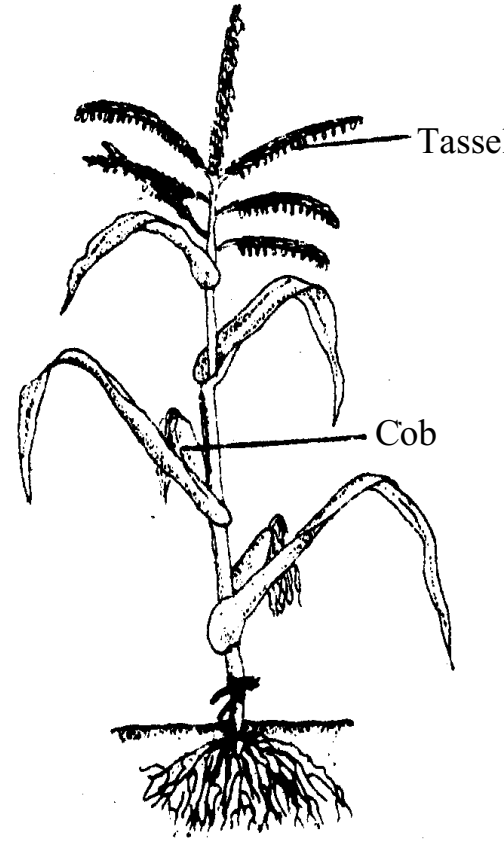


Fig. 16.2 Maize Plant

4. Potato *(Solanum tuberosum):* Potato plant is a small herb in nature. stem is soft, leaves are compound. Tip of the underground portion of stem becomes swollen and produces the potato tuber. In our country potatoes are used as vegetables, but it is the staple food in many countries like Ireland. Wheat, Rice Maize, Potatoes, these are all carbohydrate food.

The following table (Table-16.1) shows a comparative statement of the amount (in 100 grams) of Carbohydrate, Protein and Fat in Rice, Wheat, Maize and Potatoes.

Food	Carbohydrate	Protein	Fat
Rice	80	07	0.7
Wheat	72	11	1.5
Maize	67	11	3.6
Potato	18	02	0.1

Table: 16.1

5. Lentils *(Lens esculanta):* Lentils (Mosoor) is an annual winter crops. Leaves are compound, leaflet slender, elongated, and many in number per leaf. Flowers are Papilionaceous. Fruits are flat pod It is used in every day's menu as dal.

6. Gram or chickepe a *(Cicer arietinum):* Chipckpea is a winter crop. Stem attains a height of 1-2 feet. Leaves are pinately compound. Leaflet semicircular, margin dented, flower papilionaceous.

7. Groundnut *(Arachis hypogea):* Groundnut plant is an annual, small herb. Leaves are compound, imparipinnate. Flowers grow on the soil surface on the aerial part of the plant but after pollination it thrusts. into the soil. Thus the fruit develops under the surface of the Soil. Lentils, gram, groundnut etc. are proteinaceous food because they contain much protein. Ground may also be nut called oily food.

The following table (table 16.2) shows a comparative statement of the amount (in 100 grams) of Protein, Fat and Carbohydrates in Lentils, Gram and Groundnut.

Food	Protein	Fat	Carbohydrate
Lentils	27	01	55
Gram	21	04	54
Groundnut	25	40	26

Table: 16.2

8. Mango *(Mangifrera indica):* Mango plant is a big tree. Its leaves are simple, elongated and alternate. Flowers grow in inflorescence. Fruits ripen in summer. Mango is said to be the king of fruits. Mango plant grows from seeds; again it can be grown by grafting or layering. The fleshy mesocarp of the fruit is eaten.

9. Banana *(Musa sp.):* The stem of Banana plants lies near the soil surface. It is called rhizome. Aerial part develops from the rhizome. The aerial part of the plant is actually a compactly arranged leaf bases. It is not a true stem. Banana grows throughout the year. New plants grow from the suckers. The whole fruit except the outer covering is eaten. In many countries Banana is the staple food. Banana may compensate iron deficiency in our body.

10. Jackfruit *(Artocarpus heterophyllus):* Jackfruit plant is a big tree. Leaves are simple, alternate, and more or less obovate. The fruit is complex and large. Plant grows from seeds. The edible parts of jackfruit are fleshy. Bracts, perianth and seeds. In addition to carbohydrates, fat and protein, we get mineral salts and vitamins from fruits like mango, banana and jackfruit.

The following table (Table - 16.3) shows a comparative statement of different constituents (in 100 gm.) of food in mango, banana and jackfruit.

Food	Water	Protein	Fat	Carbohydrate	Calcium (m.gm.)	Iron (m.gm.)	Carotene IU	Vitamins B_1 B_{12}	Vitamin C
Mango	78:.	01	01.7	20	16	01.3	300	++	41
Banana	62	07	00.8	25	13	09	Ð	++	24
Jackfrui	88	01.8	00.1	09.9	26	0.5	4700	++	21

Table: 16.3

B. Cloth producing plants: Soft fibers are used for making thread by which cloths are produced. Cotton, jute etc. are fibre-yielding plants. Five plants of this kind are described below:

1. Cotton *(Gossypium sp.):* generally KARPAS Cotton is known as cotton. In cultivation this plant is an annual plant. Plant attains a height of 3-4 feet. Seeds develop inside the fruit and cotton fibre borne on the outer surface of the seed coat. For this reason cotton is called surface fibre. The silk cotton (Shimul Tula) develops in the inner surface of the fruit wall, not on the seed coat.

Uses: It is used in making thread and different kinds of cotton clothes.

Fig. 16.3 A part of cotton plant

2. Jute *(Corchorus sp.):* Jute plant is an annual herb. Its stem is slender and usually without any branches, leaves are simple. In Bangladesh two species of jute are cultivated. One is Tosha *(Corchorus olitorius),* the fibre which is golden in colour, fruits are long, and seeds are blue, and usually cultivated in high lands. Another one is white jute or Suti-pat *(Corchorus capsularis)* - the fibre of which is white, fruit round shaped, seeds are brown and usually cultivated in lowlands. Fibre originates from the bark of the stem thus from the secondary phloem tissue. This kind of fiber is called bast fibre.

Uses: Jute is used in making twine, sackcloth, gunny bags, carpet etc.

3. Mesta: Mesta is an annual herbaceous plant. It attains a height of 10-15 feet. Flower is large and yellow in colour. Bast fibres are collected from the bark of the stem.

Uses: Mesta fibre is used in making carpets, coarse cloths etc.

Fig. 16.4 A portion of a jute plant

4. Sunn Hemp *(Crotalaria juncea):* It is an annual plant. Stem is usually 6-10 feet in height. Flowers are yellow and Papilionaceous. Fruits are more or less like a balloon. The bast fibres collected from the bark of the stem.

Uses: The fibre is used in making coarse cloths, canvas, curtain-cloths, tissue paper, cigarette paper etc.

5. Bamboo *(Bambusa sp):* Bamboo is a perenniel long tree like plant. By chemical process Rayon - an artificial thread is prepared from bamboos. Because abundance growth of bamboos in Chittagong the Rayon mill has been established there.

Fig. 16.5 A portion of a chhon plant

Uses: It is used in making different kinds of cloth. Besides bamboo is one of the most important sources of paper pulp.

C. Plants used for house building purposes:

Many plants or plant pasts are used in makng house-pllar, fences roof. doors and windows and also for making furniture. A short description of some of them is given below:

l. Bamboos: Among the materials used in build houses in the Villages of Bangladesh, use of Bamboo is the maximum. The stem of Bamboo is slender and quite long. They propagate by the formation of suckers from the base of the stem. Large number of bamboo grows in a group, which is called bamboo--bush. There are 19 species of bamboos in Bangladesh.

Uses: Bamboos are mainly used as pillar, but it is also used in making fences and other purposes too.

2. Chhan / Ulookhar *(Impereta cylinderica):* A special long slender grass. Once it is sown need not to sow again. Once in a year it is being cut off from the land then it grows again spontaneously. New plants grow by owning suckers.

Uses: It is used for thatching house roof.

3. Golpata *(Nipa fruticans):* It is one type of palm. stem lies near the oil surface. Leaves are like that of coconut tree but remain vertically upward. Keeping only two younger leaves at the centre all the leaves are cut off from the plant once in a year.

Uses: It is used in thatching house roof.

4. Shaal *(Shorea robusta):* Shaal plant is a big tree. Leaves are simple nd alternate. All the leaves fall off in the winter. Fruits are provided with wings.

Uses: It is used for house pillar and making hard materials. The wood is very hard and durable. Colour of the wood is brown.

5. Teak *(Tectona grandis):* It is very tall tree. Leaves are simple and opposite. In rainy season inflorescence develops at the top of the branches. Flowers are white and small.

Uses: Valuable and luxurious doors and furniture are made from this wood. Colour of the wood is golden yellow.

6. Sundari *(Heretiara fomes):* It is a medium size plant. Leaves are simple. It is an evergreen plant.

Uses: It is used in making pillars; frame of doors and windows. Colour of the wood is reddish.

7. Garjan *(Dipterocarpus turbinatus):* Garjan is an evergreen tree. The trunk is less branched and very long in height. Leaves are simple.

Uses: It is mostly used in making beams, pillars and a frame of doors and windows etc. Colour of the wood is light red.

8. Gamari *(Gmelina arborea):* The P1ant is tall deciduous one. Leaves are simple and flowers are yellow in colour.

Uses: Used in making doors and windows. Mostly used in making classified furniture. Colour of the wood is white.

9. Jack fruit *(Artocarpus hertrophyllus):* It is a big tree with branches. Leaves are simple and alternate.

Uses: Mostly used in making furniture, doors and windows. Colour of the wood is yellowish-red.

10. Koroi *(Albizia procera):* It is a tall deciduous tree. Leaves are Compound. Fruit is flat.

Uses: Used in making furniture, doors and windows. The heartwood is blackish in colour. The wood of Shilkoroi is of better quality than the wood of Rendy Koroi.

D. Medicinal Plants:

People of Bangladesh have been using plants for treatment of diseases from time immemorial. These plants are used as medicine, known as medicinal plants. Brief description of ten medicinal plants is given below:.

1. Arjun *(Terminalia arjuna):* The plant is a trees in nature. Leaves are simple, opposite and look like the leaves of Guava.

Fruits are with ridges and furrows like Kamranga.

Part Used: Bark of the tree.

Uses: The main use is in heart diseases. It is said that, the bark of Arjun is being pasted and mixed with sugar, and milk and if it is taken everyday morning, cure almost all heart diseases.

2. Kalomegh *(Andrographis peniculata)* **:** It is a small herbaceous plant. Usually attaine a height of 1-3 ft. Leaves are simple and opposite .

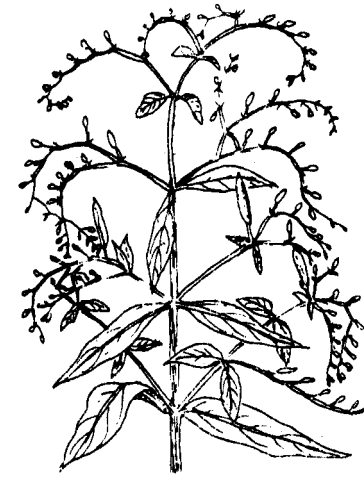


Fig. 16.6 portion of a Kalomegh plant

More or less elongated It gives flowers fruits from the end of rainy season up to the winter. The leaves are quite bitter. It is sold in the market in the name of Chirata, though it is not real, Chirata.

Part used: The whole plant, particularly the leaves.
Uses: It is a good medicine for children in the treatment of fever, intestinal worms, indigestion and malfunctioning of liver. One teaspoonful of leaf extract is to be taken.

3. Tulshi *(Ocimum sanctum):* It is a well-known small herb or shrub. Usually it attains a height of 2-4 feet. Stem is quadrangular. Leaves are simple, opposite, more or less ovate with sweet smell. It gives flowers and fruits in winter.

Part used: Leaves.

Uses: Leaf extract is very effective in Cough and cold. Usually leaf extract is given to the children with honey and zinger extract.

Fig : 16.7 A portion of Tulsi plant

1. Thankuni *(Centella asiatica):* It is a Small creeper. From every node it gives roots from below and Leaves and branches from above. leaves are simple, alternate, kidney shaped, usually 0.5 to 2 inches in length.

Part used: The whole plant, especially leaves.

Uses: It is well used in our country especially in the treatment of stomach disorder particularly - indigestion and dysentery of children. Thankuni increases longevity of life, increases memory and intelligence. It is also used in dysentery and blood-dysentery and different types of skin diseases.

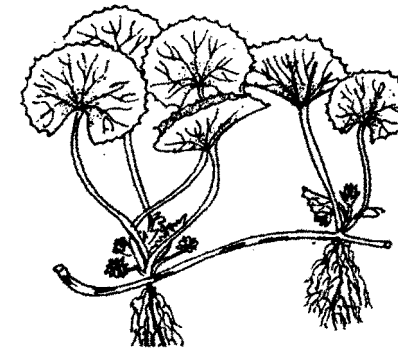


Fig. 16.8 A portion of Thankuni plant

5.-Durba *(Cynodon dactylon):* It is well. known grass of our country. Jt is a known perennial herbaceous creeper.

Part used: The whole plant.

Uses: It is a very effective in fresh wounds, where it clots blood to stop the bleeding. Usually young leaves are pasted or masticated and applied in the wounds. Besides, the extract of it is being mixed and boiled with sesame oil and is used as a curative for skin diseases and hair fall.

6. Neem *(Azadivachta indica):* It is a well-known plant in our country. Leaves are compound, small, white flowers with sweet smell borne on long rachis of the inflorescence. Fruits are green in unripe condition but ripe fruits are yellowish in colour.

Part used: Bark, leaves and small branches.

Uses: Bath in the water boiled with Neem leaves that cures various skin diseases. Taking of pasted bark mixed with salt in an empty stomach kills intestinal worms. Leaves pasted with turmeric cure scabies and itches. In our country small branches are mostly used as toothbrush.

7. Banorlathi Or Sonalu *(Cassia fistula):* It is a medium size tree. Leaves are compound. Each leaf bears 4-8 pairs of leaflets. Its yellow flowers remain hanging down in a long inflorescence axis. Fruits are long and slender.

Part Used: Matrix Of fruit.

Uses: The fruit matrix is a good purgative. It is used in constipation, stomach Pain and dyspepsia. 6-7 grams of fruit matrix are taken in the morning with one cup of hot milk. It also improves tonsillitis and rheumatism.

8. Basak *(Adhatoda vasica):* It is a shrubby plant. Usually attains a height of 7-8 feet. Leaves are simple, alternate.

Part used: Leaves.

Uses: Leaf extract is mostly used in curing cough. It is very effective in the treatment of cough and cold, and asthma. The leaf extract is more effective if it is taken with equal volume of zinger extract and honey.

9. Bel *(Aegle marmelos)***:** It is a wellkown fruit-yielding tree. Leaves are compound with three leaflets. Flowers are geeenish white in colour. Fruits Aare round and large.

Fig. 16.9 portion of Basak plant

Part used: Leaves and fruits.

Uses: As medicine mostly unripe fruits are used. Green fruit are cut into circular pieces and dried in the sun. They are popularly known as Bel Shunt. It is very effective in diarrhea, blood dysentery and other intestinal diseases. Memory gradually increases if the leaf is taken with sugar after frying it in Ghee.

Fig. 16.10 A portion of Sharpagandha plant

10. Sarpagondha

Rouwolfia sarpentina : It is a perennial shrub. It attains a height of about 1-2.5 feet. Each node usually bears 3 leaves. It gives flowers and fruit in rainy season. Ripe fruit is black in colour.

Part used: Bark of roots. The bark is collected in the winter.

Uses: Powder or extract of bark is used to control high blood pressure. It is also used in the treatment of mentally disordered people.

E. Beverage yielding plants:

Whatever we drink (except water) is beverage. We get beverage from various plants. A few beverage-yielding plants are introduced briefly:

1. Daab (Green Coconut) *(Cocos nucifera):* Daab or coconut plant is tall, branchless and evergreen tree. The leaves are compound and arranged only at the top of the stem. Flowers are borne in inflorescence. Male and female are borne separately.

Part used: Water of green coconut. This water is the liquid endosperm of the seed.

Uses: The water is taken to quench thirst and make the body cold. The water of green coconut is a good nutritional drink.

2. Tea *(Camellia sinensis):* Tea plant is a small tree. In garden the plant is pruned again and again to make it shrubby and bushy plant. Leaves are simple and alternate. Flowers are large and white or pinkish in colour.

Parts used : Young leaves (apical bud with two young leaves).

Uses: Tea is taken as a drink to be free from exhaustion by stimulating nervous system. The young leaves of the garden through especial Procesnig : commercial tea is made and then sold in the market. Liquor is made by mix the tea leaves in boiled water and taken as a drink with sugar or sugar and milk.

Coffee (coffea arabica) : It is a small tree or shrubby plant. Leaves are simple and opposite. Flowers are white and with sweet smell.

Part used : Seeds.

Uses: It is taken as a drink to get rid of *tiredness.* Seeds are processed special method to make it usable. The powdered coffee is made for drink from the processed seeds.

4. Lemon *(Cytrus* sp.): It is a small tree or bushy plant. Stem is usually with thorns. Leaves are simple, alternate and with oil glands. The endocurp of the fruit has juicy granules.

Part used : Juice of the fruit.

Fig. 16.11 A portion of a coffee plant

Uses : Sweet drink mixed with lemon juice is used extensively to quench thirst and make the body cool. It is made from sugar, water and lemon juice. It is a common drink in Indian sub-continent.

5. Sugarcane : *(Saccharum officinarum):* In cultivated condition it is an annual herb. Stem is without any branch, solid and with nodes and internodes. Leavrs are elongated, alternate and divided into leaf sheath and lamina. The leaf sheath encircles the stem.

Part used : Stem extract.

Uses : Sugarcane juice is used to quench thirst and make the body cool. It is more palatable if zinger extract is mixed with it. The use of this drink is gradually increasing in Dhaka city. Jaundice patients profusely use it. Molasses is made from sugarcane juice.

6. Khejur- Date palm *(Phoenix sylvestris):* It is a branchless tree. Leaves are unipinnately compound and are arranged in a cluster at the top of the stem.

The apex of the leaflets is spiny.

Part used : Exuded. sap of the stem. In winter a portion of stem beneath the cluster leaves is scarped and a pot/container is hold there by especial means. The sap is collected in the pot throughout the whole night. In the next morning the juice filled pot is brought down from the tree.

Uses : In winter morning date palm juice is a delicious drink. The juice is also used against intestinal worms and thus it is taken in an empty stomach. Delicious molasses is also made from this juice.

7. Fruit juice : Juice of fruits like mango, pineapple, watermelon and Kamranga *(Averrhoa carambola),* are used as beverage. Again juices of grapes, apples, pears, bananas etc. are also used as beverage but in Bangladesh most of these fruits are not cultivated at all.

Except tea and coffee other drinks mentioned here are all known as soft drinks.

PRAWN AND FISH CULTURE SILK WORM AND BEE KEEPING

Fauna is the valuable wealth of nature. There is endless importance of animals in social, economic and national life of human beings. Honey bees, silk worms lace insects, different species of snails, bivalve, fish, frogs, snakes, crocodiles tortoise alligator, poultry, dairy animals, etc are all beneficial to men directly or *indirectly.* On the contrary, germs of different diseases, harmful and poisonou. worms of crops termites, rats, ferocious animals etc do harm to men generally. Useful and harmful animals together are known as animals of economic importance. The branch of animal science, where animals of economic importance, are discussed in detail is known as economic zoology.

Amongst animals of economic importance prawn and different species of fishes, bees and silkworms are discussed below.

Prawn Culture

Introduction: Prawn is a tasty and delicious aquatic animal. It is not a fish. It belongs to the phylum Arthropoda and class Crustacea. Its body is bilaterally symmetrical and the appendages are joined or segmented. Its body is composed of two regions, namely abdomen and cephalothorax. Cephalothorax is divided into head and thorax. There are 19 pairs of appendages, which are used in catching food, walking, swimming etc. There is an extension in the cephalothorx named rostrum, which is compressed laterally and serrated. The prawn is a nocturnal and unisexual animal. They can swim in water with the swimming appendages and walk with the walking appendages on the soil in the bottom of water. There are different types of species of prawn in our country, out of which a few species live in fresh water and others in marine water. Again some species live in coastal regions. Prawn is an important fishery resource of Bangladesh.

Economic importance of prawn:

1. It is a tasty protein food.
2. Economic development can be achieved through prawn culture.
3. Prawn takes part in earning foreign currency.

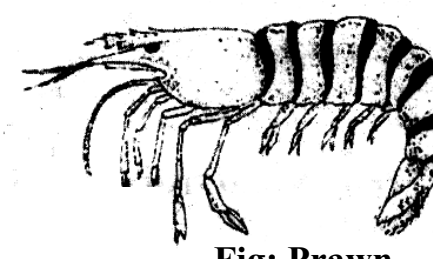


Fig: Prawn

4. It is much profitable to cultivate prawn in fresh water at a comparatively lower cost. well

So, it is very profitable to cultivate prawn in a planned scientific manner.

Kinds of prawn : Different species of prawns are available in the water bodies of Bangladesh. Several species of genus, *Macrobrachium,* are larger in size and tasty to eat. The large sized fresh water prawns are known as *Galda prawn.* In the salty water of the sea and also in the *estuary* and creek of our country, there are many species of prawns. Some species of genus *Penaeus* grow larger. This saline water or marine prawns are known as **'Bagda Prawn'.** Bangladesh earns a huge amount of foreign currency by exporting both galda and bagda prawns. In general, a slight warm weather is essential for prawn culture.

A. Method of culture of fresh water prawn or Galda prawn : About 70% 0f the exported prawns are Galda prawn. They are cultured in inland, rivers, canals, ditches, haor etc of the country. Ponds with viscous soft clay soil with humus soil are suitable for Galda culture. The Galda prawns are widely cultured in the soft soiled ponds of Khulna, Jessore, Patuakhali, Noakhali, Chittagong, Comilla, Mymensingh and Dhaka. The ponds have to be suitably prepared for prawn culture.

1. There should be two sluice gates in the culture ponds of Galda for the entrance and exit of water.
2. The banks of the ponds should be elevated and the depth of the pond should be medium. If the bank is grassy, then it would not be distorted.
3. The predatory fishes are to be removed before the release of the fries in the pond. The bottom of the pond should be cleaned, and lime and cowdung manure would have to be applied. This helps in increasing the fertility of the pond and planktons grow enormously. As a result the prawns grow faster.
4. For a better production, only the desired varieties of prawn fries should be released in the pond.
5. To earn the desired prawn fries several hatcheries or egg development tank have been established in different places of our country. Mother Galda prawn with naturally fertilized eggs, are to be set free in the hatchery, where regular and

definite quantity of food, is to be supplied. The mother prawns lay 7,000 to 30,0000 eggs at a time. Within 16-24 days the eggs hatch to small nauplius larva. The larvae are to be supplied artemia (one type of Arthropoda) and other necessary foods regularly. The nauplius larva gradually grows to an adult passing through several stages.

Besides this, larvae are also collected from natural source for pond culture. In Bangladesh naturally hatched prawn fries are collected from the rivers of Kowkhali, Noakhali, Noapara, Kalughat, Halda, Dakatia, Rampal, Dumuria, Posur etc.

B. Method of culture of saline water prawn or Bagda prawn:

'Bagda', prawn culture has been practiced by the method of blockade. During the full moon or on the night of new moon the water of high tide along with Bagda prawn fries was allowed to enter into the blockade. But due to entry of other unwanted species of prawn and other predatory fishes, the production was less. So at present by establishing modern farms `Bagda prawn culture is being done. Through this method, in the coastal regions, farms are made within blockade. Though Bagda prawns originally come from the sea, they go to the shallow waters for reproduction. During `this time' the expected species are collected and allowed to enter into the blockade through sluice gates. Due to this method, as the carnivorous fishes cannot enter, production is high. In these farms, additional food is to be supplied. Before releasing the fries in these farms they are kept in the Hapas for 2-5 days to be acclimatized to live in confined waters. Due to this practice the possibility of mortality because of the change of environment becomes less.

Among the coastal areas of Bangladesh in Khulna, estuary region of the Sundarbans, Cox's bazar, Maheskhali, Chokoria, Bagerhat, Chittagong etc. the culture of Bagda prawn is practiced in large scale.

Difference between Galda and Bagda prawn

Galda prawn	Bagda prawn
1. Mainly fresh water prawn but they are available in less saline water also	1. Mainly saline water prawn but they come to less salted water in the breeding season
2. Their body is transparent, whitish or bluish.	2. They have red grayish oblique bands on the body like those of a tiger
3. Their body is somewhat round in the cross section	3. Their body is laterally compressed
4. Their body can be bent completely	4. Body cannot be bent completely
5. There are forceps in the 1st two Pairs of walking	5. There are forceps in the 1st three pairs of walking legs.

Introduction of fishes, method of culture and importance of fish culture :

Fish: Fishes are included in the phylum Chordata, sub phylum Vertebrata and in the group of Pisces. They are very important aquatic natural resources of Bangladesh. Since the ancient time, fish is accepted as a popular normal protein food of men. Our 80% animal protein comes from fish. But along with the increase of population, the quantity of fish per head has been decreasing proportionally in the food list. Due to the construction of houses by filling up the ponds, ditches and canals, the cultivating fields have decreased and because of catching fishes in an unplanned way, the numbers of fishes are gradually decreasing. So there are two main reasons, for the decrease of fishes and fish resources. such as:

1. Natural reason: Due to alluvial deposits many of our rivers are filled up. The path of different rivers has been changed. As a result, the rivers have become inhabitable and unsuitable for fish reproduction. There have also been some changes in the periodicity of seasons.of Bangladesh. Due to the non appearance of rainy season in due time; and for draught, the rivers and canals become dried tip. This affects the habitats and Consequently the fish prodtuction.

2. Man made reasons: To meet the demand of fishes of the growing population of Bangladesh, fishes are caught in an unplanned manner. Due to the increase of the number of fishermen, and as there are more than one owner of the same pond, the fish culture is not being properly carried out. To grow more rice, jute and other crops and to build the residential areas for man, many ponds, canals etc have been filled up and thereby the habitats of fishes are decreasing. Insecticides are used to control the pest of agricultural lands which are harmful for the fishes. These insecticides enter the ponds, rivers, canals, jheels etc along with the irrigated water and rain. This causes diseases and death of fishes and thus is unfit for human consumption. Due to the conservation, fishes have become very expensive and unavailable.

Importance of fish cultivation

Importance of fish cultivation: Ones upon a time the inhabitants of the village were called fish and rice eating Bangalees. But now a days that proverb does not suit because the production of fishes is not in harmony with the population growth. It is necessary to consume 4 gram of protein per head. To meet the protein demand, it is necessary to produce annually 26 lac tons of fishes in our country. But due to the construction of man-made houses, many canals, jheels, ponds etc. are covered up and because of unplanned capture of fishes; the production of fishes has been decreasing to a greater extent. Protein food is one of the major elements of balanced diets which compensates the loss of vitality in the body and helps in growth and provides energy. About 80% of animal protein and requisite vitamins comes from fish. We can compensate the deficit of protein through increasing fish production by culture. We can meet the demand of fishes to a greater extent through reclamation of the derelict ponds of our country and cultivating fishes there. Everybody should recognize the importance of fish cultivation. Effective measures from the Government have been taken at present to cultivate fishes by using modern technology as to increase the production. Many people are cultivating fishes individually. Besides, even in town many people are rearing Shinghi, Magur, and African magur, Telapia etc in small tanks in their lawns and on the roof of their houses.

Method of fish culture: Fish culture generally means the rearing and taking care of fishes in internal fresh water bodies. An ideal pond is required to culture fishes successfully. The area of the ponds maybe big or small with a depth of about 3 meters. The culture of major carps is easier and more profitable in an ideal pond. All carps are generally herbivorous.

The essential characteristics of an ideal pond for carp culture:

1. The surroundings of the pond must be open, neat and clean and airy.
2. There should be a large quantity of planktonic food in the ideal pond.
3. The banks of the ponds must be high enough so that no outside water enter into the pond during rainy season.
4. There should be adequate water in the pond and also arrangements change water when it is necessary.
5. The weeds and predatory fishes must be removed from the pond.
6. To keep the water cool, there should be aquatic plants like kalmi, helencha etc. in the summer season.
7. Cleaning clothes and taking baths with detergents must not be allowed in an ideal pond.

The culture of carps in an ideal pond: It is divided into several specific steps, they are as follows:

1. Preparation of the pond.
2. Collection of fish fry and transportation
3. Releasing the fry in the pond and rearing.
4. Taking care of the rearing fishes; and
5. To apply manure and provide food.

A. Preparation of ponds:

It is prepared by few steps, such as:

(1) According to necessity a new pond can be excavatcd or one can be reclaimed to make it an ideal pond.

(2) Germs of the pond have to be kill ed by using lime and the pond can be made fertile with organic fertilizer. By means of this the production of phytoplankton will increase.

(3) When the pond is ready the desired kind of fries are to be released.

In the life cycle of carps there are 5 stages (i) Eggs (ii) Spawn or egg fry (iii) Fry (iv) Fingerling and (v) adult fish

B. Collection of fries and rearing: Three types of ponds are to be used one after another for the cultivation of carps in different stages.

(a) Nursery pond: Spawn collected from rivers or fish farms are to be set free in nursery ponds which is smaller in size and is shallow. Here the spawn become 20-22 mm long. They are now called fry. After this they are transferred to the rearing pond.

(b) Rearing ponds: This is bigger and deeper than the nursery pond. These ponds are to be supplied regularly with food and manure. Here within 3-4months the fry becomes bigger and are known as fingerling. When the fingerlings become 100 - 250 millimetre in length they are transferred to the stocking pond.

(c) Stocking pond: These are larger in size and here the fishes grow faster to attain marketable sizes within a short time. Regularly organic and inorganic manures and supplementary foods are to be supplied. At the end of the year the average weight of each fish becomes 700 - 800 grams. In each hector there is a production of about 2,000 - 2,500 kg of fishes. Special care has to be taken for a successful culture of fishes in all stages, particularly the egg fry and fry stage. It is necessary to maintain suitable environment and to supply them adequate food.

Culture of carps in an ideal pond is easier and profitable because (i) they are herbivorous, (ii) they do not harm one another, (iii) there is less competition among them for food and space as they live and feed in different levels of water. Katal takes food from the upper level, Rohu from the middle level and Mrigal and Kalibaus from the bottom level. As a result in the same pond, these four types of fishes if cultivated together are able to use food of all level properly. So this type of fish culture is profitable.

Recently grass carps and silver carps introduced from abroad, are being cultured together in the same pond along with our indigenous major carps. The cultivation of different species of fishes at a time in the same pond is known as composite fish culture. The exotic carps, introduced from abroad grow quickly and are quite tasteful to eat, so cultivation of this is profitable but our Bangladeshi carps are liked more.

Diseases of fishes and their treatment: There may be various types of diseases in fishes. The body of a healthy fish is slimy and its colour is bright. If the original colour is changed or discoloured it is to be understood that there is some sort of illness or trouble in the fish. The health of the fish is to be examined once or twice a month by catching them with driftnet, because by checking the health of fish, treatment might be given if required. The fishes may also become ill due to scarcity of food, insufficient or unsuitable food lack of oxygen, fluctuation of temperature, attack of parasites etc. Besides this they may be ill due to attack of different species of protozoa, round worms leeches and lice. Some important diseases of fishes are as follows.

I. Gill rot disease: This disease is caused by the attack of a kind of fungi. 1n this disease the blood circulation is disturbed in the gills which ultimately rots As a result the respiratory process is affected and the fish dies. This diseae, may become epidemic when the pond is full of rotten or half rotted organic matters and have an excessive heat.

Treatment: The pond has to be treated adequately with lime and the fishes have to be supplied with artificial food.

(II) Fin or tail rot disease: This disease is caused by the attack of a bacteria. Due to this disease white spots appear and the fin becomes blunt

Treatment: 2000 part water and one part of copper sulphate are to be mixed. and then if the fish is kept in it for one minute, then it might get cured.

(III) White speckle disease: Due to attack of a kind of protozoa minute speckles appear on the body of fishes.

Treatment: For its treatment the pond has to be purified with salt or powdered rock lime. The fish becomes free from this germ if it is kept submerged for half an hour in 100 parts water with 3 parts salt in it.

(iV) Fish lice: The name of the fish louse is Argulas. This louse is oval in shape and slightly flat. This louse remains attached with the skin below the scale with the help of a pair of suckers on the ventral side. As a result th scales become detached and the body becomes uncovered. This affects the health of the fish.

treatments: (i) The affected fishes are to be transferred from one pond to other (ii) water of the pond is to be removed and the pond has to be dried for least 24 hours in the sun, (iii) The pond water has to be sprayed with 10-30 grams of lime per litre.

(V) Leech of fish: In the body of leech of fish, there are two suckers. With one sucker leech remains clung with the fish and with the other it sucks the blood of the fish.

Treatment: The leech dies if the affected fish is kept in water having 100 parts water and 25 parts of salt for 15 minutes.

The methods of applying manure in the pond and supplying of food: For the proper growth of the fish, adequate balanced food supply is required. For this, appropriate food that helps in rapid growth of the fish and which food is liked by the fish should be known. Plankton is the chief food for fishes. Both the phytoplankton and zooplankton increase in number by applying manure in the pond. The fishes do not eat manure but the manure assists in growing minute aquatic plants in the bottom of the pond and in this way the food chain of fishes remain active. Fishes grow by eating these aquatic plants or small organisms or even both. Generally manures like nitrogen, phosphorus, calcium, potassium etc. are necessary for the growth of small aquatic plants. If the fish dies, the dead body, being decomposed by bacteria, is again transformed into organic elements. Later from the organic salts phytoplankton or other small plants grow. In this way the food cycle continues in a pond.

Place of collecting fries: The carps lay eggs in the flowing rivers with water currents. From there eggs or egg fry are collected. Later these are set free in the pond. In the Halda, the Padma and the Jamuna and other rivers eggs and egg fry are available. Within the covering of the egg the embryos remain available. These

eggs and embryos are collected in the month of Baishakh and Jaistha. In the Gorai river of Kushtia and the Brammaputra river of Mymensingh the fries are available. The fries are 80 - 230 mm .. long and are available by the end of Baishakh upto Sraban in the river.

Fish farm: Many farms have been established by the Government and Non-Govt. organization in different places of Bangladesh for the production of fish seeds. Among these, there are 96 govt. fish seeds production farms. For the supply of fry, seven Government and 50 non-Government modem nursery ponds or hatcheries have been established. The eggs and fries are collected from these centres, where these are produced by artificial spawning of local and exotic fishes. There is fishery research station for fresh wate fishes at Chadpur. In the Agricultural University of Mymensingh establishments like the artificial breeding centre for local and exotic Shinghi and Magur fishes and in Fishery research institute artificial breeding centre for Magur, Rea Telapia, Pabda, Gulsa etc. have been established.

Preservation and marketing of fishes:

The amount of fishes that we get in the country is not properly and scientifically preserved, processed and ready for marketing. As a result often lots of fishes become unfit for human consumption. In order to save this loss, transport system, refrigeration, marketing facilities and fish preservation method should be improved. These steps will enable to meet most of the demands of fishes in our country.

Culture of silk worms or sericulture

What is silk: The silk clothes that we use are made of fibers or silk threads produced from the secretion of saUvary glands of silk moth. The silk worm is included in the phylum-Arthropoda, class-Insecta and order-Lepidortera. The juice secreted by the salivary gland of silk worm, coming in contact with the air form the silk fibers which are very fine long, elastic and bright. Silk clothes are regarded as most beautiful and valuable clothes in the world. Different species of silk moth produces silk of different qualities. They ore as follows:

(a) Mulberry silkworm: Produce silk of the highest quality.

(b) Endy silkworm: Produce Endy silk fibers.

(c) Tasar silkworm: Produce a type of silk known as Tasar. Of all these silk fibers, silk produced by the mulberry silk worms is of the best quality.

History of sericulture : Silk was discovered in China about 2000 years before the birth of jesus Christ. From that time the Chinese had the monopoly to produce silk and silken clothes secretly. Two European monks about 500 years after the birth of Christ learned the technique of producing silk and sent some eggs of silk worms to Europe. It is from that time that the silk cultivation started in Europe. At present, countries like Japan, China, -Italy, Russia, India Brazil etc produce silk and silk clothes of the highest standard and earn a larg amount of foreign currency by exporting those. In Bangladesh too, silkworm of different species are reared. In Mymansingh, Tangail, Rajshahi, Rangpur Dinajpur and Bogra silkworm is cultivated. The climate and soil of Rajshahi is favourable for producing mulberry plants and so the mulberry silk worm is widely cultivated there.

Characteristics of silk fibers and economic importance of silk worms

(i) As the silk fibers can retain some moisture, the clothes made of silk can be used in both the winter and summer seasons.

(ii) The silk is non-conductor of electricity, and therefore can be used as an insulator covering of electric wires.

(iii) The silk thread is used in surgical works.

(iv) Large amount of foreign currency can be earned by exporting clothes made of silk.

(v) The silken clothes manufactured in Bangladesh play a vital role in solving problems of clothing.

(vi) Many people are employed in silk producing factories and mills and the problem of unemployment is solved to some extent.

(vii) The housewives can earn money in the house in return of less labour and less capital through the culture of silk worm.

(viii) The oil secreted from the body of pupae and their remains are useful as poultry feed. The dead pupae are also used as manure.

Method of silk culture: What is sericulture? With the aim of producing silk fiber and manufacturing silken clothes the overall process of rearing of the silk worm scientifically and to collect silk fibers from their cocoon is known as sericulture. Commercially its cultivation is very profitable.

The life cycle of mulberry silk worms: The life of an animal from zygote to sexually mature adult stage through gradual development is known as its life cycle. The stages of life cycle of animal rotate in a cycle. In the life history of all the species of silkworm in general, there are four stages which rotate in cycles e.g. (a) egg (b) larva (c) pupa and (d) adult

Life cycle and silk cultivation:

1. Egg collection: The male and female silk moths mate soon after emerging from the pupal case. The egg is fertilized in the body of the female and the zygote is formed. Immediately after that the male worm dies and the female worm starts to lay eggs. The female worm is allowed to lay eggs, for the purpose with a piece of paper spread in a basket. The eggs become attached on the paper of the basket with the help of a kind of sticky secretion secreted from the body of the female moth. A single female may lay 300 - 500 eggs at a time. The eggs look like mustard grains or small beads, yellowish in colour. The larva or polo hatches out from the eggs within 8 - 10 days in summer and it may take a little more time if the temperature is less.

2. Larva: The larva is narrow, small and brownish in colour. On the head there is a pair of small sensory appendage and on the thoracic region there are three pairs of segmented legs with claws. The claws are used to hold the mulberry leaves at the time of eating. There are five pairs of un-segmented pralegs on the abdomen of the larva. They help in locomotion. The larval stage is the active stage which lasts 20-25 days in summer. The larvae are supplied with pieces of tender leaves of mulberry and they grow larger gradually. They shed their cuticle four times. The adult larva grows about 60mm long and if more mulberry leaves are supplied to them the body growth becomes more satisfactory. From large larvae large cocoons are produced which yield better type of silk. At the end of the larval stage the pupal stage starts.

3. Pupa : At the end of larval stage the silkworm stops eating leaves and

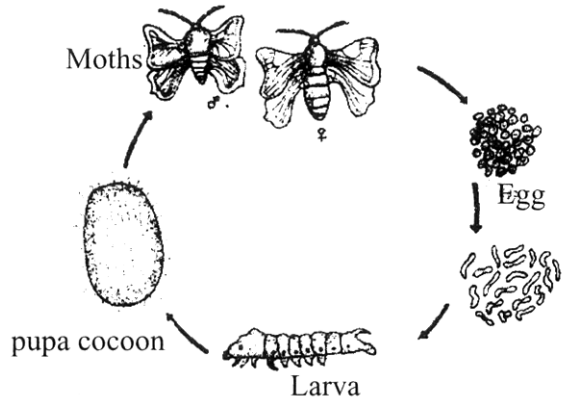


Fig: 16.13 Life cycle of silk worms

their body shrinks. When the larva forms cocoons round the body by winding the head within the cocoons, they stay and form the pupae, from the juice secreted by the salivary glands of which the fibers come out. The fibers come in contact with the air and harden to form egg shaped cocoons which takes 3 - 4 days. The pupa then is transformed into adult moths. At this stage they do not eat anything and remain inactive. After 8 - 10 days the pupal stage is over and the moths come out by cutting one end of the cocoon.

4. Adult Moth: The adult moth has a pair of long plumose Antenna on the head. They have three pairs of legs in the thorax and two pairs of wings on the dorsal side, but the moth cannot fly well. The male moth survives generally one day and female 3-4 days. After laying eggs the female moth dies. From the seed store of Bangladesh Sericulture Development Board improved quality silk cocoons are available and high quality disease free and healthy seeds can be collected if required.

Disease of silkworm and treatment: T.he larvae of silkworms may be attacked by some diseases. These diseases are caused by the attack of various kinds of parasites like virus, bacteria, fungi etc. Pebrin is caused by a type of protozoa. Due to attack of this disease small black spots appear on the body of the larvae which die due to ill nutrition.

Treatment:

(1) To control this disease, the attacked larvae should be removed.

(2) In suitable germ killing solution the eggs should be kept for few minutes and then in pure water.

A short ,description of the process of collecting silk:

This process is completed in a few steps:

i. After the formation of cocoons, they are to be kept at a certain temperature This will kill the pupae. Otherwise the pupae would come out within a few days by cutting the cocoon and thereby destroy the continuity of the fibers.

ii. Then the cocoons are to be boiled in water for a while. This removes the sticky substances from the cocoon and helps in easy reeling of the fibers from the cocoon.

iii. Silk is collected by reeling the thread of 8 - 10 cocoons. From 7000 cocoons only one kilogram of thread is obtained.

iv. Instead of killing them all. some are preserved for the use as seeds for furture.

The present condition of silk cultivation and its possible prospects in Bangladesh:

Research centre has been founded for research by the Government level in greater Rajshahi district. This research centre has discovered two improved varieties of silkworm in the name of Bipool and 'Sonali'. A greater number of mulberry plants are required for silk cultivation as the larvae of silkworm live on green leaves of mulberry plants.

Silk Development Board has been established in Bangladesh in 1978. This board takes the responsibility of

(a) mulberry plant cultivation, (b) cocoon production and (e) the weaving of clothes.

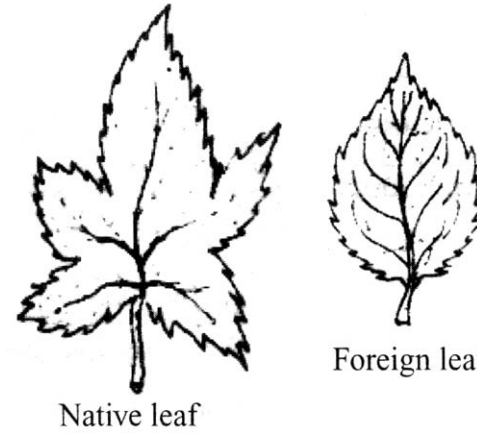


Fig: 16.17 Mulbery leaf

Cultivation of Mulberry Plant: The larvae of silkworm live on the juice and leaves of mulberry plants. This is why the cultivation of mulberry plants is essential. Great number of mulberry plants grow in Bholahat, Shibganj, Rohanpur, and neighbouring areas of Rajshahi and in the districts of Mymensingh, Tangail, Pabna, Bogra, Dinajpur etc. When the plants are six months old, leaves plucking starts. In a year at least 4/5 times plucking is possible. Two types of mulberry plants are cultivated in Bangladesh. The leaf '1amina of native' mulberry plants is segmented. The mulberry plants are attacked by various types of fungi. So, for better production, care should be taken to keep the mulberry plants free from attack of fungi.

Bee keeping:

The bee is a social insect belonging to the class Insecta and phylum Arthropoda. It does a great help to human being by producing wax and honey and pollinating the plants. The bees, in groups collect honey from flower to flower and store in their comb. Men collect these honeys and wax from the honeycomb and use it .in different ways. But it is dangerous to collect honey and wax from the comb 'as the bees are capable to attack by stings located in their abdomen.

Castes of bees: In a hive or in the residence of bees these are three kinds of bees having different structure and function.

(a) Queen bee

(b) Male or king bee

(c) Worker bee

These three kinds of bees live together in the hive and do their own work independently:

(a) Queen bee: The queen is larger than the other bees. Laying eggs is the only function of the queen and she lays about 1500 eggs per day. Their life span is of three years. Each hive contains only one active queen bee. If any new queen is born in the hive, the old queen kills her by stinging.

(b) Male or king bees: In a hive there may be a few male bees which take part in reproduction only. They are sting less and they do not collect honey.

c) Worker bees: As a matter of fact, they are female bees but they are sterile and do not lay eggs. Their function is to collect honey, to look after the king, queen and larvae and to defend the hive from the enemies by stinging, to do overall supervision of the combs. They clean the chambers of the comb and produce new chambers by secreting wax from the body. Adult workers collect honey, pollen grains from the flowers to flowers and store in the comb. The workers pollinate flowers indirectly when they roam about at the time of collecting honey and pollen grains. Due to pollination by bees, it is possible to produce many crops. and the production of many crops increases by 20-25%.

Fig: 16.1 Various types of Bee

The life cycle of bees: From the zygote stage up to attaining the adult reproductive active stage, the stages that are passed are known as the life cycle of a bee. There are four stages e.g. (a) egg (b) larva (c) pupa and (d) adult.

Egg: The queen and the king meet in the air in flying condition then when the queen collect sperms from the king and return to the comb, the king dies. The queen lays eggs in fixed egg chamber and one egg is laid in each chamber. The eggs are very small in size and some are fertilized and some are unfertilized. In the chamber the eggs are developed into larvae.

Larvae: They are small and white in colour. During this time the workers feed "Royal Jelly" to the larvae of the male and queen chamber. Royal Jelly is a very nutritious food. On the other hand, the larvae of the general chambers are fed half digested "Bee Bread" made of pollen grains and honey. The opening of the chambers is covered by wax within a few days. Within it the larvae develop into pupae. The larval stage lasts up to 4-7 days.

Pupae: A covering is formed all around the pupa, within which the pupa is developed into an adult bee, which. comes out of the chamber by cutting the cover (closed by wax). Male or king bees from unfertilized egg, and queen and numerous worker bees come from fertilized eggs: From the egg stage up to the adult, 24 days is needed for the king and 15 days for the queen.

New queen: In a comb one or more than one queen bees are born. On the lower part of the comb, the finger like elongated chamber contains fertilized eggs. which give birth to future the queen, which grows very quickly due to feeding of nutritious liquid royal jelly by the workers during the larval stage. The queen, by coming out of the chamber, flies about in the air for meeting the king. By this time, the sperms from the king is collected and stored in the sperm sac within the body of the queen. After that the queen according to her wishes whether she fertilizes her egg or not. Generally the old queen kills the pupae of the future new queen by stinging. Sometimes when the comb becomes very big or due to some reason, when a new comb is to be produced, the old queen leaves the old comb with some workers in swarms and produce new comb. This swarms of workers consists of about 25;000-30,000 bees. On the other hand in old combs, new queen and new and old workers and the king continues to live. In this way, thousands of new combs are produced in a natural way. Generally each comb contains more than 55,000 bees.

Honey: The thick, dense, gummy. sweet. heavy liquid which is available in the comb is known as honey. The worker bees collect nectar; a kind of juice from the flowers, the water of which is eliminated in the stomach of the bees and then it becomes honey.

Wax: The white, solid substance which is utilized in the construction of the honey comb is called wax. The wax is produced by the substances secreted from the wax gland present in the worker bee.

The economic importance of bees:

1. (a) The bee produces honey
(b) The bee produces wax
(c) Takes part in producing fruit by pollinating flowers
(d) Maintains the trends of producing species
(e) Maintains the balance of environment

2. Use of honey:

(a) It is used from ancient times as nutritious, blood increasilljg and strength giving food

(b) Honey is used as medicine

(c) It is also used as sweets

3. Use of wax:

(a) Wax candle is made from wax

(b) In industries and in making furniture wax is used

(c) In research laboratory and handicraft, wax is used.

4. Many people earn their livelihood by being connected with apiculture, wax and honey business.

5. Foreign exchange may be earned by exporting honey and wax.

6. The housewives may bring financial solvency in domestic life by artificial bee culture in the house with less labour.

The method of artificial bee culture and collection of honey:

Through ancient method, honey was collected from the combs in forests. In this method smokes drive out the bees from the comb, and honey and wax are collected. In this way the honey collectors collect wax and honey from the Sundarbans. But the number of naturally made honeycomb is decreasing gradually. This is why the bees are cultured artificially nowaday. Like many countries in the world, bee culture is being practiced in our country as well. By this method, scientifically the wax and honey are procured very easily.

The artificial method of bee culture:

A sort of simple comb box is discovered for bee culture in Bangladesh. The upper surface of this comb box is opened and within it long sticks are hung. There is an arrangement for covering the upper portion, so that the rainwater may not enter into it in the rainy season. The comb box is kept within the house or in the mustard field above the ground level. At times of box placement some honey is scattered within the box, the smell of which attracts the bees that enters the box through some fixed aperture and due to natural and inborn tendency the bees start to produce comb and collect honey. In this way artificially, bee culture is practiced. If the comb is kept near the naturally made honeycomb, the newly born bees easily form the nest (comb) there.

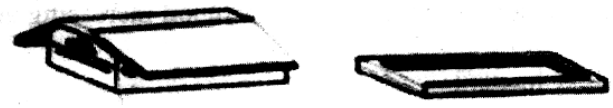


Fig. Comb box with covering

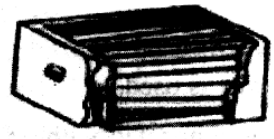
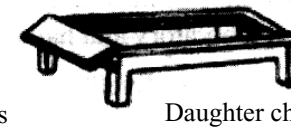


Fig. Comd box with hanging sticks



Daughter chamber

Fig. 16.16 Comb-box

Honey collection: In ancient method the honey filled honeycomb is smoked, and the honey and wax is collected. At present with the help of special type of instrument honey is extracted. In this way the artificial comb is not damaged and therefore it can be used more than once.

Some harmful insects or pests of paddy and jute

The animals, which cause harmful effect on human comforts, ease and economic profit is called pests. These animals disturb human beings in different ways. Amongst them some insects cause damage to a great extent to the crops in the fields. Of these two of each of the paddy and jute insects, along with their local and scientific names, the amount of their harmful effects and methods of control are discussed here.

1. Yellow stem borer of paddy: The scientific name of Yellow stem borer is *Scirpophaga incertulus;* the adult moth is yellow in colour. Female moth lays eggs on paddy. Larvae or caterpillar hatches from egg and comes out by piercing the stem and enters within it. It needs 35-46 days to convert a larva into pupa and 6-10 days are needed to convert the pupa Fig.16.17. Yellow stem borer into adult insects.

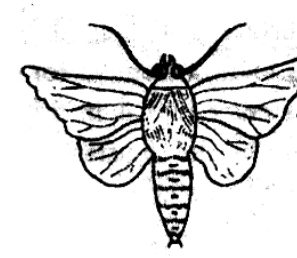


Fig.16.17. Yellow stem borer

Harmful effect: Due to eating of stem the plant dries out and dies.

Control or method of remedy:

(a) Biological control: The eggs are to be destroyed by hands.

(b) Chemical method: The insect is to be killed by proper insecticides.

2. Rice hispa of paddy: Its scientific name is *Dicladispa arnigera.* They are black in colour and have got spines on the back.

The female insects lay eggs on the leaf of paddy plant. Within 3 days larva comes out which becomes a pupa within 9-12 days, being brown in colour. Pupa becomes adult insect within 3-4 days and lives for 9-12 days.

Fig : 16.18. Rice hispa

Harmful effect: Larvae and adult insect eat up the green portion of paddy leaf which dries up and becomes white due to the absence of green parts as there is no photosynthesis and these results in the damage of the plant and the production becomes less.

Control or method of Remedy:

(a) Biological control

(i) The insect is to be destroyed by light trap.

(ii) The effected leaf is to be burnt or buried.

(iii) The insects is to be killed by hand.

(b) Chemical control: To kill insect by proper insecticide.

Fig. 16.19 Jute hairy caterpillar

1. Jute hairy caterpillar: Its scientific name is *Spilosoma oblique.* The female moth lays eggs in numerous numbers on the lower surface of the leaf which develops into larvae in 5-6 days, pupae is developed in 9-10 days from larvae and then the attainment of adult forms.

Harmful effect:

The larvae are like those of caterpillar, which eats the green portion of leaf and sometimes the twig. As a result the plant becomes weak and the production of jute decreases.

2. Stem weevil of jute: Its scientific name is *Apion corchori.* Adult forms are small and grey in colour. There is a curved antenna in front of the head. Female insect bores the node of jute plant and lays numerous eggs. The eggs hatch in 3-4 days and then by entering into stem, suck the juice. Pupae are developed within 10-13 days and within 4-5 days adult forms are developed.

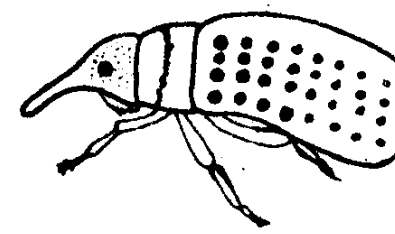


Fig: 16.20 Jute Stem weevil

Harmful effect:

In the body of the jute plants the knots are developed. During time of rottening of jute, the fibers are torn at the point of the knots. As a result the production becomes decreases.

Remedy or control method:

(a) Biological control: By cutting the twigs of jute plant the insects are to be killed.

(b) Chemical control: Proper insecticides are to be sprayed in solution with water on jute lands.

The questions in exercise at the end of each chapter of Textbook should be omitted.

Exercise

Multiple choice questions

1. Which one of the chief raw material of the mill producing rayon located at Chittagong?

a. Bamboo b.Cane

c. Sone d. Coconut

2. The fisherman off an on uses lime in the pond. The purpose is in case of fishes-

i. to control fungus ii. to control bacteria

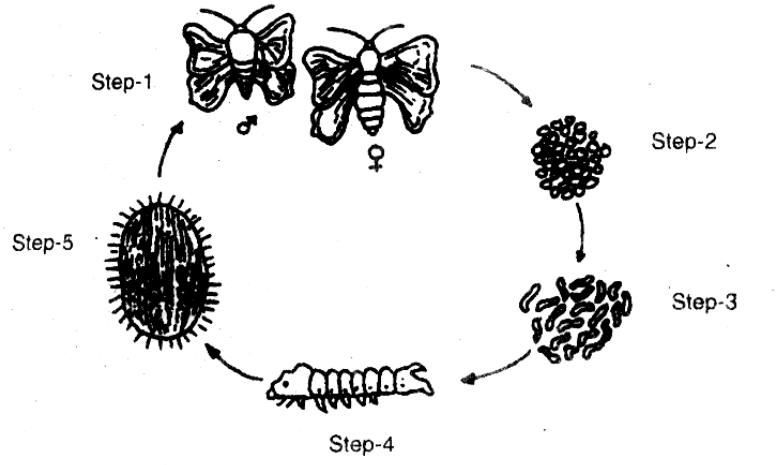
iii. to control louse

Which one of the following is correct?

a. i b. ii

c. i & iii d. i, ii & iii

Answer the question no 3 and 4 in support of the following diagram.



3. **What is the name of the step 3?**

   a. Shukkit or Larva or Polu b. Shukkit or Larva or Pupa

   c. Shukkit or Larva or Cocoon d. Shukkit or Polu or Pupa

4. **The stage by which silk worm dies in normal condition of life cycle shown in the diagram is-**

   a. stage-1 b. stage-2

   c. stage-3 d. stage-4

Creative questions

Now Mr. Safiullah of Gajipur is a successful bee culturist. He started bee culture artificially twenty five years ago by being trained up through BSIC. Today he has almost two hundred comb boxes and four to five employees have been engaged in this works. His employees collect 50 to 60 mounds of honey placing comb box in the flowering season of Mustard, Mango, Litchi etc. in different regions of Bangladesh. Not only he is benefited in this works but also yield is increased in the field or garden where the comb boxes were placed.

a. What is bee culture?

b. Why is bee culture in the comb box suitable?

c. Describe how you could start bee culture in your farm house following Mr. Safiullah.

d. Analyse the importance of artificial bee culture of Mr. Safiullah for the economic and environmental development.

PRACTICAL

(BOTANY)

Knowledge of science is not complete without the knowledge of its practical side. In case of science theoretical and practical knowledge are complementary to each other. The knowledge of one is not complete without the knowledge of the other. Like other branches of science it is also important to achieve practical knowledge along with theoretical knowledge in Biology. To achieve perfect knowledge in practical classes, student must follow certain rules and instructions.

INSTRUCTIONS:

1. To perform the practical task properly students should achieve the corresponding theoretical knowledge.
2. Students should be carefully to observe and follow the instructions of the class teacher about the class task.
3. Students should have to keep with them the required instruments and practical materials, which are required to perform the practical classes and they also should know the use of the instruments.
4. The supplied specimen should be observed carefully at the beginning of the class.
5. If there arises any controversy between the theoretical and practical knowledge about the supplied specimen, it should be shown to the class teacher and noted down in the notebook.
6. Students should always keep themselves neat and clean.
7. To sharpen pencils, sharpener should be used. Pencils must not be sharpened by rubbing it on table or floor.
8. Silence should be maintained as far as possible in the practical class.
9. Seat should always be kept neat and clean. Practical notebook, necessary instruments and dissecting tray should be arranged fairly in a suitable place.
10. Worked out specimens and seating place should be cleared and arranged neatly before leaving the class room after the class is over.

Dissection:

11. Before the start of dissection, the advice and instructions of the class teacher should be followed carefully with due importance and then start the work.
12. Dissection should be made in the dissecting tray filled with proper amount of water.
13. After dissection, unclean water in the tray should be discarded and clean water be added.
14. At the time of dissection useless parts of organs must not be thrown here and there in the classroom. These should be kept in a Petridish or a suitable container.
15. Dissection should be done with patience and attention and after the dissection is done properly, the specimen should be shown to the teacher.
16. Care should be taken that the specimen remained under water while dissection is done.

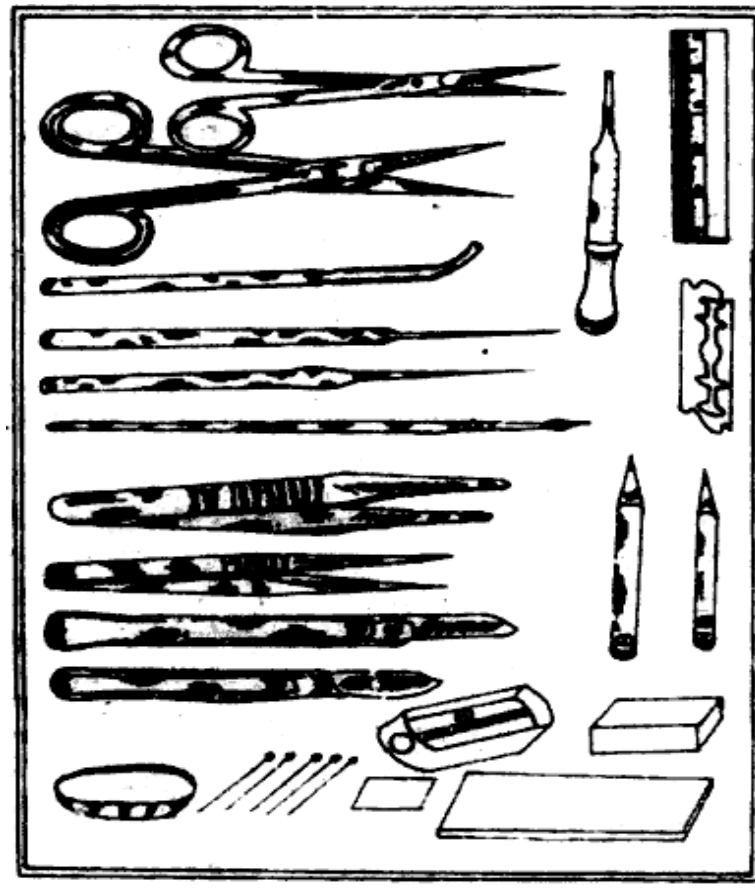


Fig. P.1 Necessary Instruments

Instruments required for Practical class:

Every student should have the following instruments with him:

1. A dissecting Box for working.
2. Different types of pencils (viz. H, HB, 2B or 3B etc.) for drawing diagrams.
3. Pencil sharpener, Eraser, Scale etc.
4. A small towel for cleaning the desk.
5. Laboratory notebook.
6. Microscope, Dye/Stains, Slides, Cover slips, Glycerin, Alcohol etc.

Dissecting Box

The box containing necessary instruments together, for dissection and observation of supplied specimens is called a Dissecting Box. Usually a Dissecting Box contains the following instruments:

1. Incision Needles with handle : 2 pieces
2. Scissors : 2 pieces [one with fine blades and another one with comparatively wider blades]
3. Scalpel (sharp small knife) : 2 pieces
4. Forceps : 2 pieces [one pointed another one blunt]
5. Brush : 2pieces
6. Watch Glass : 2 pieces
7. Blow Pipe : 1 piece
8. Razor : 1 piece

*9. Magnifying Glass : 1 piece

*10. Blade : 1 piece

11. Few Pins
12. Dropper : 1 piece

*Magnifying Glass and Blade (in lieu of Razor) may not be in the Box. These are to be purchased for observing and cutting specimens.

Microscope and its Uses.

The instrument, through which very tiny objects can be seen by magnifying the objects, is known as Microscope (Greek word **Micros** means tiny + **skopeein** means see). The inventor of microscope is Antony Von Leeuwenhoek (actual spelling is Antoj van Leeuwenhoek). **Microscope** may be of various types e.g. Optical (light) Microscope. Electron Microscope and

Phase Contrast Microscope etc. We use Light Microscope in our laboratories. Optical Microscope again is of two types: (a) Simple Microscope and (b) Compound Microscope.

A. Simple Microscope: The instrument is called Simple Microscope because the structural and functional devices of it are simple. Comparatively larger organs or it parts are usually observed or dissected with the help of this microscope. That is why this microscope is called Simple Microscope. The structure and uses of a Simple Microscope are stated below:

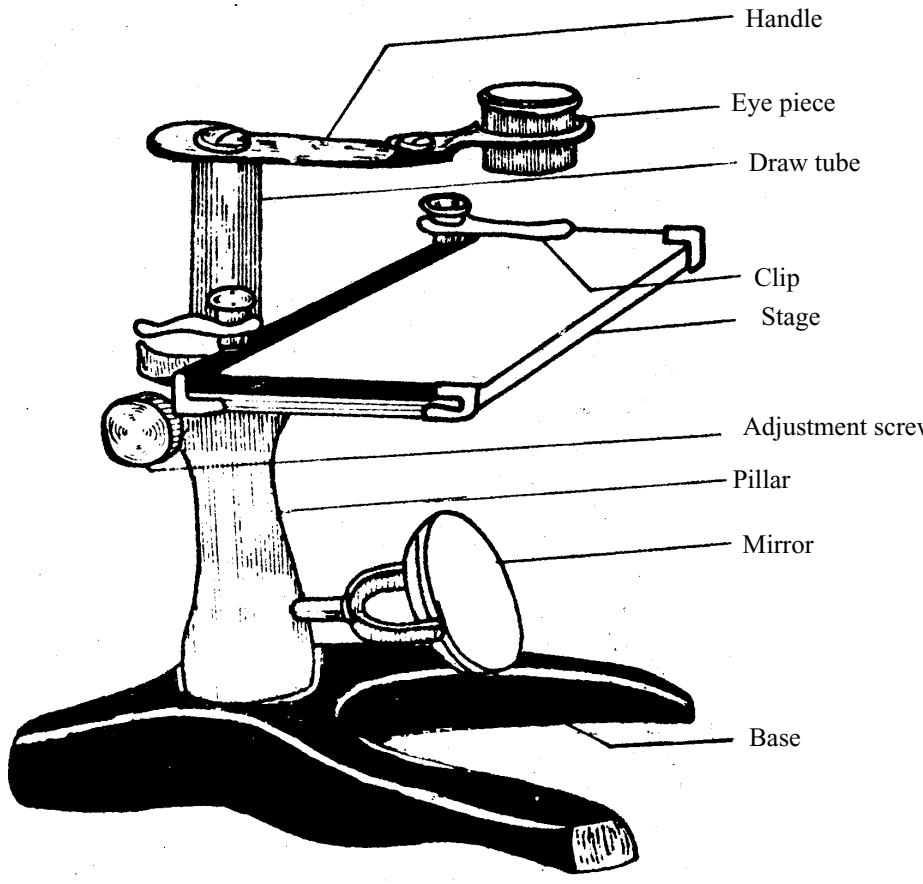


Fig. P.2A Simple Microscope

Structure: The structure of a simple microscope is very simple. It has a body, a stage made of thick glass for placing slides, two clips to fix the slides, a handle, an eyepiece placed with the handle and a mirror. There is an adjustment knob by which the eye piece may be moved upward and downward. The entire body stands on the base or foot.

Functioning Processes: At first the slide is to fix on the stage with the help of clips. The light should be focused on the slide by moving the mirror. Then keeping the eye in the eyepiece the adjustment knob should move in such a way that the eyepiece comes to a position from where the object on the stage can be seen most clearly. At this position, keeping the eye in the eyepiece, the specimen is to be observed carefully, or if required be dissected with the help of forceps or needle whichever is convenient.

B. Compound Microscope: The structure of a compound Microscope is quite complex and its working process is also complicated. Different parts of a compound Microscope and their functions are described below:

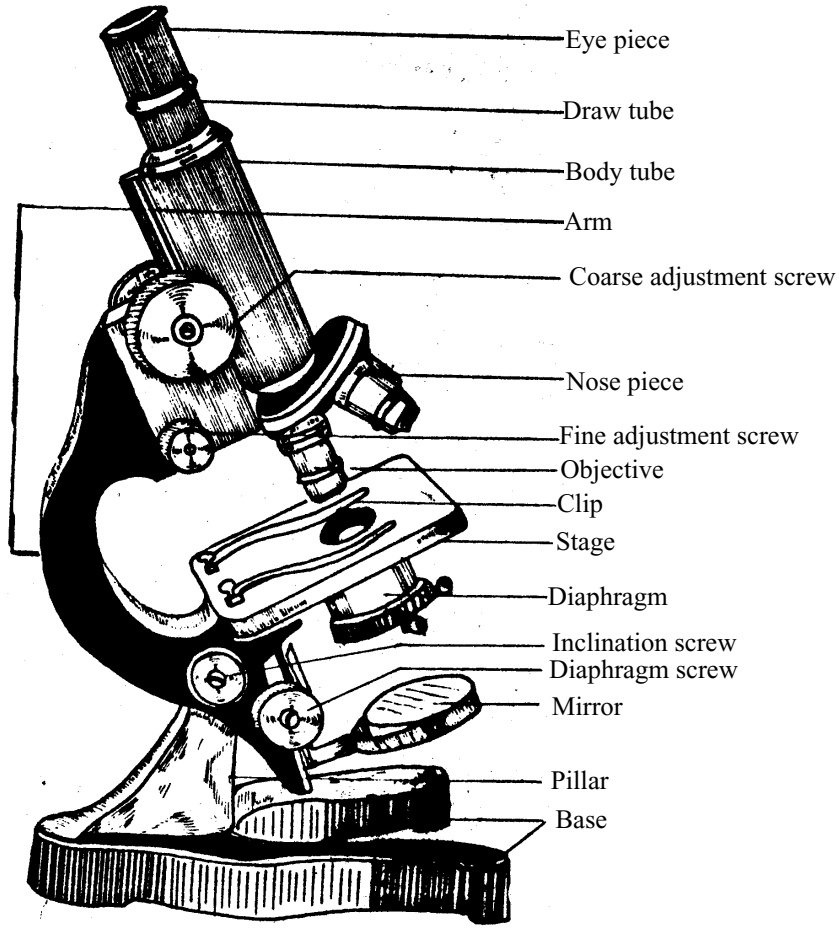


Fig.P.3A Compound Microscope

The different parts of a compound microscope again may be divided into two groups : **(1) Mechanical parts and (2) Optical parts.**

(1) Mechanical Parts:

(a) Base or Foot: The flat part on which the entire body of the microscope is situated is called the ***Base or Foot***.

(b) Pillar: The vertical part placed in the backside of the base is called the Pillar.

(c) Arm: The upper bend part flexibly fixed with the pillar by a screw is the Arm. Holding the Arm we use to move the microscope.

(d) Body tube: It is a long tube. It is fixed at the end of the bend arm. There are two screws at the junction of the arm and the body tube. One of the screw is called Coarse Adjustment and the other one is called Fine Adjustment. By turning these screws the body tube maybe moved upward or downward as per requirement.

(e) Drawtube: The drawtube is inserted inside the body tube. It may be Pulled upwardly when necessary.

(f) Nosepiece: It is circular body fixed at the lower end of the body tube. It is provided with three holes with spiral threads in its inner wall where objectives of different magnifications are attached.

(g) Stage: The stage is rectangular and attached with the arm at the base. There is a hole at the centre of the stage through which light is focused. Two clips are fixed on the stage at its base. Slide is fixed on the stage with the help of the clips.

(h) Diaphragm: By expansion and contraction of this part ascertains the amount of light to fall on the slide.

(i) Coarse and fine adjustments: At the top of the arm there are two large screws on two sides; these are called coarse adjustment screws. With the help of these screws the drawtube may be moved upward or downward rapidly. Another pair of comparatively small screw is present below the coarse adjustment screws. The drawtube maybe moved very slowly up and down, by moving these screws. These screws are known as fine adjustment screws.

2. Optical parts:

(a) Eyepiece: It is a small tube, which can be inserted into the drawtube. There are two lenses fitted at its two ends. Keeping the eyes on this eyepiece object (specimen) placed on the stage is to be observed.

(b) Objectives : There are also small tubes like eyepiece, and they are provided with lenses. Uisually three objectives of different magnifications are attached in the three holes of the nosepiece. Magnification power is inscribed on the body of the eyepiece and objectives.

(c) Condenser: It is simple a combination of two lenses. It is attached beneath the hole of the stage. Light being converged through this condenser fall on the specimen placed on the slide.

(d) Mirror: It is a Plano-concave mirror. It is attached at the base of the pillar Light can be focused through condenser and diaphragm, by turning the mirror at necessary direction.

The magnification determined by multiplying the power inscribed on the eyepiece and objectives [let the magnification power of the eyepiece is IOX and that of the objective i 20X. Then the magnification of the object is equal to 10 X 20 = 200 times. Student should learn the use of simple and compound microscope from the class teacher in the practical class.

Methods of Practical works:

The following tasks are to be performed in practical class.

1. At first, students are to know from the teacher as to what to do with the supplied specimen, or may understand by reading question papers.
2. External size, shape and other identifying characters of the supplie specimen should be observed carefully and if necessary diagrams are to be drawn and labelled its different parts in the notebook.
3. If the specimen is root, stem or leaf and if their anatomy (internal structure is to be studied, a cross section should be taken with a sharp blade and be mounted with a drop of glycerin on the slide. Then it should be observe carefully and labelled diagram is to be drawn in the practical notebook.
4. After drawing necessary diagrams and writing descriptions, its identifying characters should be found out and the specimen should be identified.
5. Diagrams should always be large in size. At the time of drawing, at first a fade line to be drawn with a hard pencil. When it is clear that the outline of the diagram is all right, then distinct line to be drawn over the fade line by a HB pencil. If necessary the diagram may be shaded by 2B or 3B pencils. Labeling of the diagram should Preferably be done at one side and in one line.

STUDY OF THE STRUCTURE OF A FLOWERING PLANT

Requirements: A small plant with flowers, fruits, leaves and roots (e.g. a mustard plant); forceps, simple microscope or magnifying lens.

Observation method: Take the plant in hand and observe it minutely. Use simple microscope or magnifying lens for observing the flower, if necessary. From the characteristics given below, pick up those characters, which correspond with your specimen and write in your notebook.

Root: Fibrous root/**Taproot**.

Stem: Triangular/Quadrangular/**more or less Cylindrical; smooth/** hairy/ spiny.

Leaves: Simple/Compound, **Petiolate**/sessile; each node contain 1/2/ more; principal vain 1/more; venation **Reticulate**/Parallel.

Flower: Solitary/in **inflorescence;** Axilliary/**terminal on the shoot apex; Pedicelate**/sessile.

Calyx: Sepals **4/5/; free**/united; **green**/coloured; **all alike**/not alike.

Corolla: Petal 3/4/5; **free/**united, white/**yellow**/violet/pink/blue/other colour; all alike/ all not alike.

Androecium: Stamen 4/5/**6**, free/ united, epipetalous/ **not epipetalous**, equal in size/unequal; anther **present**/ absent.

Gynoecium: Carpel ***present***/carpel absent; ovary *1/more* than one, style 1/2/more; stigma *1/more* than one; ovary below***/above*** calyx and corolla.

Fruit: *Present/*absent, if present fleshy***/dry, dehiscent/***indehiscent.

Comment on the following:

1 . Whether the plant is a monocot or dicot plant? : Dicot plant

2. Whether the flower is unisexual or bisexual? : Bisexual.

3. Whether the flower is hypogynous or epigynous? : Hypogynous

4. Whether the flower is actinomorphic or zygomorphic? : Actinomorphic

The bold words are applicable for ***Mustard*** plant.

STUDY OF THE STRUCTURE OF PLANT AND ANIMAL CELLS:

Requirements: Compound microscope, slide, cover slip, forceps, water, onion.

Procedure-1: Take a fleshy scale leaf from a fresh onion and pick up a thin membrane from its outer epidermis with the help of a forceps. Place the thin membrane on the slide in a drop of water. Cover the piece with a cover slip and observe under microscope.

Observation: Under high power objective a single layer of cells will be seen. The cells are with a definite shape and each of them is surrounded by a thick cell wall. Near the cell wall, a nucleus is presenting in the cytoplasm. In every cell there is a large vacuole.

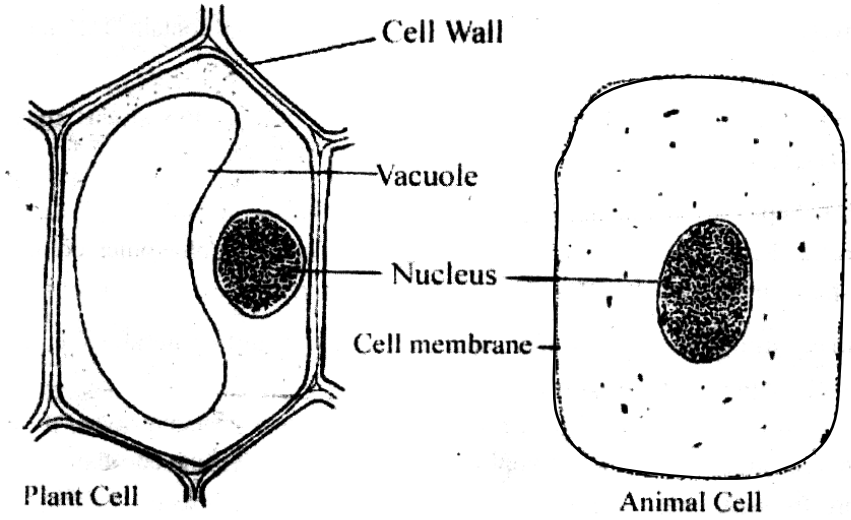


Fig. P.4 Structures of Plant and Animal Cell

Procedure-2: Wash your hands properly and bring out a thin membrane from inside your mouth rubbing with your finger. Now rub the membrane, on your finger, over the slide. A sticky layer will form on the slide. Then observe the sticky area of the slide under a compound microscope.

Observation: Cell will be seen under the microscope. The cells are more or less round in shape, a thin membrane surrounds each cell but there is no cell wall. The nucleus is present at centre of the cell and there is no vacuole.

Arrange the differences of plant and animal cells side by side in a tabular form; the differences are as follows: -

Plant Cell	Animal Cell
1. Cells are more or less hexagonal.	1. Cells are round.
2. There is thick cell wall.	2. There is no cell wall in the cell.
3. Large vacuole present.	3. There is no vacuole in the cell.
4. Nucleus is present near the cell wall.	4. Nucleus is present at the centre of the cell.

STUDY OF THE STAGES OF MITOSIS FROM PERMANENT SLIDES

The teacher will place some permanent slides on the stage of compound microscope and ask the students to observe and identify the stages of mitosis.

1. **Prophase:** In this slide some chromosomes are seen.; The chromosomes are long and scattered. No spindle fibre is seen. Therefore the stage is **Prophase of Mitosis.**
2. **Pro-Metaphase:** In this slide some chromosomes are seen. Spindle apparatus is also seen. The chromosomes are seemed to moving towards equatorial plane. The chromosomes are divided into chromatids. Therefore this is the **Pro-Metaphase of Mitosis.**
3. **Metaphase:** Some chromosomes are seen in this slide. Spindle apparatus is seen here. The chromosomes are situated on the equatorial zone. The chromosomes are divided into chromatids. Therefore this is the **Metaphase of Mitosis.**
4. **Anaphase:** In this slide two sets of chromosomes are seen. Two sets are present near the two poles. Therefore it is the Anaphase of Mitosis.
5. **Telophase:** In this slide two sets of chromosomes are seen. Two sets of chromosomes are present at two poles. No spindle apparatus is seen. Nuclear membrane is present surrounding the chromosomes in each pole. Therefore it is the **Telophase of Mitosis.**

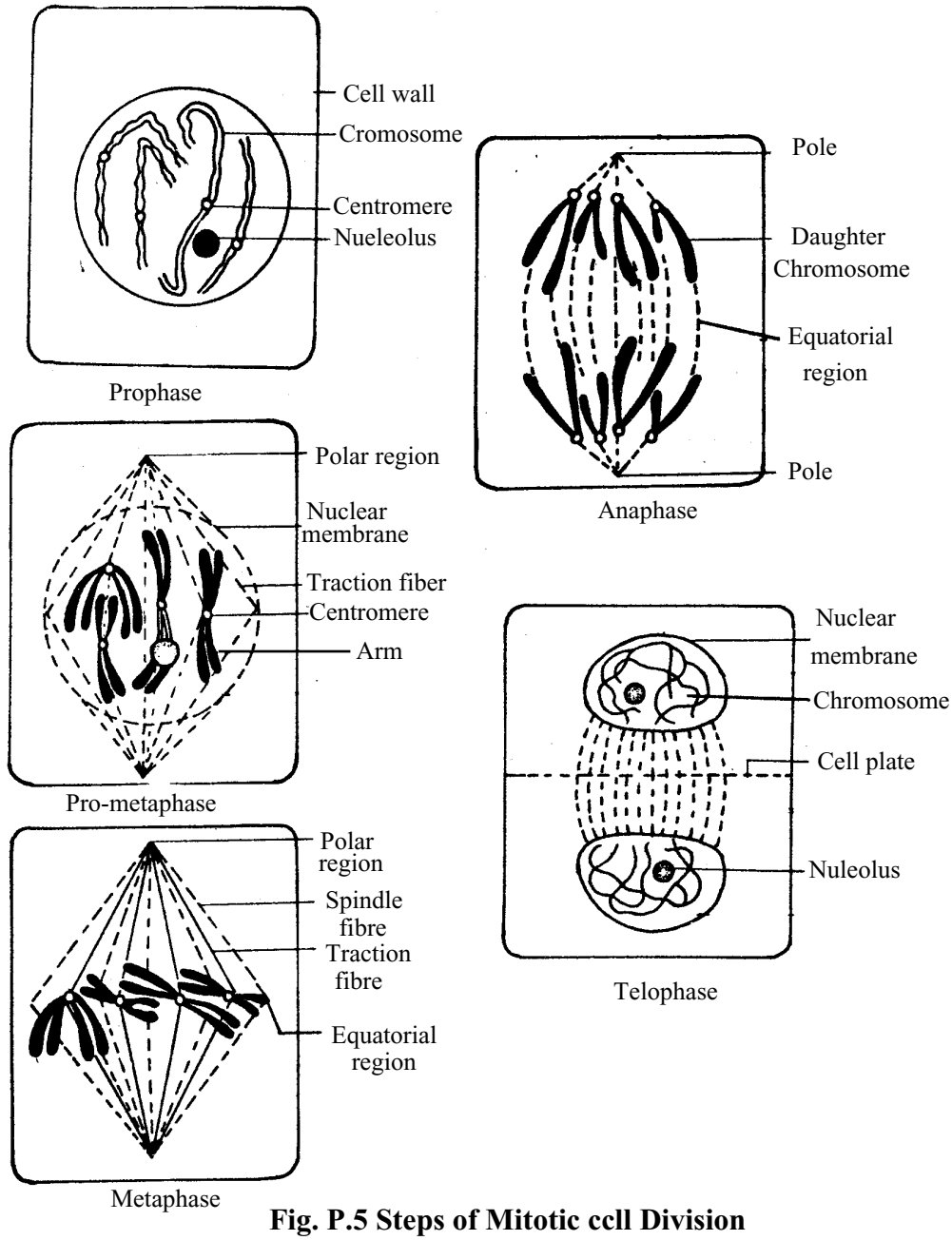


Fig. P.5 Steps of Mitotic ccll Division

STUDY OF DISTRIBUTION OF TISSUE SYSTEM IN DICOT STEM

A young slender stem of a dicot plant is to be collected from surroundings. Any plant such as Ban Sharisha *(Rorippa indiea* Muktajhuri *(Acalypha indica)* may be chosen. Ricinus (Verenda) stem is wider in breath. It may not be possible for the student to cut a transvers section of it. In such case this type of broader stem may be splitted.

longitudinally before cutting transverse section at this stage. It is sufficient to show the cuticle on the epidermis, circular arrangement of vascular bundles. and in each vascular bundle xylem and phloem tissues are present.]

Materials required: A piece of stem of any dicot plant, microscope, watch glass. water, sharp blade, safranin solution (red dye), brush, slide and cover slip etc.

Procedure: Holding the young stem with the left hand, very thin section (transverse section) is to be taken by a sharp blade holding in the right hand. Water should be placed at the edge of the blade and on the cutting end of the stem so that air does not enter into the section. Sections are to be kept in water taken in a watch glass. A drop of water is to be placed on the slide and then a uniformly thin section should be taken by a brush and placed in the water drop on the slide. A little amount of safranin solution is to be added in the water drop on the slide. Then a cover slip is to be placed over the section and the section would be observed under a compound microscope.

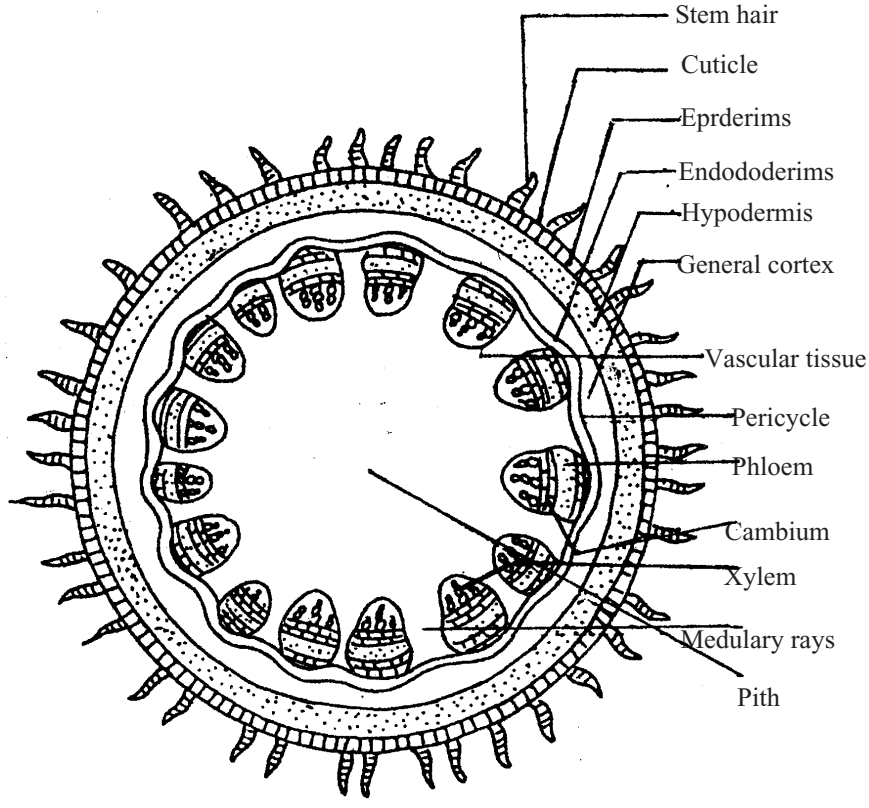


Fig. P.6 Distribution of tissue system in a young dicot stem

Observation: In cross section the stem will appear more or less circular in shape. In observation the following tissue system will be seen: A single layered parenchymatous cells present at the outermost position of the section; this is **epidermal tissue,** it is **called epidermis.** Outside the **epidermis** there is a layer of cuticle. In some plant unicellular or multicellular hairs may develop here and there from epidermal cells. Inside the circular layer towards the middle of the section there is another circular layer. Vascular bundles are encircled by this layer and are arranged in a ring. Each vascular bundle consisting of phloem tissue towards the periphery, a thin cambium layer (not easily visible) in the middle and xylem tissue towards the center. The vascular bundles together form the **vascular tissue system.** The zone in between epidermis and vascular region is called the cortex. It is the ground tissue system. The region surrounded by the vascular tissue is known as pith, which is also ground tissue.

Conclusion: Cuticle present on the epidermis, xylem and phloem tissues are present in each vascular bundle. So the section is of a young stem. Vascular bundles are arranged in a ring, cambium present in between xylem and phloem, so the section is of a stem of Dicot plant.

STUDY OF THE STRUCTUREAL FEATURES OF DIFFERENT PLANT GROUPS

Spirogyra, Agaricus, Moss, Fern, Cycas, Coconut, and Peyara *(Psidium)* these are plants of different groups. Their structural features are not alike. The teacher should show these plants to the students. Student will observe these carefully and then the following table should be filled up. The first column is filled up.

Characters	***Spirogyra***	***Agaricus***	**Moss**	**Fern**	***Cycas***	Coconut tree	Peyara tree
1.Colour (green, non-green)	Green						
2. Root present/absent	Absent						
3. Fibrous root/ Taproot	-						
4. Stem present/ absent	Absent						
5. Stem branched/unbranched	-						
6. Leaf Present/absent	Absent						
7. Leaf simple/compound	-						
8. Leaf all over/at the top of	-						

9. Venation						
paralle/reticulate						
10. Flower present/ absent	Absent					
11. In flower ovary present/absent						
12. Flower unisexual/bisexual						
13. Seed develop/do not develop	Do not form					
14. Fruit develop/not develop	Do not form					

To cut longitudinal section of a *Datura* flower and to draw labelled diagram after identification of different parts.

Take a *Datura* flower. Cut the flower longitudinally (vertically). Identify its different parts. Draw a labelled diagram in your notebook and show it to the teacher.

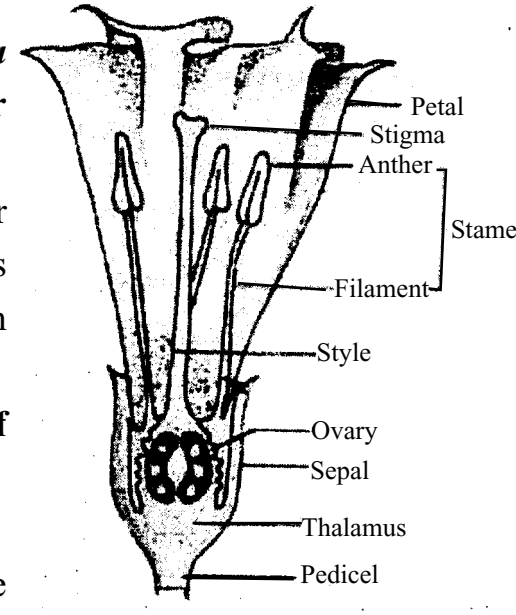


Fig. 9.7 L.S. of a Datura flower

Observation of Different Types of Flowers

Collect plant specimens from your surroundings and fill up the following Table according to your specimen:

Table according to your specimen :

S.L No.	Name of Flower	Complete	Incomplete	Bisexual	Unisexual	Zygo morphic	Actino morphic	Hypo gynous	Epi gynous
1.	*Datura*	+	Ð	+	Ð	Ð	+	+	Ð
2.	China-rose	+	Ð	+	Ð	Ð	+	+	Ð
3.	KUMRA	Ð	+	Ð	+	Ð	+	Ð	+
4.	APARAJITA	+	Ð	+	Ð	+	+	+	Ð
5.									
6.									
7.									
8.									

Study of Characteristics of Flowers Pollinated by Different Agents

Collect plants from your surroundings, which are pollinated by four different types of agents. Note their characters in the following Table: -

Type of Flower	Colour	Scent	Nectar	Pollens	Stigma	Size of flower
Hydrophilous						
Anemophilous						
Zoophilous						
Entomophilous						

Study of Dispersal of Fruits and Seeds

Observe and study plants present around you surroundings and note how they disperse their fruits and seeds in the following Table:

Name of Plant	Wind	Water	Animals	Birds	Explosion

Study of the Methods of Reproduction in Plants:

Observe different Plants present around you. Note down the names of Organ by which the particular plant perform the process of Reproduction. Record your notes in the following Table:

Name of plant	Stem	Root	Leaf

Study of Photoperiodism in different Plants

Observe and study plants present in your locality. Write down their names in the following Table and give tick (√) mark in appropriate places. Fill up the Table in your notebook and show it to the teacher.

Name of plants	Short Day	Day Neutral	Long Day

Experiment to Demonstrate the Process of Osmosis with the help of Raisin
Requirements: Some Raisins, a bowl and water.
Procedure: Let a bowl be taken and make it half filled with water. Now Put a raisin in it and kept for observation.
Observation: After an hour it will be seen that the raisin becomes swollen by absorbing water from the bowl by the process of osmosis.
Explanation: Outside the raisin there was only water in the bowl. the cell wall of the raisin is made of selectively permeable membrane and inside the cell there present concentrate sweet juice (Sugar solution) Thus water enters inside through the selectively permeable membrane, as a result the raisin has become fully swollen.
Demonstration of cell-to-cell osmosis by Potato Osmoscope:
Requirements: A large potato, a small bowl, water, sugar solution. knife.
Procedure: Take a bowl half filled with water. Peeled off the potato and cut it at two ends and make a hole at one end. Make the hole half filled with sugar solution and keep the potato in water of the bowl in such a way that the potato: hole remains above the water surface. The solution level in the hole is marked. The whole experimental set is kept for some time.
Observation: After some time it will be seen that the water level in the potato has increased.
Conclusion: There is water outside the potato while in the hole there is sugar solution. The cell wall of potato is permeable and the cell membrane is semipermiable. The solvent (water) from outside has passed through many cells and enters into the hole. According to the condition described above the process of entrance of water from outside to inside is known as osmosis. As water has passed through so many cells, to reach the cavity/hole the process thus termed as cell-to-cell osmosis.
Demonstration of Ascent of sap from root to stem and leaves with the help of *Peperomia* plant:
Requirements: A fresh *Peperomia* plant with roots, test tube, water, some red dye.
Procedure: Take water in the test tube and pour a little dye (safranin or pen ink will do) in the test tube. Then place the *Peperomia* plant in the test tube in such a way that only the roots immersed in the coloured water. At this condition the experimental set is kept for observations.

Experiment to show that Light is essential for Photosynthesis:
Requirements: A potted plant with green leaves, Black paper, Alcohol, Iodine solution, and clips, (the plant should kept in dark for a long time before experiment). .
Procedure: Cover both side of a leaf with black paper and clip so that Sunlight cannot reach inside. Then let the pot with the plant be kept in Sunlight. After one hour tear the leaf off and boil in alcohol so that the leaf becomes chlorophyll free. Now let the leaf be immersed in iodine solution.
Observation: On taking out from the iodine solution it will be seen that all the area except the covered area became blue (deep violet or black)
Conclusion: Carbohydrate react with iodine solution turns to blue (deep violet or black). Sunlight did not reach the area covered with black paper; photosynthesis did not occur there, that is carbohydrate did not produce. As carbohydrate did not produce there the area did not turn blue (deep violet or black). Thus it is proved that Sunlight is essential for photosynthesis so to say for manufacture of carbohydrate.
Experiment to prove that Heat is evolved during Respiration:
Requirements:. One Thermo flask, some germinating Gram seeds and a thermometer.
Procedure: Some germinating gram seeds are taken in the Thermo flask and closed its mouth tightly with a cork. A thermometer is introduced through the cork so that its bulb rests among the gram seeds. Note the mercury reading of the thermometer.
Observation: After some time an increase in the reading of mercury in the thermometer will be observed.
Conclusion: Rise of mercury indicates the rise of temperature. And this temperature is produced by the respiration of the germinating seeds.
Experiment to show that CO_2 is evolved during respiration:
Requirements: A round bottom flask with a cork, glass tube, flower petals, mercury, caustic potash, forceps, cotton, a stand with clamp.
Procedure: Let us put some fresh petals in a round bottom flask, two-piece of caustic potash is introduced into the flask and then some cotton also introduced in to the neck of the flask. Then a cork having a central hole is fitted to the mouth

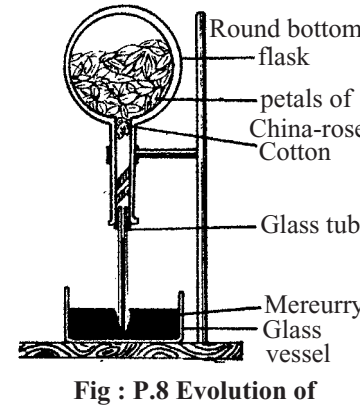


Fig : P.8 Evolution of CO_2 during Respiration

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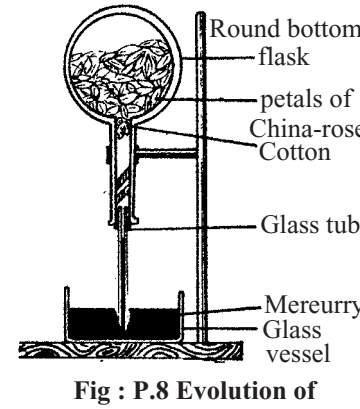


Fig : P.8 Evolution of CO_2 during Respiration

Procedure: A sieve is filled with saw dust. Four germinating gram seeds are placed towards the bottom of the sieve. The sawdust is moistened with water. The sieve then placed a little above the soil surface by supporting from either side of the sieve. The experimental set is then kept for observation.

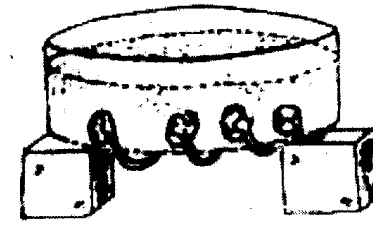


Fig. P.9 Experiment of Hydrotropism

Observation: After a day it will be seen that roots from the seeds come out through the perforation of the sieve (due to geotropism) but again they bended and entered into the sieve.

Conclusion: As the sawdust in the sieve was wet with water, thus the roots of the seedlings re-entered into the moistened sawdust through the perforation of the sieve.

Experiment to show the germination of pollen grains to form pollen tube:

Requirements: Sucrose (a sugar) solution, Sodium borate solution, slide, Microscope, fresh pollen grains; and a petridish.

Procedure: Let us take a little amount (10-15 parts) of sucrose solution in a petridish. 0.01 % sodium borate solution is then mixed with sucrose solution. On this mixture a good amount of fresh pollen grain is then spread over. In this condition the set is left for one day.

Observation: After one day let the petridish be observed under simple microscope. It will be seen a good number of pollen grain develops pollen tubes on germination.

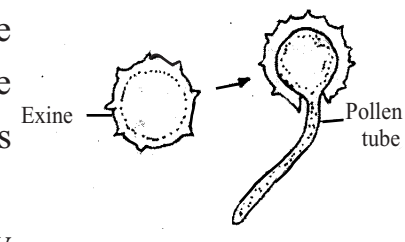


Fig. P.10 Experiment to show germinatio of pollen tube from pollen grain

If you can collect pollen grain of Gima Shak by 10 o'clock in the morning, you will be able to observe germinating pollen tubes. Most pollen grain germinates in 10 -20% sugar solution. So if you do not have sodium borate, you can do this experiment with sugar solution. In most cases germination may be observed if pollen grains are collected after a few hours of dehiscence of anther.

PRACTICAL
(zoology)

A. Earthworm:

Classification of Earthworm:

kingdom: Animalia

Phylum: Annelida

Class: Oligochaeta

Order: Neo-oligochaeta

Family: Megascolecidae

Genus: M*etaphire (Pheretima)*

species: *Metaphire posthuma*

Earthworm belongs to the phylum Annelida. it leaves in soil.

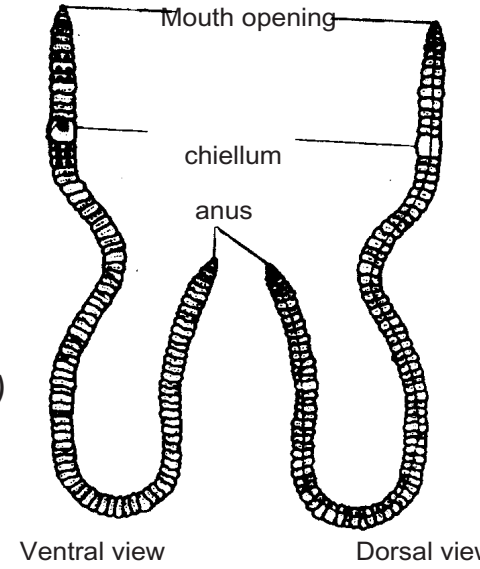


Fig : External features of earthworm

External Features:

1. The body of earthworm in cylindrical and the two ends are tapering.
2. Its body is clay-coloured, deeper dorsally and lighter ventrally. There is a fine, long black line on the dorsal side.
3. The body is segmented both externally and internally. There are about 100 segments in the body.
4. At the anterior end the mouth opening and at the posterior end the anal opening is present.
5. Near the front end on 14^{th}, 15^{th} and 16^{th} segments, there is a fleshy band like covering surrounding the three segments mentioned above, known as clitellum.
6. The integument has spine- like organs known as setae.
7. On the ventral side single female genital pore and a pair of male genital pores present.

Digestive System:

Dissection: All invertebrates animal are to dissect on the dorsal side. Earthworm is a invertebrate animal. So it is dissected on the dorsal side. The alimentary canal is extended within the body of earthworm from the anterior end to the posterior end and that is divided into seven regions, namely:

1. **Mouth and Buccal Cavity:** In the middle of first segment, there is mouth through which foods enter into the buccal cavity. It lies behind the mouth. It is a wide cavity.
2. **Pharynx:** Behind the buccal cavity the muscular pharynx present, it crushes the food.
3. **Oesophagus:** Next to pharynx, the tubular portion is the oesophagus through which the food goes to the gizzard.
4. **Gizzard:** Behind the oesophagus lies the gizzard. It is muscular.
5. **Stomach or Preintestine:** Next to gizzard stomach or preintestine is situated. It is tubular and the food is digested here.
6. **Intestine:** The intestine follows the stomach. It is also tubular and is the longest part of the gut where food is digested and digested food is absorbed.
7. **Rectum:** At the posterior end of the alimentary canal the rectum is formed with 25 segments where faeces stored. Behind the rectum, at the posterior end there is anal pore.

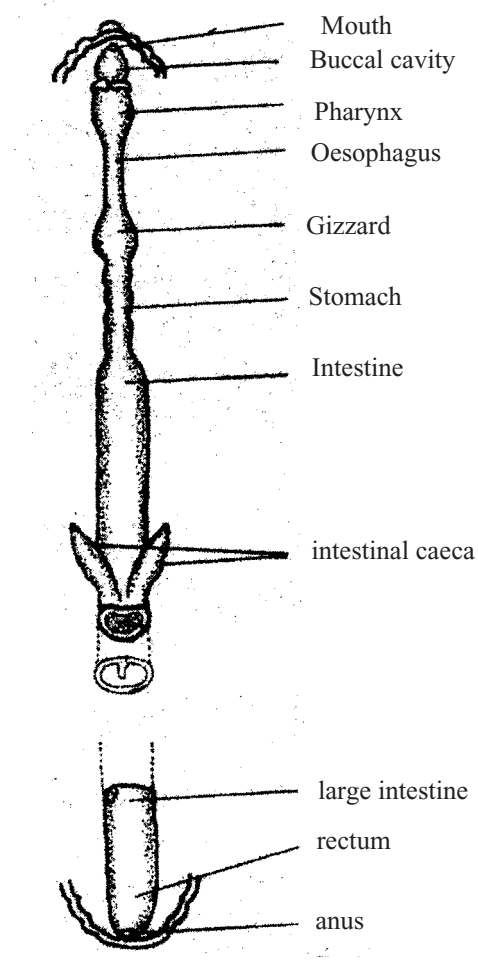


Fig : Digestive system of Earthworm

Method of Dissection:

1. The two ends of the earthworm are stuck in the dissecting tray, keeping the dorsal side upward.
2. Following the black, thread like line on the dorsal side, it is to be cut straight with blade or scissors.
3. By removing the body wall on the dorsal side, the tubular long alimentary canal is to be found.
4. Now observe the different regions of alimentary canal.

B. Prawn: The prawn belongs to the phylum Arthropoda and class Crustacea. lt is familiar as a nutritious and tasteful food. There are different species of marine and fresh water prawns in Bangladesh. Galda prawn in a fresh water species. There are similarities among all the species of prawn in their internal and external structures. Bagda is a kind of marine prawn.

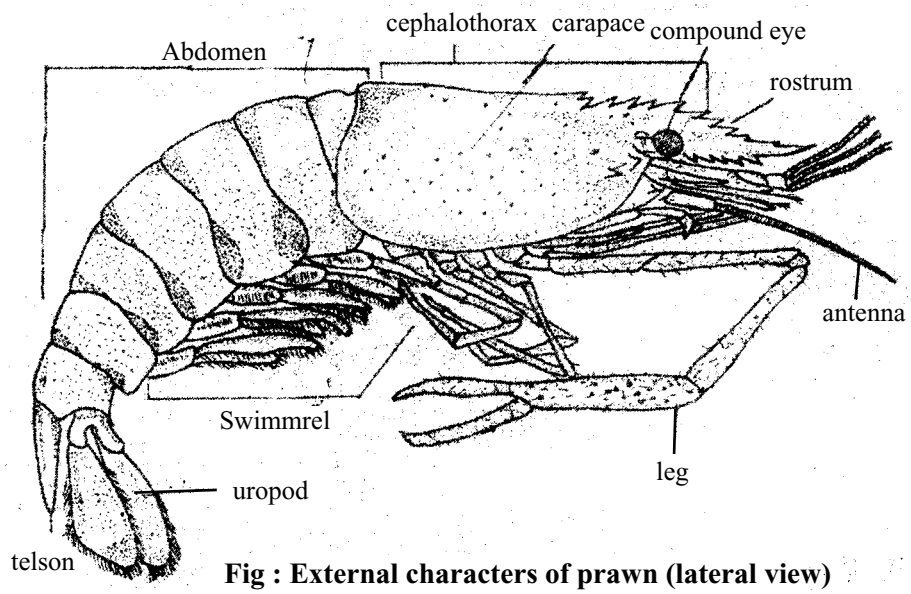


Fig : External characters of prawn (lateral view)

Classification of Prawn:

Kingdom: Animalia
Phylum: Arthropoda
Class: Crustacea
Order: Decapoda
Family: Palaemonidae
Genus: *Macrobrachium*
Species: *M. rosenbergii*

External Features of Galda Prawn:

1. The whole body of a prawn is covered by an external covering or external skeleton made of substance known as chitin. The external covering or shell is divided into many segments where bands or spots are present.
2. The body of prawn in elongated, bilaterally symmetrical and spindle shaped.
3. The body of prawn is divided into two main parts, e.g. A. **Cephalothorax B. Abdomen**

A. Cephalothorax: Cephalothorax is again divided into two portions, e.g.

l. Head: Head is the anterior part of Cephalothorax. In the head there are five pairs of segmented appendages, which are a. Antenulle b. Antenna c. Mandibles d. Maxillula and e. Maxilla.

2. Thorax: Just behind the head thorax is situated. Head and thorax together form the Cephalothorax. The first three pairs of appendages are Maxilla like and known as Maxillipeds. The last five pairs of thorasic appendages are used for walking. These legs are tubular elongated and segmented. First and second pairs of walking legs are provided with forceps. The Cephalothorax is covered by a hard covering known as Carapace. At the anterior end of *carapace* there is a pair of black, round stocked compound eyes. In between the eyes there is a laterally compressed flat saw like rostrum.

B. Abdomen: The elongated portion of the body behind the Cephalothorax is abdomen. It is round dorsally and a bit compressed laterally. The abdomen consists of six segments. In every segment of the abdomen there is a pair of appendages. They are used for swimming and known as ***Pleopods.*** The first five pairs of swimming legs are similar. All the legs are segmented.

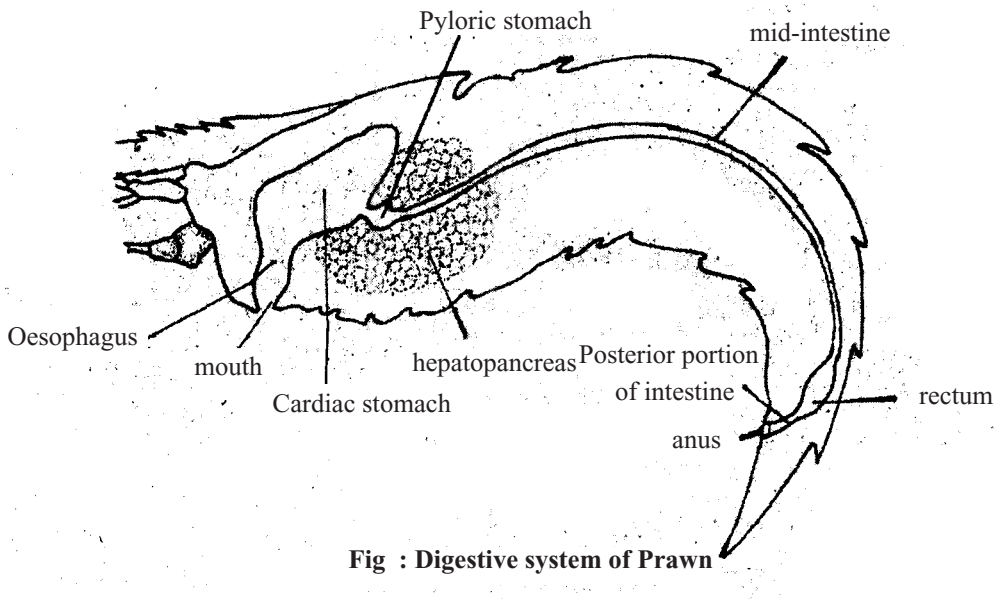


Fig : Digestive system of Prawn

Uropod: The sixth or the last abdominal appendages are uropod or tail fin. These are very big oar-shaped. At the end of abdomen the pointed portion is known as **Telson.**

Dissection of Digestive system of Prawn :

Prawn is an invertebrate animal. So it is dissected on the dorsal side. The digestive system of prawn is formed of two parts, namely: 1. Alimentary Canal 2. Gastric Gland

l. Alimentary Canal: Alimentary canal is divided into three regions, namely A. Fore gut B. Mid gut C. Hind Gut.

A. Anterior Alimentary Canal or Fore Gut: It is divided in four parts, e.g.

i. Mouth Opening: It is a big opening on the ventral side of the head situated at the junction of 3rd and 4^{th} cephalic segments. Food enters throwgh this opening.

ii. Buccal Cavity: Behind the mouth this short cavity is situated where food crushed.

iii. Oesophagus: A short and wide oesophagus is present at the back of buccal cavity from where food passes to the stomach.

iv. Stomach: It is a big sac like organ behind the oesophagus. The anterior portion of the stomach is cardiac stomach and the posterior part is pyloric stomach. Food is digested in the stomach.

B. Mid Alimentary Canal or Mid Gut: This is straight, long, narrow and tubular portion of the alimentary canal. It is extended along the mid dorsal line up to the 6th abdominal segment. Its function is to absorb digested food and undigested food passes to the rectum through mid gut.

C. Posterior Alimentary Canal or Hind Gut: Behind the mid gut a small tube extended up to anus. It has two portions, namely:

i. Rectum: Small sac-like, first portion of posterior alimentary canal rectum.

ii. Narrow tubular posterior portion: It is located behind the rectum. At its posterior end anal opening is present. The undigested waste materials are stored here. The faecal waste is eliminated through the anus.

2. Digestive Glands: The name of digestive gland of prawn is hepatopancreas, which is orange coloured and occupies most of the regions of Cephalothorax. It is a large gland surrounding the stomach. This gland functions like the liver, pancreas and small intestine of higher animals. They secret enzymes take part in digestion.

Method of Dissection:

Take the prawn on hand, the covering be cut with scissors along the dorsal line-from the posterior end up to the anterior middle end. Then digestive system is to be observed carefully.

C. Grasshopper:

Grasshopper is an invertebrate animal. It belongs to the phylum Arthropoda and class Insecta. The characteristics of grasshopper are like other insects. Grasshopper lives all over the world in grassland and leafy vegetation. They feed on grass and leaf. Some kinds of grasshoppers are known as locusts.

Classification of Grasshopper:

Kingdom: Animalia
Phylum: Arthropoda
Class: Insecta
Order: Orthoptera
Family: Locustidae
Genus: Schistocera
Species: *S. gregaria*

External Features:

1. Grasshopper's body is narrow, elongated, tubular and somewhat compressed laterally. It is about 8 cm in length.
2. Its body is yellowish gray that enables them to resemble the environment in which they live.
3. Entire body is covered by a hard cuticle or integument, cuticle is divided into a definite number of segments.
4. The body of Grasshopper is divided into head, thorax and abdomen.

A. Head: The head is big and somewhat triangular. There is a pair of large compound eyes and a pair of antenna on the head. At the anterior end of head there is a mouth opening. Surrounding the mouth opening there are some mouth appendages.

B. Thorax: There are three pairs of segmented legs on the ventral side and two pairs of elongated wings on the dorsal side. The fore wings are a bit thicker and the hind wings are broad and membranous.

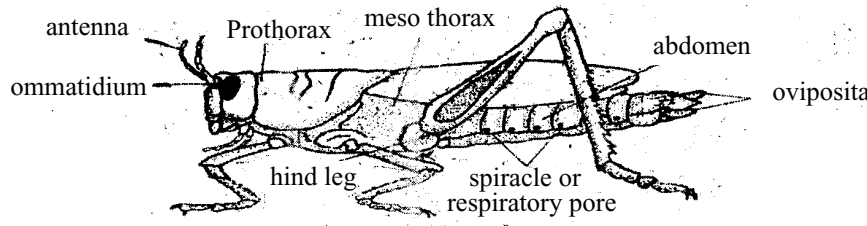


Fig : Extermal charachters of Grasshopper (lateral view)

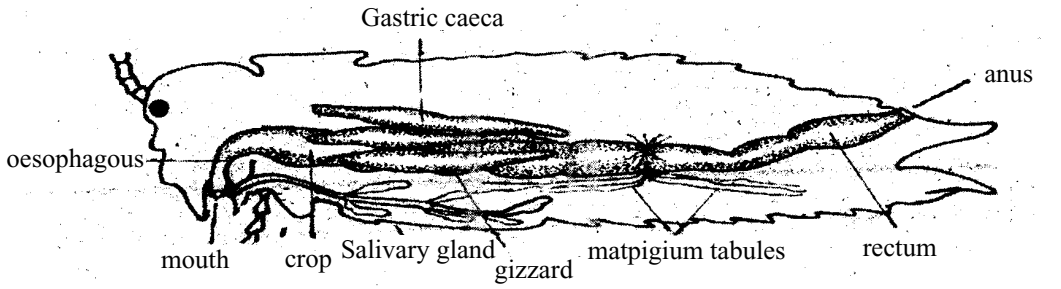


Fig : Digestive system of Grasshopper

C. Abdomen : Abdomen of grasshopper is elongated and gradually narrower towards the posterior end. The posterior end of abdomen bears a pair of out growth known as anal circi. On the two sides of body eight pairs of respiratory openings called spiracles are present.

Digestive System of Grasshopper: As grasshopper is an invertebrate animal it is dissected from the dorsal side. The digestive system consists of: 1.Alimentary Canal 2.Salivary glands.

1. Alimentary Canal: The Alimentary Canal or gut is divided into three main regions, namely.

a. Fore Gut: There are four parts of fore gut, e.g.

i. Mouth Opening: At the anterior end of fore gut there is a mouth opening through which food enters. Around the mouth opening, there are mouth appendages.

ii. Pharynx: It is smaller in size and located just behind the mouth opening.

iii. Oesophagus: First part of oesophagus is narrow and the hind portion being expanded to form sac-like structure known as crop. Here the food is partially digested and stored.

iv. Gizzard: Posterior to the crop, is gizzard. It is thick walled, muscular and more or less cone shaped. Gizzard grinds and crushes the food.

b. Mid Gut or Mesenteron: The next part behind the gizzard is mid gut or stomach. It is large wide sac where food is digested. At the junction of gizzard and stomach a number of gastric caeca are present. This caeca open into the mid gut and secrete enzymes.

c. Hind Gut: The hind portion of the gut is known as hind gut. It has two region, e.g.

i. Ileum or Small Intestine: It is tubular portion. Absorption of digested food occurs here.

ii. Large Intestine: Next to ileum, it is large intestine consists of a tubular colon and sac-like rectum. At the end of rectum lies the anal opening. In rectum undigested food is stored as faeces which come out through anus.

2. Salivary Glands: Closely associated with the oesophagus and crop, there are a pair of small branched salivary glands which secrete saliva and open to the buccal cavity.

Methods of Dissection:

1. Taking the grasshopper on the dissection tray, head and the last end of abdomen are to be stuck with pins.
2. The dorsal side has to be kept upward.
3. It is to be dissected along the dorsal mid line with scissors or sharp blade from back to the front.
4. Then the digestive system is to be observed carefully with the help of a forceps.

D. Toad: Toad is a familiar animal of the class Amphibia. Its body is bilaterally symmetrical. The body of toad is gray coloured with warts throughout and divided into two portions, namely: 1.Head 2.Trunk

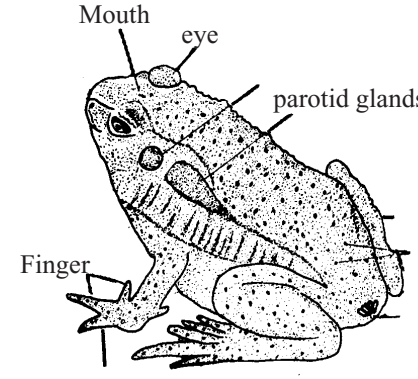


Fig: External structure of Toad

1. Head: The shape of head is like an equilateral triangle. Its mouth is very large and bordered by jaws. In front of the head there are nasal apertures and at the back two eyes. Behind the eyes there are two tympanic membrane's. Two glands known as parotid glands are located behind the tympanum.

2. Trunk: The portion of body extending from fore limbs to hind limbs is known as trunk. At the end of trunk lies the anus.

Digestive system of Toad:

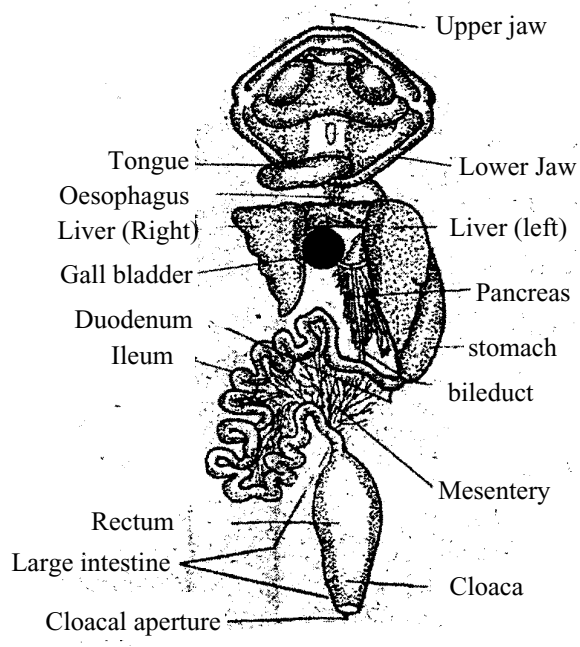


Fig : Digestive System of Toad.

The digestive system consists of: 1. Alimentary Canal 2. Digestive Glands.

1. Alimentary Canal: Alimentary Canal of toad is tube like and extended from the mouth to the anus. It consists of the following organs. e.g.

i. Mouth: The mouth and the buccal cavity is more or less wide and covered by toothless jaws. Upper jaw is fixed.

ii. Buccal Cavity : It is situated just behind the mouth opening. On the anterior end of the lower jaw there is long fleshy tongue which is blunt anteriorly.

The opening behind the tongue is glottis.

iii. **Pharynx:** It is the last part of buccal cavity.

iv. **Oesophagus:** In the lower part of pharynx there is a narrow tube known as oesophagus.

v. Stomach: It is sac-like and fleshy, wider anteriorly and narrower posteriorly. Its wider end is the cardiac end and narrow posterior end is pyloric end. This end is connected with small intestine.

vi. **Small Intestine:** It has two portions, namely: a. Duodenum b. Ileum.

a. **Duodenum:** It is the anterior narrow portion, connected with the stomach. It forms U-shaped structure.

b. **Ilium:** It is extended from duodenum to large intestine and spirally coiled.

vii. **Large Intestine:** It is a short and wider portion of intestine. The wider part is the rectum and the narrower part is cloaca.

viii. **Cloacal Opening:** It is at the terminal end of digestive system through which faeces and urine are eliminated to the exterior.

2. Digestive Glands:

Liver: It is the largest gland in the body of toad. It is divided into two portions. On either side of the heart the liver is situated. At the mid region of the liver the gall-bladder is located. **Pancreas:** In between the duodenum and ileum lies the pancreas which is light yellowish in colour.

Method of Dissection:

Bring a live toad in the laboratory, keep it in a glass jar. Insert cotton wool soaked with chloroform in the jar for a few minutes. The toad will be anaesthetized.

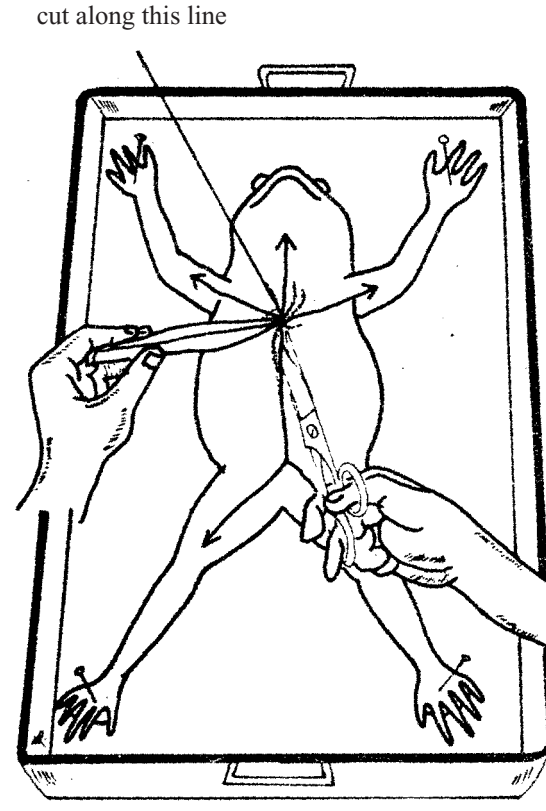


Fig: Method of dissecting a toad.

If chloroform in not available, push a pin in the brain or feed the toad saline water to senseless it. Now place the toad on the dissecting tray keeping the ventral side upward. Pull the fore limbs and hind limbs straight and fixed them with the pins in wax tray. Now pour water in the tray.

Now hold the skin with the forceps and dissect to separate the skin from the fleshy part of the body. Pin up the skin on two sides in the tray.

Now observe the different parts of the alimentary system. according to the figure.

Equipment: The instruments required for dissection of toad are wax-tray chloroform, forceps, blade or scissor and pins.

Skeleton of toad :

Pectoral Girdle:

1. The Pectoral girdle consists of two similar and symmetrical half.
2. Each half consists of suprascapula, scapula, clavicle, coracoid, precoracoid, glenoid cavity and epicoraciod.
3. Sternum is located at the lower end of pectoral girdle.

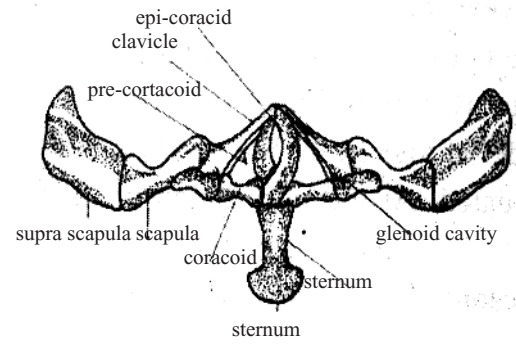
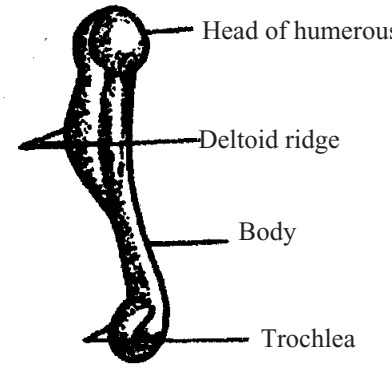


Fig : Pectoral girdle of Toad

4. Suprascapula is wide and thin. Scapula is hard thick and elongated.

Humerus : It is the first bone of forelimb of toad.

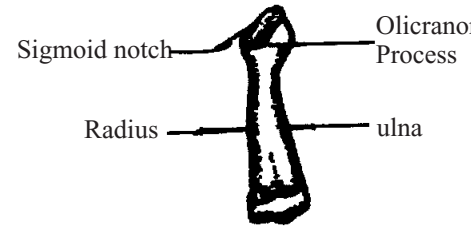
1. This bone is long and narrow towards the posterior end.
2. At the tip, there is a round head like structure.
3. The bone has a trochlea at the posterior end.
4. Deltoid ridge is present.



Humerus

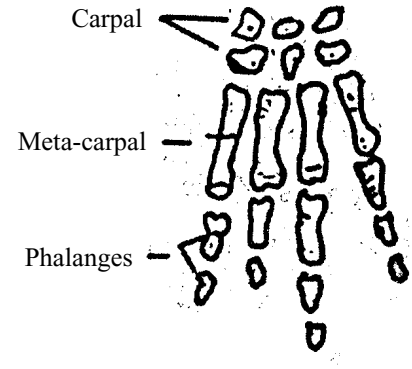
Radia-ulna: It is the radia-ulna of forelimb of toad.

1. The two bones radius and ulna, being fused together to form the bone.
2. The posterior end of this bone is comparatively wide.
3. The anterior end has a concave sigmoid notch.



Radia-ulna

Carpals, Metacarpals and Phalanges:

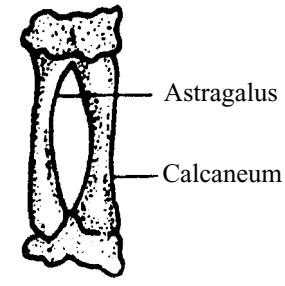


a. **Carpals:**

1. Next to radia-ulna there are small round bones known as carpal.
2. Bones are arranged in two rows.

b. **Metacarpals:**

1. They are next to carpal.
2. Four narrow long bones form the metacarpal.



Astragalus-Calcaneum

c. **Phalanges:**

l. There are four phalanges in the forelimb.

2. 1st and 2nd finger have two phalanges.

3. 3rd and 4th finger have three phalanges.

Pelvic Girdle:

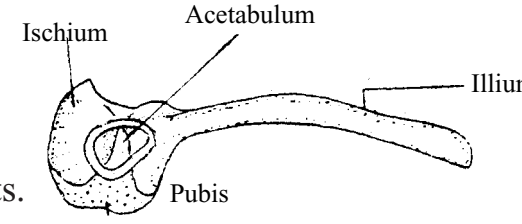
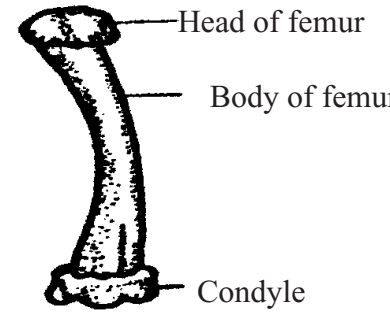


Fig : Pelvic Girdle

1. It is like the English letter "V'.
2. The girdle is divided into two similar parts.
3. In each half there are illium, ischium and pubis.
4 In the junction of these three bones there is acetabulum.

Femur: It is the first bone of the hind limb of toad.

1. The bone is elongated and sticklike.
2. The bone is a little curved.
3. The tip of the bone is round. Posterior end has a swelling.

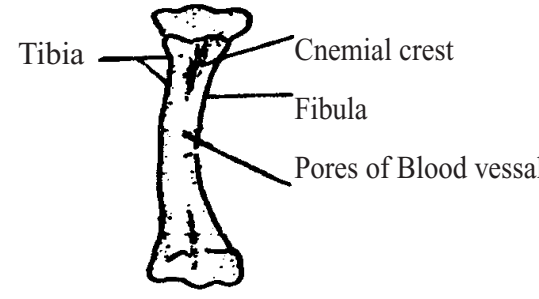


Femur

Tibia-Fibula:

It is the tibia-fibula of hind leg of toad.

1.The bone is long and the ends are wide.
2. Two bones Tibia and Fibula being fused together form the bone, at the junction there is a cnemial crest.
3.The elevated regions on both sides of the depression are clearly seen.



Tibia-Fibula

Astragalus and Calcaneum: It is the bone of hind leg of toad.

1. It is made of two bones astragalus and calcaneum.
2. Both the bones are narrow elongated with a gap in-between.
3. The terminal ends of both the bones are fused.
4. Cartilage is present at the two ends.

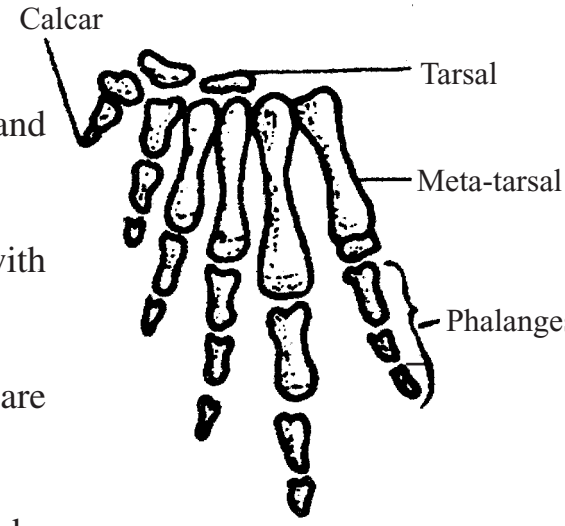


Fig : Hind limb of Toad

Tarsals, Metatarsals and Phalanges:

Tarsals : The Tarsal bones are arranged in two rows. 1st row is formed by two small bones. And these two bones are just below the astragalus and calcaneum.

Metatarsals: Five narrow and long bones form this metatarsal.

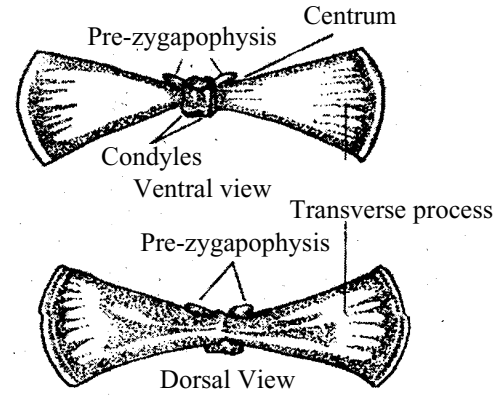


Fig : Ninth vertebra

Phalanges:

1. These are finger bones.
2. There are five fingers in the hind limb of Toad.
3. There are three phalanges in 1st, 2nd and 5th finger and four phalanges in 4th finger.

First Vertebra or Atlas: It is the first vertebra of the vertebral column of Toad.

1. It is ring like in appearance.
2. Transverse process is absent.
3. Neural canal is big.
4. Centrum is small but wide.
5. Prezygapophysis is absent.
6. Front end of centrum is concave and posterior end is convex.

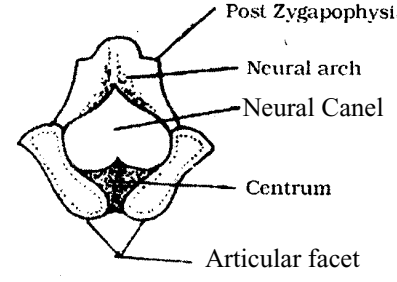


Fig. 8.17 Atlas

Typical Vertebra:

It is the typical vertebra of Toad.

1. Small, thick centrum is present.
2. Small and blunt neural spine present.
3. On both sides of neural arch there is transverse process.
4. Prezygapophysis and postzygapohsis are present.

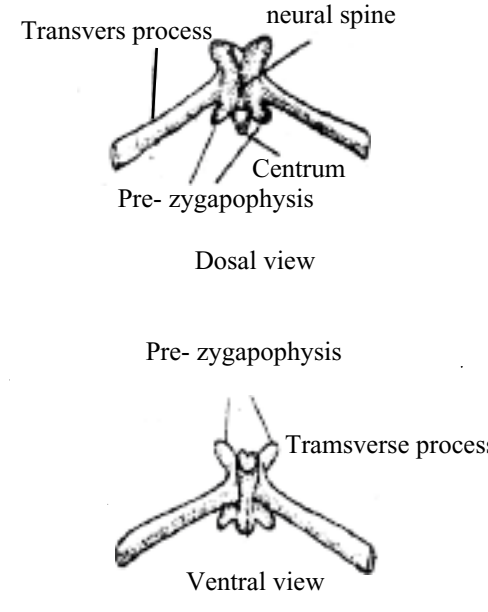


Fig : A Typical vartebra

Ninth Vertebra: It is the ninth vertebra of the vertebral column of Toad.

1. Transverse process is wide.
2. At the anterior end there is centrum.
3. On the posterior region there are two condyles.
4. Prezygapophysis is present but postzygapophysis is absent.
5. Neural canal and neural arch are not completely developed.

Urostyle: It is the last bone of vertebral column of toad or urostyle.

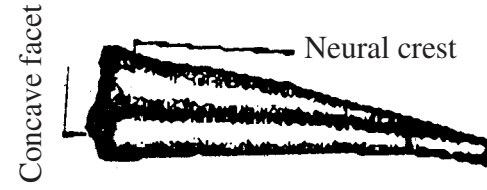


Fig. Urostyle

1. Urostyle looks like a rod.
2. It gradually narrows posteriorly.
3. At the anterior end there is concave depression or facet.
4. At the midline of the bone there is a neural crest like a blade of a knife.
5. Neural canal is very narrow.

E. *Channa punctatus* (Lata/Taki Fish):

In Bangladesh Lata fish lives in rivers, canal, jheel-beels, ponds and different water bodies. It likes stagnant water. They prefer to live in confined water. They are carnivorous. The body of Taki is elongated and bilaterally symmetrical. They are 12 cm to 20 cm in length; the whole body is covered by scales arranged like tiles of the roof of the houses. Their body is wet and slimmy due to secretion of mucus from the skin. The dorsal part is blackish where the ventral side yellowish grey in colour. The body of the fish is divided into three parts, namely:

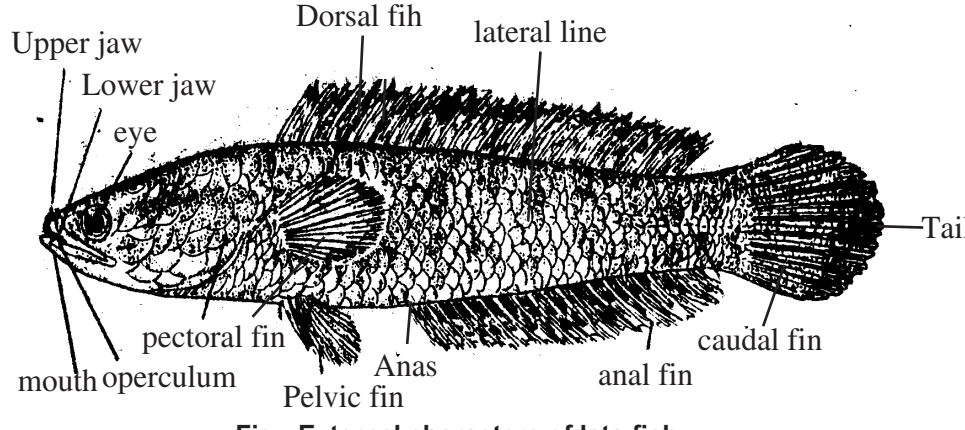


Fig : External characters of lata fish

1. Head
2. Trunk
3. Tail

1. Head: The head of this fish looks more or less like that of a snake. The head extends from the anterior end of the body up to the operculum. The head is compressed dorso-ventrally. The mouth is semi lunar in shape and covered by upper and lower jaws. The jaws have smaller teeth. Behind the upper jaw, a pair of external narial aperture is present and a bit behind these apertures, on every side, there is one eye which is without eyeled. The eye is covered with a thin membrane.

2. Trunk: The part of the body from the last part of the operculum up to the anus is called the trunk. At the anterior region, on two sides of trunk there are two pectoral fins along the middle line. Below the pectoral fin on the ventral side, there is pelvic fin. From behind the head up to tail on the dorsal side there is dorsal fin and on the ventral side from behind the pelvic fin upto anus is the anal fin. There are needle like bony structures in the fin known as finrays. The anal aperture is located at the junction of trunk and tail region.

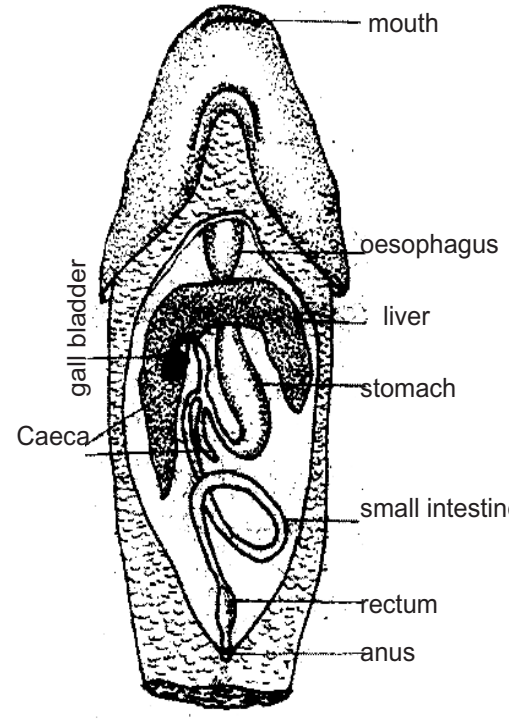


Fig : Digestive system of Lata fish

3. Tail: From behind the anus the rest of the body is the tail. Covering the terminal end of the body there is a fan shaped fin. This is called caudal fin. From behind the back of head up to the tail there are two dark lines on the lateral sides of the body, known as lateral line organ.

Digestive System :

The digestive system consists of;

1. Alimentary Canal
2. Digestive Glands.

1. Alimentary Canal: Alimentary Canal consists of namely:

Mouth: On the anterior end of the fish, there is semilunar shaped mouth bounded by the upper and lower jaw. The jaws have teeth. Mouth follows the buccal cavity.

Buccal Cavity: Behind the mouth opening there is buccal cavity. On the floor there lies the tongue.

Pharynx: Buccal cavity is connected with pharynx from behind. There are floor in two sides of the pharynx:

Oesophagus: Next to pharynx is the oesophagus, which is short, narrow and tubular. It opens into the stomach.

Stomach: It is fairly large. The anterior end is called cardiac end and posterior end connected with intestine is pyloric end.

Intestine: It is tubular and coiled.

Rectum and Anus: The last portion of intestine is a bit wider and sac like. known as rectum where the faeces remain stored. Behind the pelvic fin, there is an aperture known as anus. Faeces are expelled through this aperture.

2. Digestive Glands :

Liver: The liver of Lata fish is big, grayish in colour an devided into two Parts with a gall bladder in between. There is no pancreas in Lata fish.

Method of Dissection and Observation of Lata Fish:

1. Put a dead Lata fish on the dissection tray keeping the ventral side upward.
2. Inserting two large and hard pins fix the fish in the wax.
3. Fix the tail region also with pins.
4. Cut the body wall of the belly carefully, so that the organs of it are not damaged.
5. Now remove the body wall of the belly and examine the digestive system of the fish and try to find out the regions shown in the labelled diagram.

Examples of Animals taken from each of the major Phyla, their identifying Characters, Observations and Figures.

Protozoa :

Amoeba *(Amoeba proteus) :*

1. One celled animal. microscopic
2. It always changes its shape by projecting pseuopodia.
3. There is a nucleus in its body.

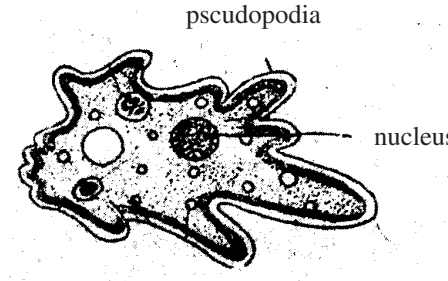


Fig. *Amoeba*

Porifera:

Sponge *(Spongilla fragillis):*

1. Its body wall is provided with numerous pores known as ostia.
2. The adult animal remains attached permanently with some object.
3. There are various types of canal system in its body.

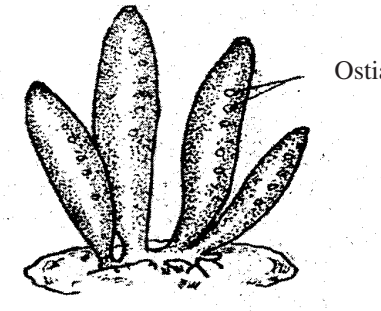


Fig. *Spongilla*

Cnidaria:

Hydra *(Hydra viridis):*

1. It has a long body. At the anterior end of the body, there is a hypostome. Hypostome bears an opening and tentacles at its base. Opposite to hypostome is basal disc.
2. There is only one cavity in the bodyknown as coelenteron.
3. All the cells of the body are arranged in two layers, namely: ectoderm and endoderm. Mesoglea Presents in between the layers.
4. Specialized nematocysts originate in the ectoderm. It helps to catch the pray.

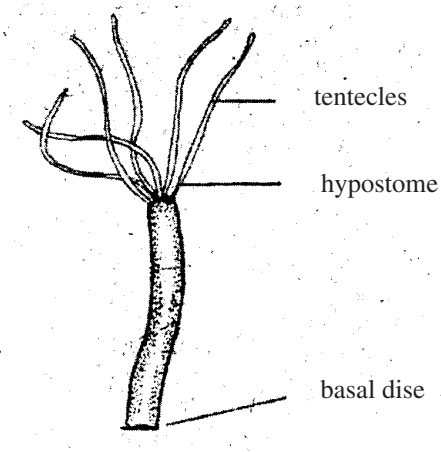


Fig. *Hydra*

Platyhelminthes :

Liver Fluke *(Fasciola hepatica):*

1. Body soft, flat and leaf like.
2. Sucker present on the ventral side and at the anterior end of the body.
3. Mouth is present within the anterior sucker.

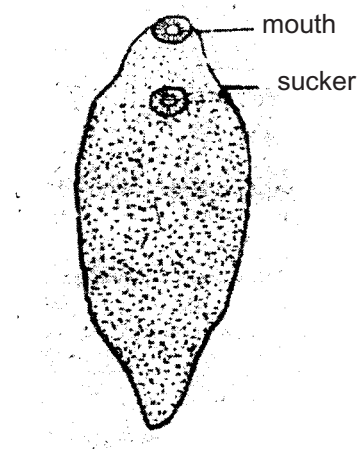


Fig. Liver fluke

Nematoda:

Round Worm *(Ascaris lumbricoides):*

1. Body is cylindrical with two ends pointed.
2. There are four lines along the length of the body.
3. Mouth opening is present at the anterior end of the body.
4. Mouth opening is lined with three lips.

Fig. Round worm

Annelida:

Earthworm *Metaphire (pheretima posthuma):*

1. Body is cylindrical and segmented.
2. In the middle of each segments fine setae are present.

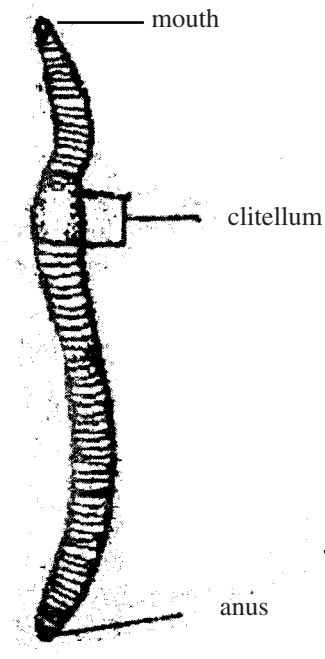


Fig. Earth worm

3. On the 14^{th} to 16^{th} segments a band like fleshy clitellum is present.

Arthropoda:

Prawn *(Macrobrachium rosenbergii):*

1. Body is divided into Cephalothorax and abdomen, no tail but telson is present.
2. Head and thorax together form the Cephalothorax. Body is covered by hard carapace.
3. Carapace is extended forward as a saw like rostrum.
4. Stocked compound eyes. on each side of head are present.

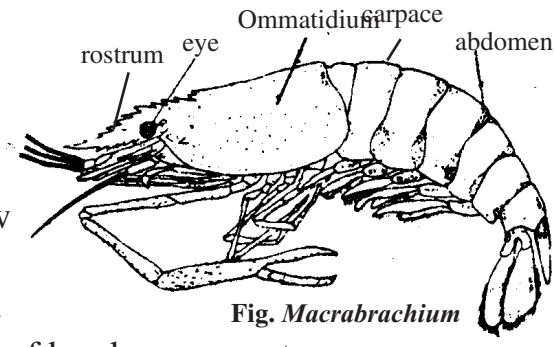


Fig. *Macrabrachium*

Mollusca:

Snail *(Pila globosa):*

1. The soft body is covered by a shell.
2. At the opening of the shell there is a 'C 'shaped lid.
3. The shell is spirally coiled with pointed tip.

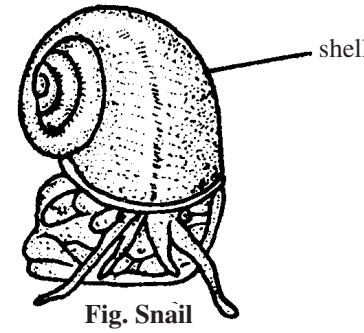


Fig. Snail

Echinodermata:

Starfish *(Asterias rubens):*

1. The body is star shaped with five arms Integument is spiny.
2. They have no head.
3. Each of five arms has tube feet.

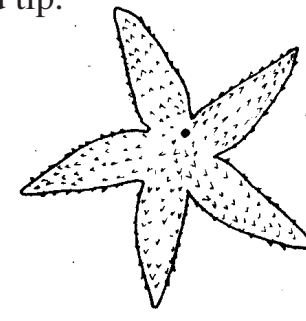


Fig. Star fish

Osteichthyes:

Rui Fish *(Labeo rohita):*

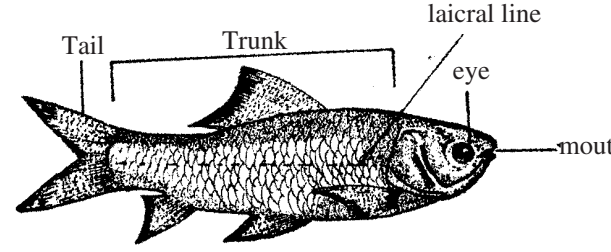


Fig. *Labeo*

1. Body covered with large scales.
2. There are four gills, covered by operculum.
3. The lips are fleshy.
4. The lateral line is conspicuous.
5. One pair each of pectoral and pelvic fins and unpaired dorsal, ventral and caudal fin are present.
6. Body is divided into head, trunk and tail.

Amiphibia:

Frog *(Rana tigrina):*

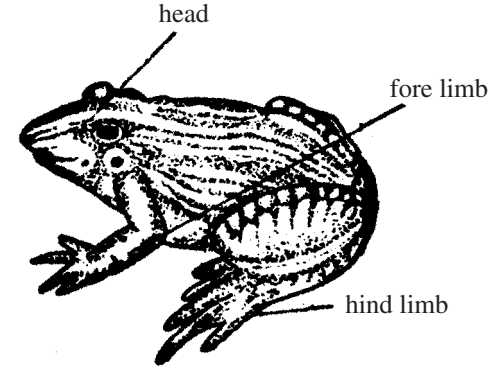


Fig. *Rana*

1. Body is covered by smooth integument and black-yellowish strips are present.
2. Head is triangular.
3. There are teeth on the jaw.
4. There are four fingers in the forelimb and five fingers in the hind limb.

Reptilia:

Wall Lizard *(Hemidactylus brookii):*

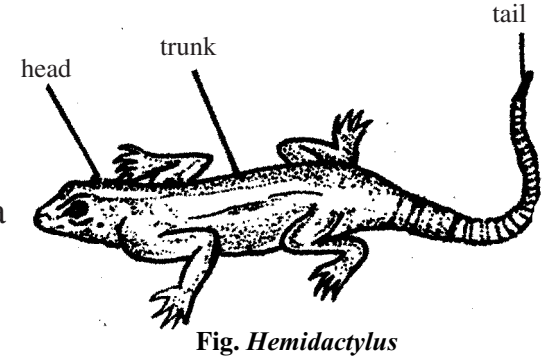


Fig. *Hemidactylus*

1. Body divided into head, trunk and tail.
2. Head is triangular.
3. On the two sides of the head there are a pair of eyes a pair of narial aperture and a pair of auditory aperture.
4. Two pairs of legs are present in the trunk region. Each leg has five fin:
5. Fingers are with pads.

Aves:

Crow *(Corvus splendens):*

1. Body covered with black feather.
2. It can fly.
3. Hard beak and two legs with claws are present.
4. In the wings there are long feathers.

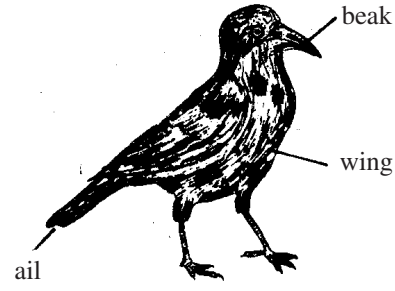


Fig. *Corvus*

Mammalia:

Rat *(Rattus rattus):*

1. Size of the mammal is small.
2. The tail is longer in proportion to the body; the two ears are small and remain erected.
3. The body is covered by hairs.
4. There are teeth in the jaws.
5. Whiskers present in the nasal region.

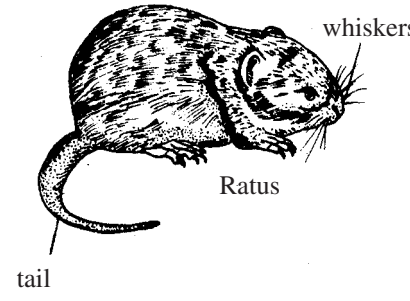


Fig. *Rat*