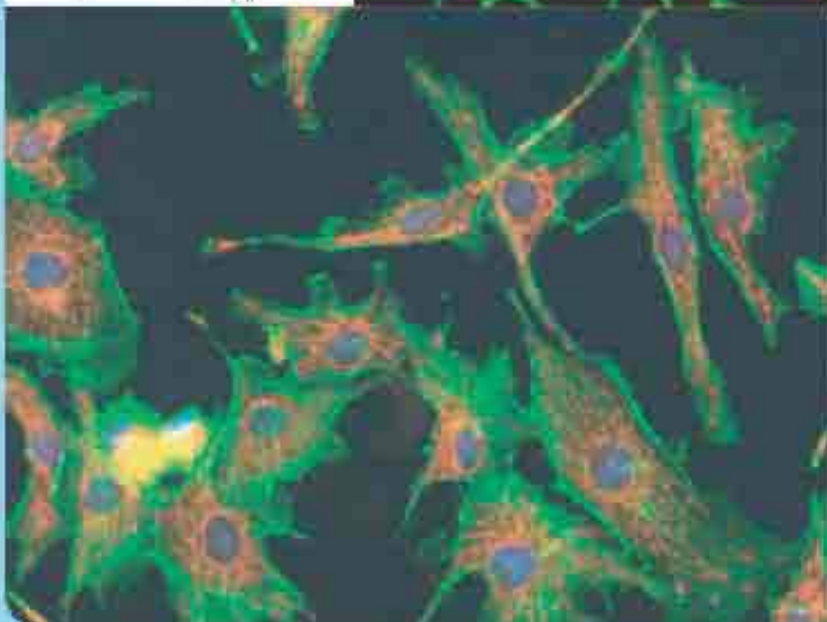
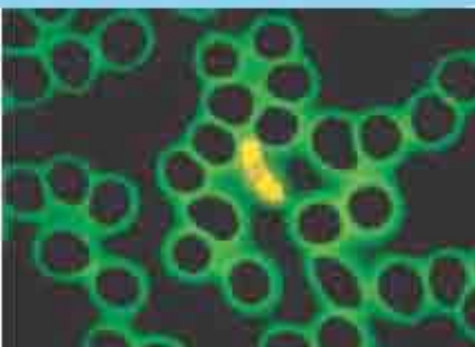


Biology

Classes 9-10



NATIONAL CURRICULUM & TEXTBOOK BOARD, DHAKA

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Biology

Class : Nine - Ten

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PREFACE

Education is the pre-requisite for the holistic development in our national life. To cope with the challenges of the fast changing world and to lead Bangladesh to the doorstep of development and prosperity, a well educated and skilled population is needed. In order to build up a nation imbued with the spirit of the Language Movement and our Liberation War, the secondary education aims at flourishing the talents and prospects inherent in the learners. Besides, the other aims also include expansion and consolidation of the basic knowledge and skills of the learners acquired at the primary level in order to make them fit for entry into higher education. The aims of secondary education further emphasise on developing these learners as skilled and competent citizens of the country through the process of acquiring knowledge at the backdrop of socio-economic, cultural and environmental settings.

Keeping the aims and objectives of National Education Policy 2010 ahead, the curriculum at the secondary level has been revised. In the revised curriculum the national aims, objectives and contemporary needs have been reflected. Along with these expected learning outcomes have been determined based on the learners' age, merit and level of acquisition. Besides, efforts have been made to raise, starting from the level of moral and humanistic values down to awareness on history and tradition, the spirit of the Liberation War, passion for art-culture and literature, patriotism, feelings for nature and equal dignity to all irrespective of religions, caste, creed and sex. Efforts have also been made to apply science in all spheres of our life in order to build a nation advanced in science. Attempts are also there to make the learners' capable of implementing the goals envisioned in Digital Bangladesh-2021.

In the light of the present curriculum almost all the textbooks at the secondary level have been introduced. While introducing the textbooks, the capacity, aptitude and prior knowledge of the learners' have been taken into utmost consideration. While selecting the contexts and their presentation special attention has been given on the expansion of the learner's creative faculty. Adding learning outcomes, at the beginning of each chapter, hints about the achievable knowledge of the learners have been given. By adding variety of activities, creative and other questions evaluation has also been made creative.

The twenty first century is important for the development of Biology. The main purpose of learning Biology is to acquire theoretical and practical education from life. To know nature and life in the sequence of learning is also essential. This scope for knowing the living world with enjoyment has been created in the new Biology curriculum of classes Nine-Ten. Applied aspect along with scientific concept and theory has also been emphasised here in the field of learning Biology. This will reduce learners' tendency for rote-learning to a great extent and they will be able to internalise and apply the achieved knowledge in addition to analysing and evaluating things.

Considering the challenges and commitments of 21st century and following the revised curriculum the textbook has been written as a trial edition. Therefore we welcome with our highest consideration any suggestions, both constructive and rationale as well for the further improvement of the book. Amidst huge activities needed for introducing a textbook, this one has been written within a very short span of time frame. We will continue our effort to make the next edition of this book more beautiful, decent and free from any types of errors.

We appreciate the endeavours of those who assisted very sincerely with their merit and hard work in the process of writing, translating, editing, illustrating, introducing sample questions and printing of the book. We hope this book will ensure joyful reading and achievement of expected skills from the learners.

Prof. Md. Mostafa Kamaluddin

Chairman

National Curriculum and Textbook Board, Dhaka.

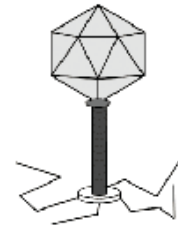
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Chapter One

Lesson on Life

Biology, an immensely important area of science, plays a variety of crucial roles in ensuring protection and welfare of all living beings on earth. With the progress of scientific development, humans are enjoying a much more comfortable life, but side by side many more problems are viciously emerging and causing a serious threat to all forms of life and their environment. In that case, biology can help human to face some critical challenges of the century, and some of these are the production of food, development of medical science and conservation of organisms in their hostile environment. In this chapter, the definition of biology, names of its branches and naming system of organisms have been discussed.



At the end of the chapter, we will be able to

- Explain the general concept of biology.
- Describe the main branches of biology.
- Explain the classification of organisms.
- Evaluate the necessities of the classification of organisms.
- Describe the systems of classification of organisms.
- Explain the concept of Binomial Nomenclature of organisms and its significance.
- Become conscious of the necessity of classification of organisms in practical life.

Concept of Biology

In nature, we generally find two types of objects, nonliving things and living organisms. The characteristics of nonliving things are usually discussed in Physics and Chemistry. Biology is a branch of scientific knowledge concerning life and characteristics of organisms. It is one of the oldest branches of natural science. Its background was even created before the origin of life on the earth, and you will learn more about it at your higher classes.

By studying biology, one can acquire interesting knowledge of different plants and animals and human life. In the realm of living creation, the presence of life in a living cell is remarkable. This is why a good command of biology plays an important role in knowing more about the different parts and organ structure of organisms, different chemical activities in them, their adaptation with their environment, their intake of nutrition and reproduction. The roles of a cell or cells in all steps of life are indisputable. Science has a great contribution in our everyday activities and developing our experience. For our living survival, the fundamental base of biology is inherent in the components of our environment. At the time of walking, our muscles conduct our legs, our nerves move our muscles and the blood circulation in our muscles provides them with oxygen, nutrition and strength. A single celled organism also survives in the same way using oxygen, nutrition and energy. For the maintenance of biological existence, all living organisms require oxygen and energy. An animal derives this energy from food produced by plants themselves and other sources.

Biology is one of the fundamental branches of science. The term *biology* is derived from the Greek word βίος, *bios*, "life" and the suffix -λογία, -logia, "study of." Greek philosopher Aristotle (384BC – 322BC) is called the father of biology. Biology is the branch of science concerned with the study of life and living organisms, including their structure, function, growth, reproduction, classification, origin and evolution.

Branches of Biology

Based on the type of organism, biology is divided into two branches – Botany and Zoology. Grounded on the aspect of consideration, there are also two other divisions of biology - physical biology and applied biology.

Physical Biology

In the field of physical biology, theoretical concepts are usually discussed. The following subjects are the general fields of its concern.

1. **Morphology:** The field deals with the form and structure of organisms. It is usually divided into two branches – external and internal morphology. The external description of the body is called external morphology and the internal description of the body is called internal morphology.
2. **Taxonomy:** Classification of organisms and the principles related to this task are discussed in the field.

3. **Physiology:** This branch of biology deals with the biochemical activities of different organs of organisms. Besides, detailed description of all the physiological process of organisms is found in it.
4. **Histology:** The microscopic structure, arrangement and function of plant and animal tissues are studied in this subject.
5. **Embryology:** The branch of biology discusses the development of embryo of organisms.
6. **Cytology:** The structure, function and division of an individual cell in a body of organisms are studied in this field of biology.
7. **Genetics:** The branch of biology deals with genes and heredity.
8. **Evolution:** The gradual development of life and organisms over successive generations on earth is studied in this subject.
9. **Ecology:** It is the science of reciprocal relationship between organisms and their environment.
10. **Endocrinology:** The field of science deals with the study of endocrine glands and hormones secreted by them in a body of organisms.
11. **Biogeography:** The branch of biology studies the geographical distribution of organisms, past and present, throughout the landscape of planet earth including the knowledge of classifying bio-geographical patterns.

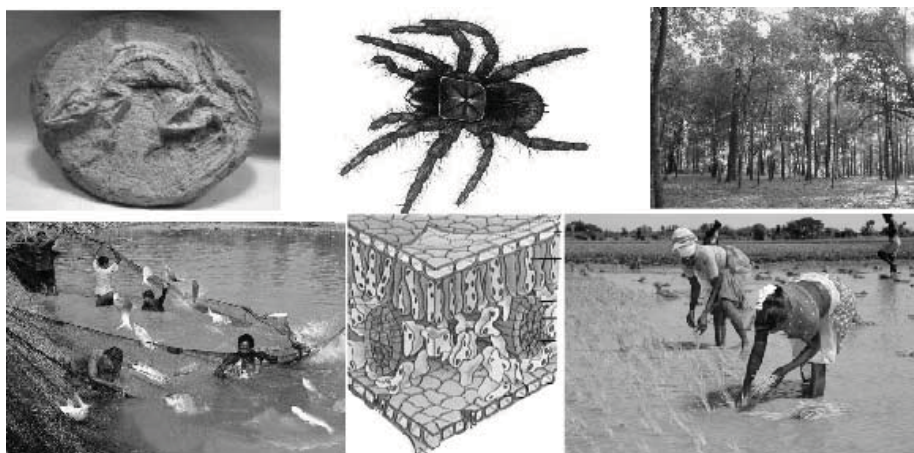
Applied Biology :

Applied subjects related to life are included in this category, and some of them are mentioned below:

1. **Palaeontology:** Science of the prehistoric life forms and fossils;
2. **Biostatistics:** Science of statistics of organisms;
3. **Parasitology:** Science related to parasitism, life process of parasitic organisms and diseases caused by them;
4. **Fisheries:** Science dealing with fish, harvesting of fish, management and conservation of fish assets;
5. **Entomology:** Science related to the study of life, merit, demerit, and control of insects including the losses caused by them;
6. **Microbiology:** Science related to virus, bacteria, fungi and other microorganisms;
7. **Agriculture:** Science concerning agriculture;
8. **Medical Science:** Science related to human life, disease, treatment etc.;
9. **Genetic Engineering:** Science associated with gene technology and its utilities;
10. **Biochemistry:** Science connected to biochemical process and diseases of organisms;
11. **Soil science:** Science related to soil, soil structure and soil environment;
12. **Environmental Science:** Science related to environment;

- 13. Oceanography:** Science related to ocean and its resources;
- 14. Forestry:** Science related to forest, management and conservation of its resources;
- 15. Biotechnology:** Science associated with the technology of utilising of organisms for the benefit of mankind;
- 16. Pharmacy:** Science dealing with technology and industry of medicine;
- 17. Wildlife:** Science related to wild animals;
- 18. Bioinformatics:** Biological information based on computer technology, information on the analysis of cancer, for example.

Work: Looking at the pictures below, present each of them in a list under the biological branch they belong to.



Classification:

About four million of different plant species and thirteen million of animal species have been named and described till today. The number is not yet final because the description of more and more new species is being added to it almost every day. It is assumed that the number will reach a crore in future when the description of all the organisms will be ended. A large number of organisms are needed to be grouped systematically for the convenience to know, understand and learn them. Many years back natural scientists felt the necessity to classify living world following a natural system. From this very necessity, a distinct branch of biology, taxonomy had emerged. The aim of classification is only one to know the vast and diverse living world accurately and classify them with little effort in a short period of time.

The contribution of Swedish botanist, physician and zoologist Carolus Linnaeus (1707-1778) in the field of taxonomy is more worth mentioning. In 1735 at the age of 28, he took his doctoral degree in medicine at the University of Harderwijk, and in 1741 he was appointed Professor of Medicine at Uppsala University. Though he was first responsible

for medicine-related matters, soon he changed his position with the other Professor of Medicine to become responsible for the Botanical Garden, botany and natural history instead. He thoroughly reconstructed and expanded the Botanical Garden. It was the main field of his intense interest to classify organisms from his botanical and zoological observations that he assembled from his many expeditions. He classified living world into two kingdoms – Plant and Animal.

In 1753 Linnaeus published his book *Species Plantarum* which is internationally accepted as the starting point of modern botanical nomenclature and in 1758 he released the tenth edition of his book *Systema Naturae* which established itself as the starting point for zoological nomenclature. He first defined the term genus and species in his book. Based on the observations of size, structure and characteristic, plants and animals are named. On the basis of each other's similarity and dissimilarity, grouping organisms is called classification.

Aim of Classification

The aim of classification is to acquire knowledge of every group and subgroup of each organism. To document the accumulated information systematically focusing on the diversity of living organisms, introduce the total knowledge concisely and take proper steps after identifying organisms to conserve them or increase the number of species for the well-being of human beings and the living world are the objectives of classification.

Living World

Until recently, from the age of Carolus Linnaeus up to the middle of the twentieth century, all living organisms were classified in one of two kingdoms: Animals and Plants. With the progress of science, on the basis of data collected from time to time, for instance, the type of DNA or RNA in a cell, features and number of cell in a living body and mode of nutrition that a cell adopts, a five-kingdom classification was proposed by R.H. Whittaker in 1969. Then Margulis introduced a modified and expanded form of Whittaker's classification in 1974. She divided the whole living world into two super-kingdoms and grouped the five kingdoms under these two super-kingdoms.

Superkingdom-1: Prokaryota

They are microscopic, prokaryotic and one celled organisms.

Kingdom-1: Monera

Characteristics: They are mostly unicellular, filamentous, colonial or mycelial. Though chromatin material is present in every cell, there is no nuclear membrane and nucleolus in their cells. No plastids, mitochondria, endoplasmic reticuli are there in their cells but ribosome is present in them. Cell divides through the process of binary fission. Their chief mode of

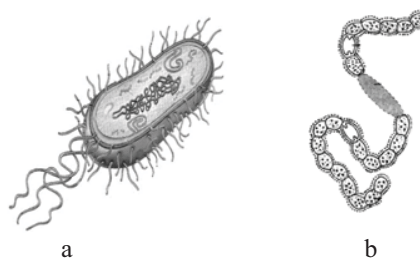


Figure: 1.1 a) Bacteria b) Nostoc (Blue green algae)

nutrition is absorption though some of them produce their food through the process of photosynthesis or chemosynthesis.

Example: Bacteria, Blue green algae;

Superkingdom-2: Eukaryota

They are eukaryotic and unicellular or multicellular and live individually or in a colonial form.

Kingdom-2 : Protista

Characteristics: They are unicellular or multicellular, individual or colonial or

filamentous and the nuclei in their cells are well structured. Their cells contain nuclear materials bounded by a nuclear membrane. In chromatin material, there are DNA, RNA and protein. All types of cell organelles are there in their cells. Their modes of nutrition are absorption, ingestion or photosynthesis. They accomplish their asexual and sexual reproduction by the process of mitosis and conjugation respectively. No embryo is developed in them.

Example: Protozoa (*Amoeba*, *Paramecium*) and unicellular algae, diatom for example;

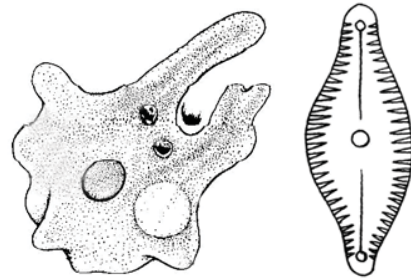


Figure: 1.2 a) Amoeba b) Diatom

Kingdom-3 : Fungi

Characteristics: Most of them are terrestrial, saprophytic or parasitic. Their body is constituted with a single cell or mycelium. Nucleus is well organised. Cell wall is composed of chitin. Their mode of nutrition is absorption. The photosynthetic apparatus chloroplast is absent in them. They reproduce by haploid spores. Their cells divide through mitotic cell division.

Example: Yeast, *Penicillium*, Mushroom etc.

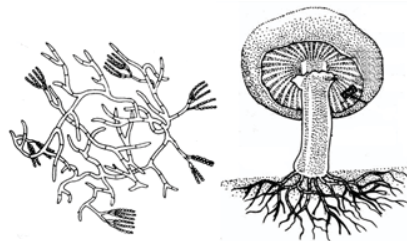


Figure: 1.3 a) Penicillium b) Mushroom

Kingdom-4: Plantae

Characteristics: They are photosynthetic and prokaryotic. Advanced tissue

systems are found in them. They develop embryo and diploid stage is started from it. They are mostly terrestrial but there are also many aquatic species under

this kingdom. Their sexual reproduction is of anisogamous type. They are archegoniates and flowering plants.



Figure: 1.4 a) Spirogyra Multicellular algae
b) Jackfruit tree

Example: Advanced green plants, multicellular algae;

Kingdom-5: Animalia

Characteristics: They are eukaryotic and multicellular animals. Their cells possess non-living cell wall, plastid and vacuole in them. Because of having no plastid in their cells, they are heterotrophs, and so they depend on other organisms for their food. After ingestion, they digest their food. They have advanced and complex type of tissue systems. Sexual reproduction is their usual way of reproduction. Haploid gametes are usually produced in the reproductive organs of mature and diploid male and female. Embryonic layers are developed at the time of their embryonic development.



Figure: 1.5 Royal Bengal Tiger

Example: The entire invertebrate (except protozoa) and vertebrate animals.

Thomas Cavalier-Smith from Oxford University divided the kingdom Protista of living world into two groups, and renamed the kingdom Monera as the Kingdom of Bacteria in 2004. In this way, he grouped the living world into six kingdoms. You will learn more about it at your higher level of education.

Taxonomic rank

In classifying the organisms, some units or ranks are used in taxonomy. The largest classification rank is kingdom, and the smallest classification rank is species.

Kingdom

Phylum / Division

Class

Order

Family

Genus

Species

In modern classifications, the ranks are divided into sub-groups as the necessity demands.

System of Binomial Nomenclature

The scientific name of an organism is constituted with two parts. The first part of the name denotes the genus to which the species belongs; the second part identifies the species within the genus. The scientific name of potato is *Solanum tuberosum*, for example. The word *Solanum* and *tuberosum* denote the genus and species name of potato respectively. The system of scientific naming of an organism with two parts is termed as binomial nomenclature. The binomial nomenclature serves only one aim, and that is to know every organism by its unambiguous name. The scientific naming of an organism is accomplished in accordance with some rules and regulations set internationally. The scientific name of a plant and an animal should be accorded with the declared principles of International Code of Botanical Nomenclature (ICBN) and International Code of Zoological Nomenclature (ICZN).

respectively. In fact, the codes are documented in a printed form. As the scientific naming of an organism is expressed in the language Latin, a legitimate name is unambiguously accepted throughout the whole world.

The great Swedish naturalist Carolus Linnaeus laid the foundations for the modern simpler system of naming organisms and effectively began the task with his book *Species Plantarum* in 1753; the original description of naming organism is found in the tenth edition of his work *Systema naturae* in 1757. He defined the term species and genus, and used the ranks of classification class, order, genus and species in his work. The introduction of the formal system of naming organism by Carolus Linnaeus is undoubtedly a striking step in the history of biology. Some of the notable principles of binomial nomenclature are mentioned below:

1. The language of scientific naming of an organism would be Latin.
2. Every scientific name should have two parts, and the genus name always comes first followed by the species name.
3. The scientific name of any organism should have to be unique because a same legitimate name cannot be used for naming two distinct organisms.
4. The first alphabet of the first name would be in capital letter with the remaining alphabets in small type, and the second part of the name totally would be with small letters. For example, Onion- *Allium cepa*, Lion – *Panthera leo*.
5. At the time of printing of a scientific name, it should be done with Italic type. Rice- *Oryza sativa*, Katla fish- *Catla catla*, for example.
6. When a scientific name would be written in hand, two parts of it should be separately underlined. For example, Oryza sativa, Catla catla.
7. If the scientific name of an organism is named by some scientists, the earliest legitimate name given by the first scientist will be accepted in accordance with the rules of priority.
8. The name of the author who would scientifically name an organism can be cited in abbreviated form at the end of the binomial name with mentioning of the year of naming.

Binomial names of some organisms:

General name

Rice
Jute
Mango
Jackfruit
Water lily
Jaba
Causal organisms of cholera
Causal organisms of malaria
Cockroach
Honey bee
Ilish

Scientific name

Oryza sativa
Corchorus capsularis
Mangifera indica
Artocarpus heterophyllus
Nymphaea nouchali
Hibiscus rosa-sinensis
Vibrio cholerae
Plasmodium vivax
Periplaneta americana
Apis cerana
Tenualosa ilisha

Asian toad
Oriental Magpie-Robin
Tiger
Human

Bufo melanostictus
Copsychus saularis
Panthera tigris
Homo sapiens

Exercise

Short answer questions:

1. What is the significance of learning biology?
2. Write down the name of physical branches of biology?
3. Write down the name of applied branches of biology?
4. What is binomial nomenclature?
5. Mention the ranks of classification.

Essay type questions:

1. What are the necessities of classifying organisms?

Multiple choice questions:

1. In which branch of biology are insects discussed?
 - a. Entomology
 - b. Ecology
 - c. Endocrinology
 - d. Microbiology

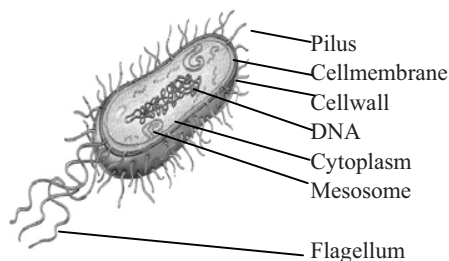
2. The aim of classification is-
 - i. to know about the sub-ranks of organism
 - ii. to be able to name the units of organism
 - iii. to present the knowledge in detail

Which one of the following is correct?

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

look at the stem and answer the question 3 & 4.

3. What is the name of the organism shown in the picture above?
 - a. Amoeba
 - b. Diatom
 - c. Paramecium
 - d. acterium
4. The characteristics of the organism shown in the picture of the stem are..
 - i. able to move
 - ii. unable to produce food
 - iii. nucleus is well-structured



Which one of the following is correct?

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

Creative question

1.



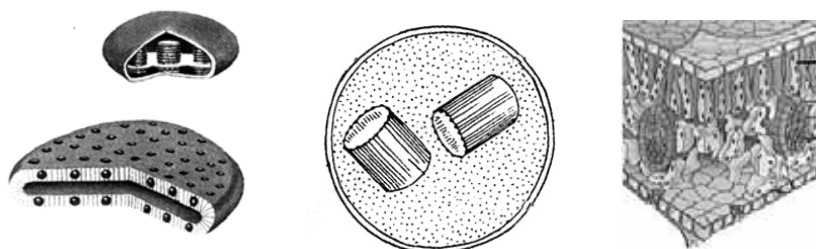
- a. What are the units of classification?
- b. Why is genetics called the physical branch of biology?
- c. How will you maintain the continuity in naming the plant in figure 2?
- d. Analyse with explanation which organism is more advanced between the two shown in figure 1 and figure 2.

Chapter Two

Cell and Tissue of Organism

You have already acquired the concept of a biological cell at your previous classes . Now, based on the previous idea, you will be able to learn more about it. Do the views of a cell of an organism appear the same under both a light microscope and an electron microscope?

In this chapter, the cells and tissues observed under an electron microscope will be discussed.



At the end of this chapter, we will be able to

- Explain the functions of main organelles of plant and animal cells.
- Compare a plant cell and an animal cell.
- Explain the role of different types of cell in performing properly the function of nerve, muscle, blood, skin and bone.
- Evaluate the appropriateness of cell in the body of a plant.
- Explain plant tissues.
- Explain animal tissues.
- Evaluate the functions of tissue on the basis of grouping the similar type of cells and performing the same action.
- Explain the organisation of cells in tissue, organ and organ system.
- Explain the concept and importance of organ and organ system.
- Draw the labelled diagrams of plant and animal cell after observing them under a microscope.
- Use a microscope properly.
- Understand the contributions of cell in different activities of organisms.

You studied at your previous level of education that the cell is the structural unit of an organism. A building is made up of thousands of bricks; likewise an organism is structured with millions of cells. What is a living cell? Some scientists describe a living cell as the unit of structure and biological function of an organism. In 1969 Loey and Siekevitz described a cell,

surrounded with a selectively permeable membrane, is a unit of living activities, which can exactly duplicate itself without any different living medium.

Types of Cell

On the basis of the organisation of nucleus, cells can be divided into two types – prokaryotic cell and eukaryotic cell.

a) Prokaryotic cell:

A prokaryotic cell does not contain any true nucleus. This is why it is called a cell with a primitive type of nucleus. The term nucleotide fits nice in this case. Nuclear materials in a prokaryotic cell are not surrounded by any nuclear membrane. They are dispersed in its cytoplasm. Though the cell organelles such as mitochondria, plastids, endoplasmic reticulum etc. are not found in a prokaryotic cell, ribosomes are present in it. Only the unwrapped DNA constitutes the chromosomal structure of a prokaryotic cell. For example, blue green algae and bacteria are constituted of this type of cell.

b) Eukaryotic cell:

In this type of cell, nucleus is well structured that means nuclear materials are well organised and surrounded by a nuclear membrane. Chromosomes are organised with DNA, histone protein and other components. From algae to higher flowering plants and from Amoeba to advanced animals, the basic structural and functional component is eukaryotic type of cell. Along with ribosome, other cell organelles are present in the cell. On the basis of function, there are two other types of cells: somatic cell and gametic cell.

i) Somatic cell: This type of cell takes part in the organisation of the body of an organism. The cell divides through the process of binary fission and mitotic division. Organisms grow in this way. Moreover, cells take part in the organisation of different organs and organ systems.

ii) Gametic cell – Gametal cells are produced in the organisms in which sexual reproduction and alternation of generations occur. Primordial germ cells divide through meiotic division and produce gametic cells. In a gametic cell, number of chromosome becomes half than that of its somatic type. A new living body is commenced after the fusion of male and female gametes. Half life fuses with another half life to produce a full life. Zygote is the first cell produced after the union of male and female gametic cells. Zygote undergoes repeated mitotic division to organise a body of an organism.

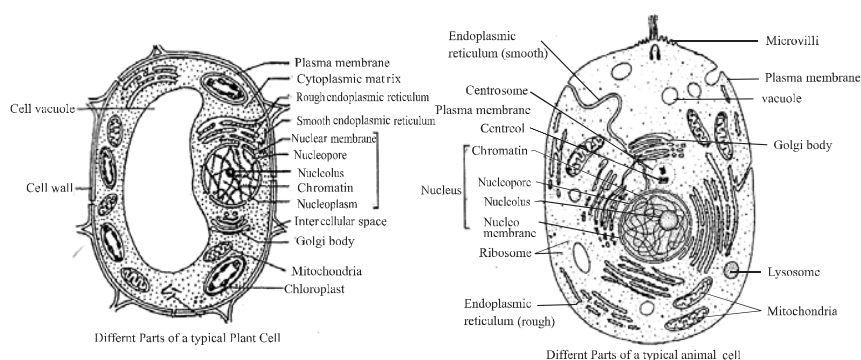


Figure: 2.1 Main organelles of plant and animal cell (Under electron microscope)

Functions of the Main Organelles of Plant and Animal Cells

We will be familiar with some cell organelles, visible under an electron microscope.

a) **Cell wall:** Cell wall is the unique and outstanding feature of a plant cell. It is composed of inert materials. Chemical composition of a cell wall is much complex. Cellulose, hemicelluloses, lignin, pectin, suberin are the chemical components of a plant cell wall. But, bacterial cell wall is composed of protein and lipid. The primary cell wall is single layered. Secondary cell wall gradually develops through the compilation of different chemical substances secreted from protoplasm on the middle lamellum. At the time of development of secondary cell wall, some cavities are formed and they are called pits. Cell wall protects a cell from all external injuries. It gives a cell its rigidity. Cell wall retains the shape and size of a cell. For exchanging materials with the adjacent cell, plasmodesmata are formed in a cell wall. Cell wall controls the movement of water and minerals. There is no cell wall around an animal cell.

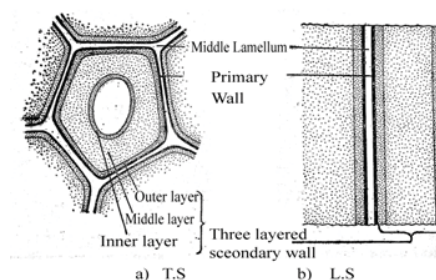


Figure: 2.2 Microscopic structure of cell wall

b) **Plasma lemma:** The double layered membrane around the protoplasm of a cell is called cell membrane or plasmalemma. In a plant cell, cell membrane is attached with the cell wall from the inner side of the cell. The double layered membrane is much flexible. The foldings of a cell membrane are called microvilli. It is mainly composed of lipids and proteins. For its being selectively permeable, the membrane can control the movement of water and minerals through the process of osmosis, and separates a cell from its neighbouring cells.

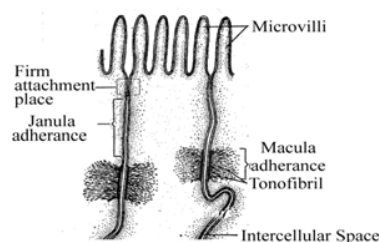


Figure: 2.3 Bilayered cell membrane

c) **Cytoplasmic organelles:** You have already studied what cytoplasm is at your previous classes. The semi-transparent, jel-like, semisolid substance in a cell is called protoplasm. All the contents surrounded by the cell membrane is protoplasm. Outside the nucleus, the harbouring jel-like substance is called cytoplasm. Many cell organelles are there in cytoplasm. They have different functions. Now, let us move on to the functions of organelles.

1. Mitochondria: Though first observations of mitochondria were made in 1840s, Richard Altman in 1894 established them as cell organelles, and in 1998 Carl Benda first coined the term 'mitochondria'. This important organelle plays a very important role in cellular respiration. It contains two membranes, and each membrane is composed of

phospholipid bilayers and proteins. The inner membrane has inflodings called cristae. These foldings are studded with small round bodies known as oxysomes. The space enclosed by the inner membrane is matrix containing a highly concentrated mixture of hundreds enzymes, ribosomes, RNA and mitochondrial DNA. The main function of mitochondria is to help organism produce energy from food through cellular respiration. The process has mainly three stages: glycolysis, the Krebs's cycle and electron transport system. The first stage glycolysis does not occur in mitochondria, but it occurs in cytoplasm with or without oxygen. A series of biochemical reactions of Krebs's cycle occur in mitochondria of a cell. Lastly, another series of biochemical reactions occur through the electron transport chain, a series of electron carrier in the inner membrane of mitochondria. In the process, energy is, ultimately, produced. This is why a mitochondrion is called 'the power house' of a cell. An organism uses the energy to perform different functions. With some exceptions, mitochondria are found in all the plant and animal cells.

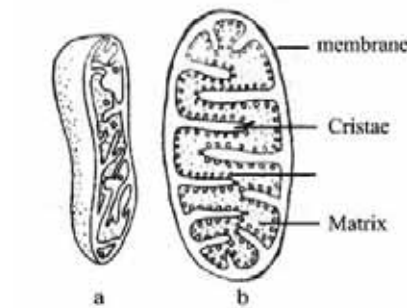


Figure: 2.4 a. Mitochondria b. L.S

2. Plastids: A plastid is an important organelle for a plant cell. The main functions of a plastid are to produce and store food, and cause the charming and colourful appearance of flowers, fruits and leaves of a plant. By adorning the flowers with appealing colours, it helps a plant pollinate. There are three categories of plastids: chloroplast, chromoplast and leucoplast.

a) Chloroplast: Green coloured plastids are called chloroplast. They are found in the cells of leaves, young stems and other green parts of a plant. The grana parts of a plastid capture solar energy and convert it into chemical energy. This captured solar energy helps produce simple carbohydrates from water and carbon dioxide taken from air with the help of many enzymes in stroma. For having chlorophyll, this type of plastid looks green. Besides, the pigments carotenoids are also present in them.

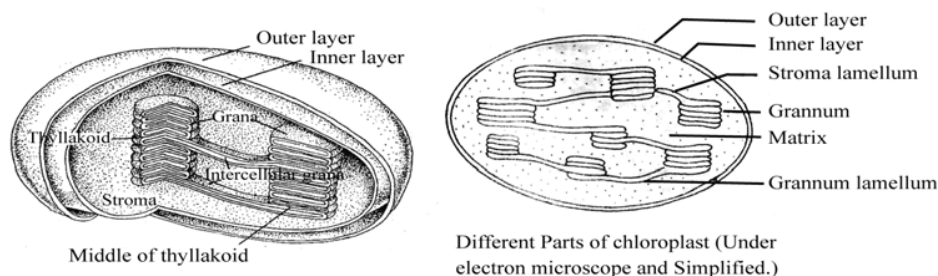


Figure: 2.5 A Plastid (Segment)

b) Chromoplast: Though the chromoplasts are coloured, they are not green. The photosynthetic pigment xanthophylls, carotene, phycoerythrin, phycocyanin etc. are present in them, and so some of them are yellow, some others are blue and red. The flowers, leaves and other parts of a plant assume their attractive colourful appearance from the mixture of those pigments. They are found in colourful flowers, leaves and roots of carrots. Their main purpose is to make flower attractive for pollination. Moreover, they synthesize and store different types of photosynthetic pigments.

c) Leucoplast: Leucoplasts are non-pigmented in contrast to other plastids. They are usually found in the cells of the plant parts where usually sunlight does not reach; for example, root, ovaries and embryo. Their main function is the storage of food. Leucoplast can be transformed into chromoplast or chloroplast in contact with sunlight.

Activity: Drawing a diagram of a chloroplast;

Essentials: Poster paper, sign pen & a picture of a chloroplast;

After drawing a diagram of chloroplast, present it before the students in the classroom hanging from a board.

3. Centriole: centriole is a hollow cylindrical structure composed of nine triplets of microtubules, fibers of protein, and found in an animal cell. A centrosome harbours centrioles closer to the nucleus of a cell. It is composed of two un-overlapped centrioles surrounded by cytoplasm condensed with a mass of protein. They are usually absent in the cells of higher plants and most fungi. At the time of the division of a nucleus in an animal cell, their main function is to organise astral rays.

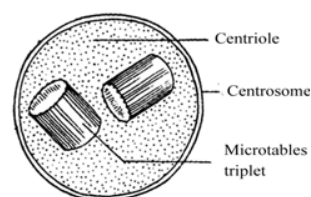


Figure: 2.6 Centriole

4. Ribosome: Ribosomes are found in all living cells. It lacks membrane around it, and is the place of the occurrence of protein synthesis. The bondage in polypeptide chains of protein is carried out by ribosome. Moreover, they provide enzymes needed for the cell.

5. Golgi body: Golgi body is found within cytoplasm of both plant and animal cells. It is composed of stacks of membrane-bound structure known as cisternae and vesicles. Hydrolysis of different enzymes takes place in its membrane. It involves in the secretion of some hormones and some other different substances in a living cell. It plays some important roles in many metabolic activities. Sometime, golgi body stores protein.

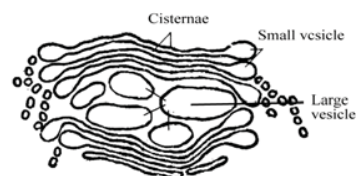


Figure: 2.7 Golgi body

6. Endoplasmic reticulum: Ribosomes are studded with the cytoplasmic side of rough endoplasmic reticulum, and so proteins are synthesized in these sites. Membrane bound vesicles from endoplasmic reticulum

shuttle proteins and other materials produced in a cell. Sometimes endoplasmic reticulum is stretched up to cytoplasmic membrane, and thus it is guessed that enzymes towards other cells and other substances produced inside the cell are transported by the endoplasmic reticulum. They also play a significant role in the development of mitochondria, vacuole etc. in a cell. Endoplasmic reticulum is found in both the plant and animal cells.

7. Centrosome: They are found in most animal cells, but they are rarely found in the cells of some lower plants. The centrioles in a centrosome develop astral rays, thus they play a significant role in constructing spindle apparatus. They also take part in forming different types of flagellum, and are mainly found in animal cells.

8. Cell vacuole: Large vacuole is prime feature of a plant cell. Its main function is to contain cell sap. Different types of substances such as inorganic salt, protein, carbohydrate, fat, organic acid, pigment, water etc. are found in a cell vacuole. No vacuole is generally found in any animal cell. If present in any animal cell, it usually is much smaller.

9. Lysosome: Lysosomes break down waste materials in a cell. The strong enzymes within them help do this task. Moreover, it protects cells by engulfing unexpectedly invaded microorganisms, viruses and bacteria. The membrane around lysosome protects the rest of the cell from degradative enzymes within lysosome. They are found in animal cells.



Figure: 2.8 Lysosome granules

10. Nucleus: The nucleus is a membrane bound prominent organelle found in the eukaryotic cells. It is roughly round or spherical in structure. Mature sieve cells and red blood cells lack nucleus. A nucleus houses the heredity information in it, and controls all the activities of a cell. A well structured nucleus has the following parts:

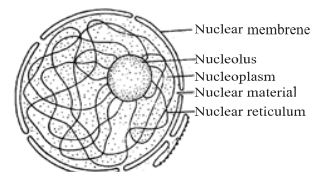


Figure: 2.9 A Nucleus

a) Nuclear membrane: The membrane that encloses the nucleus is called nuclear membrane. It is a double layered membrane, and composed of lipids and proteins. In this membrane, there are some channels called nucleopores. Substances get in and out of a nucleus through the pores. The membrane separates the contents of a nucleus from cytoplasm.

b) Nucleoplasm: The jelly-like fluid enveloped by nuclear membrane is called nucleoplasm. It is similar to the cytoplasm of a cell. The viscous fluid contains nucleic acids, proteins, enzymes and some other substances dissolved in and mixed with it.

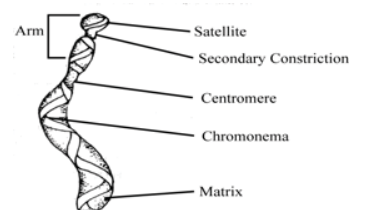


Figure: 2.10 A Chromosome

c) Nucleolus: In a nucleus round shaped structure attached with a chromosome is called nucleolus. This non-membrane bound structure is composed of RNA and proteins. Its main function is to assemble ribosomes in an eukaryotic cell.

d) Chromatin reticulum: A mass of genetic material, composed of thread like coiled structures, is called chromatin reticulum. Chromatin fibers get super coiled during nuclear division and become more condensed, and then they are called chromosomes. Chromosomes are individually more distinct. They are the units of heredity, and pass genetic information from generation to generation. The normal members of a group of identical organisms have the same number of chromosomes. Chromosomes contain genes, and thus carry hereditary trait from generation to generation.

Roles of different cells in conducting nerve, muscles, blood, skin and bones in human body:

Animal tissue cell is the structural and functional unit of organisms. Functions of unicellular or multicellular animals are performed in different ways. From the very appearance of the ancient world till today species of phylum protozoa performs their biological functions, such as: taking of food, growth and reproduction by the single cell. In multicellular animals there are differences and variations in cells.

In human body there are different types of cells which are engaged in different activities which as nerve cells spread within the human body and forms a net work. These cells are to receive stimuli and send it to the brain and again, sends off motor impulses from the brain to the definite organ. Both nerve cells in the ear and eye help in vision and hearing.

Due to the lack of different kinds of nerve cells most of the animals can not differentiate the exact colour of the objects just like human being. Many animals can see only at day time some at night.

Muscle cells are used in writing, walking and movement. Three kinds of blood cells are engaged in different activities. Red blood corpuscles absorb oxygen from lung and transport oxygen by the heart to different cells of the body through arteries and capillaries. While blood corpuscles prevent from disease.

Platelets are responsible for starting the process of blood clotting. As a result bleeding is stopped from the wound. Besides making body covering integumentary cells perform different functions according to its location. Hair grows from the integumentary cells of the head. Sweat secretes from the sweat gland in particular space. Bone cell constitutes bone with deposition of minerals or cartilage and makes structure and supports the body. Bone cells are very much important to build structure, shape, growth of the bones etc.

Plant tissue

The aggregation of cells that are alike in origin and structure and collectively perform a special function is called tissue. Plant tissue can be grouped into two types: simple tissue and complex tissue.

Simple tissue: The tissue, which contains the cells of same shape, size and structure, is called simple tissue. On the basis of the nature of cell, simple tissues are divided into three types: **1) Parenchyma, 2) Collenchyma and 3) Sclerenchyma.**

- 1) **Parenchyma:** The presence of parenchyma cells is seen in almost every parts of a plant. The cells of this type are living, isodiametric, thin walled and turgid with protoplasm. Intercellular space is found in parenchyma cells. The cells are thin walled, and the walls are composed of cellulose. When chloroplasts are present in this type of cells, they are called chlorenchyma. The parenchyma cells with air filled spaces are called aerenchyma, that usually found in aquatic plants. The main functions of parenchyma cells are to organise the body or body parts of plants to produce, conduct and store food.
- 2) **Collenchyma:** Collenchyma tissues are the special type of cells. The walls of the cells become thicker with the compilation of cellulose and pectin. Their walls are irregularly thickened with some corners. The cells are elongated, living and are filled with protoplasm. Intercellular spaces may be present in them. The borders of the cells may be triangular, slim or oblique. Their main functions are to produce food and provide the plant or plant parts with the mechanical support, rigidity. They are found in the veins and petioles of leaves. This kind of tissue provides rigidity to the young and supple stems, for example, the stems of Gourd (*Cucurbita* sp) and Leucas (*Leucas lavandifolia*).

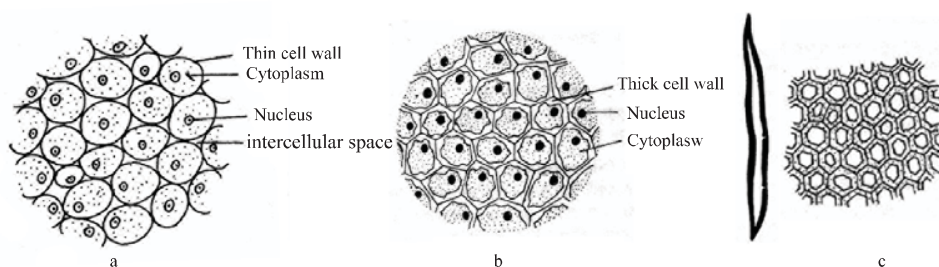


Figure- 2.11: Different types of simple tissue, a- Parenchyma, b-Collenchyma, C-Sclerenchyma

- 3) **Sclerenchyma:** The cells of this tissue are hard, much elongated with thick walls. The tissue composed of cells with the thickening of walls with lignin for providing mechanical support is called sclerenchyma. Though, in early stage of their development, the sclerenchyma cells are alive, soon they become dead losing the living protoplasm when they get mature. The main functions of sclerenchyma tissue are to provide the mechanical support and rigidity and to conduct water and minerals. . There are two types of sclerenchyma cells, namely fibers and sclerides.
 - a) **Fibers:** They are very elongated, slender, thick walled, and both the ends of them are pointed, but sometimes may be rounded. In their walls they have pores called pits. On the place of their occurrence and structure, they are called by different names, such as, bast fiber, surface fiber, xylem fiber or wood fiber.
 - b) **Sclerides:** Because of their hardness, they are called stone cells. These cells compared with most fibers are shorter, isodametric or sometimes long and star-shaped. Their secondary cell walls are very durable, thick and lignified. Mature

scleride cells are usually dead. The walls of the cells are pitted. In the cortex, fruits and seed shells of gymnosperm and dicot plants, sclerides are found. In the petioles of leaves, they may be present in cluster form associated with epidermis, xylem and phloem.

Activity: Drawing of three types of simple tissue;

Essentials: Poster papers, sign pens.

Draw the labeled diagrams of three types of tissue, and present the differences between them.

Complex tissue

The tissue composed of more than one type of cells is called complex tissue. They conduct water, minerals and prepared food, and this is why they are also called conducting tissue. They can be grouped into two types: xylem and phloem. Xylem and phloem form together the conducting structure of vascular bundle.

Xylem: There are two types of xylem: primary and secondary xylem. Xylem developed during primary growth from procambium is called primary xylem. Secondary xylem is the xylem grown during secondary growth from vascular cambium. Primary xylem comprises protoxylem and metaxylem. Metaxylem develops after the protoxylem but before the secondary growth. Protoxylem is distinguished by narrower vessel developed from smaller cells but metaxylem cells are usually larger. Different xylem cells are the constituents of xylem, and they are tracheids, vessels, xylem parenchyma and xylem fibers.

- a) **Tracheids:** Tracheids are elongated cells with slender and sharp ends. After lignification, their lumen may become narrower, and so in that case transportation of water occurs mainly through the lateral paired pits on their walls. Thickening of walls is of different types, such as, elliptical, spiral, scalariform, reticulate and pitted. Tracheids occur in ferns and gymnosperms, and also are present in the primary and secondary xylem of angiosperms. Its main function is to provide sap conduction-related organ with proper rigidity. Sometimes they also store food.

- b) **Vessels:** Vessels are short, tube in structure connected end to end. Vessel cells develop a long tube when their terminal walls are dissolved. This is why for the ascending of sap, a narrow continuous channel is developed. In their early stage of development, though the

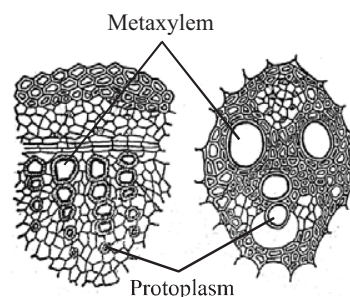


Figure: 2.12 A Vascular bundle

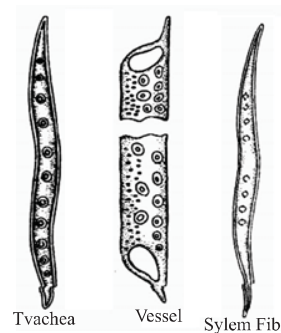


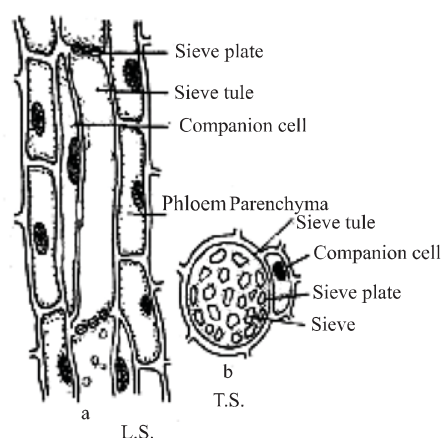
Figure: 2.13 Different types of xylem

cells are filled with protoplasm, by losing their living character, they become dead without protoplasm with the progression of their growth. Vessels walls also become differently thickened like tracheids, such as scalariform, spiral, elliptical, pitted etc. A vessel is several centimeters long. But they may be much longer in trees and creepers. They are found in almost all the parts of angiosperms. In some advanced members of gymnosperms such as *Gnetum* contains primary type of vessels. Their main function is to transport water and minerals and to provide the organs with proper rigidity.

- c) **Xylem parenchyma:** The parenchyma cells in xylem are called xylem parenchyma or wood parenchyma. Their walls may be thick or thin. The parenchyma cells in primary xylem have thin walls, but those of in secondary xylem are thick walled. Storage of food and transportation of water are their main functions.
- d) **Xylem fiber:** The sclerenchyma cells in xylem are called xylem fibers or wood fibers. Two ends of this type of cells are tapering. Mature cells do not contain protoplasm, and so, become dead. They provide plants with mechanical support. They are present in the xylem throughout dicots. Transportation of water and minerals, storage of food and giving mechanical support and strength to plants are their main functions.

Phloem: The phloem tissue organises vascular bundle in association with xylem. The xylem transports water as raw materials of food, likewise phloem conducts food produced in leaves to the different parts of a plant. This type of tissue is composed of sieve tube, companion cell, phloem parenchyma and phloem fiber.

- a) **Sieve Cell:** They are special types of cells. Sieve cells arranged end to end and make a tubular structure called sieve tube. The cells are separated from each other with a sieve like plate called sieve plates. The protoplasm in a sieve cell remains little aside and closer to the wall, so that a hollow lumen is developed for the conduction of food. Their walls are lignified. Mature sieve cells do not contain nucleus. Sieve cells and sieve tubes are present in the phloem of all the angiosperms. Their main function is to conduct food produced in leaves to the different parts of a plant.



- b) Companion cell:** Along with each sieve cell, a parenchyma cell is found. Its nucleus is much larger. It is assumed that the nucleus of a companion cell controls some activities of its neighbouring sieve cell. A companion cell is turgid with protoplasm and thin-walled. They are not found in the phloem of ferns and angiosperms.
- c) Phloem parenchyma:** The parenchyma cells in phloem is called phloem parenchyma. These types of cells are thin walled and have protoplasm like other parenchyma cells. They help store and conduct food. They are found in ferns, gymnosperms and angiosperms except in monocots.
- d) Phloem fiber:** Phloem fibers are sclerenchyma cells. These long cells are arranged end to end with other. They are also called bast fibers. The fibers of jute are bast fibers. These types of fibers are developed at the time of secondary growth of plant parts. On the walls of these cells, pits are present. Through the phloem tissue, food produced in leaves and stored in roots are simultaneously conducted up and down.

Functions of animal tissues

In multicellular animals cell may be similar or of different types involve in special function. Arising from the embryonic cell layer, certain one or more than one type of cells when remaining in a particular place of the animals body collectively perform a common function, are collectively called the Tissue. That is to say, cells of a particular tissue are similar as to its origin, function and structure. The subject in which the different types of tissue are discussed is called Histology. The differences between tissues and cells are ascertained. For example : red blood corpuscles, white blood corpuscles, platelets are different types of cells. These are called connective tissue. The liquid connective tissue take part in different physiological processes.

Types of Animal Tissues :

On the basis of nature and number of cells and the presence or absence of the intercellular materials or matrix secreted by cells, the tissue is mainly divided into four categories. The functions of these tissues are described below.

1. Epithelial Tissue :

The cells of the epithelial tissue lie closely or side by side on a basement membrane. On the size of the cell, location in the animal body and nature of work this tissue is of three types As :

a) Squamous epithelial tissue: Cells of this tissue are flat like scales, nucleus is large.

Example : Wall of the Bowman's capsule of Kidney. Apart from working as cover, it is mainly active in filtration.

b) Cuboidal epithelial tissue : Cells of this tissue are cuboidal; i.e. the length, and height of the cells are nearly equal.

Example : Collecting tubules of the kidney. Mainly active in transportation and covering.

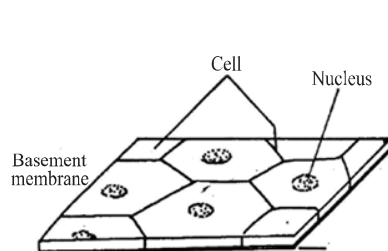


Figure: 2.15 Squamous (Scales) epithelial tissue

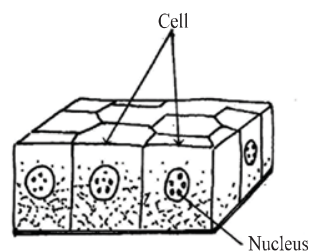


Figure: 2.16 Cuboidal epithelial tissue

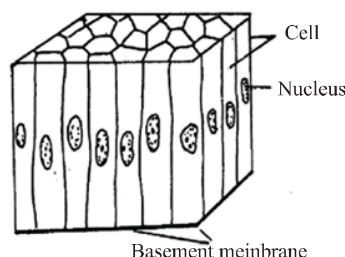


Figure: 2.17 Columnar epithelial tissue Fig 2.18: Stratified or complex epithelial tissue

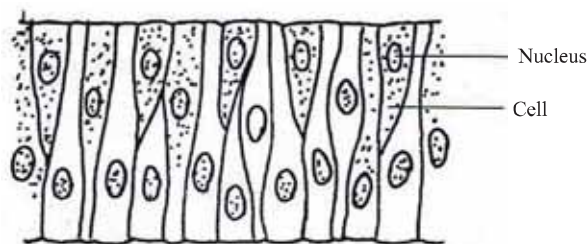
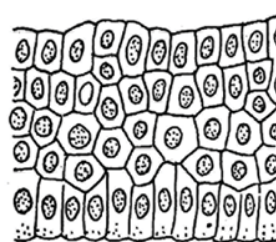


Figure: 2.19 Pseudo stratified epithelial tissue

c) Columnar epithelial tissue : Cells of this tissue are narrow and elongated like a column.

Example : In the internal wall of intestine of vertebrate animals. Mainly active in secretion, protection and absorption. Matrix is absent in epithelial tissue. On the number of cell layers arranged on basement membrane, epithelial tissue is of three types, As :

i. Simple epithelial tissue : On basement membrane the cells are arranged in a single layer.

Example : Bowman's capsule of kidney; kidney tubules, wall of intestine.

ii. Stratified epithelial tissue : Cells are arranged on the basement membrane in more than one layer.

Example : Integument of vertebrate animals.

iii. Pseudo stratified epithelial tissue : Cells of this tissue are arranged in a single layer on basement membrane. But the cells are not of the same height. So this tissue appears to be stratified tissue.

Example : Trachea.

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

- 1. Ciliated epithelial tissue :** In the wall of the trachea of vertebrate animals.
- 2. Flagellated epithelial tissue :** Flagellated muscular epithelial cells in the endoderm of Hydra.
- 3. Pseudopodial epithelial tissue :** Pseudopodial cells in the endoderms of Hydra and in the inter-membrane cells of vertebrate animals.
- 4. Reproductive tissue :** These are specially transformed epithelial tissues which produce sperm and ova. Taking part in reproduction, they maintain the continuation of species.

It appears this tissue is to form external and internal covering of any organ or tubule. Being transformed, this tissue takes part in protection, secretion, absorption, diffusion, transportation etc. So, epithelial tissue, being transformed into glandular tissue, and reproductive tissue, performs various important works of the body.

2. Connective tissue : The amount of matrix is much more in connective tissue, the number of cells is comparatively less. On the basis of structure and function connective tissue is mainly of **three** types. As :

a. Fibrous connective tissue: This type of connective tissue lies below the body-integument and sparsely in muscles. In matrix different types of fibres are visible.

b. The skeletal connective tissue: Internal structural tissue of the body is called the skeletal tissue. Skeletal tissue forms the skeletal system of the body. This tissue forms the internal structure of the body: Gives the body definite shape and affords firmness: Helps in organ movement and locomotion: Protects the soft and sensitive organs of the body (as brain, spinal cord, lungs, heart etc.). Produces various types of blood corpuscles.

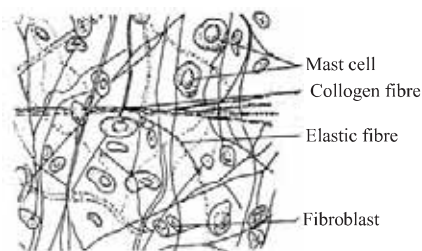


Figure: 2.20 Connective tissue

Forms the surface for the attachment of voluntary muscles.

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

Cartilage: Cartilage is a kind of flexible skeletal tissue. Its matrix is hard but soft and the cells contain lacunae. The nose and pinna of the ear of human are made of cartilage. Other than that humerus, femur etc. Cartilage covers at the two ends of the bone which protects the bone from rubbing. Bone is hard, fragile and inflexible skeletal connective tissue. But the deposition of calcium within the matrix gives strength to the bone.

c. Fluid connective tissue : The matrix of the fluid connective tissue is liquid and mobile. Different kinds of organic colloids are soluble in the matrix. The main function of the vascular tissue is to maintain circulation in the interior of the body plays a special role in protection from diseases and blood clotting.

Blood is a type of alkaline, slightly saline, red colored liquid connective tissue. Flowing through the artery, vein and capillaries blood takes part in internal circulation. In worm

blooded animal it maintains body temperature balance. Blood is formed of two components: (i) Plasma and (ii) Blood cells or Blood corpuscles. Plasma is the liquid part of blood. Its color is straw colored : It contains 91-92 water and 8-9% organic and inorganic materials. The organic substances include various types of blood protein and waste materials. Blood cells are of three types. As : Red blood corpuscle or Erythrocyte, White blood corpuscle or Leucocyte, Thrombocyte or platelets. Red blood corpuscles contain an iron compound named haemoglobin. The red colour of blood is due to the presence of haemoglobin. Haemoglobin easily mixes with oxygen to form oxyhaemoglobin compound and carry oxygen to the different parts of the body. Leucocytes destroy the microorganisms and protects the body against diseases. There are various kinds of white blood cells in human body. Thrombocytes take part in blood coagulation or blood clotting. A yellow coloured and slightly alkaline liquid store within the intercellular space of human body is collected by small ducts and forms an independent system. That is called lymphatic system. Tonsil is a part of a lymphatic system. Lymph contains lymphocyte cell. These are lymphoid cell.

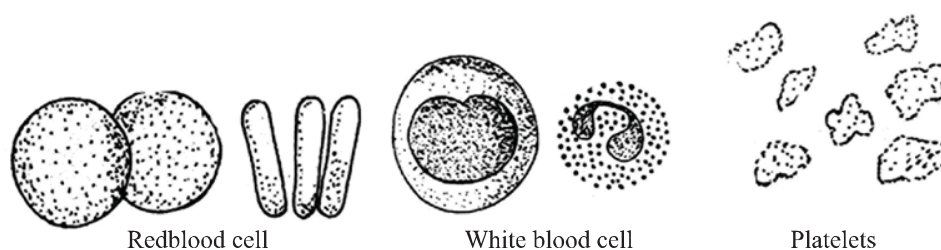


Figure 2.21 : Different types of blood cell

Red blood corpuscles : It contains an iron compound named haemoglobin. The red colour of blood is due to the presence of haemoglobin. Haemoglobin easily mixes with oxygen to form ox haemoglobin compound. In this way blood supplies oxygen to each of the living cells of the body. When necessary oxygen can mix with haemoglobin and forms oxi haemoglobin. Blood transports oxygen and partly carbon dioxide.

White blood corpuscle or Leucocyte : Generally lack definite shape and are nucleated. Cytoplasm of white corpuscles are either granular or non granular. Leucocytes destroy the microorganisms and protects the body against diseases.

Thrombocyte or platelets : Present in the blood of vertebrate animals. These are usually nucleated and spindle shaped. Nucleus is absent in the thrombocytes of many mammals. Many thrombocytes take part in blood coagulation or blood clotting.

Lymphatic system: A yellow coloured and slightly alkaline liquid stores within the intercellular space of human body is collected by small ducts and forms an independent system. That is called lymphatic system. Tonsil is a part of a lymphatic system. Lymph contains lymphocyte cell. These are lymphoid cell.

3. Muscular Tissue :

Growing from the mesoderm of the embryo the particular type of contracting and expanding tissue forming the muscles of vertebrate animals is called Muscular tissue. Matrix is nearly absent in muscular tissue. The muscle cells are delicate, elongated and fiber-like.

Myofibril provided with transverse striations are called striated muscles and striation less myofibril is smooth muscle. Muscle cells through contraction and expansion take part in organ movement locomotion and internal circulation. On the basis of location, structure and functions, muscle tissue is of three types. As, voluntary muscular tissue. b, Involuntary muscular tissue cardiac muscle.

a. Voluntary or striated muscular tissue : It can be contracted or expanded at the will of the animal. The cells of the voluntary muscle tissue are tubular, unbranched and provided with transverse striations. These have generally more than one nucleus. This muscle can contract or expand quickly. This muscle is also called marked or skeletal muscle. As : muscles of the hand and leg of man.

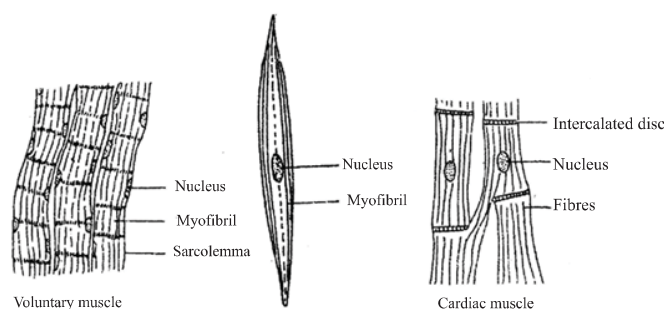


Figure: 2.22 Different types of muscles

b. Involuntary or smooth muscle : The contraction and expansion of this muscle tissue is not at the will of the animal. This muscle tissue is spindle shaped and faintly branched. Transverse striations are not present. That is why this muscle is called unmarked smooth muscle. Involuntary muscles are found on the walls of blood vessels, alimentary canal etc. of the vertebrate animals. Involuntary muscles mainly take part in the internal circulation of body. Such as : intestinal peristalsis in food digestion.

c. Cardiac muscle : The special type of involuntary muscle that form the heart of vertebrate animals is called the cardiac muscle. The cells of this muscle 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 animal. That is, the structure of heart muscle is like that of voluntary muscle and the function is like that of involuntary muscle. The cells of heart muscle remain joined together by

branched, so they contract and relax all together. Through rhythmic contraction and relaxation, the cardiac muscle control the circulation of blood within the body from a particular stage of the embryonic condition till the last moment of death.

4. Nerve tissue : The particular type of tissue which forms the nervous system is called nervous tissue. It receives stimulus from the environment, such as : heat, touch, pressure etc. the nervous tissue can transmit it within the body and according to that can make the appropriate response. The special type of cell which form the nervous tissue is called nerve cell or neuron. A typical neuron has three parts as : 1) cell body, 2) dendrite and 3) axon. Neuron cell body is poly gonal and nucleated. Cytoplasm of the cell contains mitochondria, ribosome, golgibody, endoplasmic reticulum etc. But there is no active centriole in the cytoplasm of neuron, so the neuron cannot divide. From the cell body of the neuron a long nerve fibre which is attached with the dendrite of neuron is called axon. A neuron has only one axon. Between the adjoining neurons a bridge is formed by the union of axon of a neuron with the dendrite of the other. It is called synapse. Through the synapse nerve stimulus from a neuron is transmitted to the next neurons. Nerve tissue receives stimulus and transmits it to the brain and responds to it. In higher animals nerve tissues store memory and controls works of different organs of the body and coordinate among them. .

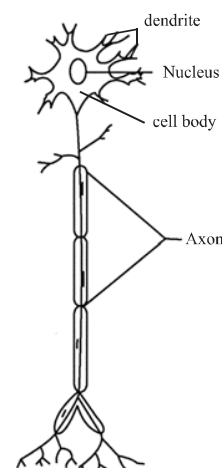


Figure 2.23 : A Neuron

Organ : 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 that organ can perform a particular work. The branch of biology where organs are discussed is called Morphology.

Necessary organs of human body : According to location there are two types of organs in human body. As :

External organs : The branch of Biology where the morphology of external organs like eye, ear, nose, hand, foot, head etc. are discussed is called External Morphology. Again, the branch of Biology where the **internal organs** of the organism are discussed in detail is called Internal Morphology. Stomach, duodenum, ileum, rectum, heart, liver, pancreas, spleen, lung, kidney, testis, ovary etc. So the systems have many fold of importance.

For performing various physiological functions., such as digestion, respiration, excretion, reproduction, etc. in man and in other animal several organs together form the organ system. Some mentionable systems description described below-

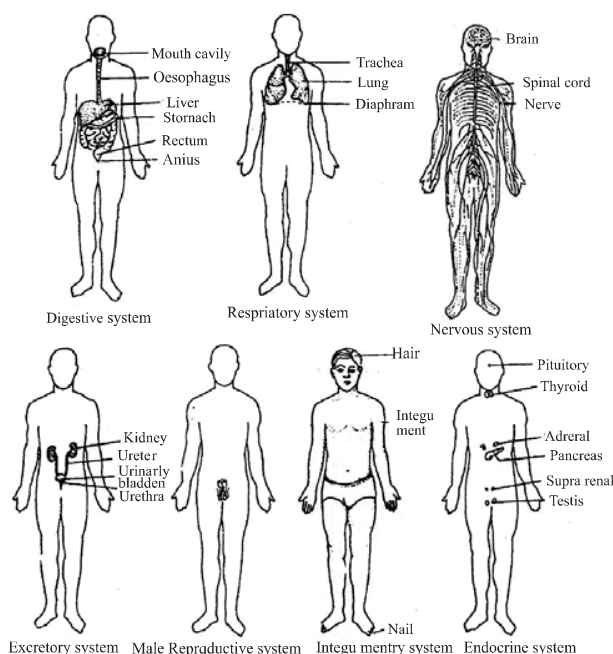


Fig. 2.24 : Simplified structure of various system of human body

1. Digestive system : This system is associated with ingestion of food, digestion, absorption and removal of undigested faecal materials. Digestive system has two main parts. As:

Digestive canal : This canal is formed with mouth aperture, mouth cavity, pharynx, oesophagus, stomach, duodenum, ileum, rectum and anus.

The Digestive glands : In main salivary glands, liver and pancreas work as digestive glands.

2. The Respiratory system : In man respiratory system consists of nasal aperture, pharynx, larynx, trachea, bronchus, bronchiole, alveoli and a pair of lungs. This system with the help of oxygen taken from the environment produces energy by the oxidation of food present in the body cell. This energy helps in doing daily activities / work.

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

4. The Excretory system : Due to various physiological metabolic reactions some waste materials are produced within the body as by-products. These materials are generally toxic to the body. So these to be removed. The process of removing unnecessary and nitrogenous waste materials from the body is called excretion. The system by which the excretion is performed is called the excretory system. The excretory system of man consists of a pair of kidney, a pair of urinary ducts, one urinary bladder, and one urethra.

5. The Reproductive system: Through this system an animal produces one or more offspring of its type to maintain the continuation of species. This system consists of gamete producing and embryo bearing organs. On maturity the child becomes capable to produce. Man is unisexual. Man possesses the male reproductive system while the female, the female reproductive system.

6. Integumentary system: The membrane covering the body from outside is called integument or skin. This system covers the body, protects from external injury and attack of microbes. Besides, it control the movement of various materials of the outside and inside of the body.

7. Endocrine system: There are few ductless or endocrine glands within the body of the animals. These produce the hormones. These have no mentioned ducts for its transportation. 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 Pancreas, Suprarenal etc.

Microscope

So, an arm is important to a fighter and a telescope to an astronomer, the instrument microscope is essentially helpful to every student of biology. A very small object invisible for naked eye can be seen with a microscope. The compound microscope you have in your school is equipped with the system of observing very small objects with the help of light. This type of microscope is called light microscope, The microscope in which electron is used instead of light is called electron microscope. Light microscopes are of two types, such as- simple and compound light microscope.

Simple light microscope

In this microscope a flat stage made of glass is set with a vertical pillar on the base of it. Two clips are attached on two upper sides of the stage to hold the slide with object to be observed. There is a sub-staged two-sided mirror set with the vertical column of microscope to use to reflect light from an external source up through the bottom of the stage. A continuous tube from the base holds a lens in its arm with a ring. Setting the lens in the ring, by adjusting the screw, an object put on the slide of the stage can easily be focused. If needed, the task of observing an object can be started by focusing on it with the reflected light. The base, which holds the whole thing, is called foot.

Different parts of compound microscope

It is better to understand different parts of a compound microscope before using the instrument. Take a look at the picture of it, printed on the left side of the page. The base on which the whole microscope is rested is called foot. The base or foot has two front facing extensions, so the whole microscope can be placed well on a table. There is a

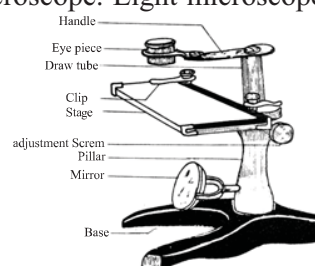


Figure: 2.25 Simple microscope

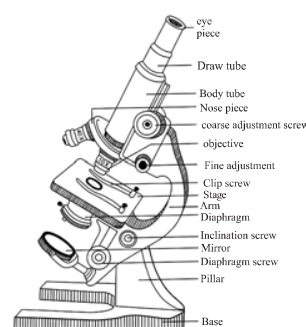


Figure: 2.26 A compound microscope

sub-staged two-sided light reflecting mirror. A half circle long metallic body is vertically attached with the base with a screw. The stage is attached with the upper part of the metallic body. Two clips are set on the two sides of the stage and there is a large hole in the middle of it. In some cases, condensers can be attached just below the hole. A long tube is attached with upper part of the body, that is curved enough to hold it with a hand. This tube and the curved part are called body tube and handle respectively. The raising part from the base holding the arm upward is called pillar. In the body tube, the eyepiece tube or draw tube holds the eye piece, where someone has to keep his eye. The body tube is attached with arm. With the help of two adjusting screws, the body tube can be drawn up and down. At the lower end of the body tube, there is a turret called nosepiece. There are some lens attached with the nosepiece. By rotating the nosepiece, expected lens can be focused on the slide on the stage.

Use of a compound microscope: To use the natural light for illumination of the object, microscope should be set in a sufficiently lit place. At first, the mirror of the microscope shall be adjusted in a way that reflected light would illuminate the object to be observed on the slide, passing through the hole of the stage. The clips on the stage would be placed on the slide to hold it properly. Now, after moving the nosepiece, the objective of lowest power would be set straight on the slide. Using first the coarse adjustment screw and then the fine adjustment screw, the object should have to be accurately brought under the focus. Now viewing of the magnified object can be made keeping eye on the eye piece lens. If required, fine adjustment screw can be used to make vision more clear. At the time of viewing an object, both the eyes should be kept open. Though it is little hard, practice will make it easy. The eyes get soon tired if one is used closing the other. If the lens of higher power is required, moving the nosepiece, the expected lens can be set to focus the object but in this case, students will obviously seek the help of a teacher.

Work-1: Observation of a plant cell (onion cell) under a microscope;

Essentials: Onion, blade, slide, cover slip, watch glass, paint brush, glycerin and a microscope.

Procedure: Peel the dry scale leaves of an onion. Now, take a wide, flesh scale leaf. After removing a small outer layer from the surface of the scale with the help of a blade, put it in water in a watch glass. Now, with a small paintbrush, place the scale piece on a clean glass slide after taking it from the water of watch glass. Leave a drop of glycerin on the specimen object to observe and slowly place the cover slip on it.

Observation: Observe it under the objective with the lowest power. You will be able to see rectangular and thin walled cells. Now, observe them with an objective with higher power. In every cell, you will find thin, granular protoplasm, vacuole and a sided nucleus.

Work-2: Observation of an animal cell (Amoeba) under a microscope.

Essentials: Microscope, slide, cover slip, dropper, petriplate, pipette, glass rod, small bowl of glass and water.

Procedure: At the beginning of the experiment, collect some rotten leaves with the branches of the plant from the bottom of a ditch or a pond. Cut them into smaller pieces and put the pieces in the water of the glass bowl and stir it steadily with a glass rod. After stirring the water for a while, set the bowl at rest in a place. When the things will be settled on the bottom of the bowl, draw some of the precipitation with a pipette and put it on a petriplate. Now, take a drop of the contents in the petridish on a glass slide with a dropper and after placing cover slip on it, set it to observe under a microscope.

Observation: After searching for a while by moving the slide on two horizontal axes, you will find some transparent, jel-like small organisms. These are amoebas. Many pseudo pods and vacuoles will be found in it and there will be a plasma lemma surrounding the cell. There will be no plastids like a plant cell. Has there any difference been found between a plant and an animal cell? Draw and label what you have seen.

Exercise

Short answer question:

1. What is a cell?
2. What are the functions of plastids?
3. Show the relation between tissue and organ?
4. What is the importance of endocrine gland?
5. Which part of cell is called the 'Power house' of cell?
6. What are the functions of blood?

Essay type questions:

1. Describe the structure of a mitochondrion with labeled diagram.
2. From a comparative point of view, discuss the structures and functions of different types of simple tissue.
3. Discuss the structures and functions of animal tissue.

Multiple choice question:

1. Which one is the function of lysosome?
 - a. to produce food
 - b. to produce energy
 - c. to engulf microorganisms
 - d. to synthesize protein
2. Amoeba is an animal cell, because it has-
 - i. well formed nucleus
 - ii. colour forming organelles
 - iii. cell membrane

Which one is correct?

- a) i and ii b) i and iii c) ii and iii d) i, ii and iii

Read the flowing stem and answer the question 3 and 4:

On the way to his village house, Ruhit saw a man extracting fibers from a jute plant.

3. What kind of tissue is being collected, mentioned in the stem above?

- | | |
|-----------------|-----------------|
| a. parenchyma | b. collenchyma |
| c. chlorenchyma | d. sclerenchyma |

4. The character of the tissue being collected in the stem is-

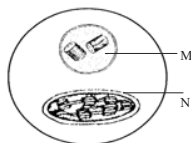
- cell wall is lignified
- cell wall is irregularly thickened
- protoplasm is absent in the cell

Which one of the following answers is correct?

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

Creative question

1.



- What is plasmalemma?
- Why are plastids called organs of constituting colours?
- Why is the organ marked with N important for the living world?
- What types of problem will appear in the living bodies if the part marked with M is absent?

2.

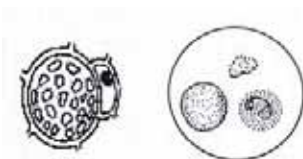


Figure- A

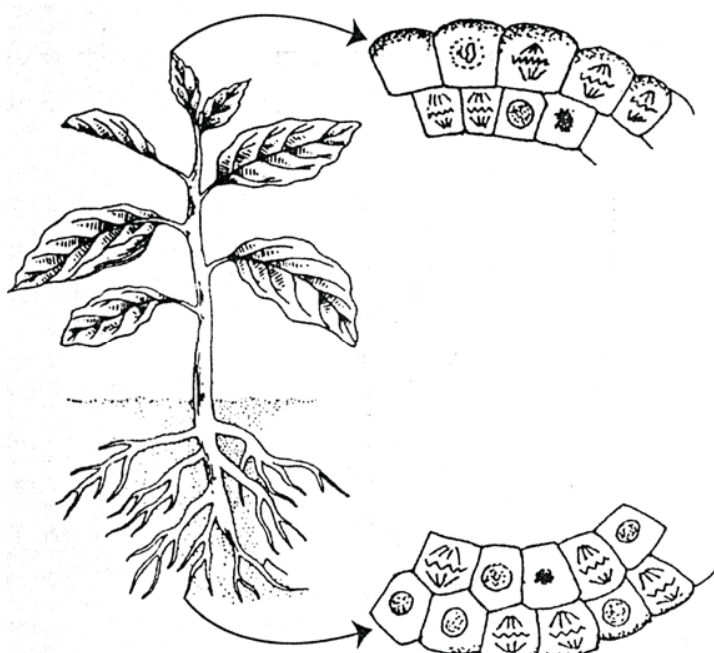
Figure- B

- What is muscle tissue?
- How skeletal tissue protects brain?
- Explain the cause of location of Q marked part?
- Between the pictures A and B, besides conduction in physiological activities, mention what other roles does it play?

Chapter Three

Cell Division

Different types of cell division occur in all the types of organism from unicellular to multi-cellular. Because of a kind of cell division, bodily size of organisms increases and in other type of cell division, reproductive cells are developed and in some other cases organisms multiplies through binary fission. In this chapter, you will know how the different types of cell division occur.



At the end of this chapter, we will be able to:

- Explain the concept of cell division.
- Describe the types of cell division.
- Explain mitosis.
- Describe the stages of mitosis.
- Analyse the significance of mitosis cell division in the living bodies.
- Explain meiosis.
- Explain the role of meiosis in the development of reproductive cells.
- Understand the role of cell division in maintenance of the continuity of life.

Every living body is a cell or cells. Life of every organism starts with a single cell. In fact, every cell is originated from a pre-existing one. The increase of cells in number through division is a very natural and important feature. The body of some organism is composed of a single cell. They are called unicellular organisms, such as bacteria, amoebas, plasmodium etc. These organisms multiply themselves from the division of a single cell. Other organisms are composed of more than one cell. They are called multicellular organisms. Humans, mango and Banyan trees etc. are composed of crores of cells. A giant Banyan tree also initiates its structure after the formation of a single cell (zygote by the union of two gametes). After the fertilization of an egg, the structure of a man is accomplished with the crores of cells dividing through the process of cell division. Again, male and female gametes are produced for the emergence of new generations. Cells divide through the process of cell division for the growth and reproduction of organisms.

Types of cell division:

Three types of cell division take place in living body, such as, 1.Amitosis, 2. Mitosis and 3.Meiosis

1. **Amitosis:** In this division the nucleus of a cell divides directly into two parts. At the beginning of division, the nucleus elongates with two larger rounded ends and little narrower middle part. The middle part of the nucleus narrowing continuously once splits into two daughter nuclei. By this time cell wall of the cell pinching inward divides the cytoplasm of it into two parts and, ultimately, two daughter cells are produced. This type of cell division is found in bacteria, blue green algae, yeast etc.

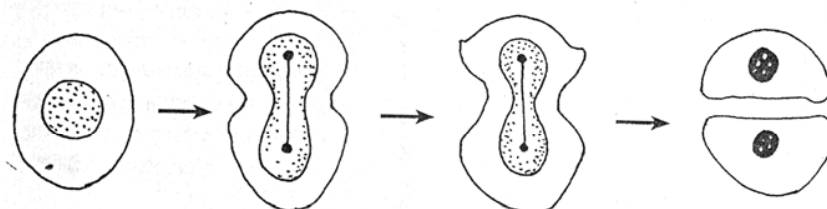


Figure 3.1 : Amitosis cell division

2. **Mitosis:** Through this process of division, an eukaryotic cell, stage by stage, divides into two identical daughter cells. In this process, nucleus and chromosomes are divided only once and two identical daughter cells are produced with the same type of chromosomes in number, physical and structural features as their mother cell contains. Mitosis occurs in somatic cells and through this division, as the number of cells increases, the plants and animals grow in length and breadth. The process usually take place in the body cells of animals and in the meristems of the plant parts growing, such as the tip of stems and roots, plumule and radicle, developing leaves, buds etc.

Stages of mitosis: The cell division mitosis is a continuous process. During mitosis, karyokinesis is usually followed by cytokinesis. Karyokinesis and cytokinesis represent the division of nucleus and the division of cytoplasm respectively. Before the starting of the cell division, a cell has to prepare itself. This stage is called interphase. For the ease of description, the process mitosis can be divided into five stages. They are:

- (e) Prophase
- (e) Prometaphase
- (e) Metaphase
- (e) Anaphase
- (e) Telophase

(a) Prophase: This is the first stage of mitosis. At the onset of the stage, nucleus becomes little larger and chromatin fibers start condensing into short, thick and tightly coiled structures called chromosomes. At this stage, chromosome can be seen under compound microscope. Though every chromosome then divides into two sister chromatids, at the centromere each one remains together. As the chromosomes are still in a mess form, it is little tough to count the number of chromosome easily in a cell.

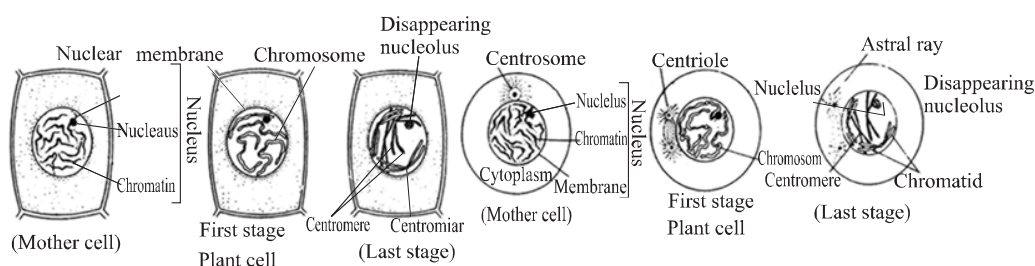


Figure: 3.2 Prophase

(b) Prometaphase: At the very early of the stage, spindle apparatus having two poles is developed in plant cells from fiber protein. The middle plane of the spindle apparatus is called equator. Spindle fibers are stretched from one pole to the other. They are called spindle fibers. At this stage kinetochores in centromeres of chromosomes get attached with some fibers of spindle apparatus. Kinetochores are protein structures assembled on

centromeres and link the chromosomes with mitotic spindles. These fibers are generally called traction fibers. They are also called chromosomal fiber as chromosomes are attached with them. Chromosomes then start assembling on the equatorial plane. The nuclear membrane and nucleolus being disintegrated begin to

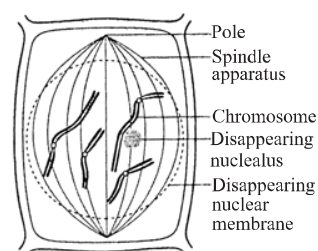
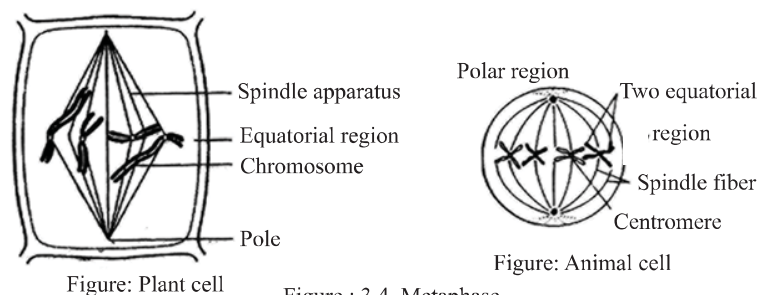


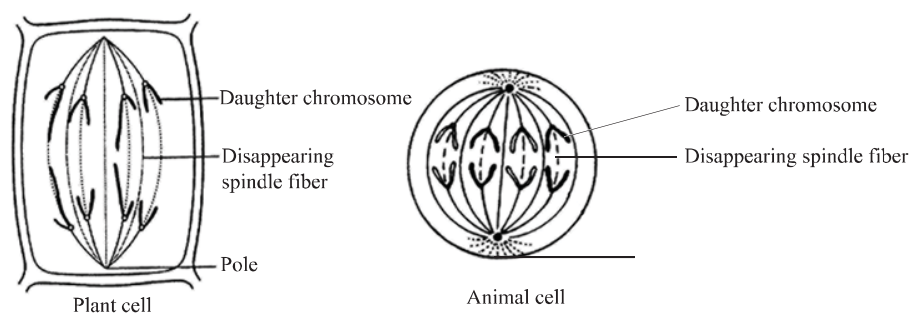
Figure: 3.3 Pro-metaphase

disappear. In animal cells spindle apparatus is developed from centrioles, and the centrioles remain in two poles with astral rays spreading round from them.

- (c) **Metaphase:** At the onset of the stage, all the chromosomes complete their assembling at the equator, middle plane from the two poles. The centromere of each chromosome remains on the equator but the two arms take position towards the poles. In this stage, chromosomes look most short and thick. Attraction between chromatids decline and repulsion increases. At the late of the stage, division of centromere starts. Nuclear membrane and nucleolus disappear completely.



- (d) **Anaphase:** The sister chromatids become the two sister chromosomes and they are pulled apart. The cleaved centromere moves first to the pole while the chromatids trail behind. Each chromosome splitting into two moves to two poles, and so the number of chromosome remains unchanged. On the position of centromere in the chromosome, chromosomes look V, L, J or I shaped, and then these chromosomes are called metacentric, sub-metacentric, acrocentric and telocentric respectively. At the end of the stage anaphase, the daughter chromosomes are totally pulled to the two poles and start their elongation.
- (e) **Telophase:** It is the last stage of mitosis and a reversal of prophase. Chromosomes being decondensed and surrounded by new nuclei elongate back into thin and long structures called chromatin fibers. Nucleolus also reappear. So, ultimately, two new nuclei are formed in two poles. The spindle apparatus is disintegrated and so, spindle fibers gradually disappear.



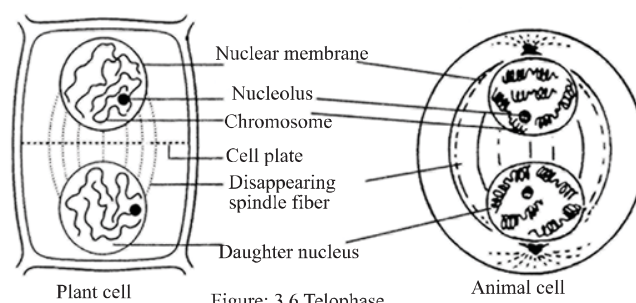


Figure: 3.6 Telophase

At the end of the stage telophase, some small parts from endoplasmic reticulum aggregate in the equatorial plane and collectively form the structure cell plate. Equal distribution of cytoplasmic organelles is accomplished. As a result, two identical daughter cells are developed. In case of an animal cell, a contractile ring on the plasma membrane at the equatorial plane pinches off the two nuclei.

Significance of mitosis

The significance of mitosis in the living body of organisms is immense. The balance in between the nucleus and cytoplasm of a cell in terms of volume and amount is maintained by the process of cell division mitosis. Through mitosis, the growth in the body multicellular organisms occurs. All the multicellular organisms start their life from a single cell zygote. The repeated division of this single cell produces innumerable cells and thus an organism grows to its complete level. As the number and feature of chromosome remain unchanged in the cells produced through mitosis, growth in organisms takes place systematically. Mitosis plays a role in maintenance of normal size, shape and volume of cells. Unicellular organisms reproduce through mitosis. Mitosis plays an important role in the vegetative reproduction of organisms and increasing the number of reproductive cells. Mitosis is essential in the body of living organisms to form new cells continuously for growth and healing of injuries. The life span of some cells is specific and they are, accordingly, replaced through the process of mitosis. As identical cells are produced through mitosis, qualitative features in the living world remain unchanged. Mitotic errors may result in abnormal mass of cells called tumours, with or without cancer cells.

Work: The teacher will group the students into some sets and will ask them to present separately different mitotic stages after drawing by themselves.

Meiosis: In this special process of cell division, four daughter cells are produced from an eukaryotic cell. Nucleus divides twice and chromosome divides once in this process, and number of chromosomes becomes half in the daughter cells than that of mother cell. As the number of chromosome decreases by half, the process of cell division is called reductional division.

The question is why meiosis occurs. In process mitosis, the number of chromosomes in the daughter cells remains the same as that of their mother cell. Mitosis is essential for the growth and asexual reproduction of organisms. In sexual reproduction, the union of male and female gametes is required. If the number of chromosomes in the reproductive cells would be the same as the vegetative cells, the zygote would contain twice number of chromosomes than that of the vegetative cell. Supposing the number of chromosomes in a vegetative and a reproductive cell of an organism is 4. In zygote the number of chromosome would be 8, and so the new organisms will have the body cells with chromosome number 8 and that is twice that of its mother organism. If every life cycle of an organism continues that way, the number of chromosome would be doubled again and again. In the second chapter, we have learnt that chromosomes bear the genes controlling the features of organisms. If the number of chromosome is increased life cycle after life cycle, the offspring will be basically different. In sexual reproduction, even through the union of male and female gametes, the number of chromosomes remains the same generation after generation as the number of chromosomes becomes half in the reproductive cells than that of the mother cell. When at the time of the development of reproductive cells and in any stage of the life cycle of plants in lower groups, the process meiosis occurs, then the feature of possessing half number of chromosome is called haploid. When the haploid cells are fused, the state of cell having two sets of chromosome is called diploid.

As the meiosis cell division occurs, the features in the species of living organisms keep on the same more or less, generation after generation.

Meiosis mainly occurs in the primordial germinal cells during the development of gametes. In the anthers and ovules of flowering plants, and in the testes and ovaries of animals meiosis occurs. During the development of pollens from diploid pollen mother cells in mosses and ferns, meiosis occurs in their zygotes.

Two consecutive divisions occur with a cell in the process meiosis. The first and the second division are called meiosis-I and meiosis-II respectively. In the first division meiosis I, the number of chromosome in a daughter cell becomes half than that of its mother cell, and

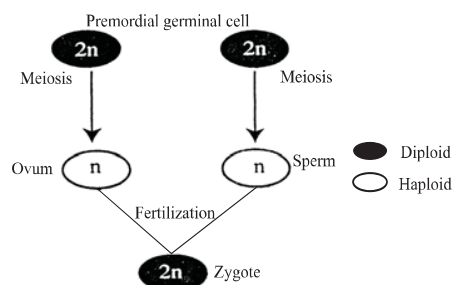


Figure: 3.7 Meiosis

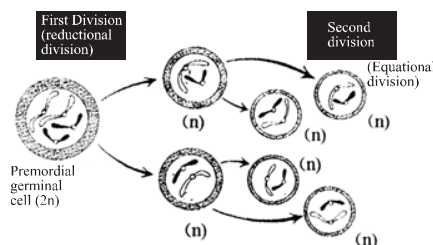


Figure: 3.8 concept of meiosis cell division

the second division is simply a mitosis.

Because of meiosis, the chromosome number in organisms remains constant. So generation after generation, the number of chromosomes remains the same in the cells of the body of offspring. Besides, genetic diversity is also found in species of organisms as the exchange of genes occurs during meiosis.

Exercise

Short answer question

1. What is cell division?
2. What is equational cell division?
3. What is called the amitosis cell division?

Essay type question

1. Describe the different stages of mitosis with the labeled diagrams.
2. Discuss the significance of mitosis.

Multiple choice questions

1. In which stage, does a nucleus become larger?
 - a. prophase
 - b. metaphase
 - c. anaphase
 - d. telophase
2. Through meiosis-
 - i. the number of chromosomes is changed.
 - ii. haploid gametes are developed.
 - iii. consistency of features in organisms is maintained.

Which one of the following is correct?

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

Answer the following questions 3 and 4 on the basis of the diagram given below.

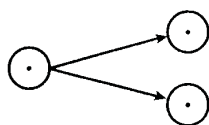


Figure-1

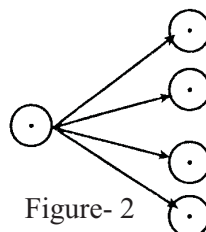


Figure- 2

3. In the cell division of diagram A-
 - i. the mother cell and the daughter cells bear same features.
 - ii. the number of chromosome becomes half in the newly developed cell.

iii. chromosomes divide once.

Which one of the following is correct?

a. i & ii

b. ii & iii

c. i & iii

d. i, ii & iii

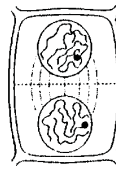
4. The division in the figure B is different from that of the figure A and so-
- a. the number of chromosomes remains the same in the daughter cells.
 - b. the number of chromosomes increases.
 - c. the abnormal cells are produced.
 - d. the normal growth of the body occurs.

Creative question.

1.



Stage-A



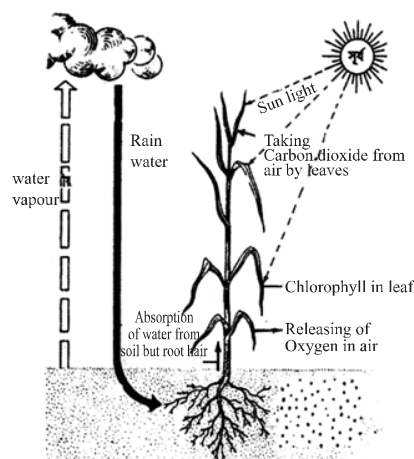
Stage-B

- a. Where does amitosis occur?
- b. Write in detail why meiosis is called the reductional division.
- c. In the stem B what changes occur? Explain it.
- d. Explain what problems may emerge if the process expressed in the figures above does not accomplish properly.

Chapter Four

Bioenergetics

Thousands of biochemical reactions are being continuously carried out in the cells of organisms for the maintenance of life. For these reactions, energy is somewhat required. The sun is the main source of energy. The green plants transforming solar energy into chemical energy produce the food carbohydrates through the process of photosynthesis. Animals and non-green organisms cannot directly utilize solar energy. They have to depend somehow on green plants for the energy they require for the maintenance of their life. The main objective of bioenergetics is to discuss the energy flow through the living system. In this chapter, these cellular processes are discussed.



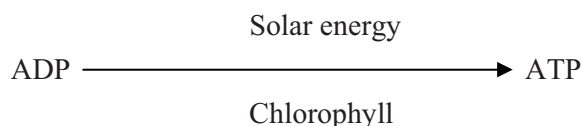
At the end of this chapter, we will be able to:

- Explain the role of ATP as the main source of energy in a living cell.
- Explain the production of carbohydrates through the process of photosynthesis.
- Explain the role of chlorophyll and light in photosynthesis.
- Describe the role of factors in photosynthesis.
- Evaluate the dependence of organism on photosynthesis.
- Explain respiration.
- Explain the concept and significance of aerobic and anaerobic respiration.
- Draw comparisons between photosynthesis and respiration.
- Perform the experiment to demonstrate the release of energy in the form of heat during respiration.
- Understand the contribution of plants in preparing food for organisms and learn conscious behaviors towards plants.

Introduction:

The basic mechanism of production and utilisation of energy in the body of a living organism is its bio-energy. The sun is the main source of energy. The green plants by transforming solar energy through the process of photosynthesis capture the chemical energy first in the organic compound named ATP and NADPH. These are the bioenergy of life. Next, in the stage of carbon reduction stage of photosynthesis, this energy is fixed in carbohydrates and in chemical bonds of other substances. For the regulation of life, thousands of chemical reactions occur in living cells and so in the living bodies. These reactions are conducted by bioenergy.

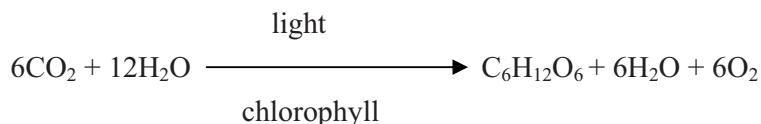
Some energy-rich compounds contain high energy and in necessity provide other chemical reactions with energy, such as ATP, GTP, NAD, NADP, FADH₂ etc. ATP stores energy and in necessity provides organisms with higher energy. This is why ATP is called biological coin or energy coin. During photosynthesis, ADP is converted into ATP by receiving solar energy. This process is called photophosphorilation.



In this process, 7300 calorie solar energy is captured in the third phosphate bond of ATP. ATP is the carrier of free energy, and energy is organised in its phosphate bonds. If energy is required for organic synthesis, conduction and other metabolic activities, ADP and AMP are formed by breaking down of ATP and so the energy is produced.

Photosynthesis

An important feature of green plants is that they produce food carbohydrates from carbon dioxide and water in presence of sunlight. In green plants, the process of the formation of food carbohydrates is called photosynthesis. In this process, light energy is transformed into chemical energy. The food produced by the green plant is used by itself to accomplish the metabolic processes required for its survival, and remaining food is stored in fruits, stems or leaves. The existence of mankind and other living creatures depends on the foods produced and stored in plants. The essential components for photosynthesis are (1) chlorophyll (2) light (3) water and (4) carbon dioxide. Photosynthesis is a biochemical reaction mentioned below:



The mesophyll tissue of a leaf is the main place of occurrence of photosynthesis. Terrestrial green plants absorb water from soil through their roots and send it to the

chloroplasts in the mesophyll tissue, and by receiving CO_2 from atmosphere through the stomata, it is sent to the same chloroplasts. Aquatic plants absorb CO_2 which is dissolved in water. The presence of CO_2 in atmosphere and water is 0.03% and 0.3% respectively. So, the rate of photosynthesis is higher in aquatic plants than that of land plants.

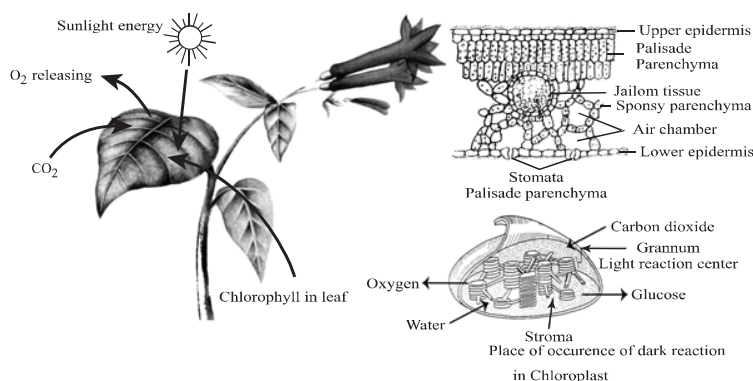


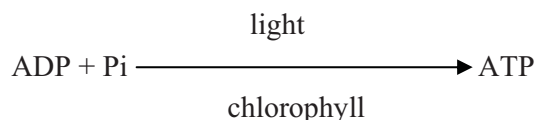
Figure: 4.1 Photosynthesis

Oxygen and water are the by-products of photosynthesis. So it is an oxidation-reduction process. In this process H_2O is oxidised and CO_2 is reduced.

The Process of Photosynthesis

Photosynthesis is a complex and a long process. In 1905, British physiologist Blakmann divided the process into two phases. They are (1) light dependent phase and (2) light independent phase.

(1) Light dependent phase: The energy light is essential in the light dependent phase of photosynthesis. In this phase, solar energy is transformed into chemical energy. Through this process ATP (Adenosine triphosphate) and $\text{NADPH}+\text{H}^+$ (reduced nicotinamide adenine dinucleotide phosphate) are produced. The organic substance chlorophyll plays a very important role in the development of ATP and $\text{NADPH}+\text{H}^+$. The chlorophyll molecules absorb photons from light and with the help of the energy obtained from the photon absorbed, ATP is formed by the addition of an inorganic phosphate with ADP. The process of the formation of ATP is called photophosphorilation.



Oxygen, hydrogen and electrons are evolved through the hydrolysis of water with the help of sunlight and chlorophyll. The process is called the photolysis of water.

ATP is produced by the process of photophosphorilation and the electrons reduce NADP, and produce $\text{NADPH}+\text{H}^+$. This process of producing ATP and $\text{NADPH}+\text{H}^+$ is called assimilatory power.

Light independent phase or dark phase:

No light is directly required in the light independent phase, but the process can be carried out in the presence of light. In this phase, carbohydrates are produced by the reduction of CO_2 with the help of ATP and $\text{NADPH} + \text{H}^+$ produced in the light phase. In the green plants, the pathways of CO_2 reduction have been identified, and they are briefly discussed here, such as, (1) Calvin cycle (2) Hatch & Slack cycle and Crassulacean acid metabolism (CAM). Out of them, the first two cycles are briefly discussed below.

(1) C_3 cycle or Calvin cycle:

Atmospheric CO_2 enters the cells through the stomata of the leaves. CO_2 being incorporated in 5-carbon compound ribulose-1, 5-diphosphate in the cell forms an unstable 6-carbon intermediate compound Keto acid. Immediately this unstable compound is broken down and two molecules of 3 Phosphoglyceric acid are formed. So, as the first stable substance produced in this cycle is the 3-carbon compound, 3 Phosphoglyceric acid, the cycle is called C_3 pathway. Using ATP and $\text{NADPH} + \text{H}^+$ produced in the light phase, 3 Phosphoglyceric acid is transformed into 3 Phosphoglycerdehyde and dihydroxyacetone phosphate. Through many different consecutive chemical reactions, carbohydrates are produced in one way and in another way ribulose 1, 5 diphosphate continuous to be formed. Resynthesised ribulose 1,5 biphosphate mixing with a molecule of CO_2 enters Calvin cycle. So, during the formation of molecule of glucose from 6 molecules of CO_2 , the Calvin cycle will circulate for six times.

The pathway of fixing CO_2 is named after its discoverers' names Calvin-Benson-Bassham (CBB) cycle or simply Calvin cycle. Melvin Ellis Calvin was awarded Nobel Prize in Chemistry in 1961. In most of the plants, carbohydrates are produced through this process. As the first stable compound, formed by the process in this type of plants, is 3-carbon compound, they are called C_3 plants.

(2) C_4 cycle or Hatch-Slack pathway:

In 1966, two Australian scientists. M.D.Hatch and C.R.Slack discovered the reduction pathway of CO_2 . The first stable substance formed in the pathway is 4-carbon Oxaloacetic acid.

In C_4 plants, at the same time both the Hatch and Slack cycle and the Calvin cycle are carried out. The rate of photosynthesis in C_4 plants is higher than that of in C_3 plants. Some examples of C_4 plant are maize, sugarcane, other plants of grass type, motha grass and amaranthus.

Role of chlorophyll in photosynthesis:

There is a direct relationship between the rate of photosynthesis and the amount of chlorophyll in the leaves because only chlorophyll can capture solar energy. We know

the old chloroplasts are disintegrated, and the new chloroplasts are synthesised. Photosynthesis is dependent on the rate of regeneration of chloroplasts or the components of chloroplasts. For the maintenance of the process photosynthesis, different components of chlorophyll are to be required to be regenerated speedily in large amount. But, too much chlorophyll in the cell results in the shortage of enzymes and the rate of photosynthesis comes down.

Role of light in photosynthesis:

The importance of light in photosynthesis is immense. For the production of carbohydrates from H_2O and CO_2 , the source of required energy is light. Sunlight takes part in the development of chlorophyll. With the effects of sunlight and stomata being opened, CO_2 can enter leaves, and take part in the production of food carbohydrates. But very little amount of light, falling on leaf, is used in photosynthesis. Red, blue, orange and purple portions of visible spectrum function better than that of green and yellow. The rate of photosynthesis increases with the increase of light up to a definite limit. If the amount of light increases too much, enzymes, being disintegrated, cause the production of chlorophyll to get lower, and consequently the rate of photosynthesis also decreases. Photosynthesis, generally, is carried out well in the light with the wavelength of between 400nm-480nm and 680nm.

Factors affecting photosynthesis:

Besides light and chlorophyll, photosynthesis is also affected by some other factors. Some of the factors are external and some others are internal. Presence and absence, less or more amount of factor affect the total amount of photosynthesis. The factors are mentioned below.

(a) External factors:

Light: It has already been discussed little earlier.

Carbon dioxide: The process photosynthesis cannot be carried out without carbon dioxide. The food produced by this process is formed from the reduction of carbon dioxide. The concentration of carbon dioxide in atmosphere is 0.03% but in this process, plants can use carbon dioxide up to 1% concentration. So, the rate of photosynthesis increases with the concurrent increase of carbon dioxide up to 1% in atmosphere. If the amount of carbon dioxide is increased to a very high level, acidic condition in the cells of mesophyll tissue increases and stomata get closed, so the rate of photosynthesis, ultimately, decreases.

Temperature: Temperature as a factor plays a very important role in the process of photosynthesis. At a very low temperature (around $0^{\circ}C$) and a very high temperature (above $45^{\circ}C$), the process photosynthesis cannot be carried out. The optimum temperature for photosynthesis is from $22^{\circ}C$ to $30^{\circ}C$. If temperature remains below $22^{\circ}C$ or above $35^{\circ}C$, the rate of photosynthesis will decrease.

Water: In the process of photosynthesis for the production of carbohydrates, H^+ (Hydrogen ion) that is required for the reduction of CO_2 , comes from water. In scarcity of water, guard cells of stomata become flaccid, and so, the entry of CO_2 is disrupted. In the excessive scarcity of water, photosynthesis may be totally disrupted as the participation of enzymes becomes inactivated.

Oxygen: If the concentration of oxygen increases in atmosphere, the rate of photosynthesis decreases and conversely, the rate of photosynthesis increases with the decrease of oxygen in atmosphere. Photosynthesis gets totally stopped in the absence of oxygen.

Mineral nutrient elements: Nitrogen and magnesium are two main components of chlorophyll. A leaf cannot synthesize chlorophyll in absence of iron, and consequently, the leaves become yellow. Thus, the rate of photosynthesis decreases at the low level of minerals in the soil.

Chemical substances: The process of photosynthesis is inhibited or totally stopped if the Chloroform, Hydrogen sulfide, Methane or any poisonous gases are present in the air.

Internal factors:

Age and number of leaves: Too young or too old leaves contain very little amount of chlorophyll. This is why the rate of photosynthesis in them is very low. With the aging of leaves, number of chloroplasts also increases. The rate of photosynthesis in the middle-aged leaves is the highest. With the increase of the number of leaves, the rate of photosynthesis is accelerated.

Amount of carbohydrates: During photosynthesis, if the conduction of carbohydrates becomes low, carbohydrates then are clogged there in the leaves. In the evening, the rate of photosynthesis is low because of the accumulation of carbohydrates produced earlier.

Potassium: The rate of photosynthesis is found to become slow in shortage of potassium since potassium probably plays a role as a catalyst in the process.

Enzymes: Lots of enzymes are required for the process of photosynthesis.

Importance of photosynthesis in living world:

Photosynthesis is the most important biochemical process in the world. Through the process, a bridge is developed between the life and the sunlight. No animal can produce its food itself. The foods we eat such as rice, bread, fruits, vegetables, fish, meat, milk, egg etc., are directly or indirectly derived from green plants. So, all the form of animals are completely dependent on green plants for their food, and the green plants produce the food through the process of photosynthesis. So, it can be said that the food for all plants and animals on earth is produced through the physiological process of photosynthesis. For maintaining the balance of different components in the atmosphere, especially the ratio of CO_2 and O_2 , photosynthesis is very important since this process maintains the crucial balance. The presence of O_2 and CO_2 gases in atmosphere is 20.95% and 0.033% respectively.

For the normal growth and survival of plants and animals on earth, these two gases should be present in atmosphere within normal limit. If the amount of the gases is different than normal, atmospheric environment becomes hostile to living world. We know that the cellular respiration is taking place in all living organisms (with plants or animals) all the time. In respiration, organisms take O_2 and release CO_2 . If only respiration would have occurred in nature, the shortage of O_2 and the predominance of CO_2 would definitely be found in atmosphere. As green plants absorb CO_2 and release O_2 through the process of photosynthesis, the correct ratio of O_2 and CO_2 in the atmosphere is maintained. Nowadays, an alarming situation of changing the ratio between the two gases has been apprehended for cutting down plants and trees in excess, and so, we should massively plant trees. The progress of human civilization is mostly dependent on photosynthesis directly or indirectly. Foods, clothes, industrial materials (such as nylon, rayon, paper, cellulose, timber, rubber), medicine (such as quinine, morphine), fuel coal, petrol, gas are produced from plants. So, if photosynthesis does not occur, human civilization would be ruined and living world would be extinct. This is why photosynthesis is the most important biochemical process in the living world.

Work:

Experiment to demonstrate the necessity of chlorophyll and light in the process photosynthesis.

Essentials: A potted plant with leaves kept in dark for one day, black paper, 95% ethyl alcohol, 1% iodine solution, paper clips.

Procedure: A part of a leaf on the potted plant kept previously in dark would be covered with a piece of black paper and clips in such a way that no light can reach there. Then, the potted plant will be kept in sunlight for an hour to decolourise the chlorophyll of that part. After allowing the leaf to inactivate the chlorophyll in the covered part for an hour of, the leaf will be kept and boiled in 95% alcohol after plucking it from the potted plant. Now the boiled and decolourised leaf will be drained with iodine.

Observation:

Apart from the portion of the leaf which was covered with the black paper, the whole leaf will turn blue (deep purple or black).

Conclusion: For the chemical reaction between starch and iodine, starch will turn blue (the deep purple or black). As the sunlight cannot reach the part of the leaf covered with the black paper, starch cannot be formed there through photosynthesis. As starch is not formed in that part of the leaf, it cannot turn blue. It proves that light is essential for the formation of starch during photosynthesis.

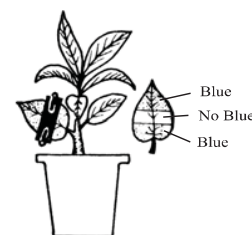


Figure: 1.2 Test of essentiality of light and chlorophyll in Photosynthesis

Precautions

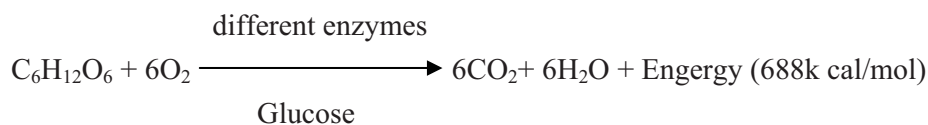
(1) Before the performing of the experiment, the potted plant should be kept in dark for sometime (about 48 hours).

(2) Black paper should be of such quality that no light could pass through it.

Before the time of performing the test, the potted plant should be kept in sunlight at least for an hour.

Respiration

In your previous classes of education, you have learnt what respiration is and through the process respiration, organisms accomplish their growth and derive energy in their body. In this chapter, little more detailed discussion will be made on respiration. To maintain the process of life of organisms in a dynamic state, for the activities like locomotion, healing of injury, growth and reproduction, energy will be required. The main source of energy is the sun. Through the process of photosynthesis, plants store solar energy in their food as carbohydrates as a potential energy. The stored energy in the food cannot be directly used by the organisms for the maintenance of their life. During respiration this potential energy is transformed into a usable form (kinetic energy) and because of the property of the chemical reactions, heat is released as a result. This kinetic energy provides all the organisms with the energy they require to perform all of their physiological activities. Carbohydrates, fats, proteins and organic acids can be processed and consumed through this process. These complex compounds in the bodies of living organisms, are broken down into simple compounds before releasing energy and later being reduced these compounds are transformed into ATP. At normal temperature, the process of respiration occurs in the living organisms round the clock. But, at the growing parts of a plant such as in floral and lateral buds, germinating seeds, tip of stem and root, the rate of transpiration is very high. Respiration takes place in the cytoplasm and mitochondria of a living cell. In this physiological process, organisms, oxidising the complex organic compound into simple substance, produce energy. The process of respiration can overall be expressed with the following equation.

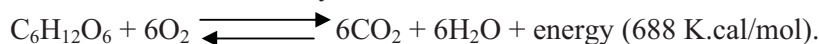
**Types of respiration**

On the basis of the availability of oxygen during respiration, the process is divided into two types: (1) Aerobic respiration (2) Anaerobic respiration.

(1) Aerobic respiration: The respiration process, which requires oxygen and produces CO_2 , H_2O and large amount of energy by complete oxidising the respiratory

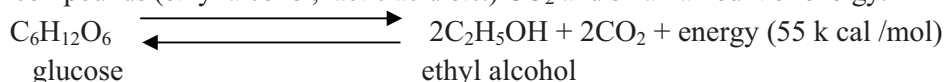
materials (carbohydrates, proteins, lipids, different kinds of organic acids), is called aerobic respiration. Aerobic respiration is the normal respiratory process of plants and animals. It can be expressed with the following equation.

different enzymes



Through the aerobic respiration, a molecule of glucose being completely oxidised produces energy, six molecules of CO_2 , 6 molecules of H_2O and 38 molecules of ATP.

- (2) **Anaerobic respiration:** The respiration, which occurs in absence of oxygen, is called anaerobic respiration. That is, in anaerobic respiration, respiratory substances being partially oxidised with the help of enzymes, produce different types of organic compounds (ethyl alcohol, lactic acid etc.) CO_2 and small amount of energy.



Only in some microorganisms such as in bacteria, yeast etc. anaerobic respiration occurs.

Short description of aerobic respiration

Aerobic respiration is generally divided into four distinct stages:

Stage 1: Glycolysis

Through many chemical reactions, a molecule of glucose ($\text{C}_6\text{H}_{12}\text{O}_6$) is broken down into two molecules of pyruvic acid ($\text{C}_3\text{H}_4\text{O}_3$). Four molecules of ATP (two ATP is used) and two molecules of $\text{NADH}+\text{H}^+$ are produced. As, in this process, no oxygen is required, it is the initial stage for both the aerobic and anaerobic respiration. It takes place in the cytoplasm of a cell.

Stage-2: Acetyl co-A formation

Each molecule of pyruvic acid, produced in glycolysis after the consecutive reactions, is transformed into a molecule of 2-carbon acetyl co-A, a molecule of CO_2 and a molecule of $\text{NADH}+\text{H}^+$ (from two molecules of pyruvic acid two molecules of acetyl coenzyme-A, two molecules of CO_2 and two molecules of $\text{NADH}+\text{H}^+$ are produced.)

Stage-3: Kreb's cycle

In kreb's cycle 2-carbon acetyl co-A, being oxidized, produces two molecules of CO_2 . The cycle is named after the name of a British biochemist Sir Hans Kreb since he discovered the cycle. At this stage, acetyl co-A enters mitochondria and participates in Kreb's cycle. All the reactions of this cycle occur in the mitochondria. Besides carbon dioxide, in this cycle from a molecule of acetyl co-A three molecules of $\text{NADH}+\text{H}^+$, a molecule of GTP (Guanosine triphosphate) are produced. So, from two molecules of acetyl co-A, four molecules of CO_2 , 6 molecules of $\text{NADH}+\text{H}^+$, two molecules FADH_2 and two molecules of GTP are produced.

Stage-4: Electron transport system

In this process $\text{NADH}+\text{H}^+$, FADH_2 , produced in glycolysis and Kreb's, cycle are oxidised, and consequently ATP, water, electrons and protons are produced. The energy is released at the time of passing of electrons containing high-energy through the electron transport system. The energy is used in the formation of ATP. Electron transport system is constituted in the mitochondria.

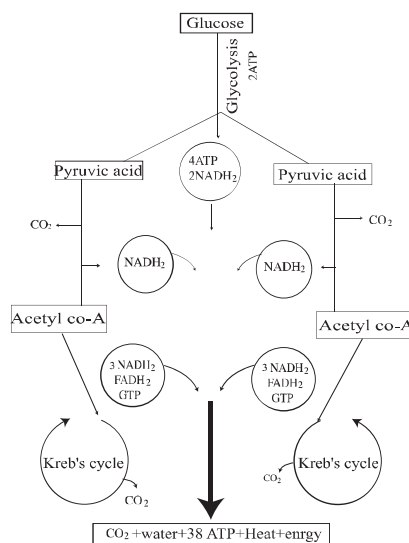


Figure: 4.3 Respiratory process

In aerobic respiration, a molecule of glucose being completely oxidized, produces six molecules of CO_2 , six molecules of water and 38 ATP. It has been shown in the chart below.

stage of respiration	substance produced	used substance	Net product
Glycolysis	2 molecules pyruvic acid 4 molecules ATP $2 \text{NADH}+\text{H}^+$	2 ATP	2 ATP 6 ATP
Acetyl Co-a	2 acetyl coA 2CO_2 $2 \text{NADH}+\text{H}^+$	2 pyruvic acid	2CO_2 6 ATP
Kreb's Cycle	4CO_2 $6 \text{NADH}+\text{H}^+$ 2FADH_2 2ATP	2 acetyl co-A	4CO_2 18 ATP 4 ATP 2 ATP
			38 ATP (net total ATP)

$$1 \text{NADH}+\text{H}^+ = 3 \text{ATP}$$

$$1 \text{FADH}_2 = 2 \text{ATP}$$

$$1 \text{GTP} = 1 \text{ATP}$$

Stages of anaerobic respiration:

Anaerobic respiration is constituted of two stages. The two stages are:

Stage-1 Glycolysis :

In this stage, from a molecule of glucose two molecules of pyruvic acid, four molecules of ATP (two molecules are spent being used in chemical reactions) and two molecules of $\text{NADH} + \text{H}^+$ are formed. It is the same as the glycolysis stage of aerobic respiration.

Stage-2: Incomplete oxidation of pyruvic acid.

With the help of enzymes in cytoplasm, pyruvic acid, being incompletely oxidized, produces CO_2 and ethyl alcohol or only lactic acid.

Significance of respiration:

An organism performs all types of activities with the energy produced in the process of respiration. This process helps plants to absorb mineral salts, which indirectly drive the growth and other physiological activities in a plant. The energy, to be required for cell division and for some concomitants, is produced through respiration. So, this process also controls the growth of organisms. Through the reaction, different sub-alkaline or organic acids are produced, and they help other physiological activities of life. Some bacteria cannot live in presence of oxygen. Their main source of energy is anaerobic respiration. Through the process, ethyl alcohol is produced and this process is used in industry. In this process, lactic acid through fermentation produces curd, cheese etc. It is also used in making bread. Yeast produces alcohol and CO_2 gas through the process fermentation. CO_2 makes the bread inflated or swelled.

Factors affecting respiration:

The factors affecting respiration are external and internal.

(a) **External factors:** External factors affecting respiration are mentioned below.

Temperature: The rate of respiration becomes low at the temperature below 20°C and above 40°C . The optimum temperature for respiration is from 20°C to 40°C .

Oxygen: In aerobic respiration pyruvic acid is oxidised into CO_2 and H_2O . So, aerobic respiration cannot be carried out in any way without oxygen.

Water: The supply of optimum amount of water keeps the process respiration on its normal state. If the supply of water decreases or increases too much, the process respiration is inhibited.

Light: Though light is not required for respiration, the rate of respiration becomes little higher in day light because the exchange of CO_2 and O_2 through stomata gets easier for the stomata being opened.

Carbon dioxide: If the amount of CO_2 is increased in the air, the rate of respiration becomes little slower.

(b) **Internal factors:** The internal factors are mentioned below:

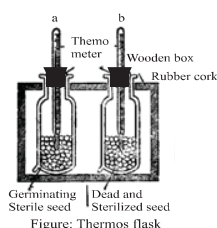
Food materials: As through the process of respiration energy, water and CO_2 are produced by breaking down food materials (respiratory substance), the amount and types of food control the rate of respiration.

Enzymes: Many types of enzymes actively take part in the process of respiration. So, the deficiency of enzyme causes the rate of respiration slow.

Age of cells: In young cells, especially, cells in the meristematic tissue, the amount of protoplasm is enough to cause respiration at a higher speed in them than that of old cells.

Inorganic salts: Though some salts inhibit the process of respiration, some salts in the cells are essential for the running of normal and proper activities of the cell and to drive the process of respiration normally.

Work: Experiment to demonstrate the release of energy in the form of heat during respiration.



Essentials: Two thermos flasks, two thermometers, two rubber corks with holes, some germinated chick-peas, 10% mercuric chloride.

Figure: Picture of thermos flasks.

Procedure:

The thermos flasks will be labeled as one A and the other with B. With some water some germinated chick peas would be taken in thermos flask 'A'. A thermometer should be inserted through the hole of a cork on the 'flask A' with its opening sealed well. The remaining chickpeas will be taken in flask B after boiling them soaking in 10% mercuric chloride solution for 10 minutes. Now, after taking the initial temperature of each thermometer 'A' and B', they should be kept at rest.

Observation:

The temperature of the thermos flask, containing germinated seed, will be marked A rises but there would be no thermal change in the other flask having seeds being inactivated with mercuric chloride.

Conclusion: The peas in the flask 'A' continued the process respiration and for the release of energy in the form heat, the temperature in the flask is raised. But, in the thermos flask 'B', the seeds being dead for soaking and boiling them in mercuric chloride solution, no heat was evolved because of the ceasing of respiration in them.

Precautions:

1. The seeds should be fresh and well germinated.
2. The tip of the thermometer containing mercury should be positioned at the middle of the stacked of seeds.

Exercise

Short answer question

1. What is photosynthesis? Represent it by a chemical equation.
2. What are the raw materials for photosynthesis?
3. What is respiration? Represent it by a chemical reaction.
4. Mention the differences between photosynthesis and respiration.
5. Write down the differences between aerobic and anaerobic respiration.

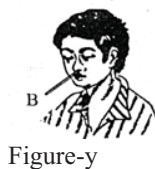
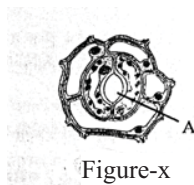
Essay type question

1. Explain the dependence of organisms on photosynthesis.
2. Discuss the significance of respiration.

Multiple choice questions

1. Which one is evolved as a by-product in the process of photosynthesis?
 - a. Water
 - b. Carbohydrates
 - c. Oxygen
 - d. Carbon dioxide
2. What number of ATP is produced in the glycolysis stage of respiration.
 - a. 4
 - b. 6
 - c. 8
 - d. 18

Pay heed to the stem and answer the question no. 3 and 4.



3. The functions of both A and B are –
 - i. To intake O_2
 - ii. To release H_2O
 - iii. To remove CO_2

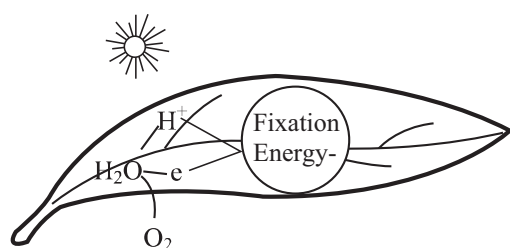
Which one of the following is correct?

- a. i & ii
 - b. i & iii
 - c. ii & iii
 - d. i, ii & iii
4. The process accomplished in the figure X-
 - i. to keep the environment cold

- ii. to help the process of photosynthesis
 - iii. to inhibit the process of respiration
5. Which one of the following is correct?
- a. i & ii
 - b. i & iii
 - c. ii & iii
 - d. i, ii & iii

Creative Question

1.



- a. What is the chemical formula of pyruvic acid?
 - b. What do you understand by anaerobic respiration?
 - c. Explain how the component A is being produced.
 - d. What will be the effects on plants if the production of A is inhibited? Explain with logic.
2. Bipasha, a student of class X, likes to eat carrots. As the carrot contains glucose, it provides her with energy. Her younger sister asks her how a plant derives the energy for its growth. She replies her sister that a plant also derives energy through the process respiration.
- a. What is the photolysis of water?
 - b. What does C₄ plants mean?
 - c. Explain with a chart what amount of energy is produced from two molecules of food component eaten by Bipasha.
What will be the effects on plants if the process mentioned above is inhibited?

Chapter Five

Food, Nutrition and Digestion

Living organisms live on food that means food is essential to live in. But the process of taking food is different in plants and animals. Different elements are necessary for plant's nutrition. In this chapter food, nutrition and digestion in human body and plant's nutrition are the subjects of discussion.



At the end of this chapter, we will be able to –

- Explain the necessity of essential elements for plant nutrition.
- Analyse the nutrition deficiency symptoms in plants.
- Describe main components of animal foods and its sources.
- Explain the ideal food pyramid
- Explain the principles of taking foods
- Explain the symptoms, remedy, and prevention of nutrition deficiency diseases.
- Explain kilo calorie and kilo joule
- Explain the amount of energy in nutrients and conversion of calorie and joule.
- Explain the importance of body mass index (BMI) and body mass ratio (BMR)
- Determine BMI and BMR.
- Determine the relation between BMR and energy spent.
- Determine BMI that differs according to the age and sex.
- Explain importance of exercise and rest for good health.
- Explain the necessity of using chemicals in preserving foods
- Analyse the effect of using excessive chemicals and colors on human body.
- Describe the organs of the alimentary canal along with accessory glands.
- Explain the functions of liver.
- Explain the functions of pancreas.
- Evaluate the role of enzymes in digestion.
- Explain different intestinal diseases, symptoms, remedy and prevention.
- Make a list taken in last seven days and compare with the balanced food.
- Draw a poster regarding the contribution of nutrition to healthy living to raise awareness among people.
- Draw the labeled diagram of alimentary canal.
- Be conscious myself and others of the family about intestinal diseases for healthy living.
- Be conscious myself and others about the contribution of nutrition to lead a healthy life.

Food, Nutrition and Digestion

Plant's mineral nutrition

Plant mineral nutrition: The nutrient, which a plant receives from soil and its environment for its normal growth, physiological activities, reproduction, is plant nutrition. As most of the nutrients are taken up from the soil, they are called mineral nutrition. About 60 inorganic nutritional elements have been identified in plants. Only 16 nutrient elements from 60 are very essential for the normal growth of plants. These 16 nutrient elements are collectively called essential elements because they are required for the normal growth, physiological activities and reproduction of all types of plants. Deficiency of any element results in deficiency symptoms in plants and causes diseases in them. The necessity of an element cannot be substituted for another element.

Of these 16 nutrient elements, some are consumed in large amount and some others are used in low amount by plants. On the basis of the amount of essential mineral nutrition consumed by plants, nutrient elements are divided into two groups: macro-nutrient or macro-element and micro-nutrient or micro-element.

(a) Macronutrient or macro element: The nutrient elements, which are consumed by plants in large quantities for their normal growth, are called macronutrient or macro-element. Plants use 9 macronutrients or macro-elements and they are nitrogen (N), potassium (K), phosphorus (P), calcium (Ca), magnesium (Mg), carbon (C), hydrogen (H), oxygen (O) and sulfur (S).

(b) Micronutrient or microelement: The elements, which are taken in very small quantities required for the normal growth of plants, are called micronutrients or microelements. Plants use 7 micronutrients and they are zinc (Zn), manganese (Mn), iron (Fe), molybdenum (Mo), boron (B), copper (Cu) and chlorine (Cl).

Source of nutrient elements: Among all nutrient elements, plants take up carbon and oxygen from atmosphere while hydrogen and oxygen are obtained from water. Other elements are taken from soil by the absorption of roots. These elements are found in the form of different salts. Plants cannot directly absorb them as salts. They are absorbed in different ionic forms, such as Ca^{++} , Mg^{++} , NH_4^+ , NO_3^+ , K^+ etc.

Role of different mineral elements in plant nutrition: Mineral nutrition plays a very important role for the normal growth of plants. The formation of chlorophyll is hindered if shortage of nitrogen is there in plants. If the formation of chlorophyll is hindered, the production of food will be affected. And, if the production of food is interrupted, the release of energy through respiration will be lessened. Magnesium is one of the chemical components of chlorophyll molecule. If any shortage of magnesium is there in a plant, the formation of chlorophyll molecule and the production of food through photosynthesis will be hampered. In closing and opening of stomata, the role of potassium is immense. Potassium controls the growth of plants through cell division. It also helps plants in developing and growing of root, flower and fruits. For the development of roots, phosphorous is very essential. Phosphorous is the structural component of DNA, RNA and ATP in living cells. So, without phosphorous, nutrition of

plants is not possible. For their role in nutrition, chemical fertilizers such as urea for nitrogen, muriate of potash for potassium chloride, triple super phosphate for phosphorus are used in the cultivating fields for high yield.

Significance of nutrient element: Different mineral nutrients play a very important role in the normal growth of plants. Nitrogen is the essential element of nucleic acids, proteins and chlorophyll. Nitrogen plays a very important role in general growth of plants and increases amount of water in plant tissues. Phosphorous is the important structural element of nucleic acids, different phospholipids, NADP and ATP. Phosphorous is a very essential element for the elongation of root. Potassium helps a plant to absorb water. It also plays an important role in opening and closing stomata. In addition, it helps the development and growth of roots, flower and fruits. Magnesium is an important component of chlorophyll molecule and helps the process of respiration.

Iron is the structural component of cytochrome, and so it is required for aerobic respiration. Iron also plays an important role in the formation of chlorophyll. Manganese is needed to construct and maintain chloroplasts. Copper is needed for the normal growth of tomato, sunflower plants, and it plays an important role in the respiration process. Boron is required for the active growing regions of plants, and it also plays a role in the conduction of sugar. Zinc is a necessary thing for the synthesis of amino acids. It is required little for the general metabolic activities of plants. Molybdenum is essential for the fixation of nitrogen by microorganisms. For the growth of root and stem of sugar beet, chlorine is a prime need.

Deficiency symptoms of nutrient elements: In deficiency of any nutrient element, deficiency symptoms are expressed in plants. These symptoms are called deficiency symptoms. By observing the symptoms, one can assess which nutrient element the plant lacks. Some deficiency symptoms of some nutrient elements are mentioned below.

Element	Deficiency symptoms
Nitrogen (N)	The formation of chlorophyll is inhibited if the deficiency of nitrogen happens to a plant. Leaves turn yellow. The condition of leaves becoming yellow is called chlorosis. Growth and division of cell is decreased and ultimately the total growth of a plant is reduced.
Phosphorus (P)	The colour of leaves turns purple if deficiency of phosphorus occurs in them. Necrotic spots are developed in leaves. Leaves, flowers and fruits may be fallen off trees. The plant becomes stunted for the growth being stopped.
Potassium (K)	In deficiency of potassium, the tip and the blade of leaf turn yellow and necrotic spots are developed. Growth of plant is reduced, and apical and lateral buds become dead.
Calcium (Ca)	Young leaves face chlorosis in deficiency of calcium and the growing apical parts of a plant become dead. At the time of flowering in plants, stems are dried up and the plants get wilted.

Magnesium (Mg)	Because chlorophyll is not synthesized for the deficiency of magnesium, the green colour gets paler and rate of photosynthesis is reduced. Chlorosis occurs deeply and rapidly in the middle places of veins.
Iron (Fe)	In deficiency of iron, the young leaves first turn pale, and the middle places in between thin veins face chlorosis being pale first. Sometimes the whole leaf becomes pale. The stem gets weak and short.
Sulfur (S)	Leaves show overall a general chlorosis, and reddish and purple spots appear on them. Chlorosis happens much with young leaves and less in old ones. The tips of stem die and die back disease is caused. Inter-nodes of stem become short, and consequently the plant becomes stunted.
Boron (B)	Necrosis of meristematic tissue in growing regions occurs in deficiency of boron. Growth of young leaves is inhibited and the leaves lose their proper shapes, and become brittle having their surface rupture. The initiation of floral bud is obstructed.

Activity: The teacher will ask the students to prepare a chart mentioning the different deficiency symptoms of different mineral nutrients.

Animals' food and nutrition: In the meantime you have learnt in class six and eight that food is essential for life, exactly same balanced diet is necessary for good health. Foods burn that means always chemical reaction occurs in cells and produces heat and energy. So combustion means the production of heat and energy by chemical reaction. Of them from the beginning to the end of life the influence of chemical reaction is endless. For moving, playing and doing other works energy is necessary. We get energy from food. The substances which are digested and absorbed within the body and that help in repairing, producing heat and growth of energy and helps in repairing, staying healthy, supplies nourishment for vital activities, protect from diseases and produce heat and energy, are called food.

Components of food and sources: As a whole all mentioned tasks are essential for living. For performing these tasks properly different types of food is necessary. Foods are the chemical combination of many compounds. These chemical substances are the ingredients of food. Nutrition deposits within these ingredients. So these are called nutritional ingredients. Most of the foods contain more than one ingredients. Food may contain more than one ingredient, the food is classified into the name of the ingredient which is more present in the food than any other ingredients. Depending on the principal of ingredients foods are divided into three classes, as –

- 1. Protein:** For growth and repair.
- 2. Carbohydrates:** Helps in producing energy.
- 3. Fat and oils:** Produces heat and energy.

Besides these three more kinds of components are essential for the body. as :

1. **Vitamins:** Increases energy for the protection against the diseases enhances the chemical reaction.
2. **Minerals:** Takes part in various organic functions.
3. **Water:** Keeps the balance of water and temperature. Regulates the cell activity and contains the organelles.

Proteins: Proteins are composed of carbon, hydrogen and nitrogen. Protein contains 20% of nitrogen. Sulphur, phosphorus and iron are also present in a small quantity. Due to the presence of nitrogen, sulphur, phosphorus and iron the importance of proteins is different from carbohydrates and fats. Nitrogen is present only in proteins. Only protein is the source of nitrogen. That's why it is considered an important component.

Sources of Protein : We have learned earlier, that we get proteins from fish, meat, eggs, milk, pulse, drilled fish, bean seed, nuts etc. According to the sources, proteins are of two kinds:



চিত্র ৫.১: আমিষ জাতীয় খাদ্য

- 1) Animal protein and
- 2) Plant protein.

Animal protein: Fish, meat, eggs, cheese, posset, liver are the sources of animal protein. These essential amino acids are obtained from these foods. So they are considered first class protein or high class protein. The energy value of this kind of food is high. At least 20% percent of animal protein should be in our food menu.

Plant protein: Pulses (dal), nuts, rice, wheat, bean seeds etc are the sources of plant proteins. These are less nutritious, because plant protein does not contain all the essential amino acids. Seeds or cereals contain excessive amino acid than other products. The energy value of plant protein is less. So it is called second class protein or low class protein.

Through researches it is proved that if two or more plant proteins are cooked together, as a result of the increase of food value eight kinds of amino acid can be obtained from it. The components, derived from this mixture are known as, mixed protein. It is also called supplementary protein. How mixed supplementary proteins can be prepared are mentioned below:

1. Preparation of rice porridge or paesh.
2. Food prepared by boiling rice and dal.
3. Preparation of 'halim' with the mixture of dal, wheat and meal.
4. To serve fish and dal with rice.
5. Eating bread and milk.
6. Eating bread and dal.
7. A supplementary protein can be prepared from different varieties of mixed dals.

Carbohydrates: Carbohydrates are the main sources of energy. It is composed of carbon, hydrogen and oxygen. Carbohydrate stores deposits in root, stem, flower and seed in different forms. Glucose in fruit juice, lactose in milk, starch in wheat, potato,

rice etc are different forms of carbohydrates. According to the composition carbohydrates are of three types. Formation and composition of three types of carbohydrates are shown in the table given below. **(Table 10.2)**

Table 10.2: Classification of carbohydrates.

Carbohydrates	Composition	Example	Sources
Mono-saccharide	One molecule of glucose	Glucose	Honey, fruit juice.
Di-saccharide	Two molecule of glucose	Sucrose, lactose.	Sugar and milk.
Poly-saccharide	Many molecule of glucose	Carbohydrate, glycogen.	Rice, wheat, green leaf, vegetables.

Mainly we get carbohydrates from rice, wheat, potato. In raw form carbohydrates can not be easily digested. We take these foods as potato, rice, wheat (ata) after cooking. After taking carbohydrates is digested and turns into glucose. Disaccharides and polysaccharides turn into simple carbohydrates (glucose) by digestion and become ready for absorption. For human nutrition simple carbohydrates are very important. Human body can absorb only glucose.

Fats: Fat is an essential component of food. The component is composed of carbon, hydrogen and oxygen and its main function is to produce heat. It remains in the stomach for a long time, so we do not feel hungry. Fat is stored beneath the skin. It is also stored in various organs, as – liver, brain and muscles. These stored fats are used during starvation. It contains two time calorie than carbohydrates and fats. Calorie is the measuring unit of energy in food. Food, cooked with oil or ghee, makes the food good. At the same time it also increases the nutritional value. Such as : fried potato instead of boiled potato, luchi or porota in stead of roti are not only tasteful but also it contains more calorie. Some fats contain vitamin ‘A’, some contains vitamin ‘E’.

According to the sources, fats are of two kinds. As – 1) Vegetable fat and 2) Animal fats.

1) Vegetables fat : Soyabean, mustard, nuts, sunflower and corn oils are used as vegetables oils. Soyabean oil is the best one.

2) Animal fats : Fats, ghee, dalda etc. are animal fats. Egg yolk contains fat but while part of the egg do not contain fat. Fats are insoluble in water. Fats floats water because it is a lighter than water. Daily requirement of healthy adult person needs 50-60 gm.



Figure: 5.2 Carbohydrates

tasteful. At the same time it also increases the nutritional value. Such as : fried potato instead of boiled potato, luchi or porota in stead of roti are not only tasteful but also it contains more calorie. Some fats contain vitamin ‘A’, some contains vitamin ‘E’.

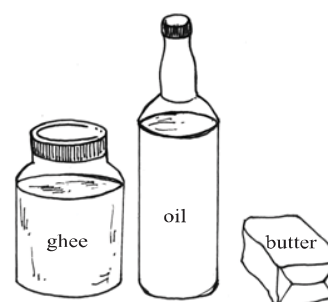


Figure: 5.3 Fats and oils

Vitamins: Very minute amount of vitamins is needed for health; even then its importance is unbounded. To grow and to remain healthy vitamin is absolutely necessary. Balanced diet contains different types of ingredients, so sufficient vitamins can be obtained from balanced diet. Absence of vitamins in regular diet may prolong or may cause long vitamin – deficiency diseases. Afterwards, it may cause severe harmful effects on the body and even death. Vitamins are of two types. As : 1) Fat soluble vitamins and 2) Water soluble vitamins. Vitamin ‘A’, ‘D’, ‘E’ and ‘K’ are soluble in water and vitamin B-complex and vitamin ‘C’ are soluble in water.

Vitamin ‘A’ is obtained from milk, butter, fats, eggs, carrot, mango, jack fruit, colored vegetables and mola, dehela fishes, yeast. Outer wall of cereal granules (e.g. rice wheat) red ata, germinated gram, peas, cauliflower, pea nut, beans, liver, heart, milk, ghees, meat, green vegetables etc are the sources of vitamin ‘B’. Vitamin ‘C’ is obtained from Guava, pomelo, star fruit, orange, cabbage, tomato, pineapple, green chilli, fresh vegetables etc. Milk, eggs, liver, dairy products, fish oil, edible oil etc are the sources of vitamin ‘D’. Vitamin ‘E’ and vitamin ‘K’ can be obtained from all the above mentioned foods.

Mineral salts or Minerals: Mineral salts are essential for body cells and body fluid. Human body contains mineral salts, such as: calcium, iron, salphur, zinc, sodium, potassium, iodine etc. These ingredients do not exist as an element. These elements remain within the food and human body as a compound with other elements. Combines with others elements and forms various organic and in organic salts. Mineral salts regulate body building and internal functions.

Mineral salts are the most essential elements in the formation of teeth, muscles, enzyme and hormones. It has a particular role in nerve impulses, muscle contraction, maintains water balance in body cells, balancing of acid and base etc.

Milk, curd, posset, cheese, small fishes (mola-dhela), different pulses, green vegetables, ladies finger, red leaves, arum leaves etc are the sources of calcium. Liver, green vegetables, meal, yolk, arum leaves contain iron. Phosphorous is obtained from milk, fish, meat, nuts, pulses etc. Table salt, chips, salty food, cheese, nuts, pickles etc. contain sodium. Fish, meat, nuts, pulses, banana, potatoes, carrots, apples etc contain potassium. Fish, meat, table salts are the sources of chlorine. The sources of iodine are sea weeds, sea fish, meat and algae.

Water : Other name of water is life. For the existence of life the position of water is just after oxygen. Water is the most essential components for nutrition. Body building and internal functions can not continue without water. The function of water are of three types as :(1) Body formation (2) Control of internal functions and (3) Elimination of waste products.

(1) Body formation: Body formation and maintenance can not be possible without water. At least 45%-60% of body weight of human body consists of water.

(2) Control of internal functions: No chemical reaction can occur inside the body without water. It acts as solvent. Blood transport is possible only because of water. Digested food, oxygen, salts, vitamins are carried to the cells as watery solution in blood and mineral salts in the body fluid as soluble form. Digested food products are absorbed by the blood from small intestine.

(3) Elimination of waste products: Water helps to remove waste products. Sufficient water goes out of the body, with urine, stools, sweat etc.

In this way sufficient amount of water goes out of the body. Demand of water for the body depends on age, labour, food habit and environmental condition. So an adult person needs to drink one liter of water daily. Such as : a man who's daily calorie demand is 2000 (kcal) Kilocalorie, then he needs 2 liter of water daily.

Fibre or Roughage: Dietary fibre or rough of the serials, vegetables, outer covering of fruits, stem of plants, roots, fruits, leaves contain fibres. Basically these are cellulose and lignin of cell walls. As bones make the structure of the body, some way plants make its structure. These are complex carbohydrates. Unlike the cattle human being can not digest cellulose as, cows, goats and buffalo can. Roughage absorbs water, increases the amount of faeces helps to eliminate stools. Roughage enriched food absorbs the harmful products from the intestine. It is assumed that roughage reduces of cancer to some extent. Roughage has a role to reduce obesity, the tendency of fat deposition and hungeriness.

An ideal food pyramid

Any balanced diet includes carbohydrates, vegetables, fruits, protein, fats or oils. If we observe a balanced food chart of a teenaged boy or girl, an adult male or female, we may find the presence of carbohydrates is the most in the list. Placing carbohydrates at the base line and considering the quantity of vegetables, fruits, proteins, fats and oils successively, if we arrange these food substances in successive tiers, it shows the presence of fats and oil at the highest. Then it looks like imaginary pyramid. This is called ideal food pyramid. This diagram shows carbohydrates at the base and fat and oils at the apex.

The necessary foods, that we take daily, are shown in the form of pyramid. You may notice the highest quantity is at the base and the lowest quantity is at the apex. We take carbohydrate in a large quantity such as: rice, potatoes, bread etc. vegetables, fruit are placed in the next tier, these substances should be taken in less amount than those of carbohydrates. Fish, meat, eggs, milk, pulses, cheese, posset, curds should be taken in lesser quantity. Sweet, fat and oil should of taken in least quantity. We have to choose diet according to the food pyramid, and then we will be able to select a balanced diet. Generally we take tasty foods in a large quantity. This habit is not good for sound health. So we should make the habit of taking adequate food. Accordingly we are to follow the rules of taking food in time.

Healthy eating

Selection of food ingredients or a balanced diet is a precondition to better living. Every body should know the rules of healthy eating because if the rules are known thoroughly, then it is easy to fulfill the demand of every family members by having knowledge of food selection, food calorie, family income etc. These activities are included within the rules of healthy eating.

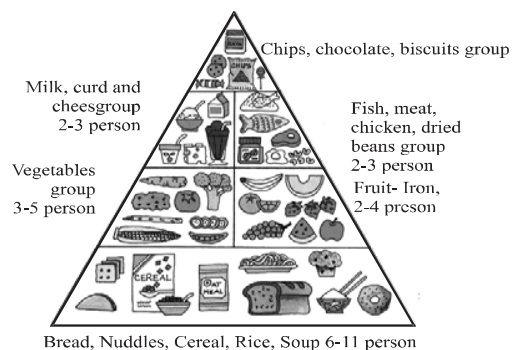


Figure-5.4: Ideal food pyramid

Characteristics of balanced diet

1. A man should have the adequate ability to produce energy through metabolism.
2. In diet the ratio of protein, fats and carbohydrates should be 4:1:1.
3. Inclusion of fresh fruits and vegetables in balanced diet for the supply of necessary vitamins, roughage or cellulose.
4. There must be sufficient amount of water and mineral.
5. Balanced diet must be easily digestible.

There is no other alternative to balanced diet for healthy and better life. For a well developed body it is an important task to make a food chart or menu by including foods that contain six ingredients. By considering these issues a real or actual food chart can be made. These are the demands of the body, easy availability and family income. A menu can be made or chalked out by selecting the low cost food that contains the equal or same food value. The mentality of selecting low cost food, that contains equal food value instead of costly food, is a good practice.

Make a suitable balanced food chart. It is essential to be specially careful about some matters. Such as-

- Person's sex, age, occupation and health condition.
- Knowledge about food value.
- To ensure adequate protein supply for repairing and body building.
- Presence of adequate amount of vitamins, minerals and water.
- Knowledge regarding climate, weather and food habit.
- Economic condition of the family and number of family members.

Observe the table mentioned below. You will get knowledge about the demand of calorie and amount of food needed for the male and female persons of different age.

Table (a) Food chart for adult male and female.

Adult male				Adult female		
Name of food grains	Without work (gm)	Moderate working (gm)	Hard working (gm)	Without work (gm)	Moderate working (gm)	Hard working (gm)
Bean/kidney bean	20	25	30	20	22.5	25
Egg/fish/meat	One/30gm	One/30gm	One/30gm	One/30gm	One/30gm	One/30gm
Leafy vegetables	40	40	40	100	100	150
Other vegetables	60	70	80	40	40	100
Root & potato	50	60	80	50	50	60
Milk	150	200	250	100	150	200
Fat/oils	45	50	70	25	30	45
Sugar/molasses	30	35	55	20	20	40

Table B: General food value/nutritional value of some food in Bangladesh:

Table has been prepared on the basis of food value or nutritional value of food grains in Bangladesh. This is published and accepted by the Institute of Nutrition and Food Science (INF s, 1975). Food value of 100 gm. edible part has been determined.

Name of food grains	Protein (gm)	Fat/oil (gm)	Mineral (gm)	carbohydrates (gm)	Energy kilocalorie
Rice	6.4	0.4	0.7	79.0	346
Wheat (ata)	12.1	1.7	2.7	69.4	341
Gram	17.1	5.3	3.0	60.9	360
Mosur (dal)	25.1	0.7	2.1	56.0	343
Carrot	0.9	0.2	1.1	10.6	48
Patato	1.6	0.1	0.6	22.6	97
Kalamni leaf	2.9	0.4	2.1	3.1	28
Basella	2.0	0.7	1.7	2.9	26
Pumpkin	2.1	1.0	1.4	10.6	60

Name of food grains	Protein (gm)	Fat/oil (gm)	Mineral (gm)	carbohydrates (gm)	Energy kilocalorie
Brinjal	1.4	0.3	0.3	4.0	24
Cauliflower	2.6	0.4	1.0	4.0	30
Cabbage	1.8	0.1	0.6	4.6	27
Kidney bean	2.5	0.1	2.0	3.7	26
Bean	7.2	0.1	0.4	15.9	96
Hilsha fish	21.8	19.4	2.2	2.9	273
Cattala fish	19.5	2.4	1.5	2.9	111
Prawn	19.1	1.0	1.7	0.8	89
Beef meat	22.6	2.6	1.0	-	114
Egg	13.3	13.3	1.0	-	173
Chicken	25.9	0.6	1.3	-	109
Mutton	18.5	13.3	1.3	-	194
Milk	3.2	4.1	0.8	4.4	67
Milk (man)	1.1	3.4	0.1	7.4	65
Ghee	-	100.00	-	-	900
Cooking oil	-	100.00	-	-	-

Besides, other matters that should be of special consideration-

- Maintain cleanliness, preparation of food, serving, and intake of food.
- Drink 7-8 glass of water daily. Drinking water must be boiled.
- Make a habit of taking seasonal fruits, fresh vegetables. These must be included in daily food chart. Avoid canned and frozen vegetables.

Work: Students will make a food chart and will compare it with the balanced diet and place it in the class room.

Vitamin deficiency diseases:

Goiter : Goiter is a disease of thyroid gland. It causes goiter in fool. When thyroid gland abnormally enlarges due to the deficiency of iodine. The place away from the sea, hilly area's soil contains less iodine, so the children of this area suffer from this disease. Goiter is of two types. As: (1) Simple goiter and (2) Toxic goiter.



Figure: 5.5 Goiter patient

(1) Simple goiter: Simple goiter: Due to the deficiency of iodine, thyroid gland swells or one of two glands swells. As a result some part of the neck swells and hang downwardly. This is simple goiter. The symptoms of this disease are – idleness, sleeplessness or insomnia, dry cough, intolerance to cold, mentally retardation in child, inattentive to studies. The thyroid gland of the patient swells and he feels troubles in respiration. The region, where there is an outbreak of this disease, there a small quantity of iodine can be mixed with the drinking water.

(2) Toxic goiter: The cause of this disease is over secretion of thyroxin. The symptom of this disease are – increase of heart beat, palpitation, increase of hunger and excessive sweating by taking radioactive iodine. According to doctor's advice the growth of the gland can be resisted or blocked. Taking iodine enriched food. e.g. sea weed, sea fish etc.

Night blindness: Night blindness is caused due to the deficiency of vitamin 'A'. Generally 2-5 years children suffer from this disease. Sensory rod cells of eyes gets damage or are damaged. The patient can not see in dim light. Everything is visibly hazy. If the disease aggravates, the cornea turns dull. These are the symptoms of night blindness. Vitamin 'A' enriched food, such as : fish liver oil, lever, green vegetables, coloured fruits (ripe mango, banana, sweet pumpkin, carrot etc) and eating mola and dehla fish, feed vitamin 'A' capsule if necessary. By following the above mentioned rules this disease can be prevented.

Rickets: This is not a viral or bacterial disease. Deficiency of vitamin 'D' is the cause of this disease. This vitamin is essential for the absorption of calcium and phosphorous in the intestine, formation of teeth and bones. Milk, butter, eggs, cod liver oil are the sources of vitamin 'D'. Human skin can produce vitamin 'D' by the influence of sunlight. The symptoms of this disease are weakening of bones, swelling of joints, bending of bones, especially the leg bones, folding of thin bones. Besides, this structure of the body can not be kept in a proper order, bones become brittle and thorax turns narrow. To feed children vitamin 'D' enriched food, it is better to keep the new born body in sunlight. So vitamin is produced by the influence of ultra violet rays of the sun light.

Anemia: Anemia is a general disease of children and females in our country. The deficiency of iron based protein is the general cause of anemia in Bangladesh. Children and pregnant mother suffer much from this disease. There may be various causes of having iron deficiency anemia. Such as – excessive blood loss, attacked by worms, shortage of iron in food in growing children and pregnant mother, obstruction in absorption of iron based food, infection in intestine. Under aged children suffer much

from iron deficiency. Symptoms of this disease are, feeling weak headache, exhaustion, insomnia, loss of appetite, palpitation to sea dark etc.

To prevent from this disease taking of iron enriched food. Such as : kidney bean, liver, meat, eggs, peanut, vegetables, molasses etc is necessary. After ensuring the infection of worms in the intestine through tests, the patient needs to take worm destroying drugs. According to the need this disease can be prevented by using drugs which contain iron ingredients.

Work: Draw a poster regarding the contribution of nutrition to healthy living.

Energy in food ingredients

We know that food gives us nutrition and energy. But do we know what amount of food gives us what amount of energy? Is the elimination of energy from different nutrients same? Among the six nutrients only proteins, carbohydrates and fats can produce energy. But the other three ingredients can not produce energy.

You know, energy is of various types. Food ingredients emit heat energy. Unit of heat energy is calorie. The unit of measurement of heat energy is calorie. A calorie is defined as heat to raise one kilogram of water to one degree centigrade. Really it is kilocalorie. But generally nutritionist terms it as calorie.

Energy consumption depends on muscle contraction and relaxation. The more energy will be spent, the more the muscles will contract or expand. Muscles of our body help in movement and locomotion. We feel easy to do any work because of muscles. Such as : for moving, walking, running, sitting etc. How much energy is spent to do this type of works?

Energy is required for the contraction and relaxation of muscles. So, the more the muscle will contract and relax, the more energy is consumed. The consumption of energy depends on work. So, is there any energy loss in the work, as : walking moving?

If we do not perform any work, only pass our time in living and sitting, still we need food, we feel hungry. We feel less energy is spent in resting time. How does it happen? At the time of taking rest our external organs, like-hand, legs do not work. But in our respiration, heart works as usual. The muscles, involved in these functions, still keep working. So all the muscles, involved in these functions, contract and relax to perform the work as a whole. So consumption of energy still goes on. This energy is called basic metabolic energy. How much energy is required for a person depends on three objects. (1) Basic metabolic rate (2) Type of daily physical labour and (3) Influence of food.

Joule :

1000 joule = 1 kilo joule.

1000 kilo joule = 1 mega joule.

1 kilo calorie = 4180 joule.
= 4.18 kilo joule.

1 mega joule = .00418 mega joule.

Example :

2800 kilo calorie = How much joule?
2800 kilo calorie = 2800×4180 joule.
 28×4.18 kilo joule.
11.7 kilo joule.

According to the international organization kilo joule should be used instead of kilo calorie. In this case 1000 kilo calorie = 4.2 kilo joule (approx).

To determine heat energy in food nutrients

Every day we take different types of nutrients. Nothing of rice, khichuri, polao, meat, fruits, vegetables and drink etc, that we take in, is discarded. So to measure the amount of energy of the nutrients we have to know about the nature of the foods.

Nature of the nutrients in mixed food and pure foods

Nature of food means whether it is mixed or single food. Mixed food contains more than one nutrient. e.g. Milk, egg, khichuri, guava etc. on the other hand the single food contains only one nutrient. e.g. sugar, glucose. It contains only carbohydrate.

Nutrients and determining of its amount

After knowing the nature of the food, we should know about the amount of ingredients. So we should know which food contains what nutrients and its amount. But nutritional constituents, its amount and food value can be known from food value chart.

Determining calorie

After knowing the ingredients of the nutrients and its amount, we have to calculate the calorie of carbohydrates, protein, fats. In this case we have to calculate it considering the calorie value of vitamin, mineral salts and water as zero. Let us determine the calorie of 20 gms of chira. According to the table the same amount of chirra contains –

According to the formula:

15.4 gm carbon (77%)

1.32 gm pro (66%)

0.24 gm fats (1.2%)

Then, according formula :

From 15.4 gm carbon $\times 4 = 61.60$ calorie.

1.32 gm protein $\times 4 = 5.28$ calorie.

$$0.24 \text{ gm fat} \times 9 = 2.16 \text{ calorie.}$$

Therefore the whole amount = 69.04.

$$\begin{aligned} \text{So, calorie value of 1kg of chirra} &= \frac{69.04 \times 1000}{20} \\ &= 3452.00 \text{ calorie.} \\ &= 3452 \text{ calorie.} \end{aligned}$$

1000 kilocalorie = 4.2 kilo joule.

Therefore, 3452 calorie = 14.49 kilo joule approx.

Basic metabolic rate (BMR) and Basic metabolic Index (BMI): Basic metabolic rate indicates the used energy of human being at resting stage. Body mass index indicates the structure of the body and presence of fats. So basic metabolic index indicates the relation between the length and deposition of the fat of a person of particular age for healthy living and maintaining good health. To determine a person's sound health and obesity these two scales are very suitable.

Determining BMR value

To calculate BMR value is a bit difficult, its equations are different in case of male and female. To get an idea regarding / about BMR popular Harris Benedict's formula is used.

$$\text{BMR (female)} = 655 + (9.6 \times \text{weight. kg}) + (1.8 \times \text{height. cm}) - (4.7 \times \text{age. year})$$

$$\text{BMR (male)} = 66 + (13.7 \times \text{weight. Kg}) + (5 \times \text{height. Cm}) - (6.8 \times \text{age. year})$$

Take A woman is 33 years old, height 165 cm and weight is 94 kg.

$$\text{So, her BMR} = 655 + (9.6 \times 94) + (1.8 \times 165) - (4.7 \times 33)$$

$$= 655 + 902.4 + 297 + 155.1$$

$$= 1699.3 \text{ calorie.}$$

Calorie demand can be measured by using the table below.

Physical condition	Calorie
Not working	BMR value \times 1.2
Light working. Playing 2-3 days in a week.	BMR value \times 1.375
Working, sufficient playing 2-3 days in a week.	BMR value \times 1.55
Working, playing everyday in a week.	BMR value \times 1.725
Hard working, sufficient jumping, running and playing.	BMR value \times 1.9

Example: It is assumed this woman is not working. Her BMR is 1699.3, so her calorie demand is (1699.3×1.2) or 2039.16. So by taking 2039 calorie this woman can maintain same weight. Relation between BMR and energy spent value of BMR depends on sex, age, body structure and food habit. BMR value has a control on the production of 60-75 percent energy. Our body gets 10%-12% of energy from taking in food and gets 20%-

30% of energy through physical activities . BMR value declines with the increasing of age. Some goes on dieting to keep the body slim. So BMR value declines more. So one becomes unable to keep the body slim. BMR can be raised or increased by adequate physical work. The health can be kept sound by following healthy measures.

Determining BMI value:

$BMI = \text{Body wt (kg)} / \text{height of the body. (meter)}^2$

As for example: A man, having 125 cm (1.25 meter) height and 50 kg weight, has 32 BMI .

BMI scales:

Body weight under 18.5, has to increase body weight by taking adequate food.

18.5 – 24.9: ideal scale for good health.

25 – 29.9: over weight necessary to decrease body weight by physical exercise.

30 – 34.9: first step of obesity. Physical work and selection of food is necessary.

35 – 39.9: second stage of obesity. Balanced diet and physical exercise is necessary.

Above 40: the extreme stage of obesity, Possibility of death risk, doctor's advice is necessary.

According to BMI scale body weight 38 kg is suitable for good health. So body weight can be controlled by taking inaccurate nutrition and exercise.

Exercise and rest:

Everybody should do adequate work to keep the body healthy. Now adays obesity increases due to the scarcity of play ground, nature of work, educational pressure, less physical works are the main causes of our obesity. We are becoming disinterested in physical work. So body remains strong which means sound health. By doing adequate physical work, we can keep our body workable. It is found that a long and healthy living is possible by practicing an hour moderate work and taking in adequate food. Excessive body weight can be decreased by physical exercise. One can get relief form diabetes, heart diseases and some kind of cancer through physical exercise.

There are different types of physical exercise. Such as: athletics, exercise that makes bones and muscles strong and stout. There are various kinds of physical exercise, as: walking swiftly, jogging, running, swimming, athletics, cycling etc.

Rest is very important for health. Rest is essential after physical and mental work. Lie down and sleeping is a part of rest. After rest different parts of the body regains energy and stores it. You will be astonished to know that almost all animals in the living world take rest. This rest is related with day and night cycle. Many animals are active in sunlight. More animals take rest by day and remain active during night, they come out in search of food. These are nocturnal.

Use of chemicals in food Preservation:

Food preservation is a process by which rotting of food can be resisted. As a result the properties, acceptability, food value remain intact. Food preservation resists the position of food by bacteria, fungal infection, oxidation of fats.

Fish drying, salted Hilsha, pickle, ice preservation, fish sidol, prawn naptae etc are the customary means of food preservation. Modern methods canning and smoking (with the help of smoke) processes are used for preserving. Healthy, approved chemical substances are used to preserve food so that decomposing bacteria and fungal infection may not happen. Generally sodium nitrate, sodium chloride or table salt, calcium apernate, sulphur di-oxide, sodium-bisulphate, anti-oxidant e.g. BHA and BHT are used. These are approved chemicals. Harmful formalin, various kinds of colored substances should not be utilized, because it increases life risk.

Adulterant in food and use of colours

As clear environment is necessary to live in the beautiful world, similarly safe food stuff is essential. At present unethically used harmful and unhealthy chemical substances are used as adulterant and colored material and these are sold. As a result public health is now threatened. This risk of health disaster continues in course of time. Bangladeshi nation will be vanished just like the Romans. The Romans used water container made of lead. By any means, people, who drank that water, were affected by poisonous lead and cripple generation took birth. In Bangladesh various kinds of adulterants are mixed with the food. Commercial colors, antibiotic, chemical substances (e.g. sorbet, carbide, insecticide, pesticide, formalin, heavy metal) are mentionable. The cattle, fishes, poultry animals etc, which are fed by the unapproved adulterant food, are threatening to human life and health. These adulterant foods are injurious to health. Some harmful effects of health risk are mentioned. Commercial colour that is used in textile or for colouring, that is used in ice-cream, blended ice cream, candies, beguni, bora etc. These types of foods gradually destroys liver function and that causes various diseases. Decomposing can not grow in the submerge fishes, fruits and other substances. So it looks fresh. In research it is found, that formalin forms a compound within cell of the fishes. After frequent washing it remains with the fish body. It enters within human body with the cooked food. These poisonous compounds are the cause of some complex disease symptom and even may occur some type of cancer.

Insecticides are used in the storage food and vegetables. Its effect remains for a certain period, before expiry date is over these substances should not marketable, because poisonous effect increases the suspicion of health risk. Infants are more affected. Poisonous insecticides produce an adverse effect on their growing cells. So infants suffer from various types of illness and their mental development is retarded. Chemical substances adulterant, used in food, are given in chart below-

Adulterant / poisonous chemical substances	Probable source	Remedy
1. Antibiotic	Used in fish and cattle food, stores in animals body.	Only approved drugs can be used.
2. Heavy metal	Used in fish & cattle food	Avoid to use inedible

Adulterant / poisonous chemical substances	Probable source	Remedy
	(such as-waste of tanneries) stores in animal body.	components, such as : waste products of tannery, coal, soil, faeces of animals.
3. Commercial colours	Unapproved colors used in industries, used in manufacturing ice-cream, blended ice-cream, sherbet, coloured drinks, Bora etc.	Avoid to use inedible components, such as : waste products of tannery, coal, soil, faeces of animals.
4. Formalin	Used in studio for developing colored photo, preservation of dead body in the morgue etc. are the main user, unapproved use for the preservation of fish, fruits, milk etc.	Avoid the use of formalin totally.
5. Insecticides	Used as pesticide in vegetables production, put its poisonous effect exists in many cases. Unapproved use of D.D.T in dry fish.	After expiry of the effects of poisonous chemicals, vegetables should be marketable, not to use D.D.T in dry fish.
6. Chemical substances	Use of unapproved chemical substances, carbide and other chemicals to ripen the fruits or tomato. Use of excess unapproved sorbet in soft & energy drinks.	Allow the fruit to ripe naturally. Not to use carbide. Use of suitable amount of sorbet.
7. Microbes	At the time of food production and preparation of microbes can mix with the food.	Be ensued of bio-security.

Digestion: Human body is composed of innumerable cells. To keep it alive and function able, it requires food in time. But most of the time foods are taken as a form of complex and organic compound. Body cells are unable to absorb these directly. So to make it absorptionable the food masses are broken down into simple, easy and soluble form.

Digestive system: There is a particular system for the digestion of food that is called digestive system. The system, by which food substances are broken down into absorptionable substance for the body and is absorbed, is called digestive system. The digestive system consists of alimentary canal and the digestive glands. Alimentary canal starts from mouth to anus. In two ways the food substances turn absorptionable. As : (1) Mechanical process and (2) Chemical process.

(1) Mechanical process: Teeth help in chewing or masticating the food substances. At first the food substances break into small pieces. Within stomach and intestine these particles turn into pulp.

(2) Chemical process: Chemical process is the second step of digestion. Enzyme in the digestive secretion helps to enhance chemical reaction. So the compounds break into simple soluble component. Besides, intra cellular reaction also depends on enzymes.

Alimentary system or alimentary canal: It is a canal running from the mouth to the anus. Parts of this canal may be narrow. The main parts of the canal are:

Mouth : mouth is the starting point of the alimentary canal. It is a transverse opening below the nostrils and bounded by lips.

Buccal cavity: Buccal cavity contains teeth and salivary glands. These organs help in digestion directly or indirectly. Teeth help to cut, grind and chew food into small pieces. The functions of tongue are to move food around the mouth for mastication and to taste. Saliva is the secretion of the salivary glands. These glands are located below the ear, at side of the jaws and below the tongue. Salivary juice secreted from the salivary glands contains mucin, it makes the food slippery and helps in swallowing of food. The secretion containing the enzymes named ptyalin and moltes takes part in digestion.

Tooth: Teeth are the hardest part of the body. An adult has 16 in each half of the jaws. Milk teeth appear first in childhood and are replaced by the permanent teeth up to the age of 18 years.

Permanent teeth are of four types. Such as :-

(a) Incisor : Incisors are used in cutting and biting food.

(b) Canine: Canines are used for grasping.

(c) Premolar : These teeth are specialized for crushing and grinding.

(d) Molar : These teeth are used in crushing, grinding. There are two teeth at the extreme end of the jaw which are called molar. Each half of the jaw bears 2 incisors, 1 canine, 2 premolars and 3 molars.

Structure of a teeth: The tooth typically consists of three parts. As :-

(1) Crown: The part above the gum.

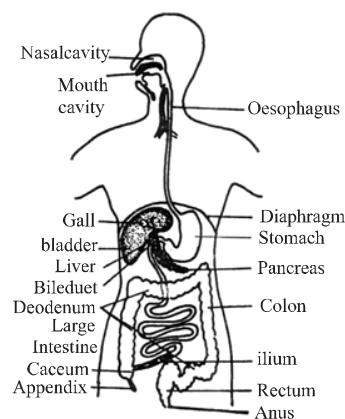


Figure: 5.6 Digestive system of man

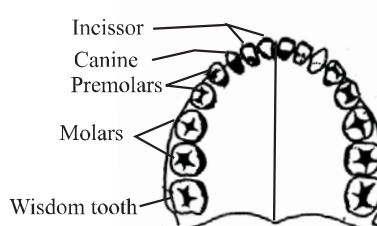


Figure: 5.7 various types of teeth

(2) Root: The part inner part below the gum.

(3) Neck: The tooth between crown and root.

Each tooth, composed of these components, are –

(a) Dentine: The main part of the tooth consists of hard substances.

(b) Enamel: The crown is covered with enamel. Enamel is the hardest component of a tooth. It is composed of calcium phosphate, calcium carbonate and fluoride.

(c) Pulp: Dentine surrounds a pulp cavity with blood vessels (artery and vein), soft cells and nerves running through it. The blood supply nourishes dentine with food molecules and oxygen.

(d) Cement: The root of the tooth is covered with a thin covering, the cement. Tooth remains attached with the gums by means of this cement.

Pharynx : The next part of the buccal cavity is pharynx. Food passes to oesophagus through the pharynx.

Oesophagus : The tube, stretching from the pharynx to the stomach, is oesophagus. Food passes to the stomach through oesophagus.

Stomach: Stomach is a bag like organ located in between the oesophagus and small intestine. Its wall is thick and muscular. Inner surface of the stomach has lines within numerous gastric glands. Continuous contraction and relaxation of the muscular wall of the stomach turn food material, bolus or pulps into semi fluid mass or chime. The juice, secreted from the gastric glands, helps in food digestion.

Intestine: The coiled duct, extended from behind the stomach, is the intestine.

Intestine is divided into two parts. As :-

(a) Small intestine: The coiled, long duct which extends from the stomach up to the large intestine, is divided into three parts. As : duodenum, jejunum and ileum. Bile duct from gall bladder, pancreatic duct of pancreas joins just before it, opens into the duodenum. Bile is produced from the liver, bile and pancreatic juice from the pancreas and enters the first part of duodenum. The inner wall of the intestine bears finger like projections called villi. There are intestinal glands in the inner of the small intestine. Villi absorb the vast majority of small soluble food molecules produced by digestion.

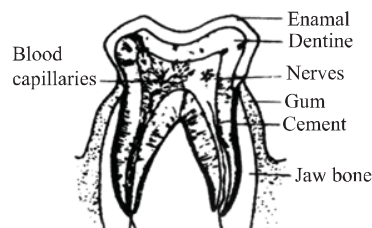


Figure: 5.8 Longitudinal section of teeth

(b) Large intestine: The region from the end of the ileum to the anus is large intestine. It is the wider part of the alimentary canal. Large intestine is divided into three parts. As caecum, colon, rectum. A small finger like projection is connected. This is appendix. The large intestine absorbs water. It forms and deposits undigested part of food that is bowel.

Anus : There is an aperture at the end of the alimentary canal. This aperture is anus.

Digestive glands: The glands, whose secretion takes part in the digestion of food, are called digestive glands. The digestive glands in human are as follows :

(a) Salivary glands : A pair of parotid glands, located in front and below each ear, below the jaw sub maxillary and below the tongue opens into the buccal cavity through different ducts. Secretion from the salivary glands is known as saliva. Salivary juice contains water and ptyalin.

(b) Liver: Liver is situated just below the diaphragm in the right side of the stomach. It is the largest gland of the body and is deep brown in colour. The right lobe of liver is larger than the left lobe. Basically liver consists of four incomplete lobes. Each lobe consists of lobules. Each lobule contains numerous cells. These cells produce bile. Bile is alkaline in nature.

Different types of biochemical reactions take place in the liver. So it is also called the organic laboratory. Beneath the liver gall bladder is attached. It stores bile. Bile is deep green in colour and of bitter taste. Gall bladder is connected with bile duct, pancreas are connected with the help of pancreatic duct. Two ducts together form a common duct that opens into the duodenum. It enters to the duodenum through pancreatic duct.

Work : Draw a labeled diagram of alimentary canal and place it before the class.

Functions of liver: The liver produces bile. The ingredients are bile mainly, water, bile salt, bile, cholesterol, mineral salts. It is stored in gall bladder. According to the necessity it passes to duodenum and takes part indirectly in digestion. There is no enzyme in the bile. Liver stores excessive glucose as glycogen. Bile neutralizes the acidic chyme and creates alkaline medium. This is favorable for digestion. So foods are not digested in acidic medium. Bile breaks fat or oil droplets into minute droplets. So it makes easier for lipase to digest fats easily. Excessive amino acids are taken to liver. After various chemical reactions urea, uric acid, ammonia, nitrogen products are produced and help in absorption of fats. When the level of blood sugar falls below normal level, the glycogen is reconverted into glucose and transmits in the blood stream. Thus the level of blood glucose remains under control.

Pancreas: Pancreas is an important mixed gland located obliquely at the back of the stomach. Pancreas secretes digestive juice, on the other hand it secretes hormones that

control the level of glucose. So pancreas acts as exocrine and endocrine gland. Pancreatic juice passes into the duodenum through pancreatic duct which joins the common bile duct (hepato pancreatic duct).

Pancreas secretes pancreatic juice. It contains amylase, lipase, trypsin named enzymes. These enzymes help in carbohydrate, protein and fats digestion. It maintains acid-base balance, water balance and controls body temperature. It also acts as endocrine glands and secretes some essential hormones, such as : insulin glucagons keeps glucose under control and it has an important role in other physiological process.

Gastric glands: The glands in the stomach wall are called gastric glands. The juice secreted from these glands is known as gastric juice.

Intestinal glands: Intestinal wall possesses villi contains intestinal glands. The secretion of these glands is intestinal juice.

Digestion of food: The bio-chemical process, by which larger complex, insoluble, unobservable food substances take part in organic chemical reactions and simple soluble, absorbable transform into form in presence of particular enzyme and hormones, is called digestion. At first food substances break into simple soluble form and afterwards it diffuses through cell membrane and enters the cell easily. At last blood transports digested simple ingredients to different parts of the body.

Digestion in mouth : In the buccal cavity tongue and teeth work together to move food about the mouth and to cut, grind and chew food into smaller pieces. Saliva from the salivary glands mixes with the food. Saliva helps in the digestion and swallowing of the food. Saliva contains the salivary enzymes ptyalin or salivary amylase. Salivary amylase begins to break carbohydrate into maltose. Protein and fats have no change in the buccal cavity. Food from buccal cavity enters the stomach through the oesophagus by peristalsis. Muscular wall of the alimentary canal contracts and relaxes simultaneously. As a result the forward movement of food. and no digestion of food occurs in the oesophagus.

Digestion in stomach: When the food reaches the stomach, gastric juice contains the following main components –

Hydrochloric acid – Hydrochloric acid destroys the germs coming with the food substances. Converts inactive pepsinogen into active pepsin, makes a acidic medium to perform its proper function.

Pepsin: It is an enzyme which breaks protein into a compound. The compound is composed of two or more amino acid that is known as peptide. Digestion carbohydrates and fats do not occur in the stomach. Because gastric juice do not contain any particular enzyme for the digestion of carbohydrates and fats.

No sooner the food enters the stomach, the above juice is secreted. The muscles of the stomach contract and relax continuously. Chemical reaction occurs that converts food into a semi liquid.

This is chyme. It is more or less like a soup and enters the small intestine through the pylorus.

Digestion in the small intestine: When the chyme enters the duodenum, two secretions namely pancreatic juice from the pancreas and bile from the liver poured through the bile duct. Both of these secretions are alkaline in nature. Pancreatic juice neutralizes the acidity of chyme. The enzyme of the pancreatic juice continues the digestion process of proteins and carbohydrate (maltose) and starts fat digestion.

Bile is secreted from the liver. It neutralizes the acidity of the food and brings the alkaline medium. Bile salt emulsifies fats that means it helps fat droplets to mix with water. Bile salt is one of the constituents of bile. It also emulsifies fats, so that it becomes easier for lipase to digest fats easily. Lipase converts the fat droplets into fatty acid and glycerol.

Pancreatic juice contains trypsin, lipase and amylase on the other hand. Intestinal juice contains the enzymes, maltase, lactase, sucrase etc. Trypsin, converts partly digested protein into amino acid and simple peptide. Amylase enzyme converts the maltase into glucose.

Absorption of digested food: Most of the foods are fully digested in the presence of particular enzyme and is converted into simple absorbable ingredients. The inner surface of the intestine (ileum) is covered by finger-like projections called villi, which contains capillary network. Each villus (singular of villi) also contains a lymphatic vessel in the middle which is called lacteal. The lacteal is surrounded by blood capillaries. As villi are folded. So it increases the surface area of the ileum. Here absorption of the food ingredients takes place.

These blood vessels (capillaries) join together to form a large blood vessel called the hepatic portal vein which carries blood to the liver. Fat droplets are absorbed into the lacteal of the villi. At first it is carried by lymph then mixes with the blood stream. After

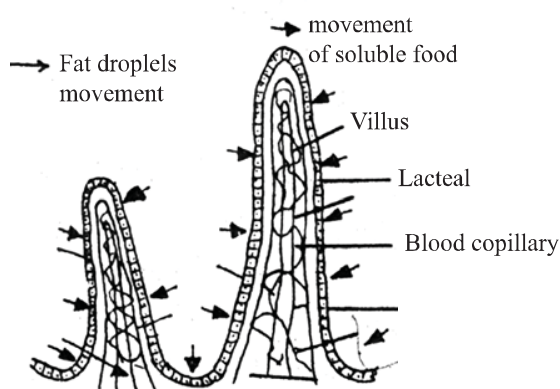


Figure: 5.9 Absorption of soluble food and fats in ileum

reaching into the cell, this bile salt becomes separate from fatty acid. At the time of flowing blood, a kind of substance comes out of the capillaries. This watery fluid is lymph. Lymph supplies nutrients to the cell and collects the waste products and returns to the blood stream.

After absorption the rest of the chime reaches the colon.

Digestion in large intestine: No chemical reaction or digestion takes place in the large intestine. But the water remains within and digested products are absorbed here. Besides there remain a small portion of protein, lipid, salt and excess enzymes. Water and salt are reabsorbed from these products and are transferred in the blood. Then the indigested products concentrate here and turn into faeces or stool. Faeces store in the rectum. According to need the faeces pass out through anus.

Assimilation: Digested food substances are converted into the constituent of protoplasm is assimilation. It is an anabolic process. By the action of the enzymes simple nutrients convert into complex ingredients. Such as : amino acid, glucose, fatty acid and glycerol. These ingredients spread all over the body through blood. The digested food substances are converted into protein, carbohydrates and lipid due to the action of enzymes secreted from protoplasm. That results in the repair of the worn out tissues and helps in growth.

Sometimes intestinal disorder causes the under mentioned diseases or physical problems. Such as :

Dyspepsia : Indigestion is dyspepsia. There are many causes of indigestion or disturbance in digestion. Such as – infection in stomach, depression, disease of pancreas, thyroid problems, enzyme deficiency, diabetes etc. Pain in the upper abdomen, abdominal flatulence, feeling stomach full, burning sensation in the chest, nausea or vomiting, chest pain, sour belch etc are the symptoms of dyspepsia. Because of stomach and intestinal ulcer causes digestion problem.

To prevent dyspepsia, what we have to do – To avoid overeating chew food slowly in the best way, avoid smoking. According to the necessary consult a doctor, find out the causes of dyspepsia, take medicine.

Dysentery : Dysentery is caused by infection of a protozoa named *Entamoeba histolytica* or by a bacteria named *Shigella*.

Frequent bowel elimination, stool with mucous, abdominal pain, mucous and blood in the stool, unable to digest dairy products are the symptoms of dysentery.

The things we have to do to prevent dysentery are as follows – drinking pure water, wash fruits and vegetables carefully. Wash hands with the soap or ash after passing

stool. Use sanitary latrine, wash hands and utensils carefully, follow treatment prescribed by physician. If it is not so then it may be fatal.

Constipation: It is not a particular disease. When stools become hard, or stool does not pass for two or more days, this situation is called constipation. There are various causes of constipation, such as : habit of not responding when the bowel impulse sound its alarm, excessive water absorption from the undigested part of food in the colour, slow movement of the undigested part of the food in the alimentary canal, leading a lazy life, intestinal disorder, slows down the contraction of colonic muscles, not taking roughage containing food increase the probability constipation.

Due to constipation passing out of stool becomes difficult. That results in uneasy feeling in the abdomen, abdominal pain and various accompanying disorder.

To prevent this disease the things to do are – take / eat fibrous food, drink enough water, regular eating of vegetables, fruits, apples, bananas, coconut, dates oranges, papaya, pine apple, tea etc. Make a habit of regular walking and passing out of stool.

Gastric ulcer : Ulcer is the inflammation and injury to stomach or intestine. Long irregularities, in taking food, cause the over secretion of acid. If it continues for a long time, injuries in stomach and intestine occur and this is called gastric ulcer.

Feeling continuous dull pain in the mid part of the abdomen is caused by this disease. Pain increases in empty stomach or after taking excessive fatty foods pain becomes severe. It may cause vomiting. Sometimes blood may come out with blood and vomit. The disease can be ascertained by endoscope or barium x-rays. To prevent this disease what is to be done are – take easily digestible food regularly, avoid spicy and oily food, taking boiled milk, cheese, banana gives good result. Take food regularly, avoid stimulating substances, as – coffee, cigarette etc. Follow treatment and consult the physician.

Appendicitis : In the right side of the lower part of the abdomen where a finger like pouch joins with the caecum of the large intestine is appendix. Infection in appendix is the cause of appendicitis. Pain starts around the navel, after sometime that moves downward in the right side. Loss of appetite, vomiting, constipation etc are the symptoms of appendicitis. In this situation consult the doctor, transfer patient with the advice of a doctor. If the situation demands, appendix should be removed by surgery. If the infection of appendix is severe, it can burst and may be fatal that may lead to even death.

Worm related diseases: Worms live in the body as parasite. Human body is the host of many worms. Round worms, thread worms, tape worms live in human intestine as a parasite. Abdominal pain, weakness, indigestion, feeling of uneasiness in the abdomen, nausea, insomnia, loss of appetite, pale face, anemia, swelling of hand and legs, enlarged abdomen, symptoms are the causes of worms. When an infant suffers from

fever, worms may come out from the nose or mouth. Through pathological examination of stool it can be ascertained in the abdomen. After being ensured about the presence of eggs of the worms, follow treatment according to the advice of the physician.

Food substances become impure by flies and worm affected people. Worms spread out from impure food. The preventive measures are as follows – making habit of taking raw fruits by proper washing, before taking food wash your hands properly, use sanitary latrine, not to walk bare footed, not to take semi-boiled food.

Diarrhoea : If any one is suffering from loose motion atleast three times in a day, then it is a case of diarrhea. Generally infants suffer from Diarrhoea. Water and salt go out from patient's body. So water reduces, the patient becomes weak. So, shortage of salt and water is noticed. At that time if the proper treatment is not ensured, then the patient may even die.

Frequent loose motion and vomiting, feeling of thirst, dried up mouth and tongue, shrinking of skin, sunken eyes etc are the symptoms of Diarrhoea. In this situation the patient refuses to take any foods and drinks. When the child cries, the crown of the skull goes down and child becomes weak.

There is every possibility to spread this disease, such as : drinking impure water, taking of other and dirty foods use of unclean utensils, in take of food with dirty hands.

If the symptoms of diarrhea are exposed, then start taking of oral saline as early as possible. Now a days, oral saline, prepared by Institute of Diarrhea Research Centre, is available in the market. The instruction of making oral saline is written on the packet. It is to be prepared following the instruction. Besides, oral saline may be prepared in the house. You have learned here to prepare oral saline. Rice saline is the one of the recent invention. Rice saline is prepared by mixing 50 gm of rice powder, one pinch of salt with 1 litre of water. Remember the following instructions at the time of using oral saline, such as : continue to drink oral saline till diarrhea stops, do not stop taking saline if the patient vomits, allow breast feeding to infant and feed the patient other foods regularly. After recovery the patient should be supplied excessive food at least a week.

Diarrhoea may occur by the infection of rota virus. 82% of death due to rota virus occurs in deprived poor countries. There are many causes. The percentage of death is high in poor countries. The severity of this disease has also been found in developed countries, but death rate is comparatively less.

Work : Prepare oral saline in a group. Prepare a poster on writing the necessity of taking oral saline.

Exercise

Short answer question

1. What are the mineral nutrients of plants?
2. How many essential mineral nutrients do plants use?
3. What is food pyramid?
4. What is the reason of Anemia?
5. Why does night blindness occur?

Essay type questions:

1. Describe the structure of a tooth with diagram.
2. What are the characteristics of balanced diet?

Multiple choice question

1. Which of the following nutrients does serve a plant as a macronutrient?
 - a. Zinc
 - b. Iron
 - c. Boron
 - d. Potassium
2. Chlorosis is caused by...
 - i. nitrogen deficiency
 - ii. sulfur deficiency
 - iii. iron deficiency

Which one of the following is correct?

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

Read the stem and answer the question number 3 and 4.

Five year old Sanjana can see all the writings in the book. But at night she can not see the writings clearly.

3. Which vitamin deficiency Sanjana has?
 - a) vitamin 'A'
 - b) vitamin 'B'
 - c) vitamin 'C'
 - d) vitamin 'D'
4. To prevent from this disease which vitamin Sanjana has to take?
 - i) liver
 - ii) carrot
 - iii) Mola fish

Which one is correct?

- a) i and ii
- b) i and iii
- c) ii and iii
- d) i, ii and iii

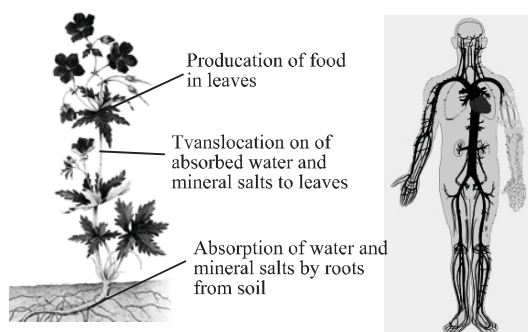
Creative question:

1. Dr. Raihan spends most of the time in the laboratory. So his body weight is increasing. On the other hand his younger brother Jahir is the regular player of national team. For that he has to play and take exercise daily.
 - a) What type of food is the source of nitrogen?
 - b) What do you mean by high protein, explain it?
 - c) Which food should be in much quantity in Jahir's food chart? Explain its cause.
 - d) Which type of food is not applicable for Dr. Raihan that is included in Jahir's food chart? Analysis this opinion
2. Irfan Ali observes that the leaves of the grass plants in his garden are becoming yellow, and the leaves, flowers and buds of flowering plants are falling off plants. To solve the problems, he asks for help from a horticulturist, and the horticulturist suggests Irfan Ali to apply some essential nutrient elements in his garden.
 - a. What is a micronutrient?
 - b. What are the essential elements for plants? Explain it.
 - c. Explain the causes of the problems found with the grass plants in Irfan's garden.
 - d. Evaluate the suggestions given by the horticulturist in the stem mentioned above.

Chapter Six

Transport in organisms

Transport is a very essential system functioning all the time in all the living organisms. In plants, conduction of water and minerals is as important as the translocation of food in them. Translocation of water and minerals absorbed from soil and taken to the leaves is as essential as the translocation of food produced in the leaves to the different parts of the plant body. Transportation of substances in a human body is not the same as it is found in a plant body. Transport systems in plants and human bodies are discussed in this chapter.



At the end of the chapter, we will be able to:

- Explain the concept and necessity of transport in plants.
- Explain the plant and water relationship.
- Explain the absorbing system of water and mineral substances and their necessity in plants.
- Explain the translocation of substances produced through the process of photosynthesis.
- Explain the conduction system of water and mineral substances and their necessity in plants.
- Explain the concept and significance of the process of transpiration.
- Analyze the role of factors in controlling the rate of transpiration.
- Evaluate that transpiration is a very essential evil.
- Perform experiment to demonstrate transpiration in plants.
- Explain the concept of transportation in human body.
- Explain the components of blood.
- Explain the characteristics of different blood groups.
- Be able to choose blood depending upon the blood group characteristics.
- Describe the rules of blood donation and social commitment.
- Describe the process of blood transportation in human body.
- Describe that the structure of heart is adapted to its functions.
- Analyse the adaptation of heart's structure and its activity.
- Analyse the role of blood pressure in blood circulation.
- Explain the ideal blood pressure.
- Describe types of cholesterol, its range, usefulness and its risk for health.
- Analyse the role of cholesterol in blood circulation.
- Describe the causes and effects of irregularities in blood.
- Analyse the symptoms, causes, remedy and prevention of diseases relating to heart.
- Analyse the method to keep the heart healthy.
- Measure the pulse rate and blood pressure at the time of taking rest and after exercise and can compare between them in two situations.
- Measure blood pressure and pulse rate.
- One could be aware of keeping heart healthy and create awareness to prevent heart diseases and

Plant and water relationship

Another name of water is life. Life cannot subsist without water. We know that protoplasm is the physical basis of life. 90% of this protoplasm is water. This is why water is called the fluid of life. If protoplasm is devoid of water, it may be dead being constricted. Moreover, all the metabolic reactions that usually occur in a plant will be ceased in deficiency of water. The important uses of water in a plant body are mentioned below:

1. There is no substitute for water in maintaining the living nature of protoplasm.
2. It is necessary to ascertain the supply of water in necessary amount for keeping the process transpiration and photosynthesis on their running state. This is why irrigation is to be maintained for the large plants in dry season.
3. Water is an important solvent. The significance of water in many metabolic reactions is immense.
4. Water plays the important roles in the cellular growth of plant and in their movement.

Now, the question arises, from where and how the plants do obtain the water for the maintenance of their life. Plants mainly absorb water at their roots from the soil. The process absorption is accomplished with the coordination of 3 processes, and these are imbibition, diffusion and osmosis.

1) Imbibition: If a piece of dry wood is placed in water, it will absorb some water in it. We know that dry or half-dry colloidal substances absorb liquid. This is why the piece of wood has absorbed the water. This process is called imbibition. The substances such as cellulose, starch, gelatin etc. are hydrophilic. When they come in contact with water, they absorb it, and conversely, they become constricted when they face deficiency of the liquid. As the cell wall and protoplasm are colloidal in nature, absorbing water they become swelled up. It is a unique process for absorbing water.

Work: Experiment on the demonstration of the process diffusion.

Essentials: a small bowl, attar or any incense.

Discuss the afterward state to explain the diffusion process by pouring incense in to a bowl.

2) Diffusion: If some incense is poured in a corner of a room, its fragrance is immediately spread throughout the whole room. The small particles of the incense are spread in the air. If some sugar is added to the water of a glass, instantly the water of the glass tastes sweet. This process is called diffusion. It is a physical process. The process through which the molecules of any substance are spread from the region of its higher concentration to the region of lower concentration is called diffusion. At a constant temperature and atmospheric pressure, the potential energy of a substance to diffuse from a solution of its higher concentration to a solution of its lower concentration is called its diffusion pressure. Under the same atmospheric pressure, the difference

between the diffusion pressure of a solution and that of a solvent is called diffusion pressure deficit. Because of the diffusion pressure deficit in the mesophyll tissue of a leaf, a cell in deficiency of water absorbs it from its adjacent cell. The significance of diffusion in the absorption of water in plants is immense.

3) Osmosis: Do you know what osmosis is? Have you ever observed when a mother places some dried grapes in water, the constricted raisins are immediately swelled up being turgid. Have you ever thought of how this happens? If you again place the turgid raisins in concentrated sugar beverage, they again turn constricted. Could you think how this has happened? This is a very essential phenomenon. Through the phenomenon, plants absorb water from the soil. This process can be watched accomplishing in the laboratory without the involvement of any living cell. If the two solutions of different concentration having the same solvent and solute are separated by a selectively permeable membrane, the concentration of both the solution will soon be equal. When two solutions of different concentration having the same solute and solvent are separated with a selectively permeable membrane, the solvent flows from its higher concentration to its lower concentration. Movement of solvent through a selectively permeable membrane from its higher concentration to its lower concentration is called osmosis.

Work: Experiment on demonstrating osmosis through cell to cell.

Essentials: piece of potato, petri plate, water, and sugar.

Prepare a potato osmoscope, and by pouring down the sugar beverage, prove the process osmosis.

Absorption of water and mineral salts

In plants, absorption of water and mineral salts occur through different processes. For the convenience of our discussion, we will know the facts about water absorption first.

a) **Absorption of water:** Plants by their roots, generally, absorb capillary water from the soil. The diffusion pressure deficit in a cell of a leaf is developed because of transpiration, and then water from the adjacent cell moves towards the cell. In the same way diffusion pressure deficit is developed in the second cell and water is moved to it from the adjacent cell. This way a continuous diffusion pressure deficit is extended up to root hair and a suction force is developed. Because of this suction force, capillary water continues to enter the cell root hair. Water enters into the root hair cell through the process of osmosis and diffusion. Through this way, water taken up into the root hairs moves through the cortex tissue. This way of movement of water is called cell-to-cell osmosis. Then water moves from the cortex tissue to the endodermis, the pericycle, and finally into the vascular bundles. Water having once entered into the vascular bundles, it

continues to be taken up and flowed laterally through xylem tissue. The water flowing through different branches and branchlets of plant, ultimately, reaches the leaves and this is accomplished by the active involvement of the two processes named osmosis and transpiration.

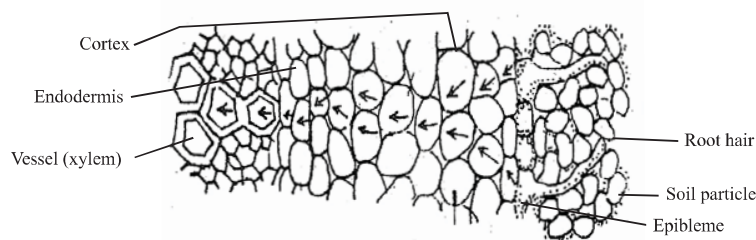


Figure: 6.1 Absorption and conduction of water

Absorption of mineral salts: Most of the plants absorb some mineral salts with the water they absorb. Though some salts are absorbed through root hair, mainly the meristematic region of the tip of root functions as the main region of absorbing mineral salts. Mineral salts are abundant in the form of ions. Absorption of salts is done mainly by the two ways and they are passive absorption and active absorption.

1) Passive absorption: Salt absorption in this way is accomplished through the root hairs of plants with the process of imbibition and osmosis, and no metabolic energy is required for it.

2) Active absorption: Active absorption is the absorption of ions with the help of metabolic energy produced in the cells.

Translocation in plants: Translocation in plants represents the movement or flow of water and mineral salts and of the food produced in the leaves.

We know that water and mineral salts are taken up the stem in plants through the vessels of xylem tissue. Scientists think that the force produced by transpiration, capillary action and root pressure cause the cell sap to reach the leaves of plants. In this way water reaches leaves, food is produced there. Then phloem tissue takes active part in the translocation of food produced by photosynthesis to the different regions of a plant. The food is translocated through the sieve tubes of phloem tissue. Different organic compounds in plants move through phloem tissue at the same time in opposite directions. The compounds in the lower region flow downwards and compound synthesized in the upper region flow upwards and the substances synthesized in the middle region flow both the directions upwards and downwards.

Necessity of translocation in plants

Translocation refers to the movement of any substance from one part of the plant to another. Movement or transportation of water and mineral salts in plants called

translocation in plants. All the scientists agree with the necessity of translocation of water and mineral substances in plants. Now, the matter of consideration is that the water and mineral substances, that are to be used, must be taken up to the place where the reactions will occur. This is why the translocation of water and mineral salts is very important. Water and mineral salts being absorbed through the root hair reach the vessels of the xylem tissue crossing the cortex region and gradually reach the leaves along with the current or flow of transpiration. Food is produced there in the leaves. The food produced in the leaf reaches the different regions of a plant through sieve tubes of phloem tissue. If the flow in the xylem vessels or phloem sieve tubes is blocked for any reason, the plant would have to die. This is why it can be said that translocation in plants is a very important activity for the existence of their life.

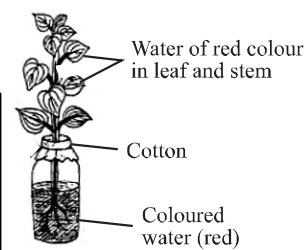
Translocation of water and minerals: We have already acquired some ideas about osmosis and transpiration. Plants absorb water from the soil with the process osmosis. It is accomplished mainly with the aid of root hairs. Side by side plants also absorb mineral nutrients from the soil though the process of absorbing water and the process of absorbing mineral salts are much different. You will be able to know much more detailed about it at your higher level of education. Water and mineral salts dissolved in it are collectively known as cell sap. Now, we will know how the cell sap from the root reaches the top most branches and leaves of a plant.

Ascent of sap: Roots absorb water and mineral salts. The cell sap ascends slowly upwards with the influence of different factors. Concurrently, the lateral translocation of cell sap also occurs. Translocation of cell sap is categorized into two steps: 1) the arrival of soil water and mineral salts from root hair to the vascular tissue of the root and 2) translocation from vascular bundle of root to leaves. At the first stage, osmosis, diffusion and suction from transpiration etc. play their important role in the absorption and translocation of water and mineral salts. The water and the mineral substances absorbed by root hair move to the adjacent cell by the process of osmosis. From that cell they move again to the next cell. Moving in this way, water and mineral substances that once reach the vascular bundle of the root, ultimately, reach the mesophyll tissue of leaves through the vascular bundle of the stem.

Work: Experiment on the demonstration of the ascent of sap in a plant.

Essentials: *Peperomia* plant, bottle of glass, water and safranin.

Procedure: Taking some water in a bottle of glass add some drops of safranin to it. Place a living *Peperomia* plant in the bottle in such a way that its roots are submerged



into water. Now place the bottle somewhere with the plant for some hours and note down the result from a careful observation.

Translocation of the substances produced in photosynthesis: You have learnt earlier that plants absorb water by the process osmosis. The water is conducted to the leaves at the top most regions of a very long plant. These very leaves utilize water for the process photosynthesis. Chloroplasts produce the food starch in presence of light by mixing water with the CO_2 taken from the air. The food produced in that way is conducted to the different parts of a plant. Every cell of a plant derives its energy to perform its metabolic activities by using the food through the process respiration. After the completion of deriving energy through respiration, the remaining food is stored in some special regions of a plant. In potatoes (stem), sweet potatoes (root), aloes (leaf) and in different fruits and seeds, the food is usually stored. Now, we will study how the food produced in photosynthesis is conducted to the different regions of a plant body.

Phloem translocation: As the leaves and the roots grow away from each other, there must be a rapid and effective transport system in between them for the conduction of food. This is done by sieve tubes of phloem. Phloem is one of the important bundles of vascular bundle. We know that there are xylem bundles and phloem bundles in a vascular bundle. In phloem bundle, there are sieve tubes, companion cells, phloem parenchyma and bast fibers. Sieve tube is a kind of thin walled living cell without nucleus. Being longitudinally side by side, they form a net like structure. The septa in between them being disappeared in some places develop sieve shaped forms. This is why food substances can easily move from cell to cell. In winter, these openings are blocked because of the deposition of chemical substance callose, and thus the movement of food is inhibited. At the advent of summer, the callose is removed being degraded and the movement of food increases.

Transpiration: Life cannot be imagined without water. Plants mainly absorb water they require at their roots. They use a very little part of the absorbed water for their metabolic activities. The remaining part of the water is lost outside the plant body. The physiological process by which generally the land plants through their aerial part lose water in the form of water vapour is called transpiration. On the basis of aerial parts through which this process occurs, transpiration is categorized into three: stomatal transpiration, cuticular transpiration and lenticular transpiration.

1) **Stomatal transpiration:** There are special types of openings with two guard cells in the leaves, young stems and sepals and petals of flowers. These openings are called stomata. 90-95% of the total transpiration in a plant occurs through the stomata.

2) **Cuticular transpiration:** There is a layer of cutin on the epidermal layers of a plant, especially on the upper and lower surface of every leaf. This layer is called cuticle. An

amount of water being evaporated is lost through the cuticle. The process is called cuticular transpiration.

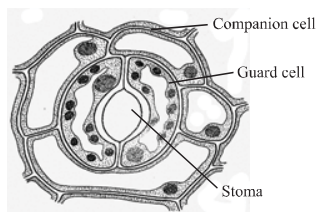


Figure: 6.2 A stoma

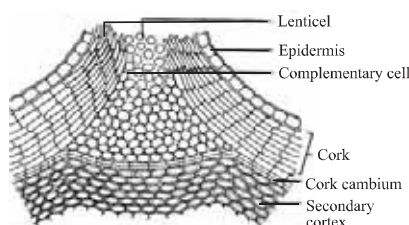


Figure: 6.3 A Lenticel

3) **Lenticular transpiration:** After the occurrence of the secondary growth in plants, the airy aggregation of cells that functions as a pore called lenticel is developed on the rapture bark of some plants. The cells aggregated around a lenticel are loosely fitted and water from inside can be lost through it. This is called lenticular transpiration.

Through transpiration, as excess water is escaped being evaporated, a suction force being developed causes the root to absorb water. The process depends on many factors. They are roughly grouped into two: a) external factors and b) internal factors.

a) External factors: The factors which affect the process transpiration from outside of the plant body are called external factors, such as,

1) **Temperature:** The rate of transpiration fluctuates with the changes of temperature. Water can easily be vapourized at high temperature and thus the process transpiration is accelerated. Water holding capacity of air in the atmosphere increases if the temperature goes up. As a result, transpiration proceeds speedily. If the temperature goes down, the rate of transpiration eventually declines.

2) **Relative humidity:** The proportionate ratio of the amount of water vapour in the air of the atmosphere and the amount of water vapour that the air can hold at a given temperature is its relative humidity. In an area, the air may be dry in spite of having high water vapour because the air may have a high water vapour holding capacity. Conversely, in spite of the presence of low amount of water vapour in atmosphere, the atmosphere may be humid for the low water vapour holding capacity of the air. When relative humidity is low, air remains unsaturated, and can retain more water vapour. If the relative humidity is high, the air being saturated loses its water vapour holding capacity. So, when relative humidity is low, the rate of transpiration increases and when high, the rate of transpiration declines.

3) **Light:** In presence of light, stomata get opened, and so the rate of transpiration increases. In dark, the process is ceased because of the stomata being closed. With the fluctuation of light, the openings of the stomata also change. Light affects the process transpiration by increasing the temperature of the plant.

4) Wind velocity: Because of transpiration, air around the plant gets moist, and causes the rate of transpiration slow. When wind removes the saturated air, the rate of transpiration increases. With the wind, the leaves are swung and a kind of pressure is exerted on stomata and, so water vapour at a high rate comes out through them. This is why with the change of wind velocity, the rate of transpiration also changes. If the atmospheric pressure raises, evaporation declines and so the rate of transpiration also decreases. Again at low atmospheric pressure, evaporation increases, and so the rate of transpiration increases.

b) Internal factors

1) Stomata: The rate of transpiration varies with the number, volume, structure and arrangement of stomata.

2) Number of leaf: The rate of transpiration varies with the number, volume, structure and arrangement of leaves.

3) Volume of mesophyll: If the volume of leaf is high, the rate of transpiration will also be high. The same way, if the volume of leaf is low, rate of transpiration will be low.

4) Volume of the aerial parts of the plant: If the total volume with all the aerial parts of a plant is increased, the rate of transpiration will be high.

Besides, presence of cuticle, area of spongy parenchyma etc. change the rate of transpiration.

Work: Prove with an experiment that water is lost as water vapour from a plant through the process transpiration.

Essentials: A fresh potted plant to be required for the experiment, a glass bell jar or a big and narrow cellophane bag, thread or clip and required water.

Procedure: At first, the plant with the pot will be placed on a table and water in required amount would be poured in the pot. Now, a branch of the plant with some leaves having been covered with a cellophane bag will be clipped or tied with thread or will be covered with a bell jar. The precaution should be taken that vapour cannot come out or air cannot get in. The pot in this stage will be kept for an hour.

Observation: After an hour, it will be found that water drops are studded on the inner surface of the cellophane bag and the whole bag would become fuzzy. Have you understood how it has been happened?

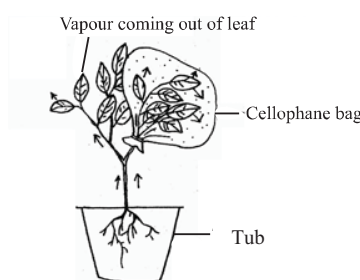


Figure: 6.4 Test of

Conclusion: As there is no scope of water to get in the cellophane bag, it is clear that the water drops are escaped from the leaves. So, it has been proved that a plant releases water in vapour form through its aerial parts.

Precautions:

- 1) The plant on the pot should be fresh and living.
- 2) The opening of the cellophane bag should be tightly tied so that no air can get in or come out.

Transpiration is a necessary evil

It seems that all scientists at present have agreed on the significance of transpiration. The metabolic activities of any living cell are mostly dependent on this process. Because of transpiration a suction force is developed in xylem channel and that is called transpiration suction. With the suction force, a plant absorbs water and mineral salts through its root hairs and the absorbed water and mineral salts are conducted to the leaves. If the force decreases, the absorption of water will be decreased and the metabolic activities along with the production of food will be slothful. In the mesophyll of leaf, diffusion pressure deficit is developed because of transpiration and helps the absorption of water. A plant keeps the temperature in the cells of leaves always in a tolerable state by continuously reducing the thermal energy absorbed by the mesophyll.

On the contrary, though this important process transpiration contributes many useful acts to a plant, it also plays some harmful roles in it. For instance, if the rate of the loss of water is greater than the rate of its absorption, it will cause deficiency of water and minerals in the plant. As a result, the plant may die. If water is deficient in soil, absorption will be very little though the transpiration would continue as before. To face this crisis, nature causes many plants to drop leaves in winter. Because of the lacking of transpiration, the required diffusion pressure deficit will not develop and as a result the rate of osmosis will be slow.

So, it can be said that transpiration is an essential activity for a plant though it causes some harms to it. For the contrary of the character, Scientist Curtis designated the process transpiration as 'necessary evil'.

Transportation in human body

Blood is the source of vitality. Blood circulates throughout the whole body by blood vessels and distributes adequate oxygen and nutrients. So the cells remain active and alive. The system, through which blood transports to different organs and parts of the body, is called blood circulatory system. The distribution of nutrients and oxygen throughout the

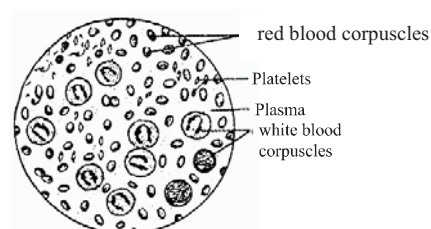


Figure: 6.5 Components of blood

body and the removal of body wastes is performed by this system.

Flow of blood is confined within the blood vessels, it never comes outside. This type of circulatory system is called closed circulatory system. For transporting blood throughout the whole body requires only one minute or less than that. The advantages of this circulatory system are (1) Blood reaches to different organs directly, (2) can control the flow of blood to a particular organ by changing its diameter and the distribution can be adjusted depending on demand, (3) blood goes round the whole body and returns to the heart fast. In comparison with other system blood circulatory system has a particular specialty but its formation is ordinary.

There are two types of circulatory systems. Such as (1) Blood circulatory system. It consists of heart, arteries, veins and capillaries. (2) lymphatic system. It consists of lymph, lymphatic ducts lacteal.

Blood : You have seen slaughtering of cows, goats and fowl. A red coloured fluid spreads out from the place of slaughtering. This is blood. It is a viscous fluid. Blood circulates through heart, artery, arterioles, veins, venules and capillaries. Due to the presence of hemoglobin blood appears red. It is a substance with alkaline, salty to taste. Blood originates from the bone marrow.

Components of Blood : Blood has mainly two components, such as • Plasma and • Blood cells.

- Plasma : The colourless fluid part of plasma which constitutes about 55% volume of whole blood. The main component of plasma is water. Small amount portion, organic subs and small portion of inorganic salts are dissolved in it. The substances which are present as follows –

(1) Protein : example albumin, globulin, fibrinogen (2) glucose (3) small droplets of fats (4) mineral salts (5) vitamins (6) hormones (7) antibodies (8) waste products example- carbon di-oxide, urea, uric acid etc. Besides it contains small amount of sodium chloride, sodium bi –carbonate and amino acid. The food substances which we take are digested and absorbed by the intestinal wall and mixed with blood and is transported all over the body. The cells absorb the nutrients, repair the worn out tissues and help in growth.

Blood cells : Blood is made of three types of cells; as- (a) Red blood corpuscles or erythrocytes (b) White blood corpuscles or leucocytes and (c) Platelets and thrombocytes.

(a) Red blood corpuscles or erythrocytes: Among the three blood cells the red blood corpuscles are huge in number and plays an important role for the transportation of oxygen required for respiration. Red blood corpuscle is non nucleated, appears mostly like a circle and biconcave discs. There are approximately 5 billion of red blood corpuscle present in cubic milliliter of an adult male. It is 500 times more than that of

which blood corpuscles The amount of red blood corpuscles is comparatively less in female. The amount of red blood corpuscles in infants is comparatively high. Red blood corpuscles are destroyed at every moment and equal amount of cells are produced again. Haemoglobin of red blood corpuscles transports oxygen as oxyhaemoglobin and also carbon dioxide.

Haemoglobin : Haemoglobin is a type of coloured pigment. It appears red because of its presence. If the number of red blood corpuscles is not of adequate amount then the symptoms of anemia are noticed. In Bangladesh almost two third of population suffers from this disease. To get rid of this disease it is necessary to take balanced diet.

(b) White blood corpuscles : There are some kinds of white blood corpuscles in human blood. It is irregular in shape and less fewer in number than red blood corpuscles. There are 5-10 thousand white blood corpuscles in cubic milliliter. White blood corpuscle is produced in red bone marrow and lymphatic glands. It is colourless but contains a nucleus. White blood corpuscles can change its shape and can move from one place to another.

White blood corpuscle engulfs the germs by spreading pseudopodia. This process is named phagocytosis. The dead white blood corpuscles turn into pus. If the white blood corpuscles in blood increases excessively, leukemia occurs. White blood corpuscles acts as a guard, destroys the germ by the process of phagocytosis and produces antibody.

Platelets: Platelets are small in size, colourless and spindle shaped. They remain in cluster. There are approximately 2.5 million platelets per cubic milliliter of blood. It helps in coagulation or blood clotting. It originates in the bone marrow. When a blood vessels are damaged, immediately chemical substance thromboplastin is released by the platelets. It helps in blood clotting. If blood does not contain the right amount of platelets, blood does not clot easily. This may lead the patient to a life threatening situation.

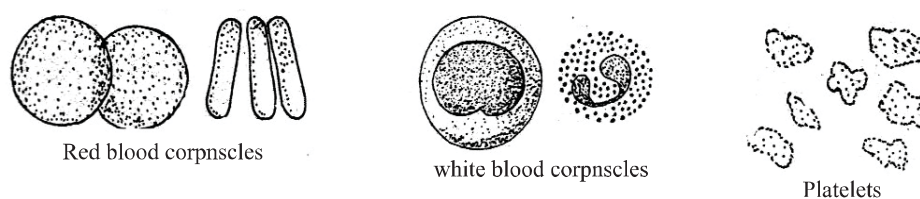


Figure: 6.6 various types of blood cells

Work : Draw the table in your notebook and fill it in groups.

Difference between Red blood corpuscles and White blood corpuscles		
Characteristics	Red Blood Corpuscles	White Blood Corpuscles
Nucleus		
Shape		
Haemoglobine		
Number		
Functions		

Functions of blood : Blood is an important ingredients. Blood performs different functions. Such as –

- 1) Oxygen transport :** Red blood corpuscles transports oxygen as oxyhaemoglobin to the cells.
- 2) Removal of carbon dioxide:** Due to the chemical reaction occurs in the tissue carbon di-oxide is produced. Carbon di-oxide is transported in the form of sodium bi-carbonate dissolved in the plasma. It carries carbon di-oxide from the tissue to lung and is then expelled during expiration.
- 3) Transportation of digested food:** It provides plasma, glucose, aminoacid, fat granules in the cell.
- 4) Balancing of temperature condition:** Heat produced in the body tissues, especially in the muscles and liver and distributes it throughout the body and there by maintaining the uniform body temperature.
- 5) Elimination of waste products:** Blood carries all the waste products and eliminates these as urea, uric acid and carbon di-oxide.
- 6) Hormone transport:** Hormone is a chemical substance which is produced in the ductless glands. It mixes with the blood directly and is circulated to the different organs of the body according to its need. It helps in different important biological process.
- 7) Prevention of Diseases:** Some types of white blood cells attack and engulf germs by the process of phagocytes, thus prevents the body from the attack of germs. It increases the resistance power against diseases by producing antibody and antigen.
- 8) Blood clotting:** If there is wound at any part of the body the clotting of blood heals the wound, preventing excess loss of blood.

Blood group: Blood is necessary for an alarming or dying patient. His or her blood group is B. You frequently watch this type of advertisement in television what is blood group? Why is the blood group to be known? Through numerous experiments, examination and researches concerning blood group it is proved that in different persons red blood corpuscles contain A and B antigen and plasma has a and b antibodies. Blood can be classified into different groups depending upon the presence of these antigens and antibodies. This is called blood group. Scientist karl Landsteiner in 1701 for the first time classified and named human blood and placed it into A, B, AB and O four groups. The blood group of a person remains same and unchanged throughout the whole life. Types antigens and antibodies in different blood group is shown in the table below-

Blood group	Antigen (in red blood corpuscles or cells)	Antibodies (in plasma)
A	A	b
B	B	a
AB	A,B	No antibodies
O	Neither	a, b

We have observed the presence of different antigens and antibodies with in the blood. On this basis we can explain blood group in this way. Example –

1. Group A : Blood possesses antigen A and antibody b.
2. Group B : Blood possesses antigen B and antibody a.
3. Group AB : Blood possesses antigen A, B and both antibodies are absent.
4. Group O : Both antigens are absent and possesses antibody a, b.

Table : On the basis of the blood group the donor's and recipient's list.

Blood group	Can donate the very groups	Can receive the very group.
A	A, AB	A and O
B	B, AB	B and O
AB	AB	All group
O	A, B, AB, O	O

From this table you can see that people with O are called universal donor. People with blood group AB can receive the blood from all groups. So the people with blood group AB are called universal recipients.

Donation of blood and social responsibilities: Excessive bleeding due to serious injury, accident, operation, natural calamities or for any other reasons the amount of blood decreases abruptly. Emergency transfusion of blood is the only way to recover this anemia. At present blood donation to other is a common practice. Emergency can be met by blood transfusion from one to another person directly or by using collected blood from blood bank to cause to enter blood from others through the veins is named blood transfusion. It is an effective measure and as a result it saves life of a patient. Without examining the blood group and its nature, blood should not be transfused at any circumstances. If it is violated that creates different complexity in patient and increases the possibility of death. Example agglutination red blood corpuscles, decomposition, causes jaundice and elimination of red blood corpuscles (haemoglobin) with urine.

On emergency basis blood is required for the accident wound people. Blood has no substitute, in this situation a lot of blood is necessary. By collecting blood from others, this emergency crisis can be met up. To meet up this emergency situation the cooperation of general mass is necessary. To donate blood to others is a noble task. It causes no harm to the donor. A healthy person can donate 450 milliliter of blood. 20 million of red blood corpuscles are produced in every second. A healthy person can donate blood in every 4 months. This amount of blood loss will not create any harm to donor.

Nowadays to inspire blood donation different programmes are arranged. Example blood donation on a particular day or occasion. Fear and false conception regarding blood

donation is decreasing day by day. Now people are more conscious and eager to donate blood or accept blood to meet the crisis.

Structure and function of heart: The heart is a triangular shaped, hollow muscular pumping organ. It is situated in the left side in between the two lungs. Heart consists of special involuntary muscles. It surrounded by a thin membrane named pericardium. The heart of the wall consists three layer, Example- (1) Epicardium (2) Myocardium and (3) Endocardium.

(1) Epicardium: Basically it consists of connective tissue. This layer is covered with epithelial tissue. Fat bodies remain scattered on it.

(2) Myocardium: This layer is in between epicardium and endocardium. It consists of strong involuntary muscles.

(3) Endocardium : It is the inner most layer. The chambers of the heart are surrounded by this the endocardium. This layer also covers the valves. The inner part of the heart is hollow and four chambered. The upper chambers are right and left auricle or atrium and lower chambers are right and left ventricles. The atria are comparatively thin walled and ventricles wall are muscular and thick. The two atria and ventricles are separated by inter auricular and interventricular septum respectively.

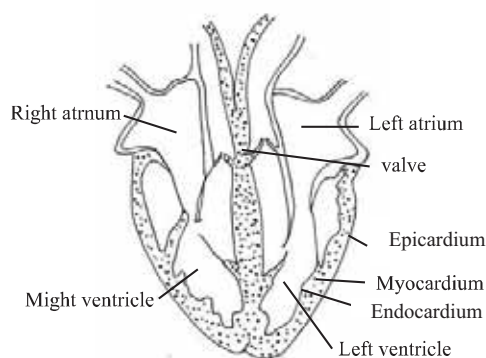


Figure: 6.7 Human heart

The aperture between the two atria (atrium singular) and ventricle are guarded by valves. The right auriculoventricular aperture guarded by a tricuspid valve made up of three flaps. Similarly left atrium and ventricle is guarded by a bicuspid valve made up of two flaps. The opening of the aorta and the pulmonary artery is guarded by valves called semilunar valves allow the transport of blood in one direction and prevents the back flow of blood.

Circulation of blood through the heart: We have learned earlier that heart acts like a pump. Heart works by contraction and relaxation. The continuous contraction and relaxation transports blood throughout the whole

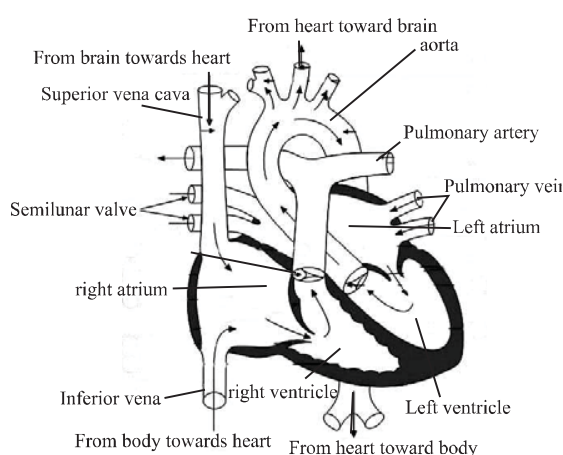


Figure: 6.8 Internal structure of heart and blood circulation

body. **Systole**: the contraction of heart (ventricle) and the **Diastole**, the relaxation of heart ventricle. A complete contraction (systole) and relaxation (diastole) of the heart constitutes a heart beat.

Due to the relaxation of atria (auricles) the blood enters the heart coming from different parts of the body. Such as – deoxygenate blood from the superior vena cava enters right atrium. At the same time, the oxygenated blood enters to the left atrium through the pulmonary veins from the lungs.

The walls of the two atrium contract and then muscles of the ventricle relax. As a result the tricuspid valve situated between the right Sino auricular ventricular apertures opens. So the deoxygenated blood from the right (auricle) enters into the right ventricle at the same time left Sino auricular ventricular aperture guarded by bicuspid valve opens. Then oxygenated blood from the two ventricles contract together and during this period the left and right auriculoventricular apertures are closed by their tricuspid and bicuspid valves. So blood of the ventricle cannot return to the atrium when the two ventricles relax deoxygenated blood, the right ventricle passes through the pulmonary artery towards the lungs. Here blood becomes purified.

At the same time oxygenated blood leaves the left ventricle through the aorta towards the body and the opening of both the artery (aorta and pulmonary artery) are closed by semi lunar valves which prevents blood returning into the ventricle. Thus successive contraction and relaxation of atrium and ventricle help in continuous transportation of blood.

Functions of Heart: Heart is the principal organ of the circulatory system. It helps blood in keeping continuous moving. The human heart is divided into four chambers. In higher animals the chambers are completely separated so oxygenated and deoxygenated blood does not mix.

Blood vessels : The channels, through which mass flow of the blood occurs, are called blood vessels. Through these vessels blood is carried away from the heart to different parts of the body and again blood from the different parts of the body is carried to the heart. According to the size, shape and function blood vessels are of three types; artery, veins and capillary-

1. Artery: The blood vessels, which carry oxygenated blood away from the heart to different organs of the body, are called arteries. Pulmonary artery is the exception. This exceptional artery carries deoxygenated blood from heart to the lungs.

Each artery is made of three layers : (1) Tunica external- which is made of connective tissues. (2) The middle layer made of round involuntary muscles is tunica media. (3) Tunica intima is the innermost layer made of simple endothelial tissue. The walls of the arteries are elastic and thick. The arteries do not have any valves and has narrow passage or lumen. When the heart contracts the blood transports through the arteries and

arteriole (small arteries) it proceeds like wave. The dilation and contraction of artery are known as pulse. Flow of blood within the artery elasticity and contraction and relaxation pushed into the arteries presses outwards against the artery walls. The ripple of pressure which passes down the artery. As a result of heart beat is the cause of pulse. You can feel the pulse by pressing the finger tips of one hand on the wrist of the other.

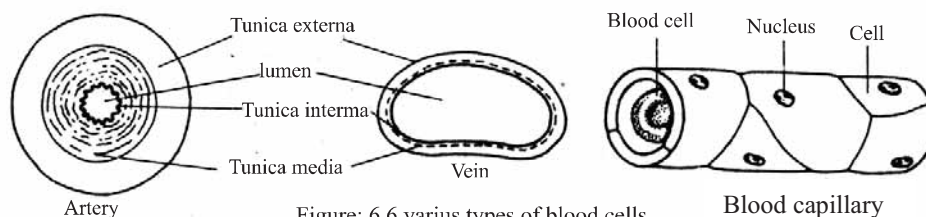


Figure: 6.6 various types of blood cells

Capillaries : The hair like small delicate blood vessels are visible in the muscle fibre, are called blood capillaries. These connect with smallest artery in one side and vein on the other side. All arteries are divided into secondary and lateral branches and form a fine net work. Each cell is surrounded by blood capillaries. The walls of the capillaries are thin. Through this thin layer substances dissolved into the blood diffuse into the cells.

Veins : The vein vessels which carry blood from the various organs of the body towards the heart are called veins. They spread all over the body just like artery veins originate from the capillaries, numerous capillaries together form small veniule, veins and vena cave open directly into the heart. Veins are also made of three layers, veins are thin walled, less elastic and with less muscles. The veins have valves and wider passage or lumen. Besides some exceptions all veins carry deoxygenated or carbon dioxide enriched blood.

Work : Determine differences between artery and vein.		
Characteristics	Artery	Vein
1. origin and ending		
2. Direction of blood flow		
3. Nature of blood		
4. wall		
5. Lumen or passage		
6. Valve		
7. Location		
8 Blood pressure		

Blood pressure: Blood pressure is the pressure of the blood against the wall of the arteries. The contraction of the heart is called systole. The pressure in the artery during systolic condition is called systolic blood pressure. The pressure in the artery during

systolic condition is high. Relaxation of the heart is called diastole. The pressure during the diastole condition is called the diastolic pressure. The pressure in the artery during diastole condition is called the diastolic condition when blood pressure is less. Blood pressure can be measured with the help of sphygmomanometer. By observing systolic and diastolic pressure with the help of this machine blood pressure is determined.

The systolic and diastolic blood pressure of a normal healthy man is 100-150 mm and 65-90 mm of the height of mercury respectively.

Ideal blood pressure: According to the physician a normal adult man's blood pressure is generally near about 120/80. This indicates two digits. That indicates two ranges one for higher and the next one for lower. The blood pressure in the arteries is the highest during systolic blood pressure ranging from 120 or slight less than that. The blood pressure in the arteries decreases during diastole. This is diastolic blood pressure ranging from 80 or slight less than that. In between the time of two heart beats this pressure is created. The difference between the two pressures in the arteries are called pulse pressure. The normal rate of the pulse, therefore the heart beat rate is about 70 beat per minute in an adult at rest. Normally pulse rate is measured in the radial artery at the wrist. It can be measured by the blood pressure machine on sphygmomanometer.

High blood pressure or Hypertension: High blood pressure is considered as the silent killer disease. According to World Health Organization report within 2020 stroke, coronary artery diseases will be the number one life threatening disease. In the south Asian countries it will break out as an epidemic disease. One of the main causes of heart disease and stroke is high blood pressure.

What is hypertension?

When the heart pumps blood into the arteries, the blood pressure against the wall of the blood vessels is called blood pressure. When blood pressure rises above the normal pressure then it is considered as high blood pressure. A normal adult person possesses the systolic pressure 120 and diastolic pressure 80 or below it is considered as desired measure. When systolic and diastolic pressures rise more than the normal pressure, this is called high blood pressure or hypertension.

Causes of Hypertension and its risk:

There is strong probability of hypertension for those whose parents have got this disease. Besides this those, who suffer from tension or smoking habit, have the probability of hypertension. Increase in body weight, intake of excessive salt and fatty diet and history of diabetes and cholesterol of family members are the causes of this disease. Eclampsia at the time of child birth is the cause of hypertension.

Diagnosis: Blood pressure can be examined with the help of pressure measuring apparatus called sphygmomanometer. Before measuring blood pressure the patient

should take rest. Blood pressure should be measured at least two times at the interval of 1 or 2 minutes.

Symptoms and signs of Hypertension: Headache, primary symptom is ache at the back of the head, vertigo, shoulder pain, palpitation, and weakness. Sometimes bleeding from nose, sleeplessness or insomnia, easily tiredness after little exertion.

Work : Learn the skill of measuring blood pressure and write your friends blood pressure in the table given below.

Name of the student	Blood pressure systole/diastole.	Remarks

The blood pressure may vary more or less due to health, age, activities and disease, To prevent blood pressure certain rules should be followed, such as:- decreasing of body weight of those who are over weight, taking less amount of fatty food, use less salt in food etc. If the pressure is very high, consult a doctor and take medicine regularly.

Cholesterol :

Cholesterol is a compound hydro carbon cholesterol. It is an important component in the cells of higher animal. Cholesterol circulates with blood as lipoprotein. It is made of three types of lipoprotein. It is called LDL (Low density lipoprotein) many persons describe it as a bad cholesterol. Generally there is 70% LDL in our blood. This amount may vary person to person. Usually HDL (high density lipoprotein) is called good protein. According to the specialist's view, HDL decreases the risk of heart disease. HDL does the quiet opposite task of LDL in growth.

The third type of cholesterol is triglyceride. It remains within our food and as fat in our body. That's why it exists in plasma. Blood fat exists as a compound which is formed by the combination of triglyceride and cholesterol. Triglyceride is produced from animal fats and carbohydrates in food. Range of cholesterol in blood that is shown in the table below.

Types of cholesterol	Male m mol/L.	Female m mol/L
LDL	1.68-4.53	1.68-4.53
HDL	0.90-1.45	0.90-1.68
Triglyceride	0.45-1.81	0.40-1.53

Food contains huge amount of cholesterol. Such as- Butter, Prawn, Oyster, Liver of cattle, egg especially egg yolk etc.

Problems of high cholesterol in blood : Different health problems are created for the presence of high cholesterol. By the formation of arteriosclerosis the passage of artery becomes narrow, so the space for blood flowing decreases. It increases the possibility of

having coronary heart disease. In the lining of the large and medium arteries depositing of cholesterol forms obstruction in blood flowing and it hampers in mechanism of circulation through heart. So cardiac muscles can not get sufficient oxygen that causes damage to the muscles.

Blood flow in the heart decreases, so the diseased feel chest pain. This is called angina. Blood flow in brain may stop when any vein or artery of the brain ruptures, this is called stroke. In this situation brain cells tend to die. As a result it hampers the normal activity of the brain.

Functions of cholesterol- Usefulness and its risk:

Cholesterol is involved in constructing cell membrane and its protection. It determines the permeability, allows different substances to enter or resist. It helps in producing and reproducing hormones such as, androgen and estrogen. Cholesterol is utilized in producing hormone of adrenal gland and in production of bile. Cholesterol in skin prepares vitamin 'D' in presence of sunlight. Cholesterol is essential for the metabolism of fat soluble vitamins, such as- vitamin A, D, E and K. For the activities neurons cholesterol is essential. Cholesterol is closely related to the prevention of diseases. It is proved by research the presence of high cholesterol is related to the irregularities of heart and blood transportation. Though it is one of the important components of bile, it is a waste product and it is eliminated by the liver. Increased amount of cholesterol deposits in the gall bladder as sediments. The sediment of cholesterol forms stones which is familiar as gall bladder stone or gall stone. If the amount of lipid increases up to the 20-30 percent for certain reasons diseases like malaria, diabetes, syphilis etc and poisonous action of alcohol, carbon monoxide, phosphorus etc are the causes of increasing cholesterol. This condition is called fatty liver.

Irregularities in blood- (Leukemia) :

There are three types of blood corpuscles in a healthy body. The red cells in blood are the red blood cells, that supply oxygen to the body. Germs enter the blood, white blood corpuscles destroy them easily. Platelet helps to clot the blood at wound of the blood vessel, to stop the bleeding. Blood cells are made by the red bone marrow of certain bones.

The cancer of blood cells is named leukemia. It is formed because of over formation and over multiplication of white blood cells from the bone marrow. As a result the symptoms are exposed, such as- heart problem, chest pain, hemorrhage from the nose, wound in skin, bone joint pain in hands and legs and swelling, tremor of hands and legs etc. These are several varieties of leukemia. Swift spread of this disease may create severe problems, especially in young people.

Some diseases of blood circulatory system and remedy:

Heart Attack: When blood clots at any parts of the heart that stops the blood circulation or is obstructed. That causes the damage of cardiac cells or cardiac muscles. It results in myocardium infarction or coronary thrombosis disease. The number of heart attack

particularly coronary heart disease patient is increasing in Bangladesh. Oxygen and digested food products are carried by the blood stream to all cells of the body from heart. There are mainly three blood vessels of the heart itself to carry out its activity properly and to gain the strength of the muscles.

These are called coronary artery. Sometimes there is deposition of lipid that forms blockage in the wall of these arteries which creates obstacle in the flow of blood stream. So it causes life threatening heart disease. Now a days not 40-60 years old persons are attacked with heart disease but also in many cases 18 years old young men are attacked with this disease.

The main causes of this disease are over weight, taking of unhealthy diet, example:- oil enriched food (Biriani, Tehari etc.) fast food. (Berger, Beef or chicken patties etc.) leading lazy life, lack of physical exercise causes this disease. After all depression, emotional strain, anxiety, sadness increase the risk of this disease of any age.

Symptoms of the diseases : Symptoms of heart attack are feeling severe chest pain, particularly pain in mid chest that does not decrease by taking antacid. The pain spreads from the left side to all over chest. Pain also spreads towards neck and left hand. The patient complains that he or she feels pressure on the chest and sweats.

Remedy: Do not ignore the situation, do E.C.G as early as possible consult the doctor and render treatment, coronary heart disease is a dangerous heart disease.

- To keep free from this disease some rules should be followed, so that the blood pressure can be controlled.
- Avoid smoking, take regular exercise like walking.
- Change food habit, eating sufficient amount of fruits and vegetables.
- Avoid fatty diet, fried spicy and fast food.

Measures to keep the heart sound / healthy: Through rhythmic contraction and relaxation, the cardiac muscles control the circulation of blood within the body from a particular stage of the embryonic condition till the last moment of death. For life and death role of heart is very important. exact life style and selection of food is the necessary to keep the heart healthy. Different kinds of fats or oils obstructs in its task, cholesterol creates obstacle in blood vessels that is injurious to health.

For alcoholism and addiction increase heart beat than its normal amount. So the addicted person get mental pleasure and peace for a while, but it causes serious harm to the heart. Poisoning due to smoking and nicotine of tobacco (Jordha) damages not only the other organs but also the heart. One can be sound in body by proper selection of food. Avoiding fatty diet, Such as- oils, fats, excess carbohydrate and taking balanced diet, regular exercise and walking can make a person healthy.

Rheumatic fever: Rheumatic fever is the result of a streptococcus infection such as inflammation of trachea, scarlet fever, tonsillitis or middle ear infection. The initial attack of the disease usually occurs in childhood and may affect many parts of the body especially the heart. If the rheumatic heart disease does develop, it sometimes injures the heart muscle and its valves. So heart can not pump adequate blood and flow of blood within the body decreases.

Sometimes it is difficult for a doctor to diagnose rheumatic fever. Later increasing severity of disease, weight loss, anemia, exhaustion, poor appetite, pallor etc indicate the presence of the disease. Later pain in the joint, which may even become red and swelling is seen. If the disease is detected or identified in early stage, penicillin may be used to prevent it. Many physicians recommend penicillin be given regularly to children who have rheumatic fever until they reach adulthood.

Exercise

Short answer questions

1. What is transpiration?
2. What is diffusion?
3. How many kinds of blood cells are there and what are those?
4. What are the functions of artery?
5. What do you mean by blood pressure?

Essay type questions

1. Describe the measures of keeping the heart healthy / sound.
2. Describe the process of absorbing water with diagram.

Multiple choice questions:

1. What is the name of the heart covering membrane?

a) Epicardium	b) Miocardium
c) Pericardium	d) Endocardium
2. Arafat saw some swelled raisins at the time of eating a food (payesh) made of rice, milk and sugar. In this case, what is the cause of the swelling of these raisins?

a. diffusion	b. absorption
c. osmosis	d. imbibition

Observe the stem given below and answer questions 3 and 4.

Name	Blood group
Rafin	A
Tamim	B

Tasmia	AB
Ratul	O

3. If blood input is necessary for Rafin , from whom he can take blood?

- a) Tamim b) Tasmia c) Ratul d) Tamim and Ratul

4. Tasmia –

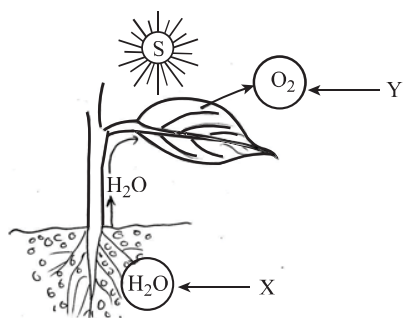
- i) Carries A, B antigen in blood ii) can donate blood to Rafin
iii) Can receive blood from Tamim.

Which one is correct?

- a) i and ii b) i and iii c) ii and iii d) i, ii and iii

Creative question

1.



- What is adhesion?
- What is imbibition?
- Explain what the effects will be on the process for the absence of the constituent S.
- Analyze the problems that may develop with the plant if the element X does not reach the region Y.

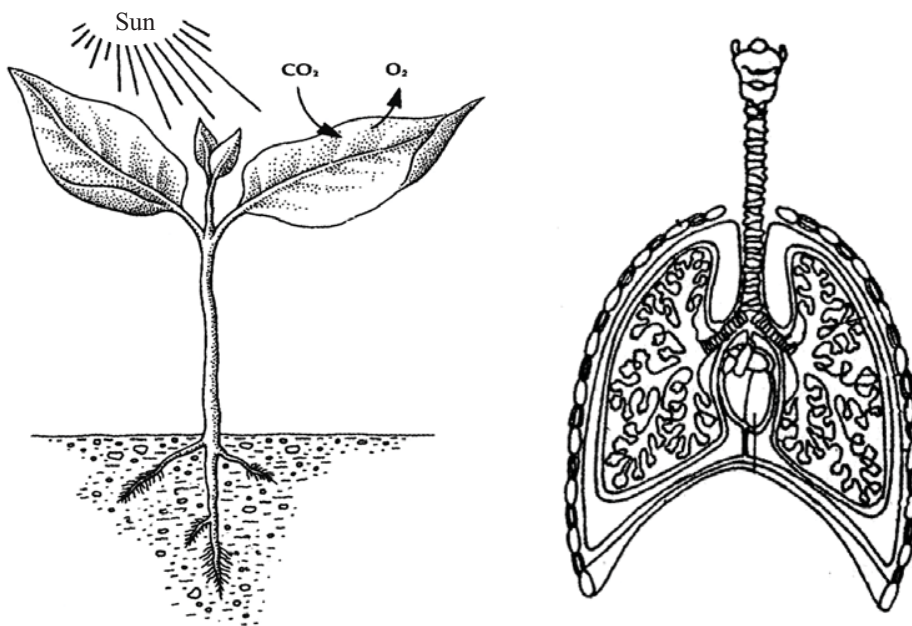
Creative question :

- Mr. Hasan is 50 years old. He serves in a socio-economic institution. He is feeling headache, palpitation, restless. On the other hand his 7 years old daughter Moon feels joint pain, and her skin turns swollen and reddish. They consulted a doctor. After some tests he advised necessary measures.
 - What is blood?
 - Explain how white blood cells protect body?
 - Explain the causes of Mr. Hasan's disease?
 - Which disease is incurable from the problems mentioned in stem- explain with reasons.

Chapter Seven

Exchange of gases

Except some exception gaseous exchange occurs in all organisms. gaseous exchange in plants are of different types. Gaseous exchange in plants and animals are discussing matter in this chapter.



At the end of this chapter, we will be able to-

- Explain the idea of plant's gaseous exchange.
- Explain the function of main organs of respiratory system.
- Describe the structure and function of lungs.
- Describe the gaseous exchange in human.
- Explain the causes, symptoms, remedy and the preventive measures of respiratory system.
- Determine the nature of exhaling air.
- Draw the labelled diagram of lung.
- Create awareness to prevent respiratory diseases.

Gas exchange in plants

We know that photosynthesis and respiration are the two very important processes in the life of a plant. A plant exchanges gases mainly through these two physiological processes. These two processes are accomplished through many chemical reactions. A plant acquires different gases from its environment for its physiological activities, and after the completion of chemical reactions, it releases another gas in the environment. There is no special organ in

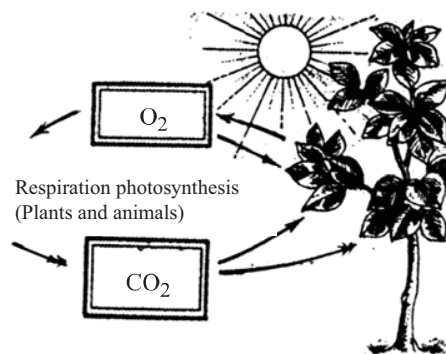


Figure: 7.1 Gaseous exchange in plants

the plant to breathe. The exchange of oxygen and carbon dioxide and other gases occurs through the stomata of leaves and lenticels on the bark of the mature stem. In plants, the frequent exchange of oxygen and carbon dioxide does not occur as it happens to an animal. In daylight or in the presence of sufficient light, the rate of photosynthesis becomes high. A part of oxygen gas, produced in photosynthesis, is spent in respiration. Reversibly, a part of carbon dioxide gas, produced in respiration, is used in photosynthesis and so the amount of gases, exchanged, are approximately the same.

At night the photosynthesis process ceases, and so oxygen gas is not produced. But the respiration process occurs round the clock day and night, and the production of CO_2 continues. The carbon dioxide gas is released in the environment through stomata. These gases are also exchanged through the lenticels developed in the bark of the mature stem. This is why breathing problem may develop if someone sleeps under a big tree at night.

A plant obtains its required gases from its environment. Just as the leaf absorbs oxygen, carbon dioxide and other gases, root also absorbs required gases from the soil water. In this way exchange of gases goes on in a plant.

Human respiratory system:

To sustain life, oxygen is indispensable for a living being. Not a single animal can survive without oxygen even for a while. Oxygen enters the body with air and is pushed into the lungs and that is carried to all of the organs through blood. Within the somatic or body cells food substance uses oxygen to break down the digested food substances sugar (glucose) to produce heat and energy. This heat keeps the body warm and supplies necessary energy.

Oxygen reacts with the digested food substances (sugar, glucose) to produce carbon dioxide and oxygen. Blood carries these substances to lungs. Here oxygen is absorbed and carbon dioxide is expelled. The process by which inhaling of oxygen and exhaling of

carbon dioxide occurs is referred to as breathing. The biological process, in which digested food substances in the body cell are oxidized, converts the potential energy into useable (kinetic energy) energy and eliminates carbon dioxide, is called respiration. The exchange of oxygen and carbon dioxide occurs within lungs and cell simultaneously. The simple equation of respiration is given below-



You have learnt in class seven that inhaling of oxygen is inspiration and breathing out of carbon dioxide is expiration. Otherwise one can not survive because if the supply of oxygen stops for 3 – 4 minutes death is eminent. In both conscious and unconscious conditions inhaling of oxygen and expelling of carbon dioxide goes on continuously. Along with this process other processes also continue as usual. So animals survive.

Human Respiratory System:

Organs, which take part in respiration are called, respiratory organs. These organs comprise the respiratory organs. These organs comprise the respiratory system. The organs related with the respiratory system are :

- (1) Nasal cavity and Nasal passage,
- (2) pharynx,
- (3) larynx,
- (4) trachea,
- (5) bronchus,
- (6) lung and
- (7) diaphragm.

(1) Nasal cavity and nasal Passage : Nose is the beginner of respiratory system. It is a triangular hollow organ situated above the buccal cavity. It helps to feel sweet and bad smell of a substance. A specific type of nerve stimulates the organ, so it gives us the sense of smell. It consists in such a way that makes inhaling air suitable, so lung can accept it.

Nasal passage extends from aperture in front of the nose and up to pharynx behind. A thin partition divides it. Its front side is covered with cilia and hinder part is lined by mucous producing membrane.

The cilia together with mucus serve to trap or arrest the passage of foreign substances, such as germs and

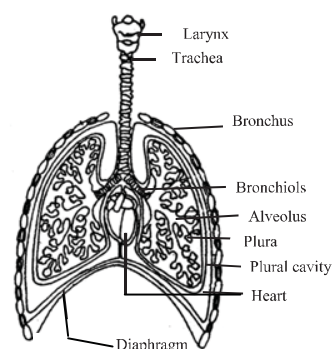


Fig: 7.2 Human respiratory system

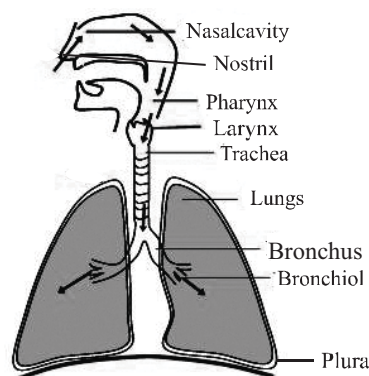


Figure: 7.3 Nasal passage and pharynx

dust. Before entering the lung this makes the air relatively free from dirt to some extent. The air in the nasal passage is warm upto body temperature and humified. So that the cool air can not do any harm to the lung.

(2) Pharynx – If we open our mouth, pharynx can be seen at the hind part of the mouth. It extends posteriorly of the nasal passage upto the upper part of larynx.

(3) Larynx – The larynx or voice box is a cavity. It is situated below the pharynx and at the top of the trachea. There are two folds of membrane situated on opposite sides of the larynx. These cords are vocal cords. A flap of soft tissue at the back of tongue is epiglottis. It acts as a lid at the time of taking food. This lid covers the opening of the larynx, so the food particles can not enter the esophagus but keeps the larynx open during respiration. So air gets into lungs through this passage. But it has no function in respiration.

(4) Trachea- It is a long tube which lies in front of the esophagus and extends from the larynx downwards in the thoracic cavity. It is supported by rings of cartilage and smooth muscles. The inner layer of the trachea is covered with mucus membrane and cilia. Air flows through the trachea. But the constant rhythmic beating of the cilia the trapped dust, germs and other unwanted particles throw it out.

(5) Bronchus- The lower end of the trachea is divided into two bronchi which lead to right and left lung lobe respectively. These are bronchi divides and sub divides repeatedly form bronchioles. The structures of the bronchi are just like trachea.

(6) Lungs- Lung is the main organ of the respiratory system. The right and left lungs are situated on either side of the heart within the thoracic cavity. It is spongy, soft and light reddish in colour.

Right lung is three lobed and the left one is two lobed. The inner surface of the lung is covered by a double layered membrane. Which is named as pleura. Space between the two layers contains one type of fluid.

It saves lungs from friction as the lungs rub against the thorax during breathing. Movement. Lung contains numerous air sacs or alveolus, smaller bronchioles and blood vessels. The air sacs are called the alveolus.

The smaller bronchioles (alveolar ducts) terminates in clusters of alveoli. So air can enter from the nasal passage to the alveoli directly. Each alveolus (singular of alveoli) wall is

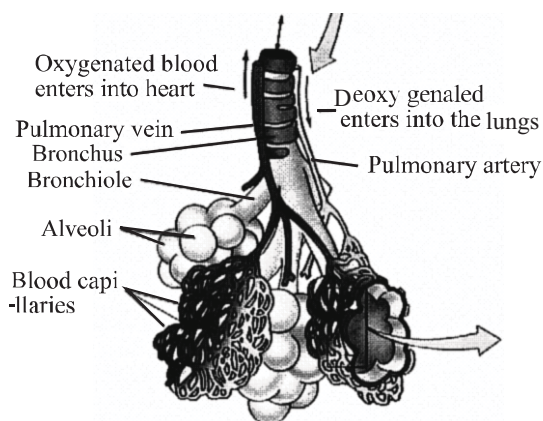


Figure: 7.4 Airsacs inside the lungs

composed of a single layer of epithelial. The alveoli are surrounded by mesh work of capillaries.

When air enters the alveolus, it expands like a balloon and contracts automatically. The wall of the alveoli and blood capillaries are so thin that gaseous exchange occurs between them.

(7) Diaphragm- Diaphragm is muscular sheet which separates the thoracic cavity from the abdominal cavity. It looks like a spreading or stretching umbrella. When diaphragm contracts, it moves downwards the volume of the thoracic cavity increase. When diaphragm expands it moves upward. Thoracic cavity contracts return to its normal position. Diaphragm plays an important role in respiration.

Work: Draw the diagram of respiratory system and label its different parts.

Breathing- All the organs related to breathings remain open only through pharynx and other ends of the organs remain closed. So the air enters air sacs of the lung easily through the nasal passage. Nerve impulses help in managing breathing. Inter costal muscles (muscles within the ribs) and diaphragm contract. So the diaphragm goes downwards and thoracic cavity expands. The space / volume of the thoracic cavity increases and the air pressure decreases. So the pressure within the thoracic cavity becomes less than the outer atmospheric pressure. So forcing the lung to expand and draw air through nose and trachea. This is inhaling. After contraction the muscles relax. Then the diaphragm expands and muscles relax allowing the diaphragm and thorax to return to its normal position. So the air pressure increases, the lung shrinks back forcing to moisten and carbon dioxide enriches air expel out again. This is exhaling. In this way breathing goes on at every moment / constantly. This is external respiration.

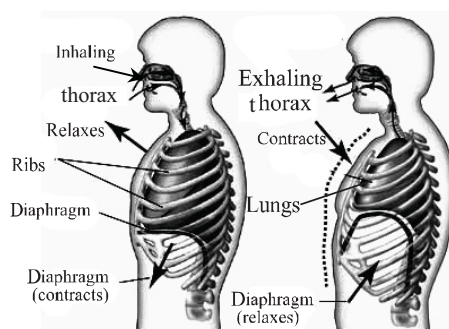


Figure: 7.5 Inhaling and exhaling

Gaseous exchange: means the exchange of oxygen and carbon dioxide. Basically it occurs in between the air and blood vessels of the lung. Gaseous exchange occurs in two steps, such as absorption of oxygen and giving out or expelling of carbon dioxide.

Absorption of Oxygen: Gaseous exchange in the lung takes place by diffusion. In blood oxygen does not remain free. A large amount of oxygen combines with the haemoglobin of the red blood corpuscle and forms oxyhaemoglobin. It is a temporary compound. Production of these compounds depends on the concentration of oxygen in plasma. During the blood transport a large amount of oxygen diffuses from the plasma to lymph.

It happens when oxygen concentration in lymph is less. So the oxygen concentration in plasma becomes less. Then haemoglobin begins to give up oxygen which was bound with it. In this way at first oxygen enters plasma and then into lymph or intracellular fluid. Mentionable steps which occur during oxygen transportation are described below.

The exchange of gases between alveoli and blood and tissue occurs by the process of diffusion. Diffusion of gases takes place due to gas pressure difference. After entering oxygen into blood from the lung dissolving oxygen flows in two ways. Small amount oxygen flows in plasma and most of oxygen makes a loose bond with the heme part of haemoglobin and forms a temporary compound that is oxy haemoglobin. From oxy haemoglobin oxygen separates easily.

Haemoglobin + oxygen \longrightarrow oxy haemoglobin

Oxy haemoglobin \longrightarrow free oxygen + haemoglobin

After entering the blood capillaries oxygen separates and penetrates into lymph by diffusion first from red blood corpuscle and then blood capillaries. At last from lymph oxygen reaches to cell after penetrating the cell membrane.

Carbon dioxide transport: Carbon dioxide is produced by oxidation of food. This carbon dioxide at first diffuses through the cell membrane into the lymph and then from the lymph enters the plasma by diffusing through blood capillaries. Generally carbon dioxide is transported in the form of carbonic acid, bicarbonate and carbamino. There after carbon dioxide mainly transports in blood as bicarbonate to the lung. In the lungs the carbon dioxide is released from bicarbonate and passed to the alveoli. Then carbon dioxide forced out diffusing through blood capillaries and alveoli.

Work – 1 : Experiment to show the nature of exhaled air.

Apparatus : Two large test tubes, lime water and two plastic tubes.

Procedure: Prepare two large tests as shown in each containing a little clear lime water. Put the end of both plastic tubes with in the test tubes that it touches the water surface. Now put the other ends of both plastic tubes at the same time in your mouth and breathe in and out quietly through the tubes for about 15 seconds. Notice which tube is bubbling when you breathe out and which one bubbles when you breathe in. Notice is there any difference in lime water? It after 15 second there is no difference in the appearance of the lime water in the two tubes. Continue breathing through them for another 15 seconds.

Observation: You will observe that the lime water in the testtube B. has changed. Because exhaled air has entered into the lime water.

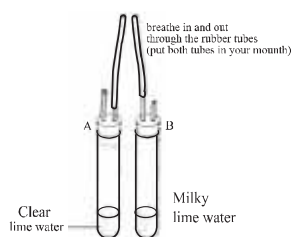
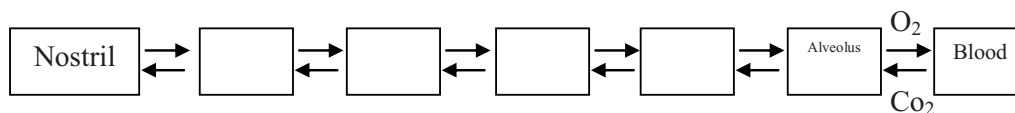


Fig: 7.6 Comparing the carbon dioxide content of inhaled and exhaled air

Result: The presence of CO_2 in exhaled air has changed the colour of lime water into milky white. Exhaled air contains more CO_2 than the inhaled air. On the other hand inhaled air contains less CO_2 . So the colour of lime water remains unchanged.

Work: Fill in the table given below:



Diseases of Respiratory system: Lung is an important organ of respiratory system. This organ is damaged by the infection of bacteria virus owing to our ignorance and uncarefulness causes complex diseases and infections. Complexity and death of common diseases can be decreased by acquiring knowledge about cause, symptoms, remedy, prevention of common diseases.

1. Asthma : Cough and cold are the causes of smoking, pollution and viral infection. Asthma develops permanently due to prolong cough, cold and sneeze. It is not a contagious or microbes borne disease.

Cause: Certain allergic foods, (prawn, beef, hilsha-fish etc.) smoke, dust, pollen etc. entering the lung with the inhaling air, can be the cause of Asthma. In infants common cold may cause symptoms of asthma.

Exception: Difference from other disease is that a seasonal variation is noted. Symptoms of asthma increase in certain seasons round the year.

Symptoms and signs: The symptoms of the disease are as follows –

- Sudden increase in respiratory distress.
- Suffocation, lip becomes blue, the veins of the neck swell.
- Rapid deep breathing is attempted and whizzing and whistling sound in the chest.
- As sufficient oxygen is not available in the alveolus, that results the suffering of the patient.
- White cough secretion may come out with sputum cough.
- Usually there is no fever.
- During inspiration, the skin between two ribs is drawn inward.
- Patient becomes weak.

Remedy: By proper medication the disease is not fully cured. But by proper medication prompt relief may be ensured.

- Avoid of taking allergic food.

- To live in clean open air.
- To avoid eating or contact with items that exacerbate the symptoms of such as animal fur, artificial fiber etc.
- Be careful and follow physician's advice.
- Stay away from smoking, tobacco, jarda, gul.
- Serve liquid diet to the patient.

Prevention :

- Live in the healthy / atmosphere.
- Avoid air pollution, place or occupation of those whose asthma is caused.
- Always carry breath relieving medicine and utilize it when necessary.

2. Bronchitis: This is acute and chronic inflammation of the inner lining of any part of the bronchi and bronchial tube is called bronchitis. The disease is caused by bacterial infection. Living in the unhealthy conditions, inhaling dust, polluted air, smoking cigarettes and cold are some of the reasons that may cause bronchitis. Once attacked by bronchitis there is every possibility of frequent attack. Usually infants and elderly persons are attacked by this disease. Unhealthy environment and pollution is considered as the principal cause of this disease. e.g. industrial dust, smoke.

Symptoms :

- Cough, chest pain and breathing distress.
- At the time of coughing the patient feels severe chest pain.
- Fever and gradual weakness.
- Can not take solid food.
- Secretion of sputum.

Remedy : Preventive measures include-

- Stop smoking, drinking alcohol, use of tobacco.
- Follow treatment according to physician advice.
- Keep the patient in tolerable temperature and dry environment.
- Feed nutritious liquid and hot food, e.g. hot milk, soup etc.
- Taking full rest.

Prevention: Bad habits like smoking, drinking alcohol, taking tobacco should be stopped.

- Abstain from dust, smoked.
- To be careful children and elders are not attacked cold on their head.

3. Pneumonia: Pneumonia is a lung disease. Excessive cold may cause disease. Excessive cold after Bronchitis may lead to Pneumonia. It is a dangerous disease for children and elderly people.

Cause: Pneumonia is caused by pneumococcus bacteria.

Symptoms: These include-

- Deposition of mucus like liquid substances which produce cough.
- Coughing and breathing distress.
- High fever and chest pain.
- Severe respiratory distress, at the last stage whizzing sound in the chest.

Remedy: These include –

- Seeking timely advice from physician and to follow the treatment given.
- Feed hot and liquid nutritious diet.
- Drink plenty of water.

Prevention: Preventive measure are-

- To be careful that the children elders are not attack cold.
- Live in well ventilated house.
- Keep the patient in tolerable temperature and dry environment.

4. Tuberculosis: Tuberculosis is well known air borne infectious disease. Any body at anytime may be affected by disease. Those who work hard, weak, live in moist and unhealthy environment are malnourished and is exposed to patients of tuberculosis are more risk of contracting tuberculosis. Most of us think tuberculosis is only a lung disease. This idea is not correct at all. Tuberculosis occurs at any organ of the body. such as- intestine, bone, lung etc.

Not every person infected with tuberculosis becomes very sick and the symptoms are not exposed easily. When the germs destroy white blood corpuscles, body become weak then the symptoms are exposed.

Cause: The disease is caused by tubercle basillus, a type of bacterium. This germ spreads in un healthy environment easily.

Diagnosis: This disease can be found out by skin test and 'X' ray.

Symptoms and signs:

- weight loss, general weakness.
- Usually cough and cold continues more than three weeks.
- Coughing, sometimes cough up blood. Evening sweat and rise of low fever.
- Chest pain, indigestion, abdominal diseases.

Remedy : It includes –

- Continue treatment according to the advice of physician.
- Treatment of the disease is a lengthy process, treatment should continue till the complete cure is achieved.

According to the physician's instruction: Follow the rules strictly by to prevent from the disease.

- Patients with tuberculosis should be isolated or send in sanatorium for effective and complete treatment.
- Keep the used material of the patient separately.
- Patient's cough and sputum should be buried in the soil.
- Proper treatment and nutritious adequate diet should be arranged without consulting the physician medicine should not be stopped.

Prevention :

- To get rid of this disease, all children should be vaccinated by B.C.G. The baby should be vaccinated within one year after birth. But to vaccinate the new borne baby is safer. At present there is an arrangement of vaccination in different health centres of the country.

5. Tumour and cancer: All of us are acquainted with the word tumour and cancer. These are the results of irregular cell divisions. In mitosis cell division a cell divides into two and two cells divide into four cells and the process continues. But here the process remains controlled. If this control is lost due to any reason, cell division continues in an irregular way. This results in the formation of tumour.

Formation of cancer cells is also the result of uncontrolled irregular cell division. It has been revealed through research that various types of papilloma virus are responsible in the development of cancer cells. Two genes E_6 and E_7 of the virus produce a chemical substance that displaces the two protein molecules which control cell division. As a result the controlling factor of cell division is eliminated and tumour is formed. Sometimes these two genes amalgamate with those of host cell and stop the functions of protein molecules that control increase of cell. Thus develop cancer cells or in other word cancer.

Cancer is a dangerous disease. Cancer develops in liver, lung, brain, breast and skin that is almost all organs of the body.

6. Lung Cancer: Among the various types of cancer lung cancer is extensive and terribly prevalent. In our country it is the leading cause of male cancer death. Smoking is considered one of the causes of lung cancer.

- Lung cancer may be caused by air and environmental pollution, habitat or can polluted working place exposure to such substances (such as- asbestos, arsenic, chromium, nickel, solid metal powder etc.)
- Tuberculosis or any other pneumonia causes one type of wound that afterwards turn into cancer.
- It is assumed that shortage of roughage in diet increases the possibility of the disease.

Symptoms and signs: Treatment of lung cancer can be started as soon as possible after detection of primary symptoms, then the possibility of long life may increase. Primary symptoms of lung cancer are found,

- Long lasting dry irritating cough.
- Chest pain, hoarseness of voice.
- Gradual or day by day loss of weight, loss of appetite.
- Asthma, frequently fever.
- Repeatedly infected by pneumonia and bronchitis.
- Feel pain in bones, weakness paralysis of any gland.
- Jaundice.

Diagnosis:

- At the primary stage lung cancer can be determined by examining cough and sputum.
- X-ray of chest.

Remedy-

- When the symptoms are found as soon as consult with the physician.
- After detection of the disease follow the advice of physician.
- Depending upon the necessity, use or apply radiotherapy.

Prevention : According to the view, preventive measures include-

- Abstaining from smoking and drinking alcohol.
- Not taking excess fatty food.
- Regular exercise.
- Making the habit of taking adequate amount of vegetables.

Professor Troll and other cancer experts of American Cancer Institute, University of New York have disclosed that different vegetables can prevent cancer.

Exercise

Short answer question

1. What is cellular respiration?
2. What is the function of Pleura?
3. What is Bronchitis?
4. What is the function of Diaphragm?
5. What is the cause of Pneumonia?

Essay type question

1. Write down the symptoms of tuberculosis?

Multiple choice questions:

1. Which is the cause of tuberculosis?
- a) virus
b) bacteria
c) fungi
d) protozoa
2. Gaseous exchange in plants occur-
- i) stomata ii) lenticels iii) root hair
- Which one is correct?
- a) i and ii
b) i and iii
c) ii and iii
d) i, ii and iii

Read the stem, answer question 3 and 4.

Rita went to the doctor with a complaint of weakness. Doctor informed her that there is a deficiency of a particular cell of blood. To meet this insufficiency he advised her to take more nutritious food and vegetables.

- 3. Which one is deficient in Rita's blood?**
- a) Red blood corpuscles b) white blood corpuscles
- c) Platelet d) plasma.
- 4. Particular cell –**
- i) constitutes with iron ii) reacts with oxygen
- iii) contains carbon dioxide

Which one is correct?

- a) i and ii b) i and iii
c) ii and iii d) i, ii and iii

Creative question:

1.



Figure-P

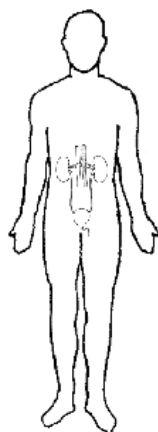
Figure-Q

- a) Which cell does carry oxygen in blood?
 - b) What do you mean by trachea?
 - c) Explain the process meant by ---- P.
 - d) F and Q are dependent to one another in connection with gaseous exchange. Give your opinion.
2. Rashed and Jamil works in ship breaking in dusty. Both of them called in a doctor chest pain, cough and other complain. After different type of tests doctor diagnosed that Rashed respiratory organ has irregular cell division.
- Jamil's disease has spread intestine and bones except respiratory organs.
- a) What is diaphragm?
 - b) What do you mean by external respiration?
 - c) Explain how does the disease spread in Rashed's body.
 - d) Which one of two diseases of Rashed and Jamil is comparatively easier to be cured – analysis the causes?

Chapter Eight

Human Excretion

A good number of chemical reactions take place inside the cells of an organism. So all the physiological phenomena are performed neatly. Organisms remain alive. Some products are produced by chemical reactions which are essential for body. The products of some of these reactions are poisonous and these must be removed from the body. For example, the breakdown of glucose during respiration produces carbon dioxide. This is carried away by the blood and is removed from lungs. Elimination of nitrogenous waste products and various diseases in kidney are discussed in this chapter.



At the end of this chapter, we can-

- Explain excretion in human body.
- Describe production of excretory products in human body.
- Describe the structure and functions of kidney.
- Describe the structure and functions of nephron.
- Explain the role of kidney in osmoregulation.
- Describe the formation of kidney stones, remedy and prevention.
- Describe symptoms of kidney failure and what measures are to be taken in these respects.
- Explain the role of dialysis to maintain the normal functions of kidney.
- Explain the concept of kidney transplantation and posthumous kidney donation.
- Describe the diseases of urinary tract and measures taken to keep it free from diseases.
- Investigate the public opinion about posthumous kidney donation.
- Draw a labeled diagram of human kidney and nephron.
- Draw poster to create social awareness about posthumous kidney donation.
- Draw leaflet to create awareness to keep kidney and urinary tract (ureter) free from diseases.

Metabolism is the biological process through which waste products are produced in and excreted from the body. These substances are of no use for the body, but it may cause various diseases if they remain inside the body for a long time. It may cause death. Excretory system assists to remove the poisonous products from the blood that maintains the physiological balance. Excessive water, salt, carbon dioxide and organic substances are excreted or expelled from the body.

Kidney is the excretory organ. The basic unit of kidney is nephron.

Excretory products: Basically excretory product means nitrogenous waste. Human excretory product is expelled from the body as urine. Almost 90% water is the component of urine. Other components are urea, uric acid, creatinine and different kinds of salts. The colour of the urine is light yellow due to the presence of a pigment called urochrome. Excessive intake of proteins increases the acidity, fruits and vegetables generally makes the urine alkaline.

Kidney: Excretory organ of human body is kidney. Two kidneys lie at the back of the abdominal cavity, on either side of the vertebral column and lower part of the ribcage attached to the back wall. They are red brown and bean shaped. The outer side of the kidney is convex and inner side is concave having an indentation called hilus. The chamber in the hilus is pelvis. There are two ureters (urinary duct) one arising from the pelvis of each kidney and proceeding downwards to open into the urinary bladder. From the hilus the renal vein comes out and renal artery enters the kidney. Pelvis is the enlarged funnel shaped part of the ureter.

Each kidney is enclosed by one type of fibrous membrane. This is capsule. In longitudinal section of each kidney shows two regions, the outer one is cortex and part is inner medulla. The regions are composed of connective tissues and blood vessels. Generally, there are 8-12 renal pyramids in the medulla. The apex of each pyramid is called papilla. These papilla projects directly into the ureter.

Each kidney contains a particular type of tubules, these are uriniferous tubules. Each uriniferous tubule has two parts, such as- nephron and collecting tubule. Urine is produced in nephron and collecting tubules carry urine to the pelvis.

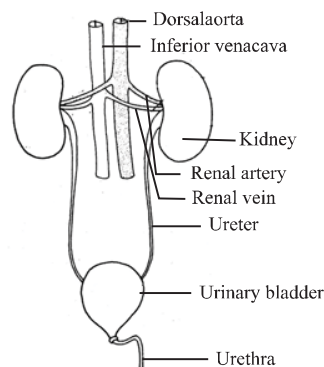


Figure: 8.1 Excretory system

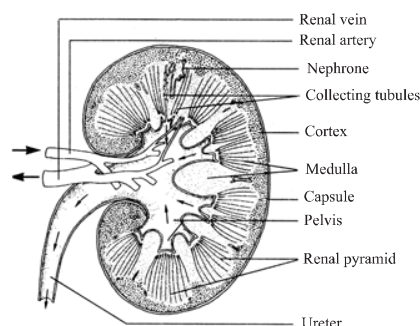


Figure: 8.5 : A nephron

Nephron : The functional unit and secretory part of uriniferous tubule of kidney is nephron. Each human kidney contains about 1 million (10,00,000) nephrons. Each nephron is composed of a renal corpuscle, malpighian body and renal tubule.

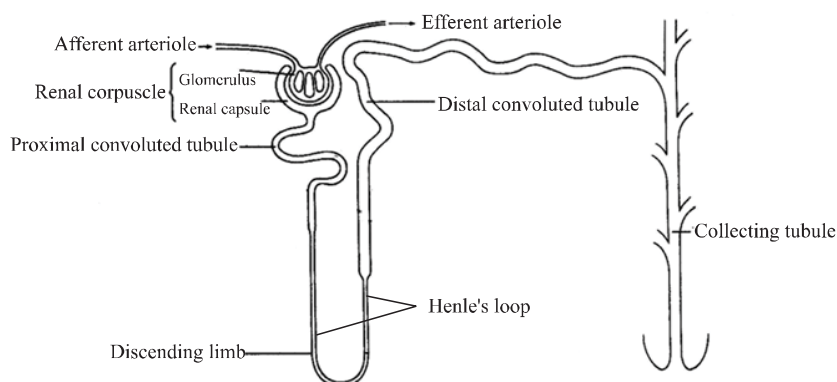


Figure: 8.5 : A nephron

Each renal corpuscle is divided into two parts, glomerulus and Bowman's capsule. Bowman's capsule encloses the glomerulus. Each Bowman's capsule is a cup shaped organ and composed of two epithelial layers. The Bowman's capsule, containing a small cluster of blood vessels is called glomerules. Afferent arteriole from the renal artery enters the capsule, after entering the Bowman's capsule it breaks into about 50 capillaries. These capillaries divide again and form a mass of fine capillaries. These capillaries unite together and form efferent arteriole and leaves the Bowman's capsule.

Glomerulus acts as a filter and produces glomerular filtrate from the blood. The convoluted tubule behind the Bowman's capsule, which spreads up to the collecting tubule, is called the renal tubule. Each kidney contains about 2 millions renal tubules. Each renal tubule is divided into three regions e.g. **proximal convoluted tubule, Henley's loop and distal convoluted tubule.**

Work: Draw a labelled diagram of kidney and a nephron.

A normal adult man expels almost 1500 milliliter urine daily. Urine contains nitrogenous waste products, such as- urea, uric acid, ammonia, creatinine etc. These are very much harmful to health. Kidney has an important role to eliminate these harmful and needless products. Each nephron of the kidney is continuously producing urine through a complex process. This urine reaches to the pelvis of the kidney through collecting tubules and proceeds through the funnel like extended part of the pelvis and enters ureter. Ureter carries urine from kidney to urinary bladder, stores there for the time being. When the urinary bladder is filled up with urine, a sensation of urination is created and allows

urine to pass out of the body through urethra. In this way kidney helps to expel nitrogenous waste product from the body. Kidney maintains the balance of mineral salts e.g. Sodium chloride, potassium chloride etc. Besides this it maintains the balance of water, acid and base of blood.

Work: Write down the organs that take part in expelling the waste produced in table given below.

Waste products	Organ	Remark
Carbon dioxide		
Nitrogenous waste products		
Urea, Uric acid		
Excessive water		

Osmoregulation

For all physiological processes adequate amount of water is inevitable. Basically, most of the water goes out of the body as urine. The main function of kidney is to keep balance of water. Nephron of kidney maintains the water equilibrium by re-absorption. Liquid substances are filtered in glomerulus. If the blood contains too much water, blood becomes dilute. It creates different complexity within the body, such as – excessive nitrogenous products in blood, harm of cell, disturbance in blood transportation etc.

Kidney stone: Small stones like substances produced by kidney is known as kidney stone. Any one can be attacked by these diseases. But it has been noticed that the male have the higher possibility of stone formation than the female. Excessive body weight/obesity, infection in kidney, drinking insufficient water, in taking of excessive protein e.g. meat and eggs are the causes of kidney stones.

Initially formation of kidney stones causes no remarkable problem and problem occurs when it goes downward the ureter water and obstructs urination. A very dull and steady pain in the back waist is the symptom of this disease. Blood passes into the urine. Fever starts with shaking. Treatment depends upon the size and location of the stones. Stones can be removed by taking sufficient water and medicament. Stones can be removed by the modern methods uteros uteroscopic copic, ultra sonic lithtripsi or surgical operation.

Kidney failure, dialysis and kidney transplants: Kidney failure occurs gradually from the diseases like nephrities, Diabales, hypertension (high blood pressure). Complex nephritis, excessive blood loss, diarrhoea etc are the causes of sudden kidney failure.

Symptoms of kidney failure are, difficulty in urination, increased level of creatinine in blood. Kidney machine (dialysis machine) can be used to remove the harmful waste

products from a patient's blood. The patient has to use the kidney machine after particular / definite intervals and the blood is purified.

Dialysis: When kidney failure happens then the process of purifying by scientific method is named dialysis. Usually with the help of kidney machine, blood can be purified.

A kidney machine (dialysis machine) receives blood through a tube connected to an artery. Inside the machine blood flows through dialysis tubing which allow small molecules, including urea, uric acid to pass through its walls. The 'cleaned' blood is returned to the patient through a tube connected to a vein.

The dialysis tubing is bathed in a liquid similar to blood plasma. In this way a kidney machine purifies blood through dialysis tubing. This allows wastes to diffuse out of the blood. But regular dialysis is expensive and time consuming.

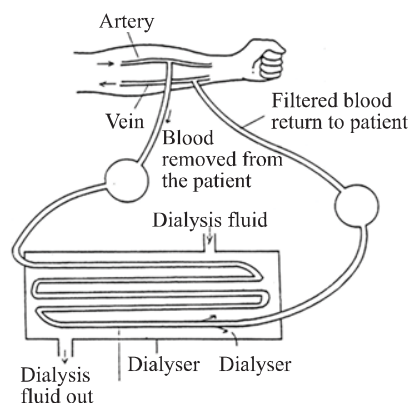


Figure: 8.4 Dialysis machine

Transplantation: An alternative to this is kidney transplantation. A person can survive adequately with one kidney. In such cases it is to replace the diseased kidney with a normal kidney from some other person. But one should be aware / sure of tissue matching between donor and recipient. There is every possibility of tissue matching if it is donated by parents, brother or sisters and nearest relatives. Again the kidney transplant can be done by collecting it from a dead man. Here dead means "brain death". Like posthumous eye donation kidney donation can save the life of a kidney failure patient. Donation of posthumous kidney is a good service to mankind.

Leading unhealthy living, drinking insufficient water causes urinary tract or ureter disease. Infection in ureter causes burning sensations along with other symptoms. Consult with doctor as soon as immediately and with proper treatment most patients recover completely.

Work: Draw a poster regarding posthumous kidney donation and place it before the students in the class room.

Measure to keep the urinary tract sound / free from diseases: Be careful about the tonsillitis and scabies of the children, keep control of high blood pressure and diabetes. Immediate treatment for diarrhoea, blood loss, avoid smoking and pain relieving medicine, drink adequate amount of water, lead a regular life.

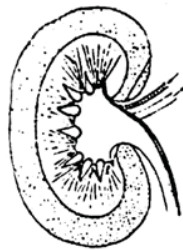
Work: Make a leaflet in a group regarding how to keep kidney and urinary tract sound.

Which one is correct?

- a) i and ii
- b) ii and iii
- c) i and iii
- d) i, ii and iii

Creative question:

1.

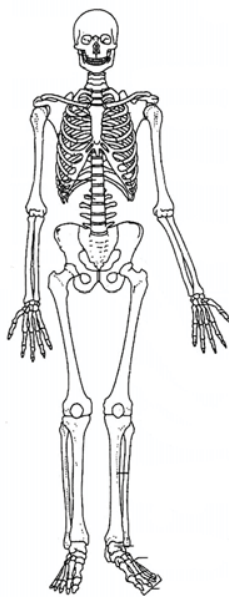


- a) What is medulla?
- b) What do you mean by glomerulous?
- c) Explain why fig. A is compared with a filter?
- d) If Fig A is damaged or inactive what measure will you take to prevent it? Give your opinion.

Chapter Nine

Firmness and Locomotion

In adverse situation man moves from one place to another in search of food, protection and breeding, etc. The process, by which animal moves from one place to another by their (it's) own effort, is called locomotion. The system, which gives the structure, definite shape and protection different organs from injury and helps in locomotion, is called skeletal system. We will be able to know about structure of skeletal system, it's function and its way of protection.



At the end of this chapter, we will be able to –

- Describe human skeleton.
- Describe the role of skeleton in firmness and locomotion.
- Explain the function of bone and bone joints.
- Explain the function of muscles.
- Explain the functions of tendon and ligament.
- Describe the cause, symptoms, remedy of osteoporosis.
- Explain the cause, symptom and remedy of arthritis.
- Assume the cause of osteoporosis and arthritis.
- Draw and label different parts of skeleton.
- Be conscious about the health / soundness of bones.

Introduction of human skeleton:

For the construction of a house at first a structural frame work is essential. Skeleton is the frame work of our body. The human skeleton is composed of in combination of long, small, flat, unequal 206 bones. It gives the definite shape to the body and protects the internal organs, such as : heart, lungs, stomach, intestine, brain etc. Without strong bony structure a fixed shape is not possible. All bones and other associated parts together constitute the skeleton which consists of bones and cartilages. Bone joints are connected together with the various parts of skeleton and assists in movement. Bones are remaining attached with the voluntary muscles that helps movement of different organs. The skeletal system is composed of bones, cartilages, ligaments, tendons, bone joints and muscles.

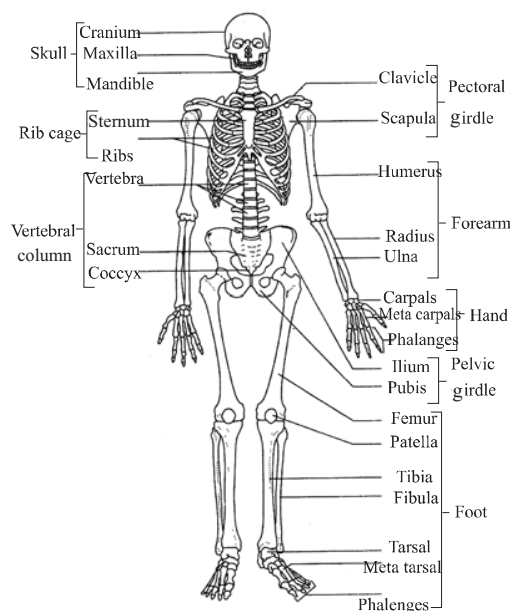


Figure: 9.1 Human skeleton

Human skeleton is divided into parts, as- (1) Exoskeleton and (2) Endoskeleton.

(1) **Exoskeleton** : The parts of the skeleton exist outside the body e.g. it includes nail, hair etc.

(2) **Endoskeleton** : The skeleton of man means endoskeleton which can not be seen from outside. The endoskeleton mainly composed of cartilages and bones.

Role of skeleton in firmness and locomotion:

Functions of skeleton: The skeleton does the following functions such as :

(a) **Structure and firmness of the body-** The skeleton forms the hard structure of the body and gives a definite shape to the body. It joins lower organs with the upper organs.

(b) **Protection** – Skull protects brain, spinal cord within the vertebral column or backbone, lungs and heart within the thorax. Muscles remain attached with the skeleton and skeletal muscles involved in carrying the weight of the body.

(c) **Movement and Locomotion:** Hands, legs, shoulder or pectoral girdle and pelvic or hip girdle help in movement. Muscular system has an important role in this act. Due to the attachment of muscles with the bones we can move the bones and we can move.

(d) **Production of red blood cells-** Bone marrow produces the red blood cells.

(e) Storage of mineral salts – Bones store mineral salts (calcium, potassium, phosphorus). That's why the bones remain hard and strong.

Bone – Bone is the modified form of connective tissue. It is the hardest tissue of the body which is composed of organic substances. The matrix of the bone is hard and brittle. The bone cells remain scattered within the matrix. Bone cells are called osteopath. These cells are branched and look like a spider. Bone is mainly composed of phosphorous, potassium and calcium different compounds. Besides it contains approximately 40%-50% parts of water. Living bone cells contain about 40% organic and 60% inorganic substances. Sufficient vitamin -D and calcium enriched foods are necessary. Due to the deficiency of these substances the normal growth of bones is resisted / obstructed / hindered.

Cartilage: Cartilage is not hard just like bone. These are relatively soft and elastic or flexible. It is the different form of connective tissue. These cells are found solitary or pairs and densely scattered out within the matrix. From the cartilaginous tissues a kind of hard semitransparent organic substances are secreted. Matrix is composed of chondrin. It is mild blue or bluish in color. In living cartilaginous cell the protoplasm is very transparent, with round nucleus and cavity is noticed within the chondrin. These are called capsule or lacunae, chondrocytes and chondroblasts remains within it. All cartilages are enclosed by a layer of fibrons connective tissues that is called perichondrium. This layer is glazing white in colour. So, cartilage looks white, bluish and glazy shining. There are various types / kinds of cartilage within our body. Cartilages are found in different joints, or articulating surface of some of bones. e.g. the cartilage in pinna.

Work : Find out the differences between bone and cartilage.

Bone joint or articulation: The joints in between two or more bones are called bone joints. In every joint, bones are joined firmly together by flexible elastic tissues called ligaments. So the bones can not be dislocated easily. The joint helps in the movement of limbs. All the joints of our body are not of same type. Some of it is fixed, e.g. – intervertebral joint. Again some of it is freely moveable e.g. – joints of hands and legs.

Synovial joint: A bone joint is a joint where two bones touch and make a simple synovial bone joint. When more than two bones make a joint it is called complex synovial joint. A joint, which is composed of a capsule, synovial membrane, a synovial cavity with a kind of lubrication

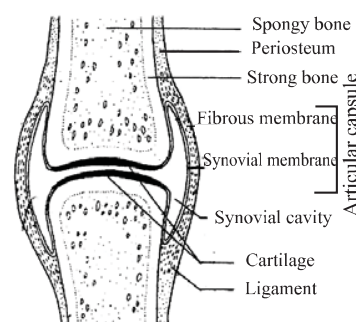


Figure: 9.2 Synovial joint

fluid or synovial fluid, is called synovial joint. The parts of the joint are the articulating surface of bone, covered with smooth cartilage, synovial fluid and synovial membrane. Synovial joints have ligaments for holding the bones together collectively to form a strong fibrous capsule. The synovial fluid and the cartilage of the joint reduce friction and less energy is used for the movement of the joint. Types example – Bone joints are of different types.

1. Fixed joint – The bones are joined firmly, so it is immovable example – joint of cranium.
2. Slightly movable joint – These joints are joined with one another still it has small sliding surface. So, we can bend the body example – joint of back bone.
3. Freely movable joint – These joints can be moved easily. Example wrist joint ball and socket joint.

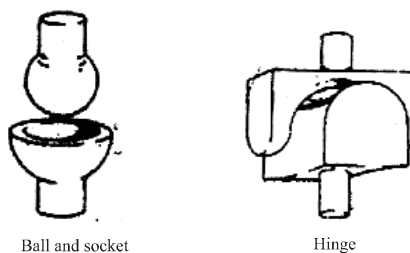


Figure: 9.3 Ball and socket and hinge joint

Ball and socket joint – Joints where the round one head of the bone fits into a cup shaped socket or cavity of another bone in such a way that allows the bone's movement in all planes.

Hinge joint: The elbows, knees, joints of the finger are the examples of hinge joints. It moves like a hinge of a door. It can be moved in one plane only.

Work : Draw the different parts of human skeleton and label them.

Activities of Muscles: The muscular system consists of involuntary muscles of internal organs and the wall of the blood vessels, cardiac muscles of heart and the voluntary muscles are attached with the bones. You have learned earlier about muscles. Muscular system performs various important functions such as :

- Movement of organs, helps, movement, placing the organs in orderly manner and balancing.
- Muscular system along with the skeletal system gives a definite structure that stores energy for future and muscles stores glycogen.
- The cardia muscles are of special type, it maintains the heart beat and blood circulation.

Role of bones and muscles in human locomotion:

The muscles and bones perform important role in locomotion. The skeleton constitutes the structure of the body and muscular system makes the covering of the structure. Voluntary muscles remain attached with the bones by a strong's elastic part named a tendon. Muscle contraction is the result of nerve impulses. With the withdrawal of impulses the muscle again stretches / extends or relaxes. This contraction and relaxation of muscles, attached with the bones, help in movement. In this way muscles help in stretching / extension of limbs and fold the organ, contraction of the muscle draws a bone or limb away from the

body or towards the body, helps in lowering a part, lifting a part or rotating a part etc. The role of muscles in the movement of bones is described with an example : observe how muscles work to bend or extend the elbow. The arm can bend at the elbow. The biceps muscle is attached to scapula at the top and radius at the bottom. By the stimulation of voluntary nerves when it contracts, it pulls the radius and ulna towards the body, so the arm bends. At that time triceps muscle relaxes. To push the arm back down again quite opposite phenomenon occurs. That means by the stimulation of voluntary nerves the triceps muscle contracts and straightens or extends the radius and ulna. At the same time biceps relaxes. In this way we can bend and extend our arm by the simultaneous contraction of biceps and triceps muscle. In this way various muscles help in the movement of different organs.

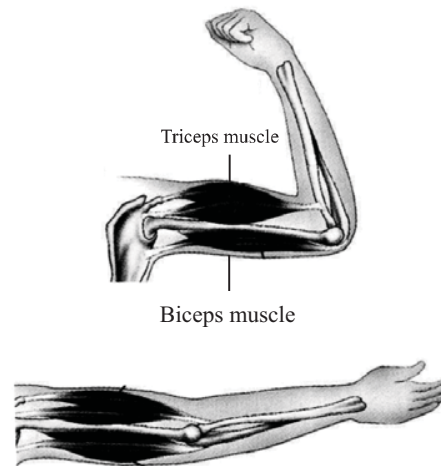


Figure: 9.4 shows opposite action of biceps and triceps muscle in movement of forearm

Tendon and ligament:

When we say to you that muscles remain attached with the bones or one bone remains attached with another bone with the help of a band. Then a question may arise to you how and why it happens. Muscles are joined to bones by tendons. Tendons are composed of dense, white fibrous connective tissues. The tissues are composed of unbranched, wavy and



Figure: 9.5 tendon and Ligament

shiny white fibers. White fibres are scattered in the matrix. The fibers are unbranched and white in colour. These are composed of parallel bundles. Numerous fibres form bundle. These bundles together make a bunch of bundles. The outer surface of these bundles is surrounded by areolar tissue and make a big bunch. It is called peritendium. The space between the bundles remains fibroblast cells. Blood vessels, lymphatic ducts and nerves enters into the tendon through areolar tissue. It is flexible but inelastic. In this way tendon is formed.

The fibres of tendon are attached with the sarcolemma of muscle fibres. At the junction between muscles and tendons the areolar tissues that surround the bunch of bundles of tendon forms a continuous connection with the muscle bundles to build the connection more strong. Tendon is strong and has less possibility to tear or break than that of muscle or bone. Tendon becomes a rope like structure which remains attached with bone and constitutes a structure of the body that renders firmness, helps in formation of ligament and makes a mechanical defense against pressure.

Bones are attached to each other by a thin cloth like soft but strong, elastic band like structure. These are ligaments. It is composed of the combination of white and yellow fibres. But number of elastic yellow fibres is excessive. Fine, branched net work of elastic fibres remain scattered in this kind of tissue. The fibres stay separately instead of staying in bundles. These have elasticity and are composed of elastic protein. There are fibroblast cells in the fibres. As a hinge attaches the door with its frame, in the same way tendon and ligament are firmly attached to the bones. So the organ can bend, stretch and move and the bones are not dislocated or separated.

Draw the table in your note book and fill it up.

Characteristics	Tendon	Ligament
Structure		
Function		
Elasticity		

Osteoporosis : You have known earlier, calcium is an important ingredient for the formation of bone and for its strength. Calcium and vitamin enriched food is essential for the growth of bones. Osteoporosis is a calcium deficiency disease.

Generally elderly males and females suffer from this disease. there is every possibility of having this disease, males who are taking medicine with steroid and the females after their menopause. Those, who lead lazy life, do less physical labour and are suffering from arthritis, have the chance of being attacked with this disease.

Cause : This disease develops due to the deficiency of mineral salt particularly of calcium. After reaching the menopause stage the density and thickness of bones decline in female, bones become brittle.

Symptoms :

- thickness decrease,
- muscle strength reduces,
- feel back pain,
- pain in bones.

Diagnosis : The disease can be diagnosed by examining the density of the bone with the help of density measuring equipment. At the preliminary stage of the disease the symptoms are not noticed. Suddenly hip bones or any other bone fractures even or minor shock.

Remedy:

- Elderly people about 50 years should take 1200 milligram calcium.
- Take skimmed milk and other dairy products.
- Taking orange juice, green vegetables, Soya product and calcium enriched food.

Prevention:

- Taking food of vitamin – ‘D’ and calcium. enriched
- Regular exercise.
- Take balanced diet.

Arthritis : Arthritis is a type of rheumatic disease. Prolong suffering with rheumatic fever and are not treated properly may have the possibility of being attacked with this disease. Mostly the elders suffer from this disease. In case younger’s joint pain may be symptoms of any other disease. Such as : Rheumatic fever or tuberculosis.

Symptoms:

- Inflammation and pain in bone joints.
- Stiffen bone joint.
- Get pain in articular movement.
- Joint swelling.

Remedy : The disease is not fully cured in elders. But the following measures may relieve the disease to some extent.

- To avoid hard labour.
- Take a short nap at day time, it gives a good result.

- Take deep heat in the affected joint.
- Do light exercise to keep the joint moveable.
- Avoid pulse (dul) type of food.
- According to the doctor's advice taking pain relieving medicine and proper treatment can relieve form this disease.
- Live in the healthy environment.

Prevention:

- Try to live in clean open air and well ventilated house.
- Regular exercise.
- Taking balanced and fibrous food.

Work : Collect information about life style, in taking of food of the women who are above 50 years. Find out the cause of osteoporosis, arthritis among them and write down in your note book.

Exercise

Short answer question

1. What is called bone joint?
2. Mention five functions of skeleton?
3. Find out the differences between tendon and ligament?
4. What are the characteristics of synovial joint?
5. Mention the differences between bone and cartilage.

Essay type questions

1. Write down the causes and symptoms of osteoporosis.

Multiple choice questions:

1. Which one is the characteristic of bone?
 - a) elastic
 - b) soft
 - c) strong
 - d) fibrous

2. Tissues of tendon's are –
- i) white and glassy
 - ii) unbranched and waved
 - iii) fibrous and in cluster

Which one is correct?

- a) i and ii
- b) i and iii
- c) ii and iii
- d) i, ii and iii

Observe the stem and answer question 3 and 4.

60 years old Rahima Begum can not work. Doctor has said she is suffering from osteoporosis due to calcium deficiency.

3. Which one is the symptom of this disease?
- a) increase the density of bone
 - b) bone becomes brittle
 - c) feel pain in waist
 - d) increasing muscle strength
4. Which one is the preventive measure of disease -
- i) taking roughage based food
 - ii) to avoid lazy life
 - iii) taking less vitamin 'D' enriched food

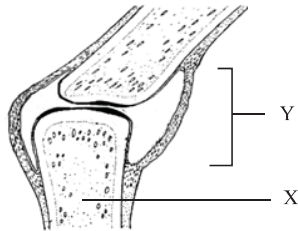
which one is correct?

- a) i and ii
- b) i and iii
- c) ii and iii
- d) i, ii and iii

Creative question

1. 12 years old Binita is healthy and restless. She spends most of the day time by running and playing. One day while she was running he fell down and her ligaments of the leg injured.
- a) What is bone?
 - b) What do you mean by Arthritis?
 - c) Explain why the injured part of Binita's body is compared with hinge.
 - d) What type of co-ordination is necessary to carry out the activities done by Binita – analyze it.

2.



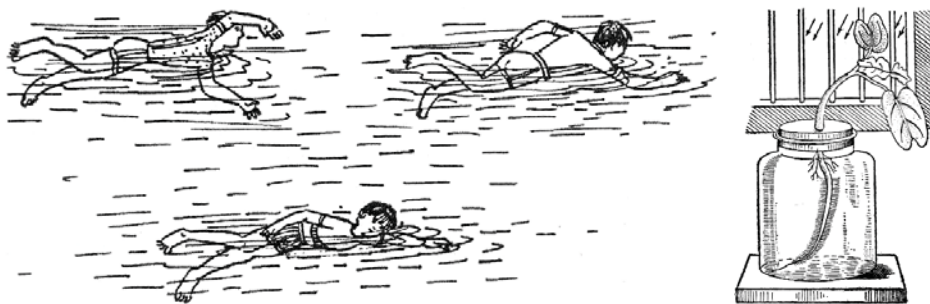
- a) What is tendon?
- b) What do you mean by osteoporosis?
- c) Explain why the cell structure of 'x' part is different?
- d) How the co-ordination between x and y plays a role in movement, analyse it.

Chapter Ten

Co-ordination process in animal

We know that, various physiological action and reaction are happening within the body. These activities happen all together. So it needs co-ordination to each other because if there is a lack of co-ordination then various abnormalities are found or noticed. In plants there is co-ordination to perform all physiological process, such as: movement, reproduction, metabolism, germination, growth etc.

Human body performs different activities with the co-ordination of brain and hormones. The co-ordination of plants and human is the matters to be discussed in this chapter.



At the end of this chapter, we will be able to:

- Explain the co-ordination system in plants.
- Explain the co-ordination system in animals.
- Explain functions of different parts of nervous system.
- Explain the structure and functions of a neuron.
- Explain reflex action.
- Explain transmission of impulses.
- Explain main functions of hormone.
- Explain irregular secretion of hormones that creates the main physical problems.
- Describe instant measures to be taken against stroke and its remedy.
- Describe the nervous disorder's cause, symptoms and remedy.
- Analyse the effects of tobacco and drugs in coordinating activities.
- Investigate the cause of physical disorders regarding hormones.
- Arise awareness regarding the harmful effects of drugs or addition.
- Draw a leaflet or poster regarding the harmful effects of drugs or addition.
- Be aware regarding harmful effects of tobacco and drugs on nervous system.

Coordination in plants

Like an animal cell, different physiological activities are simultaneously and continuously carried out in a plant cell. These activities are accomplished through some systems and methods. So in the life of a plant, the coordination of physiological activities is an essential act. If there is no coordination in a plant life, many abnormalities will arise.

In the life span of a plant in coordination with the time, stages in life cycle, such as germination, growth and development, flowering, development of fruit, aging, dormancy etc. follow a set of systematic rules. The significance of weather and climatic factors on the process is also notable.

With the growth and movement, different physiological activities in plants are really complex and ceaseless. Despite the complexity and ceaselessness, these activities are accomplished following some special regulation and system. An activity does not interrupt another in any way.

How is this coordination maintained in all the activities? The growth and development of plants, development of different organs in plants etc. are accomplished under the influence of a special kind of biochemical substance produced in the plant body. The substance, which controls all the activities, is called hormone. These chemical substances, found in plants, are called phytohormones. Some designate the phytohormones as the plant growth substances. According to most of the scientists, the chemical substance, being produced in cells and being translocated to other distant cells, controls their activities and this substance is called phytohormone. Every cell of a plant has the ability to produce hormone. They are not any nutrient substances but being produced in small quantity play roles in differentiation of cells and development of body. The main natural phytohormones are auxin, gibberellin, cytokinin, abscisic acid, ethylene etc. The hormones, which are usually found in plant, are auxin, gibberellin, cytokinin and abscisic acid.

Besides these hormones mentioned above, there are some other hormones which could not be separated or identified. They are called postulated hormones. They mainly help the activities related to the development of flowers and reproductive organs. Florigen and Vernalin are the chief hormones of that type. Florigen is formed in the leaves and, being translocated to the base of the petiole, transforms the vegetative buds into floral buds. So, it is found that florigen helps a plant in its flowering.

The chief phytohormones are mentioned below.

Auxin: (Charles Darwin first discovered it and later Kogl and Haagen Snit named it as auxin. Charles Darwin studied the effect of light on the coleoptiles of plants). When light

is reflected obliquely on one side of coleoptiles, it turns towards the source of light, but in darkness it grows erectly. By performing experiments, scientists became assured of that kind of chemical substance at the top of the coleoptiles which is responsible for that type of movement. The name of the substance is auxin. After the application of auxin, root grows from grafted buds, prevents the premature shed of fruits. In plant cell movement of auxin happens downwards. The rate of osmosis and respiration is increased on the effect of auxin. It also plays a role in producing fruits without seeds.

Gibberellin: The causal organism of Bakanae disease of rice is a kind of fungus, which causes an over growth of the rice plant. An organic substance can be extracted from it by which the overgrowth of rice plant occurs. The substance is gibberellin. Most of the gibberellins are found in mature seeds but they are also traced in seedling, cotyledons and meristematic regions of the leaves. Elongation of internodes are influenced by the phytohormone. So the plants grow excessively in length. If this hormone is applied to a stunted plant, it grows more in length than a normal plant. It plays effective roles in blooming flowers, in shortening the period of dormancy in seeds and in germination.

Cytokinin : The phytohormone or plant hormone is found in fruits, cereals and water of green coconut. It is also found in the roots of some plants. They generally stimulate the process of cell division being mixed in different concentrations with oxygen. Besides, the hormone also plays roles in the growth of cell, development of organ or plant parts, breaking the dormancy of seeds and organs and in delaying the aging process. At the time of cell division cytokinesis occurs in a cell because of the effect of cytokinin.

Ethylene: This hormone is a gaseous substance. It helps the fruit to be ripened. This hormone is also found in fruits, flowers, seeds, leaves and roots. Ethylene breaks the dormancy in seeds and buds, and helps seedling to grow much in length. It also plays roles in the growth of seedling, stem and triggers the initiation of growing flower and fruits. Ethylene accelerates the shedding of leaf, flower and fruit.

Uses of hormones: Auxin and other artificial hormones help in growing roots in graft tissue. A kind of auxin named Indole acetic acid improves the effectiveness of cambium. As a result a kind of uncontrolled cell clusters are developed and the injuries are healed up. By applying auxin, the shedding of fruits is delayed. Auxin and gibberellin are used in producing fruits without seeds.

Growth

The effect of light and temperature on the development of different organs of plant is remarkable. Through different synthesizing methods, formation of distinct elements causes the development of new organs. According to the opinion of some scientists, in presence of light, the hormone auxin becomes inactive and so in the dark days,

concentration of auxin increases. Some other scientists believe that auxin in lighted part moves to the dark region and there growth occurs at a higher rate and the growth of lighted part being inhibited turns more towards light.

The tip of plumule or radicle can feel the stimulus of gravitation. This is called geoperception. Owing to gravitation, the components of cell are translocated downwards. They cause a pressure on the wall of cell laterally. This is why gravitational movement is accomplished. In the development of the different organs in plants, the role of light is remarkable. This is why new organs are developed by evolving of different components through different synthesizing ways and the components of a cell moves downwards.

Garland chrysanthemum is a short day plant. The leaves of the plant are considered to be the place of receiving stimulus at the photoperiod. Long dark period causes inhibition in the flowering of long day plant. But the long photo period is helpful for their flowering. So it can be said that the flowering of plants is more dependent on photoperiod. The rhythm of light and dark in a plant is called biological clock.

On the basis of the rhythm of light and dark in plants, plants are divided into three categories.

1. Short day plant: Average daily photoperiod of 8-12 hours is required for flowering. For example, Garland chrysanthemum and Dahlia.
2. Long day plant: Average daily photoperiod of 12-16 hours is required for flowering. For example, Lettuce and Jhinga.
3. Day neutral plant: Photoperiod has no role on flowering. For example, Garden Cucumber and Sunflower.

As light, heat and the chilling of winter also play roles in the growth of plant and flowering in them. If chilling is applied to the germinating seeds of many plants, their flowering periods get forwarded. The acceleration of flowering of plants by applying chilling on them is called vernalization. Scientists have proved the effect of temperature on the flowering of plants. Flowering is prolonged if the wheat of winter is cultivated in summer. If 2° - 5° C temperature is applied on the seeds after sowing, the normal flowering occurs in them. Different stimuli, such as light, gravitation etc. affect the growth of plants.

In this way, plants develop the coordination in their physiological activities.

Movement:

Like other living organisms, plants are able to perceive stimuli. This is why the reflex that is made by external and internal stimuli cause movement in plants. Some movements in plants happen because of growth and some other movements occur in plants because of some internal and external stimuli. The movement caused by any reason is obviously occurred because of some factors.

Movements in plants can be categorized into two: movement of locomotion and movement of curvature. When any part of a plant holistically moves from one place to another to serve any purpose is called movement of locomotion. For example, this type of movement is found in the gametes and zoospores of some fungi and higher plants. Besides, this type of movement is found in some bacteria and algae, for example, *Volvox*, *Chlamydomonas* and diatoms. In other way, the higher plants anchored in soil cannot move from one place to another. But they can move and curve their organs or organ parts to some extent in any necessity. This type of movement is called movement of curvature. Movement of stem towards light, movement of root towards dark and twining around suitable host of tendril etc. are the examples of their movement. Movement of locomotion and movement of curvature are of many types. Among them phototropic movement is notable. Phototropic movement is discussed below.



Figure: 10.1 Response of plant to light

Figure 10.1: Response of plant towards light.

Phototropic movement or phototropism:

Phototropic movement is a kind of movement of curvature. The stem and branches of a plant always move towards light and the root always moves away of light. The movement of stem towards light is called positive phototropism and the movement of root away of light is called negative phototropism.

Work 1: Observe a plant for a week keeping it by the side of a window of your classroom and present the results obtained with reasons.

Work 2: Test the movement of root towards gravity and present the results with reasons.

Co-ordination in animals:

Influence of Hormones : Necessary co-ordination in animals is not only done by nerves but also by the influence of hormones. What is hormone? you will know it after wards. Animals' activities that means movement or behavioral change occurs due to hormone. Different research work has done about this matter. Hormones are secreted from different ductless glands. Ductless glands exercise control to each other. The activities of hormones are controlled by nervous system. The matter is like that, activities of hormone is considered as worker, but as a whole which worker works, where, how long he will work all these are controlled by the manager, like that nervous system controls the activities of hormones.

For co-ordination different animals use hormones. If any ant gets a trace of food, it secretes one kind of hormone from the source to its destination which is known as feromon. Depending on it other ants collect food following the same path. For this reason ants move in the same

path. After collecting the food ants stop to secrete feromon, that evaporate easily that influence / indicate other ants not to go again. Some insects can search its own counter part of own species. Some insects secrete feromon in the air, so that its counter part can be attracted from 2-4 kilometer distance. You may have seen to destroy insects by using feromon. Because of feromon harmful insects are trapped and sink in water. This process is very environment friendly to control the harmful insects.

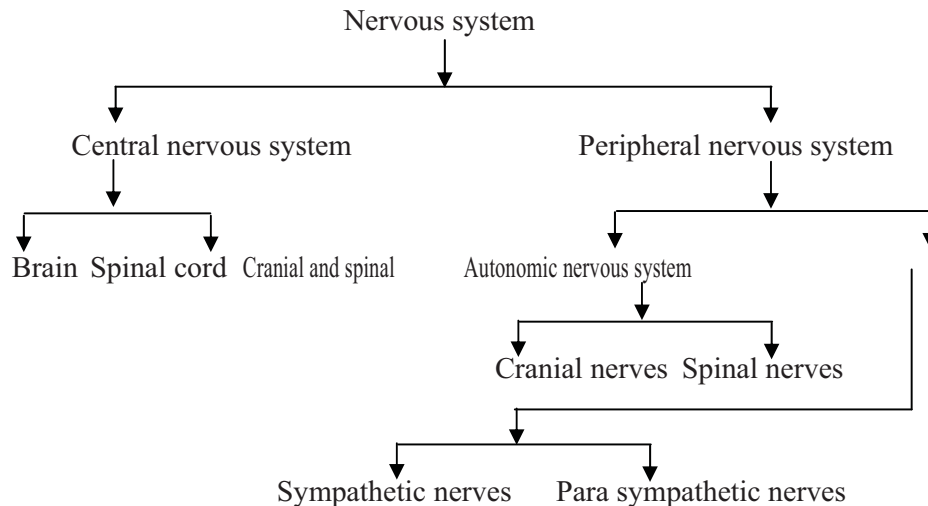
Influence of nerves : Different organs take part in several works, such as : walking, sitting, talking, thinking, laughing, crying, learn the lesson by heart etc. To regulate these organs properly coordination and integration are necessary. The system, through which the animal responds to stimuli, maintains connections of various organs, co-ordinates various activities, physiological process and maintains relations with the environment, is called the nervous system To perform different activities in our whole body needs co-ordination of million of cells.

For the activities of different organs co-ordination is needed, nervous system has an important role to do it. All the works of the body are performed by receiving stimuli from the environment and producing response. The outer side of the world is the external environment and the inner side of the body is the internal environment. Stimulus of the external environment is light, a sight, a taste and a touch. These create stimulation at the tip of the sensory nerves of ear, nose, tongue and skin. Internal stimulants are heat, pressure and various chemical substances. Some nerve impulses originate inside the central nervous. Any stimulus can create stimulation to the sensory and motor nerves. Impulses which pass along sensory neuron fibres to the brain. The brain receives impulses from the sensory organs and then sends off the decision through the motor nerves to the glands and muscles, causing them to function according.

Excluding nervous system there are some specific chemical substances named hormones that take part in co-ordination. But these are under controlled by brain. At first there was an idea that it is a stimulating substance. But afterwards it is found that all hormones are not stimulating in function, but some are inhibitor. Very small amount of hormones are required to control particular physiological function. They act as stimulant or inhibitor and control many bodily functions, such as : development, growth, functions of various tissues. The influence of hormones on behavior of an individual, nature, transmission of impulses is very important. Blood carries them from the place of origin to the distant places where they stimulate certain cells or organs respond to them. So they are termed as chemical messengers.

Nervous system co-ordinates in different organs and system, maintains a relation with the environment by responding impulse. Main function of the nervous system to carry impulse to the different parts of the body, co-ordinates various activities of the organs and maintains a relation with the environment.

Table shows central nervous system :



Central nervous system :

Central nervous system consists of brain and spinal cord. Brain is protected in the skull.

Brain :

The swollen part of the nervous system, which is at the top of the spinal cord and remains in the skull, is called the brain. Brain is the manager of the nervous system. The brain is divided into three parts. As : a) Fore brain b) Mid brain and c) hind brain.

a) Fore brain or prosencephalon : The largest part of the brain is cerebrum which consists of two incompletely divided lobes, the right and the left lobes. They are separated by deep furrows. These are cerebral hemisphere. The right hemisphere controls the left side of the body and the left hemisphere controls the right side of the body. This part of the brain is provided with much folded and wrinkled surface. The left lobe of cerebrum is comparatively well developed. Cerebrum is called fore brain. It is covered by a membrane, called maninges. The exterior surface of the cerebrum is named as cortex is composed of numerous neurons and is gray in colour. So the other name of the cortex is grey matter which keeps internal connection with the spinal cord. Spinal cord is located in the vertebral column. Inner layer of cerebrum contains nerve fibres, these are white in colour. That is why it is called white matter. White matter carries nerve impulses to the upper and lower part of the spinal cord.

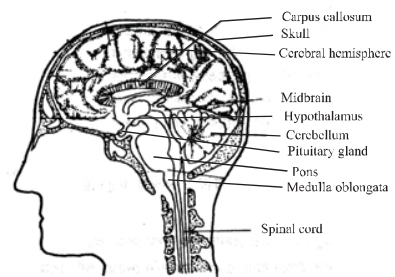


Fig: 10.2 Human brain in Sagital Section

Cerebrum is the higher organ which receives nerve impulse and sends response (nerve impulse) to the various organs of the body. Sensory centre is cerebrum in movement of the body that is for every work. The conscious activities, e.g. speech, vision, hearing, intelligence, memory, thinking, will and activities voluntary muscular are controlled by cerebrum. It also helps to take the decision and responding against stimulation.

b) Mid brain or Mesencephalon : The upper part of the hind brain is mid brain or mesencephalon. It is a bridge between fore brain and hind brain. There is a cylindrical part that is located at the back part of mid brain is pons. It forms a connection cerebellum and medulla oblongata. Its functions is to co-ordinate the activities of various muscles and balance.

c) Hind brain or Rhombencephalon : It consists of cerebellum, pons and medulla oblongata.

Cerebellum: Cerebellum is localated at the back part of pons. It is divided into right and left lobes. Its exterior part is composed of grey matter and the inner part with white matter. Cerebellum controls the muscle strech, co-ordinates in movement, balance, control the voluntary activities of voluntary muscles. As : jumping and running.

Pons : The pons is a bridge of white fibres, that is located in between the medulla oblongata and mid brain.

Medulla oblongata : It is the most posterior part of the brain. Its front part is connected with pens and spinal cord behind.

There are 12 pairs of cranial nerves, extend from the cerebrum and medulla oblongata and within which pairs of nerves originate from medulla oblongata. These nerves control the functions of heart, lung, pharynx, swallowing of food, Moreover the nerves are associated with important functions, as : hearing, balancing.

12 pairs of cranial nerves originate from the brain and spread in different regions. as : mouth cavity or buccal cavity, tongue, eye, nose, ear. The nerves are sensory or motor or mixed in nature.

Spinal cord : Spinal cord originates from the posterior part of medulla and leaves the skull through the foramen magnum and extends upto the lumber vertebra. It is protected by vertebral column. Spinal cord is composed of grey matter and white matter. But their position is quiet opposite to the brain. That is white matter at the outer part and grey matter at the inner part. 31 pairs of nerves originate from the spinal cord and passes through the hole located in between the vertebrae. These are the nerves of neck, shoulder, chest, back, hand and legs. These nerves are mixed in nature. The nervous system helps in receiving

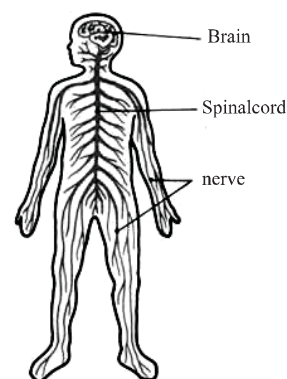


Figure: 10.3 Human nervous system

impulses from the sensory organs then produce respond, remembering, planning, implementation and co-ordination of different organs and systems.

Nervous tissue:

The tissue that can receive stimulus from the environment and can transmit according to make an appropriate response, is nervous tissue. Nervous tissue is composed of many nerve cells or neurons. Neuron is the basic functional unit of the nervous system.

Structure of neuron:

The neuron comprises of two parts; as: a) cell body and b) processes.

a) Cell body: The part of the neuron which contains a nucleus, cytoplasm remains bounded by plasma membrane, round, oval, star shaped is known as cell body. Cytoplasm contains mitochondria, golgi bodies, lysosome, fat, glycogen, nissel's granules.

b) Processes: A variable number of nerve fibres extends from the cell body which is called processes. Processes are of two types, e.g.

(1) Dendrite: There are small branched process around the cell body is called dendrite. The number of dendrite in a cell body may be from zero to few numbers.

(2) Axon : A long unbranched extended process originates from cell body is axon. Mainly neurilemma enclosed axon is called nerve fibre. Numerous dendrites and axons together forms a nerve, the fatty layer in between neurilemma and axon is called myelin or myelin sheath.

This layer is not continuous. Generally it is interrupted at regular intervals. There is direct connection of neurilemma and axon at the interrupted part. This uncovered part is known as nodes of Ranvier. The membrane which covers the main axis of axon is called axolemma. One neuron do not join directly to the next neuron cell. Between the two adjoining neurons a bridge or tiny gap between axon of a neuron with the dendrite of the other. The sites or function of these gaps are called synapse. At this junction a kind of liquid is present named neurohumor. Nerve impulses transmit into the dendrite of next neuron by a electrochemical process. Through this nerve impulses or stimuli travels in one direction only. The main function of neuron is to conduct nerve impulses. Sensory neuron receives stimulation by the receptor and transmit it to the brain then send off motor impulses to effector.

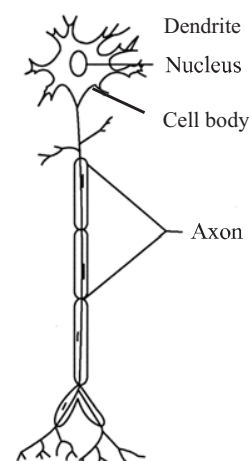


Figure: 10.4 A neuron

Work : Draw a labelled diagram of a neuron.

You focus in your friend's eye with the help of a torch light. No sooner his pupil contracts. Why it does happen? The impulse reaches the brain from the retina and according the direction of the brain, circular muscle of lens contracts. So the pupil becomes small. The sudden response causes automatic reaction, so eye closes instantly.

Reflex action : Reflex action means sudden response or automatic reaction. Suddenly a needle pricks in the hand or on touching a hot object, we immediately turn off hand from the source of stimulation. This is the the result of reflex action We can not control the reflex action according to the will. Basically it is controlled by the spinal cord, not by the brain. That is the immediate response to a specific stimulus is not controlled by spinal cord instead of brain is called reflex action. Example: A needle prick in the hard while sewing in an unconscious way or carelessly may cause a sudden jerking away of the hand. That is a reflex action. The events in such a reflex action are described in this way :

At the time of pricking the dendrites of the sensory neuron, skin accepts the stimulus. Skin acts as a receptor.

This stimulus transmits from the finger to the grey matter of the spinal cord through the axon of the neuron. It is the motor or efferent neurons which transmit impulses from

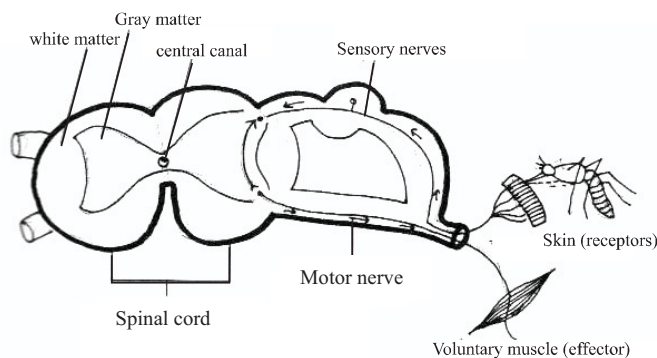


Figure: 10.5 Reflex arch in Human

the spinal cord to the dendrite of motor neuron. Here impulse is transmitted from the axon of the sensory neuron located at the grey matter of the spinal cord to the dendrite of the motor nerve by electro chemical process. Impulse transmits between the axon of the sensory nerve and dendrite of the motor or efferent nerve through synapse. Then the impulse from the dendrite impulse ultimately reaches to the muscles and the muscles contract according to the command of the central nervous system. So hand is turned off from the source of stimulation automatically.

(2) Peripheral nervous system : 12 pairs of nerves from the brain and 31 pairs of nerves from the spinal cord originate, divide into small branches and spread all over the body. These nerves all together are called peripheral nervous system. The cranial nerves originate from the brain controls the functions of the organs, as : eye, nose, tongue, teeth, face, heart, stomach etc. The nerve originates from the spinal cord, helps in the movement of organs.

Autonomic nervous system: The organs, which are not controlled by us, are regulated and controlled by autonomic nervous system. The functions of internal organs of the

body, e.g- heart, intestine, stomach, pancreas etc are regulated by the autonomic nervous system. As there is no influence of brain and spinal cord on the functions of the system, these are independent.

Impulse transmission :

Numerous neuron fibres are connected to each other. Impulses transmit through it and finally reaches to the brain. The velocity of it is approximately 100 meter per second. The message is taken by the nerves from the environment and the nerves carry it like a wave and sends message to the brain. These are called nerve impulse. Nissle granules in the cytoplasm of the nerve is associated with the transmission of impulse. As a result neurons act as an impulse transmitter from the receptor centre to the different various organs.

If it is transmitted to the muscle then it responds by contracting muscles. So we can move our different organs according to our need. If this impulse reaches in the gland, then it secretes chemical substances. When a sensory nerve is stimulated, it transmits towards the brain then one can feel the sense of touch, sight, pain etc.

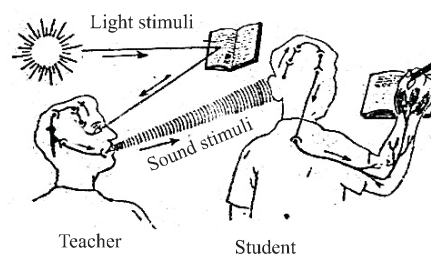


Figure: 10.6 Impulse transmission process

How nerve impulse works can be explained from the example given below. Say, a teacher is giving dictation and you are writing. In this event the light reflected is from the book that stimulates the retina of your teacher and impulse creates. This impulse reaches the sight centre of the brain. Then impulse sends response or command to the centers. Such as centre of thought, memory etc sends message or impulses to the voluntary muscles of the face. Muscle contracts and accepts the impulse. Here teacher's muscles involved in speaking are the effectors or response organ.

Teacher's speech creates a sound wave. This sound wave stimulates the ear drum, of the student and that reaches to the auditory centre of the brain through the auditory nerve. From there impulses transmit through the centre of memory, thinking etc and afterward it reaches to the voluntary muscles through by the motor nerves. Then the muscle responds and the student starts writing. Here the student's muscles are the effectors or organ response.

What is Hormone ?

There is a special kind of glands in different animals and in human. The chemical substance secreted from the glands and are carried by blood and controls various physiological process. The secretions produced by the ductless glands or endocrine glands are known as hormone. These glands have no separate duct to transport hormones. Hormones are carried by blood current and reach to the specific cells, influence the biochemical function within the cells and

regulate the biological process. Continuously hormones are secreted from the glands according to the demand of the sound healthy body. But over and under secretion of hormones causes various undesirable reactions.

Introduction of main endocrine glands, functions and secreted hormones.

Pituitary gland : Pituitary gland or hypophysis is situated beneath the brain. In human Pituitary gland is the main hormone producing gland. Because Pituitary gland secretes several hormones. Some of these have influence on other endocrine glands. Though it is the smallest in size but it is a very important endocrine gland. It secretes hormones, such as: Gonadotropin, thyrotropin, prolactin, adrenocorticotrophic etc.

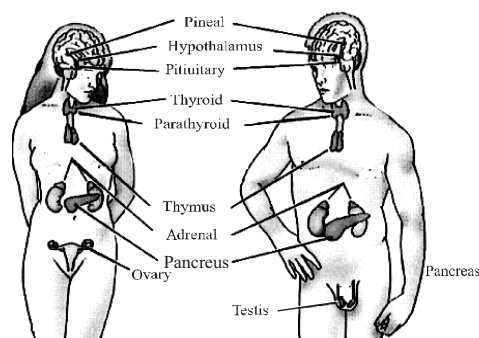


Figure: 10.7 Main endocrine glands in human body

Thyroid gland : Thyroid gland is situated at the upper part of trachea. Hormones secreted from thyroid gland control the rate of metabolism. Protrusion of eye balls is caused due to the problems of thyroid gland. The shortage of iodine thyroid gland can produce a swelling or enlarges and that is goiter.

Parathyroid gland : Parathyroid glands are situated in the posterior part of the thyroid gland. The hormone basically regulates calcium and phosphorus metabolism. These glands secrete parathormone hormone.

Thymus : The thymus gland is located in the neck region. Thymus gland helps in the growth of sex organ. In childhood it remains in developed form but with the increasing of age its size reduces. The secretion of thymus hormone is thymosin.

Adrenal gland : The adrenal glands are located just above the kidneys. Adrenal glands regulate the essential metabolic process. It helps to relieve from mental pressure. These glands secrete adrenaline hormone.

Islets of Langerhans : In the endocrine part of the pancreas islets of Langerhans are situated. The group of cells in islets of Langerhans secrete insulin. The ductless cells secrete insulin and glucagon which controls the level of glucose in blood. Thus the group of cells in islets of Langerhans regulate carbohydrate metabolism.

Gonad or reproductive glands : These glands are situated in the ovary of female and in the testis of male. The hormones secreted from the glands control the development of sex organs and secondary sexual characters. It also controls the development of sex organs, reproductive cycle and reproductive behavior. In mature male and female reproductive organs produce testosterone and oestrogen respectively.

Abnormalities due to Hormone

Thyroid problem : Sea water contains iodine. So marine fishes are one of the main sources of iodine for human being. Food, containing iodine, helps to produce thyroid

hormone. It is found the place away from the sea, such as – the number of goiter patient is high at the foot of the Himalayas, Nepal or in north region of Bangladesh. Deficiency of thyroid hormones creates obstruction in mental development. It causes rough skin, oval shaped harmless face. Due to the deficiency of iodine the production of hormone is hampered, this decreases mental development. A good effect can be obtained by taking iodide salt, banana, sea fished, fruits, arum etc.

Diabetes : Within the pancreas there are ductless glands called islets of Langerhans. These glands secrete the hormone insulin. This hormone regulates the metabolism of carbohydrates. If for some reason the pancreas fails to produce the required / adequate amount of insulin then the level of glucose increases permanently in the blood much above the normal level. Then glucose is eliminated with urine. This condition is called diabetes mellitus. Diabetes are of two types, such as : type – 1 and type – 2. In type – 1. patient's body insulin is not produced at all. So the patient has to take insulin injection. Partly insulin is produced in case of type – 2 patient's body. In this situation the patient has to take medicine orally, it helps pancreatic cells to produce adequate amount of insulin. This disease is usually genetically transmitted or occurs under the influence of the environment. It is not an infectious or contagious disease. When the level of glucose increases in the blood much above the normal level then the symptoms may be found in a patient suffering from diabetes mellitus. **The symptoms** are frequent passing of urine, excessive thirst, excessive hunger, gradual loss of weight in spite of excessive eating, feeling tiredness and weakness, disturbed vision, roughness of skin, delayed healing of wound etc.

Earlier it was assumed that only the elder suffer from this disease. But this idea is not correct. People of any age, younger, elder suffer from this disease. But people, who lead a lazy life, sedentary workers, that is who do not work physically and are obese or overweight persons have a greater chance of developing diabetes mellitus. This is a hereditary disease. If a close family members, like father, mother, grand father, grand mother suffer from diabetes mellitus, then there is a great chance of developing the disease. Because of inheritance a little amount of insulin is produced in children's body that results in the suffering of insulin deficiency disease.

Diagnosis and treatment of Diabetes mellitus: Diabetes can be detected by testing the urine and the blood sugar level. This disease can not be fully cured, but by treatment it can be kept under control. According to the views of doctors, the disease can be controlled by following three 'D'. These are Discipline, Diet and Dose.

a) Discipline: Discipline is the medicine for a diabetic patient. Besides, (1) Regular intake of adequate quantity of balanced diet, (2) Regular exercise (3) Cleanliness and foot care (4) Regular checking of urinary glucose and (5) Consulting physician or doctor if any problem arises.

b) Diet : Dietary restriction is one of the measures to control diabetes. According to doctor's advice balanced diet should be taken regularly and sweet items should be avoided. By following doctor's suggested food menu, one can get good result.

c) Dose : Without doctor's advice no medicine should be taken. On doctor's advice, oral drugs or injectable insulin should be taken regularly. If the patient is not treated properly, his respiratory rate decreases, due to the scarcity of water sugar level of blood increases. In blood so the patient becomes senseless. By heart attack the patient may die even.

Stroke : Colloquial name of brain hemorrhage is called stroke. It is a deadly or fatal disease. Generally arteriosclerosis and high blood pressure is the cause of brain hemorrhage. Frequently excess nerve pressure such as : agitation / excitement, over work is the cause of this type of hemorrhage. Hemorrhage or blood clotting may happen at any artery of the brain. Blood vessel affects brain. If blood enters into the ventricle of brain and skull of the patient may lead to death.

The symptoms expose suddenly. Symptoms are—

- Vomiting, severe headache,
- Patient becomes unconscious within a few minutes.
- Shoulder may be hard.
- Muscle relaxes.
- Respiration and pulse decreases rate.
- Face turns red.

In such an emergency the patient should be transferred immediately to the hospital and ensure proper treatment. By proper treatment some times the patient may survive. If the diseased patient survives, may get back conscious after few days. Then the diseased patient becomes restless and gradually the paralysed organ restores firmness. If the speech controlled centre is harmed then the diseased patient's word mumbles. Attached paralysed organ muscles of (such as- hand) gradually get back its power of movement but the patient loses the power of doing minute work forever. At the primary stage the patient recovers quickly but after two months improvement slows down gradually. After shock primary improvement is rapid. According to the scientists, it may happen following severe injury of the central nervous system and hemorrhage results from this reaction. Sudden attack of nerves temporarily loses its activity. These types of strokes show rapid recovery and restore the ability to work. The nerves, which are affected totally, lose their ability to work forever.

Diagnosis :

Diagnosis and treatment: Doctor may ensure by detecting if there is any blood clotting or brain hemorrhage. In many cases exact cause of this disease can not be ascertained. It is not possible to stop bleeding in the case of hemorrhage. Take measure to keep high blood pressure under control, after getting back the sense surgical operation can be done if it necessary. Proper nursing, better arrangement to evacuate the bowl, cleanliness,

ensuring sick diet are very necessary. According to the necessity or demand arrangement can be made to feed the patient by using the tube. It is also necessary to move the paralyzed organ, to resist stiffness of the joints. On gaining sense the patient is to be encouraged to move by his own or her. When stroke's symptoms are found, ensure proper treatment as early as possible that gets desired result.

Prevention : Avoid smoking, keeping high pressure under control, diabetic patient should take medicine regularly, keep free from anxiety and leading a normal life.

Physical disability due to nerve disorders:

Paralysis : Loss of sensation and motion (muscles) in a part of the body is termed paralysis. When there is damage in a part of the brain, then stimulation receiving muscles loses its activeness. After that an entire or half of the body is paralysed. Generally stroke is the cause of paralysis. Beside it neck and spinal cord injury or accident may be the cause of paralysis. Nerve disease, damage of spinal cord may also be the cause of paralysis.

Epilepsy : Epilepsy is a type brain disease that starts with convulsion. In many cases the patient becomes unconscious. It is also known as fainting disease. Only because of this disease the diseased person loses his ability to work temporarily and fell on the ground with convulsive movement. Any way / By any means if the patient fell in water, he or she can not get up from water by one's own effort may die by drowning.

The main cause of Epilepsy is yet unknown and undiscoverable. But it happens due to the location of the brain. Ischemic stroke patient suffers from fainting disease. Symptoms of epilepsy may be found due to various causes, such as : Tumor, head injury, AIDS, inherited abnormality of brain, meningitis, encephalitis etc. People of any age may suffer from this disease, but it is extensive 5-20 years old people.

Parkinson disease : Parkinson disease is such a condition of brain that causes jarring of hands and legs, the patient becomes unable to walk and move. Generally the disease starts after the age of 50 years. But in exceptional cases young people may suffer from this disease, in this case it is considered as hereditary. Nerve cells produce a substance called dopamine. It helps in muscular movement. Their dopamine producing cells gradually destroy. Without dopamine nerve cells become unable to send stimulation to the muscles. So the muscle loses its effectiveness. With the increasing of age muscles of the Parkinson disease patient become more inactive, so the patient feels trouble to move or to write.

Parkinson disease gradually turns severe: At the preliminary stage of the disease it begins with tremor and patient feels trouble to move leg or foot. Moreover tremor of eye lids, constipation, trouble in swallowing of food, problem in walking straight, stiffness in face, pain in muscles, feels trouble in movement, such as : feeling uneasiness at the time of standing or while starts walking.

Work : Try to investigate the cause of physical distress, difficulties created by hormonal problem and make a investigatory report on it.

With the consultation with a doctor, taking physiotherapeutic treatment, balanced diet and leading a healthy life the patient may feel better.

Influence of tobacco and drugs in co-ordination :

In Bangladesh tobacco ganja, charas bhang, affim, morphin, cocaine, alchol and heroin etc are known as addictive substance. Besides, medicine prepared artificially from coccain and affim. These substances create addiction. Example – sleeping pill.

There is many reasons for drug addiction in humans. Such as : inquisitiveness regarding addictive drugs, influence of friends and partners, trying out a new experience, looking out for easy happiness, use of addictive substance in the family, easy availability of addictive substances, family dispute and discontentment, unemployment, economic insolvency, frastation, unawareness about the harmful effects of addictive substances are mentionable.

Use of tobacco, chewing jarda or smoking increases nicotine level in blood. At first nicotine stimulates nerve cells and afterward it creates the demand of nicotine in the body. To meet this demand peoples become addicted of smoking and using jarda. Nicotine destroys the effectiveness of nerve cells. Hands, legs and head trembles involuntarily. So it causes the problems, such as : put thread in the needle, draw a straight line, unable to write etc. Addiction creates bad effect and influence on nervous system. Due to addiction a person is defeated to his will power and is compelled to take addicting substances. His thinking capability gradually destroys only because of addition. Addicted person losses his attention to his work and fail to lead a normal life. Excess addition makes him unconscious or senseless and fall here and there. Now a days there are treatment and rehabilitation centers for drug addicted. So one can get rid of that bad habit by taking treatment from rehabilitation center. It needs co-operation and sympathy of family members towards the addicted person.

Harmful effects of addiction : The intake of addictive substances may cause harmful effects. Such as : physical, social, economic etc.

Measures to get out of this situation :

- Increase wide spread of moral education.
- Arrange employment for the unemployed.
- Stop easy availability of addictive substances.
- Stay away from bad company and raise awareness about its harmful effects.
- Initiate social mobilization and strongly in force laws regarding addiction.

We should not hate or neglect / disregard the addicted persons, they are to be handled sympathetically and make arrangement to rehabilitate them. Take the assistance of rehabilitation center if it is necessary. In Bangladesh the Directorate of Narcotic control was established and started functioning in 1990. Day by day its field of work is widening. In this program law making, its implementation, control, treatment and rehabilitation are mentionable.

Work : Draw a poster or leaflet regarding the bad effect of tobacco and addictive substances and place it before the students in the class room.

Exercise

Short answer question

1. What is phytohormone?
2. What is gravitational feeling?
3. What is nervous system?
4. What does constitute the central nervous system?
5. What are the causes of paralysis?

Eassy type question

1. Discuss the role of hormone in the growth of plant.
2. What are the symptoms of thyroid problem?

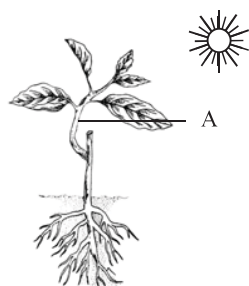
Multiple choice

1. What hormone is secreted by thymus gland?

a) Thyroxine	b) Parathyroxine
c) Thymoxine	d) Thyrotrapine
2. Islet of langarhans –
 - i) helps in carbohydrate metabolism.
 - ii) secretes insulin hormone.
 - iii) controls metabolism of the body.

Which one is correct?

- | | |
|---------------|------------------|
| a) i | b) i and ii |
| c) ii and iii | d) i, ii and iii |



On the basis of the following diagram answer the question 3 and 4.

3. Which one of the following is applied to 'A'.
- | | |
|-----------------|-----------------|
| a. phototropism | b. geotropism |
| c. hydrotropism | e. chemotropism |
4. Which one of the following is applicable in the development of a lateral bud if the apical one is cut off.
- | | |
|--------------|------------------|
| a. auxin | b. gibberellin |
| c. cytokinin | d. abscisic acid |

Creative question

1. Ohona observes different types of plants going to visit an agricultural farm with her father. She notices some small seedlings kept in electrical light in a much cold room. Moreover, she observes that flowering is not being accomplished in some fruit trees, and some fruits being immature are falling off the trees.
- What is biological clock?
 - What is vernalization?
 - What are the causes of the problems found in the fruit trees mentioned in the stem above?
 - Explain the causes of keeping the seedling in that environment as she notices them in the stem.
- 2.

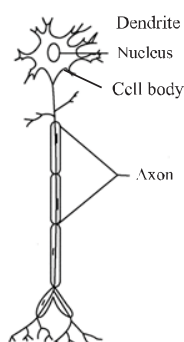


Fig: A neuron

- What is reflex action?
- Explain what is hormone?
- Explain the role of part 'A' to create stimulation in human body.
- The structure and nature of this cell is different- analyse it with your opinion.

Chapter Eleven

Reproduction

Reproduction is one of characteristics of an organism. Organisms give rise to other organisms of the same kind in life time and then continues its generation. The process of reproduction may be of various types. Diversified reproductive processes are being observed. Human reproduction are to be discussed in this chapter.



At the end of the chapter we will be able to.

- Explain the concept and significance of reproduction in organisms.
- Describe the functions of a flower as a reproductive organ.
- Explain the sexual reproduction in plant with the life cycle of flowering plants.
- Explain the asexual and sexual reproduction of animal.
- Explain the nature of reproduction.
- Make differences between the external and internal reproduction.
- Explain the steps of human reproduction.
- Describe the role of hormones in reproduction.
- Explain the development of embryo.
- Explain the mode of transmission, prevention and remedy of AIDS in human body.
- Explain the preventive measures of AIDS to develop awareness.
- Can raw the poster and leaflet for the prevention of AIDS.
- Show sympathy towards AIDS patient.

Concept of reproduction in organisms and its significance

Death is inevitable for life if it is born. If only death would have been occurred, once organisms would be extinct. But actually is not happening because in one hand organisms are dying on the other hand organisms are also reproducing. Reproduction is such a physiological activity through which organisms continue the existence of their offspring by producing their replicas. The process through which organisms produce their offspring is called reproduction.

Reproduction is of two types, such as, asexual and sexual. Generally in lower organisms, sexual reproduction does not occur but some lower organisms reproduce sexually. Most of the higher plants and all-higher animals produce their offspring through sexual reproduction.

In sexual reproduction, two reproductive cells of opposite characters are fused. In this case, one is called male reproductive cell and the other is called female reproductive cell or egg. Two types of reproductive cells can be produced in the same flower or in the same body. In higher plants, there are two types of reproductive cells produced in the same bodies. They are monoecious plants. When two types of reproductive cells are produced in separate bodies, these plants are called dioecious plants.

The precondition of developing of any reproductive cell is that germinal mother cell will have to divide through meiosis. As a result, the number of chromosomes in a reproductive cell becomes half than that of the mother cell. Later, zygote being divided repeatedly through the process mitosis develops the new body of the newly born organism. In this way, an organism gives birth of many organisms. An organism this way also maintains the flow of its future generations. If reproduction would not occur in organisms, they would be extinct. From a virus or bacterium up to human beings, all organisms maintain the existence of their species by reproducing their new generations. Which way an organism will accomplish its reproduction depends on the characteristics of the organisms. This is why when a lower organism does its reproduction through cell division then an organism of higher level accomplishes its reproduction through the complex process of sexual reproduction.

Flower: Reproductive organ of plants

A flower is a special type of modified shoot for reproduction. A flower is a reproductive organ of a higher plant. We know that the two (androecium and gynoecium) of the five whorls of a flower is very significant for reproduction. They directly take part in the reproduction. Though other parts or whorls of a flower do not directly take part in reproduction, they meaningfully help the process reproduction. The flowers, which have five whorls, are called complete flowers. If a flower lacks any of the five whorls, it is called an incomplete flower. When both androecium and the gynoecium are present in a flower, it is called a bisexual flower. If any of the whorls androecium or gynoecium is absent, this flower is called unisexual flower. If both androecium a gynoecium are absent in any flower, it is called a neuter flower.

Different parts of a flower

Thalamus: This is usually round and is developed at the tip of a floral axis. The other parts or whorls of a flower are arrayed consecutively on the floral axis one after another. Floral axis holds up the flower attractively.

Calyx: The outermost whorl of a flower is called calyx. If the sepals of the calyx are not separate, it is called aposepalous. Each of the part of calyx is called a sepal.

The green calyx takes part in the production of food. Their main function is to save the inner parts of a flower from the sun, rain and attack of insects and pests. When the calyx is of different colours, it plays important roles in pollination, and it attracts different animals such as insects, birds etc. as the medium of accomplishing pollution.

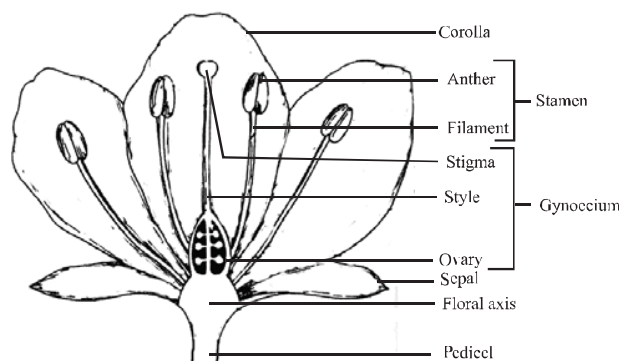


Figure: 11.1 Different types of flower

Corolla: It is the outermost-but-one whorl of a flower. If the corolla is segmented, each one of it is then called a petal. If the petals in a corolla are separate from each other, the term polypetalous is used then. In case of having sepals wholly or partially fused, they are called gamopetalous. Corolla usually looks colourful. They protect the internal parts of a flower from the sun and rain. Bright colourful corolla attracts animals – birds, insects etc. and helps pollination. Sometimes insects draw nectar sitting on the corolla of a flower. The purpose of pollination is served when the carriers complete these activities.

Androecium: It is the third whorl from outside of a flower, and it is an essential whorl. Every part of an androecia is called stamen. In an androecium, there may be one or more stamens. The stalk like structure of stamen is called the filament and a sac like apical structure of it is called anther.

The part of a stamen, which connects the anther to the filament, is called connective. Pollens are developed in an anther. A pollen tube is produced from a pollen after germination. Thus, pollen male gamete is produced in the pollen tube. The male gametes directly take part in the process reproduction. In some plants, the filaments may be connected to each other, sometimes anther may combine with each other. When the stamens with all the filaments merged together into a tube like group, it is called monadelphous, such as in Chinese hibiscus. If the filaments are attached with two

groups, it is called diadelphous and when in many groups, it is called polydelphous, such as cotton tree (*Salmaaliala malabarica*). When anthers are united into a single group, it is called syngensis. The state of being of the stamen free attachment to corolla, the androecium, then be called epipetalous, such as in *Datura*.

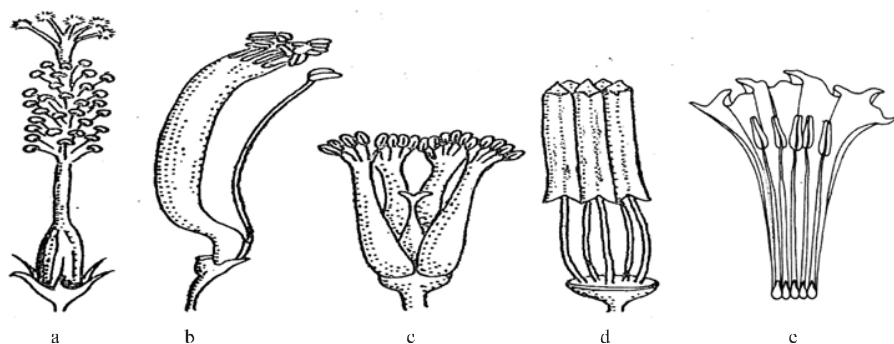


Fig: 11.2 Different types of stamen: a. Monodelphous b. Diadelphous, c. Polydelphous d. Syngensis e. Epipetalous

Gynoecium: The portion of gynoecium is at the centre of a flower. It is the another essential whorl of a flower. A gynoecium may be structured with one or more carpels. A carpel has three parts, such as ovary, style and stigma. When a gynoecium is formed with many more carpels and is completely merged with each other, then it is called, syncarpous and when they are separated, it is called polycarpus.

One or more ovules are there in a flower in accordance with some orders arranged inside of an ovary. Within the ovule, female reproductive cell ovum is produced. This ovum like an androecium directly gets involved in the process reproduction.

Work 1 : Observation of different whorls of a flower.

Essentials: a flower, bread, forceps, and blotting paper.

Work 2 : Separating the ovary from a flower, collect a transverse section with a blade and place them aesthetically on the piece of blotting paper. Write down the names of object that you have seen.

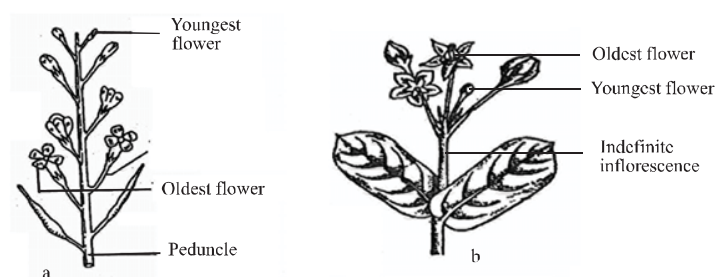


Figure: 11.3 a. Definite inflorescence b. Indefinite inflorescence

Inflorescence: All of you have seen clusters of flower arranged in a small branch of a tree, following some special orders of arrangement is called inflorescence. Along with

the flowers, the branch of a tree is called inflorescence. It is called peduncle on which flowers are orderly arranged. If the growth of this axis is unlimited, it is called indefinite inflorescence and in case of unlimited growth of the axis it is called definite inflorescence. An inflorescence plays important roles in the process of pollination. Two consecutive steps are there in reproduction, consecutively pollination and fertilization. The two issues are addressed below.

Pollination: Pollination is also called the linking of pollens. Pollination is a precondition for the development of fruits and seeds. The transfer of pollens from the anther to the stigma of the same flower or to the stigma of another plant of the same breed is pollination. Pollination is of two types, such as, self-pollination and cross-pollination.

1. Self-pollination: Transfer of pollen to the stigma of the same flower

On the same flower or on the two flowers of the same plant, transfer of pollen can occur, it is called self-pollination. For example, Brassica, cucumber and Datura usually pollinate through this way.

Wastage of pollen is less, and does not depend on a carrier for pollination and the happening of pollination is ensured. The plant that develops in that way of pollination cannot make changes in their characters and so the features of a species can be maintained. This way a species can maintain purity in it. No new characters appear in the new generation of plants. The newly born plants breed seeds with less vigour. The ability of adaptation in the new plant is reduced and once this species can be extinct.

2. Cross-pollination: When the attachment of pollen occurs in between two distinct flowers of the same species, it is called cross-pollination. Such as, cotton tree (*Salmaal malbarica*), papayas (*Carica papaya*) pollinate this way.

New characters emerge through cross-pollination. The rate of germination goes up and much more vigorous seeds are produced through this way of pollination. So the new species is ordained to pass its life on earth. As the pollination occurs in between two different plants, the seed produced this way is born with new more characters. The plant, which grows from that seed, is also with the new characters. This is why new varieties of those plants emerge. As it is a matter of carrier dependent process, pollination may not be ensured and large waste of pollen is a consequence of this type of pollination. So the purity of species is impaired.

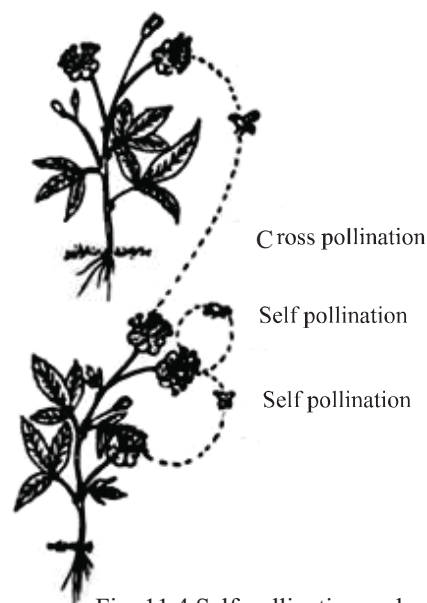


Fig: 11.4 Self-pollination and Cross pollination

Medium of pollination:

In most of the cases, a medium or cues accomplishes the transfer of pollen. The carrier, which carries pollen, is called pollen courier. Air, water, insects and flies, birds, vampires, snails and even men may be the media of pollination. To consume nectar from a flower or after fallen in love with the charming colour of the flower, the carriers loiter from one flower to another. Then pollens get attached to the carrier at that time when the carrier sits on the lap of the flower causing the pollen get attached with it. To obtain the aid of the carrier, some plant adaptations are remarkable.

Fly pollinated flowers are big in size with coloured nectar secreting glands. In those flowers fragrance of wet fluid is very much alluring. For example, Chinese hibiscus, Squashes, turnips etc. do pollination this way.

Air pollinated flowers are lightweight and without nectar secreting glands. No fragrance is with the flower and can easily wander in the air. Their stigmas are sticky form a structure like a feather branched will to attain pollens from the air.

Water pollinated plants are small and lightweight, so that they can float in the water. No fragrance is with them. The petiole in the female flower is long but short than that of male. Mature male flowers being detached from the petioles float in the water and after coming in contact with the female flowers, they immediately accomplish pollination.

Animal pollinated flowers are usually large in size. If they are small, they are arranged in the inflorescence. They have attractive colours. Fragrance may be present or absent in them. Such as Kadam, cotton tree (Shimul) and taro are animal pollinated.

Microsporogenesis

A pollen is the first cell of the gametophyte. Soon after becoming mature harbouring in the pollen sac starts to germinate. The nucleus of the pollen gets divided through mitotic division and two cells, one large and another small, are formed. The large one is called tube cell and the small one is called generative cell. The tube cell turns into pollen tube and two male gametes are produced. Division of generative cell takes place in the pollen or pollen tube.

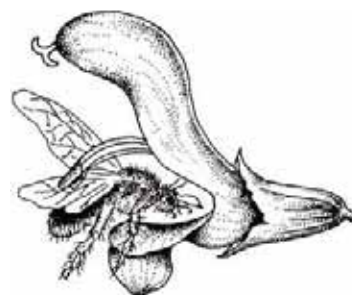


Figure: 11.5 Entomophilic flower



Figure: 11.6 Zoophilic flower

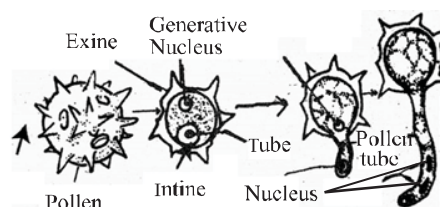


Figure: 11.7 Different stages of development of male gametophyte

Megasporogenesis

Near the micropyle being nourished in the nucellus of an ovule, a cell starts to become larger. Its protoplasm is dense and the nucleus is comparatively larger. The cell divides into four haploid cells through meiotic division. Every cell except the smallest one, gets disintegrated. Growing gradually the larger cell matures into an embryo sac. The nucleus of the cell is haploid. The nuclei are evolved as the nucleus divides. These two nuclei take position in two opposing poles. Next, these two nuclei consecutively divide twice and result in four nuclei.

In the next stage, two nuclei form the two poles coming at the middle of the cell get fused and cause the emergence of two haploid secondary nuclei. The nuclei in the two poles turn into cells with some amount of cytoplasm. Collectively, the combined structure of the three cells near the micropyle is called egg apparatus. In between the cells, the one occupying the middle place is the ovum, which is little larger. This is called an egg cell and the other two are called synergid cells. The cells in the opposite pole to the egg apparatus are called antipodal cells. This way the process of developing embryo sac is ultimately done.

Fertilization:

Trough pollination, mature pollen lands on the stigma of a carpel. Then pollen tube grows penetrating the style and becomes little flatulent absorbing some liquid. Once the tips of the extended pollen tube entering into the embryo ejects two male gametes in the embryo sac. One of them meeting with the egg causes the emergence of a zygote. Another male gamete mixing with the secondary nuclei develop triploid endosperm cells.

The two fusions, mixing of a male gamete with an egg and mixing of another male gamete with secondary nuclei, take place at about the same time. This phenomenon is called double fertilization.

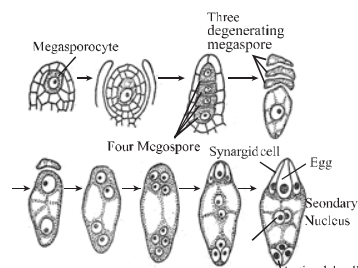


Figure: 11.8 Different stages of development of female

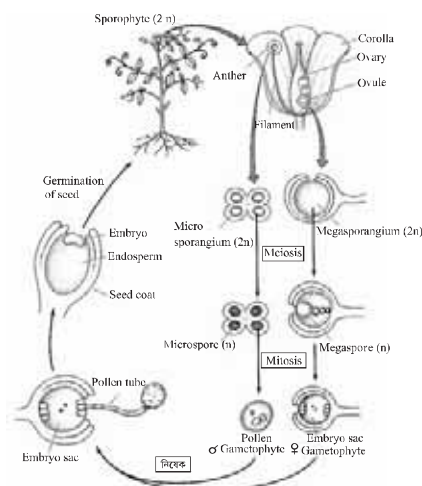


Figure: 11.9 Life cycle of flowering plant.

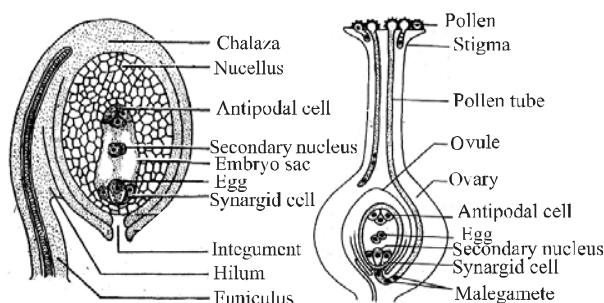


Figure: 11.10 Structure of ovule and fertilization

Development of new sporophyte:

A zygote is the first cell of a sporophyte. Two cells are produced after its first division. At the same time, flourishing of endosperm is also ignited. A zygote divides transversely. The cell towards the micropyle is called the basal cell and the cell towards the centre of the embryo sac is called the apical cell. The division of these two cells continues side by side. Gradually, the apical cell turns into embryo. The suspensor also gets developed concurrently. Cotyledon, radicle and plumule are developed one after another and the secondary nuclei start to make the endosperm. The cells in an endosperm are triploid that means they possess three sets of chromosome ($3n$). At maturity, the ovule with the endosperm and embryo turns into a seed. As the seed germinates, a complete sporophyte is developed.

So it has been found that sporophyte and gametophyte, two states run in a repeating way one after another through the life cycle of a flowering plant.

Origin of fruits: When we think about fruits in our mind appear the images of mango, jackfruit, lichi, banana, grape, apple, guava, sofeda etc. appear in our mind. Bottle gourd, gourd, Jingha, pointed gourd are also fruits. As they are not eaten green, they are called vegetables. In fact, they are all fruits. The process of the formation of fruits begins just immediately after the completion of fertilization. Fertilization ignites stimulation in ovary to make the way of developing fruits steadily and ultimately, ovules are turned into seeds. The ovary after fertilization with the different parts of it turns into a nice structure called fruits. If only the ovary turns into a fruit, it is called true fruit. Mango and Jackfruits can be the examples of true fruit. When along with the ovary, other parts of a flower get mature, this type of fruit is called false fruit. Apples, Chalisa are the examples of false fruit. All the true and false fruits are grouped into three categories: fleshy fruit, aggregate fruit and compound fruit.

Animal Reproduction: Reproduction is of two types in animal kingdom. (1) Asexual reproduction and (2) Sexual reproduction.

(1) Asexual reproduction : Asexual reproduction happens in lower animals. Asexual reproduction occurs in different ways. Such as – budding, binary fission, fragmentation etc.

(2) Sexual reproduction : The process through which two animals of opposite sex (male and female) compete their reproduction by means of producing male and female gametes, fertilizes and produce offspring is called reproduction.

Fertilization : Fertilization is necessary for sexual reproduction. It is a universal biological process. Sexual reproduction takes place by producing dissimilar gamete that is male. Fertilization occurs by the fusion of that is called fertilization. During sexual reproduction active sperm penetrates into the ovum and the two nucleus fuse together. The cell is formed by the fusion of nucleus is zygote. It requires sometime for fertilization. Each of the sperm and ovum contains haploid number of chromosome it

signifies it carries (one set of chromosome). Due to fertilization zygote is produced, Zygote is a diploid new cell that means it carries two set chromosomes. Maturity of sperm and ovum is the precondition of fertilization.

Fertilization is a particular process. It happens only with the matured / full grown sperm and ovum of some species. Generally fertilization is unchangeable. Once an ovum is fertilized it will not fertilize again. On the basis of the place of occurrence, fertilization is divided into two types. (1) External reproduction and (2) Internal reproduction.

(1) External reproduction : If the fertilization takes place outside the body of male and female animals, generally in water is known as external reproduction, example in fishes. But exception are there, such as : sharks and different fishes.

(2) Internal reproduction : The fertilization which takes place inside the reproductive organ of the female is called internal reproduction. This fertilization occurs introducing sperms of the male into the female reproductive organ. It is one of the characteristics in most of the terrestrial animals.

Some basic significance of fertilization : Restoration of diploid chromosomes within the embryo accumulates hereditary characters of both male and female, makes the ovum active for its development. Chromosomes carry the characteristics of both father and mother. These characteristics combine, determine the sex of the embryo. Block picture shows the stages of gamete formation is give below.

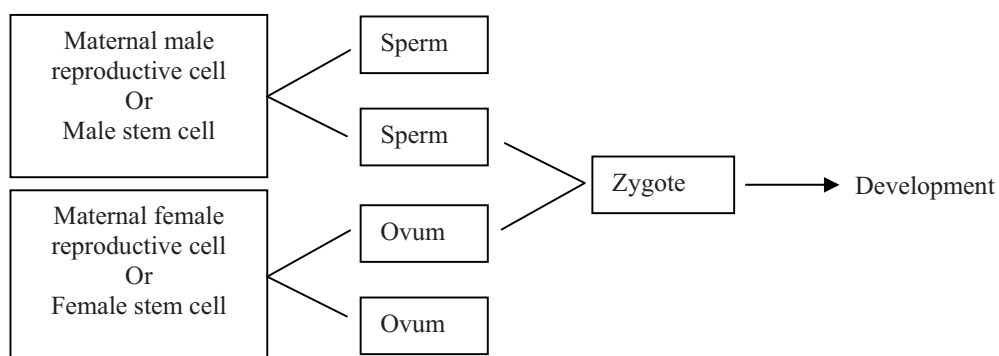


Figure : 11. 11 Different stages of human reproduction.

For the continuity and restoration of hereditary, reproduction is essential. This process includes formation of embryo and give birth to offspring. Man is unisexual, so that male and female reproductive organs are present in different individuals.

Role of hormone in human reproduction :

In the meantime you have learned that hormone is a type of organic substance, that is secreted from the ductless gland. It acts as a chemical messenger and is transported all over the body organs through blood, help in chemical reaction and controls different metabolic and physiological processes. A particular hormone secretes in small amount

yet it controls different physiological processes. Over secretion and deficiency of these hormones create disturbance in different functions. So it creates different irregularities within the body.

Reproductive hormones secreted from endocrine glands within the body are described below. (1) Pituitary gland (2) Thyroid gland (3) Adrenal gland (4) Testis (5) Ovary (6) Placenta.

Growth stimulating hormone and growth hormone are produced by the pituitary gland. These hormones regulate growth of reproductive glands and secretion and control the functions, control mammary gland and milk secretion. Besides, these hormones regulate the contraction of uterus. Thyroid glands secrete thyroxine hormone. It regulates metabolic function, ensures physical and mental development, sexual characters. Hormone secreted from the adrenal gland regulates development of reproductive organs, external sexual characters. Testosterone hormone secreted from testis and androgen helps to produce sperms and sexual secondary characters, such as: deepening of voice and growth of beard. Ovary secretes estrogen, progesterone, relaxin hormones. These hormones cause the development of sexual characters, menstruation, enlargement of the wall of uterus for implantation of the embryo and placenta. Besides, this it has a particular role in the formation of ovum. (singular of ova). Gonadotropic and progesterone of placenta stimulates ductless glands of ovary and helps in enlargement of mammary glands.

When the baby takes birth their reproductive system remains tender or immature. Along with physical growth, reproductive system also grows and develops with the increasing of age. Hormones play a significant role in this process. Children pass over their childhood, adolescence and attain to youth. The transitional period adolescence and the youth is named as puberty. At that time physical, mental and secondary sexual characters develop. Both inner and outer changes occur, such as: growth of extra hair on the face, deepening of the voice, widening of shoulder etc are the external changes.

During puberty the changes within the girls are noticed, these are – shyness, hesitation, softness in skin, loveliness in appearance etc. In this stage of puberty usually starts monthly discharge of blood or menses from the uterus at regular intervals. This is menstrual cycle or menstruation. After 1-2 years of puberty girls gain the ability of reproduction. Then they begin to produce ovum from the maternal female reproductive cell (mother stem cell) within the ovary. It continues up to 40-50 years. Menopause is the time of cessation of the menstrual cycle it normally occurs in woman aged between 40-50 years. Here it is mentioned that menstrual cycle remains temporarily stopped during pregnancy. After 6 weeks of child birth it starts again.

Marriage is a social, spiritual and a family tie. By readjustment as a couple begin their life together. They become intimate to each other unhesitatingly. A relation of love, affection and attachment develops between them. There should be a specific time limit to get married. Before 20 years a female should not marry. As a result early marriage

causes a girl pregnant in immature age. There is every possibility of getting harm in both mother and the baby.

Sexual reproduction occurs by physical relationship in between husband and wife. During physical contact sperm of male enters into female reproductive organ. A sperm has a tail which helps it to swim into the female reproductive system. Fusion of sperm and egg nucleus occurs within the oviduct. This fusion is called fertilization. But it is necessary to know that an egg (ovum) fertilized with a single sperm only. In this way internal fertilization occurs within the human body. Each of the sperm and ovum contains one set of chromosome (haploid). By the fusion of these haploid sperm and ovum a diploid zygote is formed.

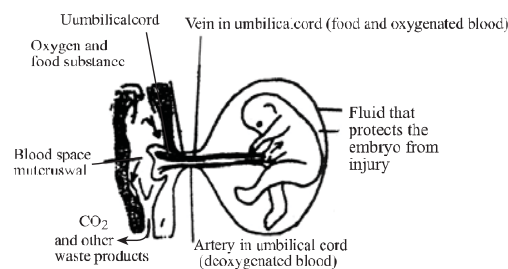


Figure: 11.12 An embryo and placenta

Development of the embryo : The fertilized egg gradually passes along the oviduct to the uterus. Immediately after the fertilization, cell division begins in the zygote. The cell division is called cleavage. At the last stage of cleavage the growing embryo arrives in the uterus. At this stage this mass of cells of the growing embryo is called blastocyst. The changes that happens in the uterus is very important for the development of the embryo.

For the development of next stage of blastocyst. The embryo has to be embedded with inner wall of the uterus. So the blastocyst becomes embedded with the uterine wall this process is called implantation or conception. Imbedded with uterus the embryo grows and turns into a human body. Time between the implantation and child birth is called pregnancy. At that time menstruation or menstrual cycle remains stop. The embryo or fetus develops in the uterus for 38-40 weeks.

Placenta : A particular organ built up of material and fetal tissue forms a connection jointly is called placenta. Implantation is completed within 4-5 days after reaching the embryo in the uterus. The placenta is a disc shaped and blood vessel enriched organ composed of cells derived from the fetus and the endoderm of uterus. In this way a temporary unseparated organ is formed between the fetus and endoderm of mother's, uterus. At the time of child birth placenta is eliminated from the body.

The embryo is implanted with the uterine wall with the help of placenta. It does no harm of the embryo. Embryo needs food for its growth. Carbohydrate, (glucose), protein (amino acid), essential minerals, water etc. are transferred from maternal to fetal blood to nourish the developing embryo. Placenta acts more or less like a lung. The dissolved oxygen in the blood of the maternal blood diffuses into the fetal blood and exchange carbon di-oxide from the fetus to the mother. Placenta also acts as kidney; metabolic waste product is diffused from the embryonic blood capillaries into the mother's blood

stream. In this way the waste products are eliminated. Placenta produces some important hormones. Hormones protect the embryo and helps in normal development.

Placenta is formed within 12 week after fertilization. During pregnancy exchange of waste products and essential materials which are exchanged between the mother and fetus through placenta.

Placenta contains a huge amount of blood capillaries. The embryo is attached to placenta by a tube called the umbilical cord. It is also known as cord. Basically it is a tube through which exchange of different materials occur between mother and fetus. At the time of pregnancy it secretes some hormones which helps to produce milk and easy child birth.

Embryonic membrane : The embryos of each species have a series of embryonic membrane which are essential for easy, normal and safe development of the embryo. These help in fetus nutrition, gaseous exchange and elimination of waste products. Embryonic membrane protects the fetus (embryo) and controls other important action.

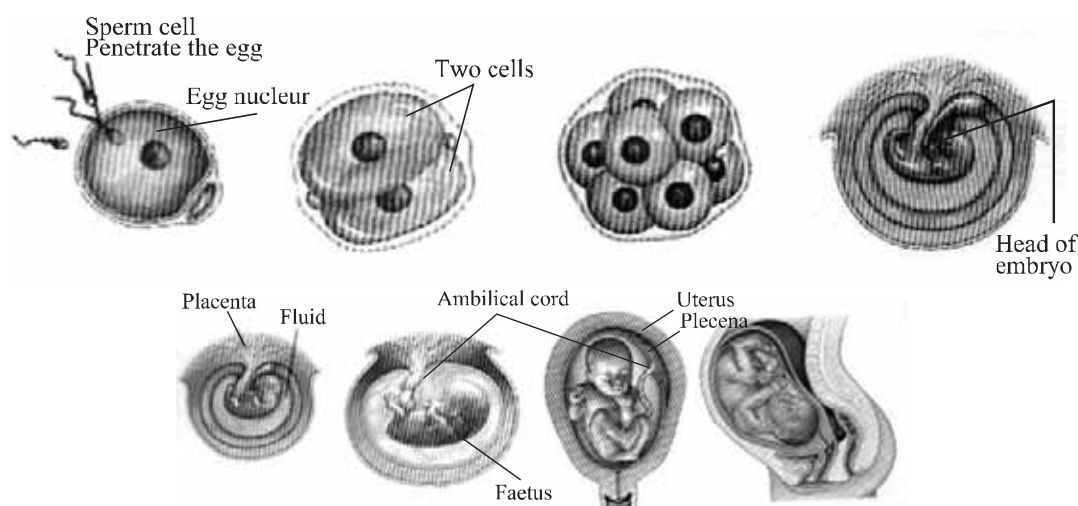


Fig. 11.13 : Embryonic Growth and development

In human, pregnancy lasts for an average of 40 weeks. At the same time mother's anterior pituitary and placenta begins to secrete two hormones. Two hormones becomes active at about 40 week. The hormones actively promote uterine contractions at regular intervals that results pain. This increasing pain is called labor pain. At the last stage of child birth the embryonic membrane bursts and fluid enclosed by the membrane comes out and the fetus or baby push out of the uterus that means child takes birth.

Reproduction relating diseases: Acquired immune deficiency syndrome (AIDS). At present AIDS is well known as a killer disease of the world. This disease is invented in 1981. Taking from the first alphabet of Acquired Immune Deficiency syndrome the disease I named. According to the statistics of USAIDS known that world wide more

than 2.5 million people are infected by AIDS germ. Almost 40% of the infected persons are female. According to world health organization this disease is spreading about 164 countries. AIDS disease is caused in human body by the attack of one kind of virus named HIV – Human Immune Deficiency virus. This virus destroys white blood cells causes obstacle in antibody formation, that results the gradual shortage white blood cell and antibody. In human body this virus can remain dormant for a long time. It destroys the victim's immune system. It destroys the defence or immune system. Because till today there is no effective medicine discovered to regain the immune system completely. So the ultimate fate is death.

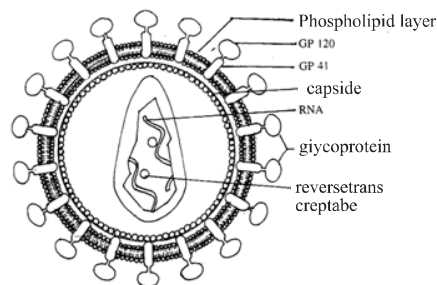


Fig. 11.14 Structure of HIV

Causes of AIDS : A healthy person can be infected by this life threatening disease as follows such as –

1. Sexual relation or physical relation with infected males and females. Transfusion of blood is necessary such as – blood loss due to accident, excessive bleeding at the time of child birth, anemia, thalassemia, cancer etc. Transfusion of blood from a HIV infected person to a healthy person may transmit the disease.
2. A newborn body of HIV infected parents may be infected. A baby may be infected from HIV infected mother during breast feeding.
3. The disease may transmit to a healthy person Such as – Sharing of infection needles, syringe or other/surgical operation related instruments etc.
4. Trans placement of HIV infected organ or tissue in the body of healthy person.

Symptoms and signs of AIDS : Signs and symptoms of the disease are exposed after 6 months of entering the germs of the disease with the body of healthy person. Before it can not be comprehend that infected person is the carrier of this disease. The symptoms are –

- Rapid loss of body weight.
- Fever for more than one month for unknown reason.
- Dry cough for prolonged period.
- Pain in armpit, neck and face become rough.
- Puffiness and swelling of some organs. Such as : face, eyelid, nose etc.
- Itching in the whole body.

Prevention AIDS : You have learned earlier about this disease. Let us examine whether we can remember it.

- What is the necessity to prevent AIDS.
 - Can it be possible to abstain or avoid the causes that spread the infection of the disease.
- Write the measures of prevention on the black board and make a summary of it.

Work : Form a group of 5 students, draw a poster / leaflet regarding the preventive measures of AIDS.

Exercise

Short answer question

1. Why human is called unisexual animal?
2. What is uterus? What is its functions?
3. What is placenta? What are the function of placenta?
4. What measures should be taken to prevent AIDS.
5. Explain the function of hormones in reproduction.

Essay type question

1. Why is a flower called the reproductive organ?
2. Describe the causes, symptoms and remedy of AIDS.

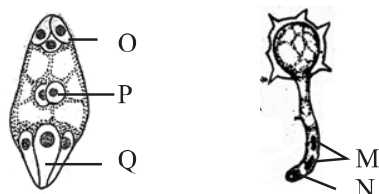
Multiple choice question

1. In which flower, stamens are diadelphous that is filaments of stamens are united in two bundles?
 - a. Chinese hibiscus
 - b. Pea
 - c. Cotton tree or shimul
 - d. Sunflower
2. The air pollinated flower is ..
 - i. large in size.
 - ii. with undivided stigma.
 - iii. without nectar glands.

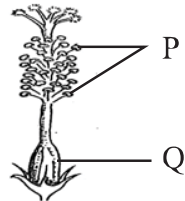
Which one is correct?

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

Look at the stem and answer the question 3 and 4:



3. Which one of the stem turns into a seed?
 - a. N
 - b. O
 - c. P
 - d. Q
4. Which one does play a role in producing endosperm?
 - a. M & Q
 - b. M & P
 - c. M & N
 - d. N & P

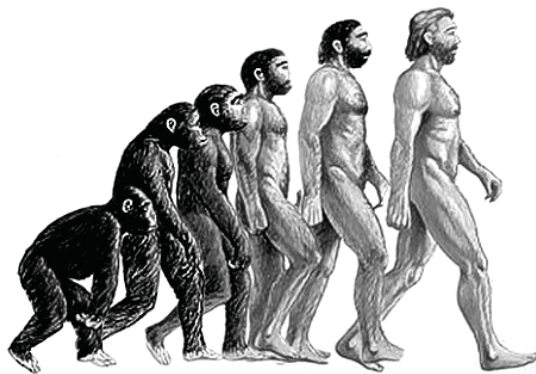
Creative question**1.**

- a. What is an embryo sac?
 - b. What is indefinite inflorescence?
 - c. Explain what problems there will be in pollination if the part P in the stem is absent.
 - d. Express your opinions, how the part Q in the stem serves its own species.
2. 12 years old Ridoy sings with a melodious voice. Recently with change of his physical and mental changes his voice becomes deep. So his mother consulted with a doctor, he said this change is a normal procedure.
- a) What is placenta?
 - b) Why AIDS is called a fatal disease?
 - c) Explain the cause of that events happened in Ridoy's body?
 - d) Explain what are the role of the elders towards Ridoy.

Chapter Twelve

Heredity in organisms and evolution

Structural and behavioural traits from both the parent, mother and father, are passed to the offspring generation after generation. We will learn from this chapter how traits from both the parents are transmitted to the offspring. Moreover, we will be able to know that there exist classes are in the living world, and being emerged from the ancestors through the way of evolution, organisms express their visible form of present existence.



At the end of this chapter, we will be able to:

- Explain the concept of heredity.
- Describe the content containing the behavioural materials obtained through generations.
- Explain the passing of the behavioural characteristics from generation to generation.
- Explain the necessity of heredity.
- Explain the replication of DNA.
- Describe the roles of DNA in transferring heredity materials.
- Explain the necessity of DNA test.
- Explain the role of a male in determining the gender of an offspring.
- Explain the causes and results of genetic disorders.
- Explain the natural selection theory in evolution.
- Describe the natural selection theory of evolution.
- Explain the significance of evolution in the survival of species.
- Determine the differences between the similar and dissimilar features of mother and father.
- Conceive the roles of DNA test in our life.

All the organisms in the world are characterized with their own unique features. Features of individual organisms pass to the next generation and evolve in them. This natural principle is applied to all organisms in the world. This is why we notice rice plant grows from rice seed, mangoes from their seeds; jute does also this thing in the same way. This way the characteristics of species are maintained in offspring through generations. Heredity is the passing of traits from father and mother to their offspring through generations. In depth discussions and researches concerning heredity are done in the special branch of biology called genetics.

Work: Identify the similar and dissimilar traits from parents and place them in a chart with a nice presentation.

Components carrying (heredity materials) behavioural features to the offspring from generation to generation

The features of parents are transferred to their offspring through heredity materials. These are chromosomes, genes, DNA and RNA. These are discussed below:

Chromosome: The main heredity material is chromosome. It is spread in the nucleoplasm of a nucleus as a thread like structure named chromatin. The scientist Strasburger in 1875 first discovered chromosome. In different species the number of diploid set of chromosome (two sets chromosome, one set is from father and the another set is from mother) may be 2 to 1600. In length a chromosome may be from 3.5- 30.00 micron (1micron=1/100mm) and in width 0.2 to 2.0 micron. The function of chromosomes is to carry genes (which control the characteristics of organisms) to the offspring from parents. Colours of human eyes, nature of hair, compositions of skin etc. continue intact through the flow of heredity carried by chromosomes. This is why chromosomes are designated as the physical basis of heredity.

DNA

The main component of chromosome is deoxyribonucleic acid. It is usually a double stranded spiral structure of polynucleotides. A strand is complementary to the other. In it there are five carbon sugars, nitrogen bases (adenine, guanine, cytosine, thymine) inorganic phosphate. These three components collectively are called a nucleotide. DNA is a stable substance in a chromosome. American scientist Watson and British scientist Crick in 1953 described first the double helical structure of DNA and for this contribution both of them won Nobel Prize. Nitrogen bases are of two types, such as, purines and a pyrimidine. Adenine (A), guanine (G) are purines and cytosine (C) and thymine (T) are pyrimidines. Adenine of a strand bonds with a thymine of another strand by two hydrogen bonds, and guanine of a helix connects with a cytosine of another helix by three hydrogen bonds. This bond is always developed in between a purine and pyrimidine. So a strand of DNA is complementary to another strand but not just as the same. A complete twist in a helix is 34\AA long and in a complete twist, there are ten nucleotides. So the length between the two adjacent nucleotides is 3.4\AA . Two strands of

polynucleotides in DNA are positioned antiparallelly. It mostly looks like some rungs in a twisted ladder. Bases are connected flatly and horizontally in the position from the main axis. External two strands or two axis of DNA are composed of consecutive arrangement of sugar and phosphate, and internal nitrogen bases are plainly aligned. In fact, DNA is a precise thread but in prokaryotic cell DNA is usually circular and the surface area would be some microns to centimeters. It is composed of thousands of nucleotides and the diameter of the twisted helical structure in everywhere is 20\AA . DNA is the main component and chemical carrier of heredity. DNA is the true structure and carrier of the behavioural characters of organisms and it directly carries the characters of parents to their offspring from generation to generation.

RNA

RNA stands for ribonucleic acid. Most of the RNAs are single structured. It is composed of 5 carbon ribose sugar, inorganic phosphate and nitrogen bases (adenine, guanine, cytosine and uracil). In the genome of RNA virus, RNA is found as a permanent component or the inherited component. In some viruses (tobacco mosaic virus) DNA is absent. The viruses which are not composed of DNA possess RNA as their nucleic acid. In this situation, RNA serves itself as the hereditary material.



Figure: 12.1 DNA

Gene

The unit of controlling all the visible and the invisible signs and characters of organisms is called gene. They are positioned throughout the chromosome of organisms. The location of a gene throughout a chromosome is called locus. In a pair of chromosomes, genes are spread or structured in pairs. For a specific character, a gene is responsible. In some cases, a character is expressed through a cooperative action of more genes. In other cases, a gene controls more than one character. From the theory of different researches, it has been made clear that a gene is the perfect master of heredity. The number of gene in different organisms is not the same. In the same nature of organisms, the number of gene is more or less the same. Genes are arranged in a common principle alongside from one end to another end. Chromosomes are separately spread from each one in a leaner form. The character, which is expressed in the first generation from the parent is called, dominant character and the character, which does not express in the first generation but is expressed in the second generation, is called a recessive gene. The factor, which Gregor Johan Mendel in

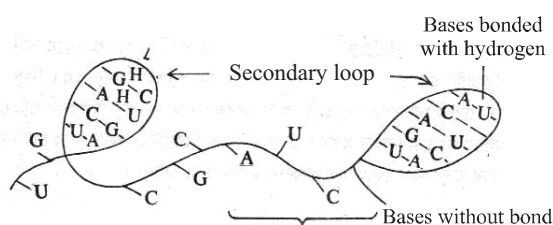


Figure: 12.2 RNA

1866 mentioned in his work concerning heredity in plants, takes the presently glamorous known as gene. Gregor Johan Mendel is called the father of genetics.

DNA replication

Through the process, a new DNA molecule is synthesized from a molecule of DNA. DNA replicates in a half-conservative way. Through this process, the double stranded DNA becomes single stranded by breaking hydrogen bonds in between them and each strand causes the emergence of a new strand. At the end, a new strand, combining with another old strand, forms the structure of a molecule of DNA. As the new DNA emerges, it has a new and an old strand. This principle is known as semi-conservative method. In 1956 Watson and Crick first successfully proposed the replication process of DNA.



Figure: 12.3 DNA replication

Work: The teacher will ask the students to demonstrate a diagram of a DNA after drawing it in a big piece of paper with a pencil.

DNA Test: Throughout the present century, DNA technology and the significance of it in the field of medical science, agriculture, fish and animal resources and in the industry of medicine have introduced a new chapter on creation.

In Bangladesh, along with evidence, witness, eyewitness dependent judiciary system, DNA has opened a new window of ensuring true justice.

A scientific and practical method of DNA test is called DNA fingerprinting. Besides, the name DNA typing or DNA testing is also used in some practices. To perform the DNA test, the first requirement is an organic specimen. Bone of a person, teeth, hair, blood, saliva, semen can serve as valuable organic specimens. The small profile on the place of occurrence of crime or profile from the specimen of victim of a crime is compared with the map obtained from the blood or organic specimen of a suspected person. In this process, first forms of specimen DNA should be isolated. By more than one small restriction enzymes, DNA is then cut into many pieces. Through a special method called small electrophoresis agarose or polyaxialamaid gel, DNA fragments are separated alongside their length. On a special type of nitrocellulose paper, the radioactive isotope hybridized with DNA and keeping it on x-ray film through the method of autoradiogrphy visible rows of bands are determined and with the specimen from the place of occurrence and suspected specimen, it is compared. This method is called DNA finger printing. Nowadays, it has become possible to identify more accurately the suspected specimen with little amount of it through the process of polymerase chain reaction (PCR) method.

Determination of human sex (gender)

In human and other mammals sex is determined the same way. In the cells of human body, the number of chromosome is 46, i.e. 23 pairs. Among them 22 pairs or total number of 44 are autosomes and the remaining pair is sex chromosome. Autosomes play roles in physiological, embryonic and the formation of body of organisms which have no part in determining sex. The two sex chromosomes are marked with X and Y. They play significant role in determining sex. In women, in the diploid cells both sex chromosomes are X i.e. XX. But in case of men of the two chromosomes one is X and the other is Y. Both the chromosomes are long in structure, rod shaped but chromosome Y is little shorter than the chromosome X. At the time of development of egg, meiosis occurs, and every egg possesses a chromosome. But in case of a man at the time of the formation of sperms, half number of sperms contain X chromosome and other half number of sperms contain Y chromosome. An egg can be fertilized with either one of the sperm type X or Y. So, zygote can be having both the chromosomes as type X, or can be having one X and the other one Y. The baby, which is born having both the chromosomes as X i.e. XX, will be a baby girl and the baby, who is born with a chromosome of type X and the other one is of Y, will be a baby boy.

If the principles and orders of determining human sex are pondered over well, we will find that in determining sex, a mother plays no role because a mother always produces eggs containing only X chromosome. The other side of the fact is that a father produces sperms contrarily, with having both the type X and Y. At the time of conception, the type of sperm, that will fuse with the egg, determine the sex of the offspring. As in fertilization only one sperm is fused with an egg, this is why either X or Y chromosome of a father successfully accomplishes the job of determining sex of offspring. If the Y chromosome bearing sperm fuses with an egg, the zygote would bear chromosomes of both the type X and Y. The chromosomes would be XY. The result would be the offspring as a son. In most of the traditional societies, because of ignorance, mothers are held responsible for giving birth to a baby girl. For these erroneous concepts, mothers have to endure many mental and physical oppressions. Though it is an accidental coincidence from the scientific point of view, responsibility of determining sex lies on the shoulder of the father, but not on the mother.

The issue is shown through the figure.

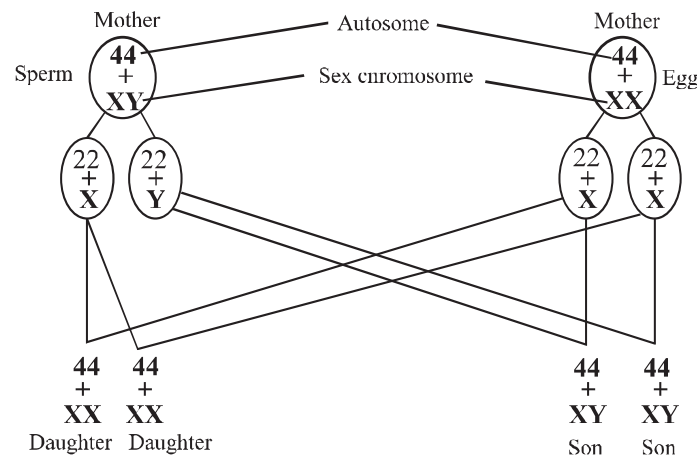


Figure: 12.4 Human sex determination

Work: Determine whether a son or a daughter will be born following the following chart				
Mother	Father	X	Y	
X	X	X X		X Y
		Daughter		Son
X				
X				
X				

Genetic disorder or genetic diseases or abnormalities

Colour blind or colour blindness:

Colour blindness is a condition when someone cannot properly identify any colour. To identify colour, we have pigments in our optical nerve cells. Being colour blind, the patient is deficient of colour identifying pigments in their optical nerve and suffers from colour blindness. If someone lacks a single pigment then he would not be able to differentiate colour red and green. It is the universal problem of colour blindness. For lacking of more than one pigment besides red and green, the patient cannot differentiate the colour blue and yellow. One man out of ten is seen colour blind. In comparison, very few numbers of women suffer from this problem.

Along with heredity, some medicines such as taking hydroxy chloroquine for the treatment of rheumatism triggers a side effect causing colour blindness by disintegrating the colour pigment in the eyes. Advice from a registered ophthalmologist can be a worthy solution to cope up with the situation of colour blindness.

Thalassemia

Thalassemia is the name of a disease of acquiring abnormal state of red blood cells. Because of this disease, red blood cells are disintegrated. So, the patient suffers from anemia. This disease genetically passes from generation to generation. In Bangladesh context, Thalassemia is an important hereditary blood concerning problem. It is guessed that every year 7000 babies are born with the problem Thalassemia and at present the number of patient may be one lakh. A red blood cell is composed of two types of protein α globulin and β globulin. Thalassemia is caused for the disintegration of the two genes related to the above mentioned proteins. Consequently, defective red blood cells are usually found α Thalassemia is caused if the gene for α globulin production is absent or changed. This type of disease is found at large in the community of South East Asia, Middle East, China and Africa. As the same way, β Thalassemia is caused when the gene for the production of the protein β globulin is disintegrated. Though this type of disease is more found in the people of Mediterranean region, some people having Africans, Americans, Chinese origin may also suffer from the blood disease. β Thalassemia is also called Thalassemia of a khuli. On the basis of the inherited gene, Thalassemia is grouped into two categories. In case of major Thalassemia, the victim baby obtains genes from both the parents and in case of minor Thalassemia a baby obtains genes either from the father or from the mother. This type of body does not express any sign of Thalassemia but functions as a carrier of Thalassemia genes.

Treatment:

The disease Thalassemia is treated by transfusing blood at regular intervals and by providing the patient with the required medicine. The patient must not have to eat iron rich fruits and medicine, as they being accumulated may cause much harm to other body organs. The patient suffering from major Thalassemia faces threats of life from the age of 20 to 30. Besides, if the liver is badly affected other diseases or jaundice can be initiated.

Theories on evolution of organisms

After studying all the vast array of scientific data, the rhythm of life in the universe is only found on this green planet earth. The organisms who are surviving now, all emerged in different times in the biosphere. Many plants and animals have become extinct with the waning of time. Dinosaurs became extinct thousands of years back. Some other organisms are still surviving by slowly adapting them with little changes. In the span of some thousands years of time, the species of living organisms for their emergence and survival change themselves furnishing new changes with them and is called organic evolution.

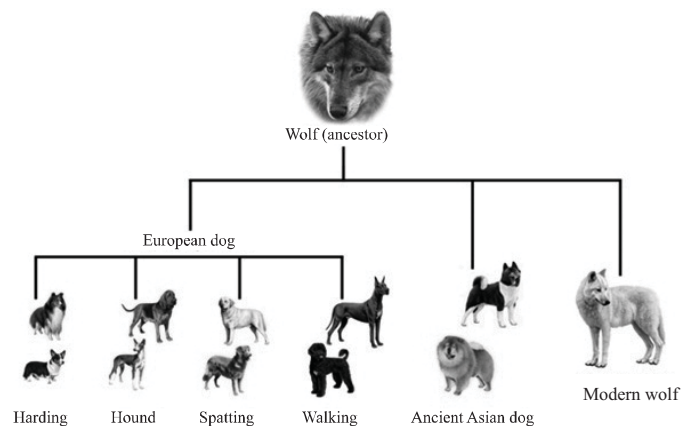


Figure : 12.5 Diversity in the species dog

Charles Robert Darwin was a British natural scientist. At the time of studying at Cambridge University, he availed himself of doing his job as a natural expert of a ship named H.M.S. Beagle and traveled to many different countries in the world. He traveled for five years throughout the islands of Atlantic Ocean, Tahihiti, New Zealand and Australia, Mauritius, Maldives, Brazil and Galapagos and other clusters of islands. Later being familiar with the population theory of Thomas Robert Malthus, Darwin started thinking on the struggle for surviving of organisms. Malthus believed that increase in the number of mankind is interrupted with diseases and the limited supply of food. A dweller of Brunei natural scientist Alfred Russel Walles sent his write up on the theories of population control to Darwin, and those write up inspired Darwin to postulate his own concept. Later on, Darwin gave birth to the torrents of debate with the opinion of Alfred Russel Wallace by presenting his opinions on the changes along with his own opinions. He mentioned the opinions of Walles on the changes of animal population through natural selection before the members of the London Linnaeus Society. On first July of 1858, In 1859 his book 'The Origin of Species by Means of Natural Selection' was published. Twelve hundred copies of this book were sold on its first day of publication. Different aspects of the theories on evolution of Darwin and Walles are given below:

Variation in living world

Darwin observed that on the earth two animals or groups of animals are never completely same. Within the same species, even within the offspring of the same parents differences are found. According to Darwin, because of continuous struggling to protect one different type of changes occur. As a result of these changes, organisms are different from each other. The differences among the species of dog are shown below:

Excess tendency of reproduction in organisms:

There are differences in the power of reproduction, birth rate and the ability to survive up to the last. It is the intrinsic ability of organisms. This way the number of animals

having been reproduced that the number of surviving animals is much larger. A Catla fish in the river Halda of Chittagong lays 3-5 lakhs eggs per season. In a favourable condition only some thousands of young fishes can avail the scope of becoming mature ones. The same way, an adult Hilsha in the river Meghna can lay, irrespective of size, 3.00 to 10 lakh eggs. It is guessed that in a favourable condition very few number of Jalkas at last get the scope of becoming a grown up Hilish. Among the vertebrates, in Elephants reproduction happens in a very slow process. Darwin presented a calculation describing if all the elephants survive being born from a pair of elephants in 750 years the total number of elephant would be 19 lakh. But it is not usually found in nature. From the example it is clear that the rising of the number of any organism continues without any inhibition, any one species would make the world covered by the members of the species. But in reality, it is also not usually found. For anthropogenic causes such as excessive acquisition, environmental pollution etc. through different ways control the population of organisms. It is guessed that in case of not catching of puna for Ruhi in favourable condition in our rivers the number of Ruhi, Catla and Hilsha fishes would highly be multiplied.

Struggle of organisms for existence

Darwin placed the logic that because of every organism giving comparatively birth to offspring in a large number in comparison. This is why struggle of organisms for survival is inevitable. This struggle mainly cycles round the struggle for food, dwelling places and the scope of reproduction. For the survival of organisms the following matters draw our special attention.

Objects of consideration:

1. For every organism, food and dwelling place are very limited. This is why for a large number of animals in excessive number of population many deaths are caused because of shortage of food and starvation. It has been found if some deer are released on an island, they grow there, reproduce there and rapidly their number continues to rise. As the many more number of deer finish all the food or leaves, many deer die from starving and the number of deer rapidly comes under control.
2. In the world every animal is struggling. The inter-species competition between the different members of the same species goes on. For example such competition between Ruhi and Ruhi, Cat and Cat, or Monkey and Monkey is there and there is interspecies competition between the members of different species, such as struggling between snake and mongoose, butterfly and fly etc.
3. Every animal is struggling with its adverse environment. Flood, drought, storm, rain, excess heat, winter, volcanoes, tsunamis, tornado, earthquake etc. disturb the normal form of life in an environment. Lots of organisms are destroyed with the natural catastrophes. So the natural calamity plays a very important role in controlling the number of population.

Natural selection

According to Darwin, the organisms which gain success in struggling by being changed in physical characters have won the fight. By their excellence in modification and in inheritance of characters developed through adaptations from generation to generations, make the win in the competition in evolution to survive. In other way, the organism which cannot introduce new changes in them, are nominated or selected by the nature. So they become extinct. The animal of the past dinosaur became extinct in spite of its being much strong. They became extinct because they could not adapt well with the environment.

Survival of the fittest

The characters, nature and the trends in organisms and in their offspring are the diversity expressing favour and make the organisms to cope up with the environment. These positive characteristics are inherited through generations. Conversely, the organisms, with adverse diversity in the struggling with the passage of time ultimately, are destroyed. Darwin mentioned that this type of adaptation is the first solution to win the struggle against the nature. In the nature, many plants and animals attain some abilities being well adapted. They are suitable in struggling against the nature. In desert, many plants adapt with some striking techniques to store water, introduction of new mummery to protect them. These adaptations are notable components of evolution.

Significance of evolution in surviving of species

Through evolution at the emergence of new species, many other species are lost in the passage of time. For instance, dinosaurs came before our focus. It has been found that the species which possess the more ability to adapt through the way of evolution can go far. So, those who will attain the more ability to adapt with the environmental flow of life and population demography, will be surviving for longer period of time. In most of the cases, it is called adaptation.

Exercise

Short answer question

1. What is RNA?
2. What is a gene?
3. Why is a chromosome called the physical basis of heredity?
4. What is autosome?
5. What does Thalassemia mean?

Essay type question

1. Describe with diagrams how DNA replicates itself.

Multiple choice question

1. Where is uracil found?
 - a. DNA
 - b. RNA
 - c. gene
 - d. locus

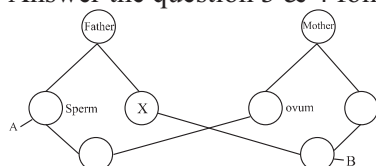
2. Which one does RNA contain?

- i. ribose sugar
- ii. inorganic phosphate
- iii. nitrogenous bases

Which one of the following is correct?

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

Answer the question 3 & 4 following the concern of the figure give below



- 3. In the state of X mentioned in the stem, what would be the number of chromosomes?
 - a. 46
 - b. 44
 - c. 23
 - d. 22
- 4. What type of chromosome are there in A and B mentioned in the stem
 - a. X, XY
 - b. X, XX
 - c. Y, XX
 - d. Y, XY

Creative question

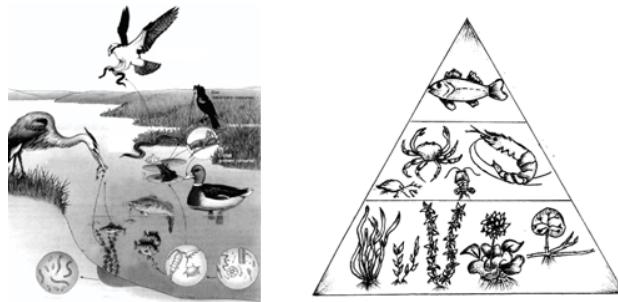
Sifat is a farmer. He has two daughters. The elder daughter is like her father but the younger one looks like her mother concerning hair, complexion etc. Recently, as he has given birth of a baby daughter, he has become anguished at his wife. He could know that he was responsible in determining the sex of his offspring with the help of health workers of his village.

- a. What is heredity?
 - b. What is replication?
 - c. What are the causes of difference found with the offspring of Sifat?
 - d. It is irrational that Sifat got anguished with his wife. Explain it with reason.
2. Soheli has watched on television channel that cats are being killed in a town of Brazil. He saw in spite of their belonging to the same species, they look different in size, colour. Some days later, he watched the film of growing up of wild cat. His father gave him the concept on evolution and adaptation when he became interested to know this.
- a. What is locus?
 - b. What do you understand by the term adaptation?
 - c. Explain the causes of difference with the animals seen by Soheli.
 - d. What will happen if the organisms found in the stem first are left in the environment where the animals of second group found?

Chapter Thirteen

Environment around life

The environment of an organism means all the living and non-living components around it. Light, air, rain, storm, soil, water are so important in the life of organisms, the effect of living world around it also plays as significant roles in the life of the organism. The steps that the organisms take in the different stages of the survival for the maintenance of life, have also effects on the life of the other organisms living in the same environment. In the living world food chain and food web are very important issues subtracting which the existence of life cannot be imagined.



At the end of this chapter twelve, we will be able to

- Explain ecosystem.
- Explain the interrelationship between the elements of an ecosystem.
- Explain two objects: food chain and food web.
- Draw the comparisons between the energy flow and the nutrient elements of an ecosystem.
- Compare the relationship between energy performances in between more tropic levels.
- Explain the concept of ecological pyramid in limiting the food chains.
- Explain biodiversity and types of biodiversity.
- Evaluate the roles of biodiversity in sustaining the stability of an ecosystem.
- Explain the interactions and inter dependence in between different organisms in maintaining balance in environment.
- Explain the methods used for the conservation of environment.
- Analyze the importance of conservation of environment in maintaining the balance in it.
- Determine the reciprocal interrelationship between the producers, consumers and transformers in a given locality.
- Identify the causes of pollution of all the elements of a specific environment.
- Draw the flowchart showing the flow of energy, food chain and food web in an ecosystem.
- Perceive the contribution of the components of an ecosystem to the maintenance of balance of the environment.

Ecosystem

Our environment consists of all the organisms, non-living substances and other physical conditions in the world. Organisms actively collect their components from the non living world and carry on their life, and after death being waste substances or getting mixed with the environment again send back all the elements to the environment. Green plants collect carbon dioxide from the air and water from the soil through the process of photosynthesis, and produce chief food carbohydrates releasing oxygen in the air. For the whole living world (plants and animals) the oxygen, required for respiration, comes from the oxygen produced through photosynthesis. Both the green and non-green plants absorb some mineral salts from the soil as food. Herbivorous animals survive by eating different parts of plants in different ways. Carnivorous type of animals consumes herbivorous animals and other small carnivorous creatures. Waste materials from all animals get mixed with the environment again. Besides after death, all plant and animal bodies go back to the environment being disintegrated. Some bacteria and microorganisms do this disintegration process. This way balance in the natural environment is maintained naturally.

The exchange of energy and materials, between plants and animals and both the living and nonliving substances, is called interaction. Interrelations are developed through this interaction. A place like this one, this world is an ecosystem. So, ecosystem means any unit of landscape where there are non-living substances, food producing green plants, some animals dependent on plants and many more microorganisms for the disintegration of the dead bodies of organisms, and a proper interrelation between these elements exists. For the source of different elements for nutrition and other physiological activities, soil, air and water are required.

Components of an ecosystem

Living community, inanimate components of the environment and the physical conditions collectively develop an ecosystem. Each of these main components is composed of some other small components. The living components are most diverse.

- a) **Non-living matter:** The non-living matter harbors the habitats of living organisms, provide them with oxygen for respiration and supply some nutrient components as well. The components of all inanimate materials can be divided into two groups, such as, inorganic matter and organic matter.
 - i) **Inorganic matter:** Water, air and mineral substances in the soil, which have not evolved from any living body rather before the emergence of organisms they existed, and they are the inorganic components of an ecosystem, such as calcium, potassium, iron, nitrogen, oxygen and carbon dioxide etc.
 - ii) **Organic matter:** The waste materials of plants and animals or the dead bodies of organisms or substances derived from them are called the organic matter of an

ecosystem. They are generally termed as humus. Some of the components of the humus are urea, cells, tissue and organs of plants and animals. The organic matters are more nutritious for plants. This is why for the cultivation of plants more compost should be applied. Most animals also like soil composed of rich humus.

- b) **Physical components:** The amount of sunlight, temperature, presence of water vapour in the air, air pressure and wind, depth and height from the surface of the earth (under the ground or under the water) in different ways influence the ecosystem. With all their components, weather and climate of any locality develop. These are all the physiological components of an ecosystem.
- c) **Living organisms:** Living world is the active component of ecosystem. They cause changes in the environment through their activities. Living components of the environment are of three types: 1. Producers 2. Consumers 3. Transformers.
 - 1) **Producers:** Green plants, in presence of sunlight obtaining carbon dioxide from the air and absorbing water from the soil, produce their chief food carbohydrates. At this time oxygen is produced as a by-product. The whole living world directly or indirectly depends on the photosynthesis process for their main food carbohydrates. Moreover, the non-green plants in any way depend on green plants for the maintenance of their life. This is why photosynthesis is the production process of an ecosystem. The producers are the green plants. On the other way, these green plants are called autotrophs because they can produce their food themselves, they do not depend on others for their food.
 - 2) **Consumers:** No animal can produce food from the non-living substances in the environment. They directly or indirectly depend on plants for their food. This is why they are called heterotrophic animals. The animals, which directly consume plants as food, are called herbivorous. They are the consumers of first line. Grasshoppers, hens, cow, goats and deer are the examples of herbivorous animals.

The animals, which depend on herbivorous animals for their food, are called secondary consumers or consumers of second line. They are carnivorous kind of animals. Toad, fox, tiger are the examples of the carnivorous animals. The animals, which eat secondary consumers, are also carnivorous. They may be called tertiary consumers or top consumers, such as peacock, snake, tiger etc. These are a kind of animals who like more to eat dead bodies of other organisms than the living body of them, for instance, fox, hyena etc. They are called scavengers because they keep the environment clean by eating the dead bodies of different organisms.

- 3) **Decomposers:** The microorganisms, like some bacteria and fungus, get their food from wastes of plants and animals and their dead bodies, and as a consequence, they get mixed with the soil and water by being decomposed. These mixed components can be again consumed as food components. This is why these microorganisms are called decomposers or transformers.

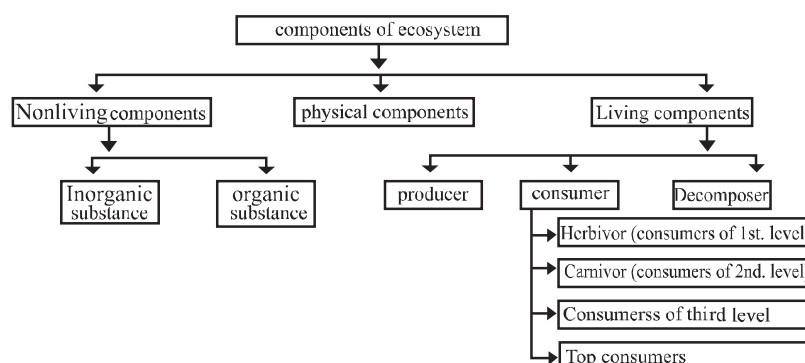


Figure: 13.1 Components of an ecosystem (in a chart)

Ecosystem of a pond

To take a closer look at an ecosystem, a pond can fit here best. The deeper relationship, between the living organisms living in the ponds and the non-living substances there, can be conceived. The non-living components are different types of organic and inorganic components, water, sunlight, carbon dioxide, oxygen, calcium, phosphorus etc. The living components are producers, consumers of first level, consumers of tertiary level and different types of decomposers.

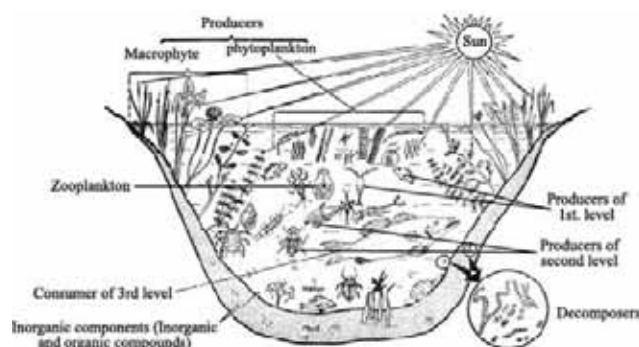


Figure: 13.2 A pond ecosystem

Producers: The producers are the photosynthetic algae and plants of shallow water. The free-floating microscopic organisms are called plankton. Phytoplankton, green algae and other aquatic plants, which produce food through the photosynthesis process, are called primary producers.

Consumers of primary level: Different types of floating insects, larva of mosquito, very small animals, zooplankton etc. are the consumers of first level. The free-floating small animals are called zooplankton. These consumers cannot produce their food themselves. So they live directly consuming the primary producers.

Consumers of secondary level: Small fishes, some aquatic insects, toad etc. are the consumers of second level. They cannot produce their food themselves and cannot

consume directly the primary producers. They choose the consumers of the first level as their food.

Consumers of tertiary level: Some small fishes, prawns etc. are the examples of tertiary consumers since they eat secondary consumers as their food. Shoul, Bhetki, Boal like big fishes and stork are the consumers of tertiary level.

Decomposers: Many fungi and bacteria live in the pond as saprophytes, and they are decomposers. They live there floating in the water or at the bottom in the muddy habitat. They attack living and non-living organisms and help them to be degraded, as a result organic and inorganic chemical components required for the producers are produced again by them. The producers in the pond can again consume the substances decomposed by the decomposers.

Food chain: Among the living components of any ecosystem, first the green plants start their job. If they do not produce food, herbivorous animals and other carnivorous animals may die in want of food. When the food energy is flown from the primary producers through different tropic levels, then this flow is called food chain.

For instance, the green grass on a field is the primary producers and grasshoppers live on some plants of the grass. Toads eat the grasshoppers as their food. The toad eats grasshoppers and the snake eats the whole toad as its food. If the snake is small and there is a large Gui snake around it, a reptile of lizard family, it will definitely engulf the snake. In this case, food chain may be formed according to the flowchart.

Grass	grasshopper	toad	snake	gui snake
Producer	consumer of	consumer of	consumer of	consumer of top
	primary level	secondary level	tertiary level	level

In different ecosystems food chains may be different, such as 1) Predator food chain 2) Parasitic food chain and 3) Saprophytic food chain.

(1) **Predator food chain:** The food chain, where organisms of the primary level are of the smallest size and consecutively consumers of higher level prey the organisms of lower level and at last eat them, is called predator food chain. The food chain, mentioned above, is an example of predator food chain.

(2) **Parasitic food chain:** Parasitic plants and animals in most of the cases derive their food from the host much larger in size than they are. In some cases some other smaller parasites are dependent on all the parasites for their food. In this type of food chain, primary producers may not be always at the beginning level. The chain remains incomplete.

Man----- mosquito-----Dengu Virus

- (3) **Saprophytic food chain:** If any food chain is stretched from the dead organisms to the different trophic levels, then it is called a saprophytic food chain.

Dead body----- fungi-----earthworm

Needless to say, this kind of food chain is incomplete and food chain develops only the part of the total interaction or interrelations of an ecosystem. Parasitic and saprophytic food chains are always incomplete since there is no producer in them. Both types of food chains to maintain their activities depend on one or more levels of the predatory food chain. So, the food chains of an ecosystem are based on the activities of the photosynthesis of the producers green plants.

Food web:

In most of the cases, it is found that the same consumer can be placed in different trophic levels. This way some food chains collectively may form a net or web like structure. It is called food web. This is a true phenomenon for both the terrestrial and aquatic ecosystem. This concept would be clearer by the concept of a pond ecosystem.

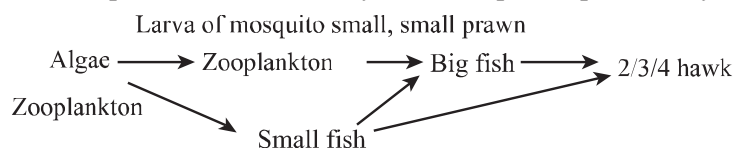


Figure: 13.3 Food web

In the diagram above, it is found that primary producers algae directly provide zooplanktons and small fishes with their food. Both the small and big fishes eat zooplanktons as their food. This big fish also eats the small fishes. A hawk eats small fishes and some other small members of the big fish belonging to the same species. Here five organisms have developed some food chain in different ways. This way more complex food webs can be developed in different ecosystems than the food web developed here.

Total five food chains are found in the food web mentioned above.

1. algae → small fish → hawk
2. algae → zooplankton → big fish → hawk
3. algae → small fish → big fish → hawk
4. algae → zooplankton → small fish → big fish → hawk

Food web in a terrestrial ecosystem may be as the following one.

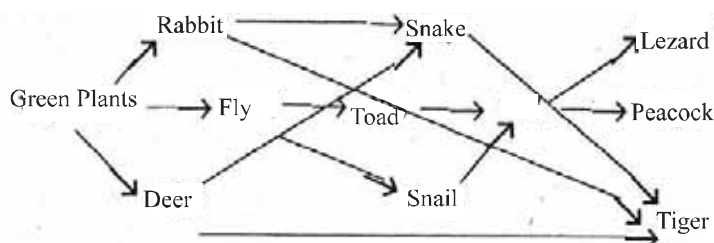


Figure: 13.4 A food web of a forest

Work: Write down the food chains in the food web mentioned in the figure 13.3

Nutrition flow in ecosystem: Plants produce food through the photosynthesis process after obtaining necessary inorganic substances. A plant uses a part from the food it produces itself, remaining food is stored in the plant body. Herbivorous Animals eat these plants and consecutively carnivorous animals eat the herbivorous. After the death of these plants and animals, decomposers transform them into inorganic substances by using them as their food and the decomposers return the substance to the states from where they are taken. Green plants obtain these substances and again use them in producing food. The cyclic movement of nutrition materials is called nutrition flow. The flow of nutrition materials through food chains is a unique character of ecosystem.

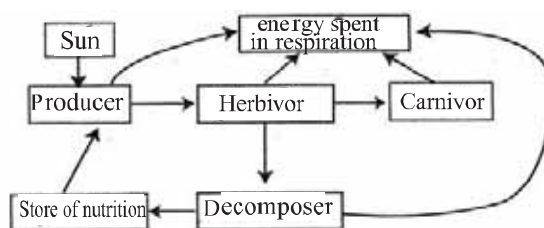


Figure: 13.5 Brief chart of flow of nutrition and energy

Energy flow in the ecosystem

The sun is the main source of energy in any ecosystem. From the amount of light and heat energy that reach the planet earth, the green plants store only 2% of the received energy through the photosynthesis process primarily as the chemical energy in carbohydrates for the requirement of the next stages of the ecosystem. This energy, stored in plants, reaches different trophic levels through different kinds of food chain. At last the energy again comes back to the environment by the terminal acts of the decomposers.

The herbivorous animals, consumers of first level, maintain their life by eating leaves, stems, flowers, fruits, seeds or roots of green plants. The way the chemical energy produced in green plants reaches first to the herbivorous animals. The carnivorous animals, who live by eating the consumers of first level (herbivorous animals) are the

consumers of second level. The chemical energy, from the consumers of first level, is transferred this way to the bodies of consumers of second level. Exactly, the chemical energy from the consumers of second level reaches the consumers of third level in the form of food. If any other superior consumers eat the consumers of third level as their food, this way the energy reaches the consumers of top level.

After death, procurement of energy is stopped in all the organisms. Then the chemical energy stored in the dead bodies comes back to the environment in the form of inanimate substances and energy after being broken by the activities of decomposers. The energy being stored in different inanimate substances of the environment becomes suitable for the plants to use again. And this way the flow of natural energy in ecosystems is being continued.

Some energy gets wasted in every level of all types of food chain. The herbivorous consumer does not store that amount of energy, which it procures from the producers green plants. Again, the amount of nutrition that a consumer of second level obtains from the herbivorous consumers does not even reach its own body, as some of the energy is released in the inanimate environment. This way at the time of transferring food from one organism to another, much energy goes out of the system in accordance with the principle of ecosystem. This is why if in an ecosystem the number of trophic level is fewer, energy waste decreases accordingly.

Relation of energy between trophic levels: Every step of a food chain is called a trophic level. According to the principle, each of all these levels, primary producers, primary consumers of first level, consumers of second level and the consumers of top most level is a trophic level. The producers represent the first or the lowest level in an ecosystem. The herbivorous consumers, consumers of first level are the representatives of second trophic level. This way carnivorous animals of both the higher and lower levels represent third and top most trophic levels respectively. Some of the energy collected from the sun in the producers or in the lowest trophic level of any food chain goes out in every consecutive step as heat energy. As a result it is found that the energy the producers collect from the sun is reduced reaching the second trophic level. The amount of energy is more reduced reaching the top most trophic level.

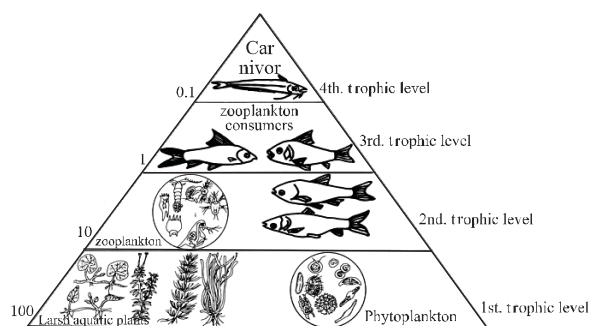


Figure: 13.6 Energy pyramid

Concept of energy pyramid: The narrow apex of the three-dimensional structure based on its triangular base is called a pyramid. The structure of trophic levels in an ecosystem is shown with the structure of a pyramid. The chart, describing the arrangement of energy storage and transfer of every nutrition level, connected to food chain, is called energy pyramid. The amount of energy is much higher in the level of producers than that of the next trophic levels. The organisms of higher trophic level than those of lower trophic level lose more energy at an ever increasing rate for respiration and other activities. This is why the producers and the top most consumers are placed on the base and at the top of the pyramid respectively.

Effects of energy pyramid to keep food chain in limit.

The flow of energy is always unidirectional. This energy flow can never be turned opposite. About 80% to 90% energy is reduced in every stage. The ever-increasing loss of energy limits the size of a food chain within 4 to 5 stages. The more a food chain is long the more energy would be reduced in higher trophic level and at one stage there would be remain no energy.

Biodiversity

The environment of our planet is composed of animate and inanimate substances. Here is the assemblage of many types of organisms and innumerable kinds of inanimate substances. How many types of organisms are there in the world? It is too tough to give the exact figure of it but on account of species (who are similar to each other in physical and reproductive characters and originate from the same ancestor) this can be much easier to present. Until now, it has become possible to describe and identify 15 lakhs species. Every species is characterized with its own unique features and is different and identifiable from all other species by these very characters. For instance, jackfruit is a species, and it is possible to separate it from other species by its special characters. It has become possible to group the living world into millions of species because of the existing diversity in the organisms. Again, human being is a species. At present about seven hundred crores of human beings live on the Earth. They are all not exactly the same and are different from each other in some characters. So, diversity is there even among the members of the same species. Briefly, to say it can be said that biodiversity is the abundance and variability among organisms existing on the earth.

Types of biodiversity

Biodiversity can be divided into three categories. Such as **(1) species diversity, (2) genetic diversity and (3) ecosystem diversity.**

Species diversity: Species diversity generally means the total number of organisms existing on the earth because a species is different from other species by its distinctive characters. Such as, a deer is distinct from a tiger in size, habit, ferocity, number, mode

of multiplication etc. The difference in different issues of a species from other species is species diversity.

Genetic diversity: Differences in many issues are found in the members of the same species. Though they belong to the same species, their structure, size, and ability to resist diseases and to endure environmental adversities are different. These differences emerge because of the little diversity in composition of their genes. Hereditary characters of organisms are transmitted through generations by genes. There is a gene for every character. Changes in character in organisms occur because of the different changes in the structure and arrangement of genes and new species may evolve. Through this process, the diversity introduced with the organisms is called genetic diversity.

Ecosystem diversity: If any changes occur with the physical, chemical and organic components of any ecosystem, the balance of the ecosystem is hampered. These changes are, of course, slow and steady. To adapt with the changes, changes also occur with the organisms living there. As a result the biodiversity, developed there, is called ecosystem diversity. In a small pond ecosystem, the habitats, grown for the plants and animals are different than those of a river ecosystem. In the ecosystem of forest, grassland, lake, river, water reservoir, hill, sea, desert etc, the living communities are developed with their own distinct characters.

Effect of biodiversity on the maintenance of stability in an ecosystem:

The components of the environment are deeply interrelated with each other. For maintaining the balance in the environment, this complex relationship has been developed. With the activities of a large number of organisms, the balance is maintained in the environment. Only the extinction of a species in an environment may cause a large catastrophe. So, for the stability of the environment biodiversity is especially important.

The organisms and animals, which were once considered unnecessary and undesired, with the passage of time, it has been found that these organisms are continuously playing their necessary roles for the conservation of the environment. Once there were innumerable oysters in the coast of Check Pick in United States of America. They could purify the water of the total locality by only three days. But now 99% of those oysters have been extinct. As a result, the remaining oysters cannot purify the water of that total locality even by a year. This is why, the water of that coast is gradually becoming muddy and the level of dissolved oxygen in the water of that locality is being reduced. A mature toad in a day can eat the amount of worms and insects equal to its body weight. These worms and insects cause much harm to our cultivated harvest. For the use of different pesticides, toads are being killed. Worms and insects are the main food of birds. Among them, the number of the pests, which cause harm to humans and cultivated harvest, is high. Besides that, birds play significant role in pollination. We know that owl, eagle, vulture, and raptor are predatory birds. By eating rats, they keep the number of rats under control. If a pair of rats, living at a house of a human without any trouble

could reproduce freely, the number of rat would be 880 at the end of a year. But an owl can digest three rats in a day. If vultures, raptors and crows would not clear the dead and decaying organic matters, the world would be covered with them. This is why no organism can be considered unnecessary. If any organism is extinct from the environment, the stability of an ecosystem is destroyed. So, for the sustainability of ecosystem the role of biodiversity is unquestionable.

Interaction and interdependence among different organisms and the balance of environment

Green plants are generally called self-dependent because they are autotrophic. If it is considered from environmental point of view, it can be said that no organism is self-dependent even the green plants. Plants, birds and animals, worms and insects and other organisms influence each other.

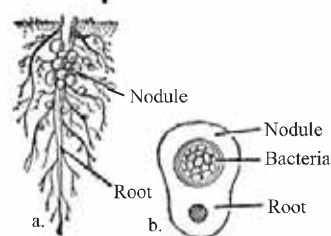
A flowering plant depends on worms and insects for its cross-pollination and on others birds and animals for the dispersal of seeds. For photosynthesis the green plants use the carbon dioxide that is released by animals during respiration. Conversely, animals use the gas oxygen released by plants at daytime. Moreover, bacteria, fungi and different microorganisms in different ways affect plants, animals and worms and insects. So, it can briefly be said that mutual assembly and dependence are the key to the regulation of the activities of life. So, in the living world existing organic relationships between plants and animals can be designated with the term symbiosis. The actions-reactions, that occur in between the symbiotic organisms, are called interaction. It has also been clear from the discussion made above that the organisms, participating in interactions, are interdependent and none is self-sustaining. Environmental scientist Odum says that this interdependent relationship can be in two ways. Such as,

(a) by positive interaction and

(b) By negative interaction.

(a) **Positive interaction:** In the interrelationship, in which the two organisms help each other, is called positive interaction. In this symbiotic organisms, one or both may be benefited. This beneficial interaction can be grouped further into two categories named mutualism and commensalisms.

Mutualism: The relationship is mutualism when in the association both the organisms become benefited. Such as bee, fly, worm and insect etc. fly around from flower to flower to attain the nectar and as a result the pollination is accomplished. Many birds and bats live on eating fruits and they release seeds with their stools. This way seeds are transferred and the distribution of plants is done. This seed helps to



a. Nodules in leguminous plant

b. L.S of root and nodule

Figure: 13.7 Mutualism

develop a new plant. The association of an algae and a fungus forms lichen. The fungus collects water vapor from the air and mineral salts to use for both of them. On the other side, the algae by its chlorophyll produce food carbohydrates for itself and for the fungus. The bacteria rhizobium, residing at the roots of leguminous plants form nodules, fix atmospheric nitrogen in them. They supply this fixed nitrogen to the host leguminous plant and in return collect their food carbohydrates from it.

Commensalism: In this association only one gets benefited. Though the other associate is not benefited, it does not lose anything. Such as, creeper plant with its root is anchored in the soil and creeps up round a big tree. This way it collects sufficient amount of light by spreading on other plant. Woody creeper does not depend on the plant that is providing shelter for it for food and does not do any harm to it. Epiphytic plants collect food from the air but do not do any harm to the plant providing shelter. Some algae dwell in bodies of other plants, but do not do any harm to them.

Negative interaction: In this case the relationship is detrimental to one or to the both. Negative interaction can be grouped into three categories, such as

Exploitation: In this case an organism enjoys its rights by deceiving directly or indirectly another organism from its rights, for example, dodder. A dodder with the help of the absorbing structure haustoria collects food from the plant, which has provided it with shelter. A cuckoo can never be able to build a nest. It lays its egg in the nest of a crow, and the crow hatches its egg and once the embryo of cuckoo comes out of the egg being sufficiently grown up by breaking the shell of the egg.

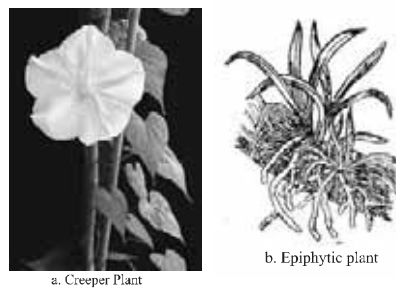


Figure: 13.8 Commensalism

Competition: In any place there may be tough competition between organisms for light, air, water and food. In this competition the stronger one survives and the weaker one is abandoned.

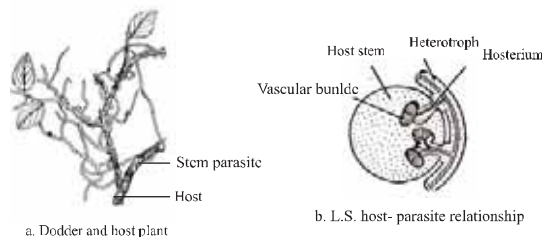


Figure: 13.9 Absorption

Antibiosis: If the growth and development of any organism is partly or wholly interrupted by the biochemical substance produced by other organism or even the organism may die, then this process is called antibiosis.

It becomes clear from the discussion made above those actions and reactions are continuously occurring in between the organisms existing in an environment and every component is interrelated to each other. By this relationship, some are becoming benefited and some are harmed. This way they are maintaining the balance of the environment.

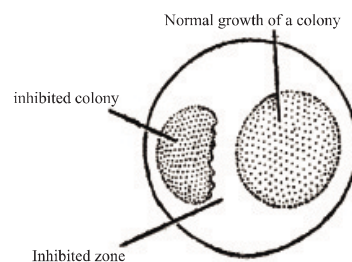


Figure: 13.10 Antibiosis

Significance and method of conserving environment

It is essential to conserve the environment to maintain the habitable condition for the organisms living on our planet the Earth. There are innumerable number of organisms on the earth and for their survival there are different substances such as soil, water and air etc. All these natural components are being damaged to meet the different types of demands such as food, clothes, dwelling place, and health care for the excessive population of the present world. In this catastrophic situation if people do not become much conscious of it, catastrophe will turn into a more serious state. In our environment from the smallest plants, worms and insects to the large animals and plants, none is unexpected or valueless. In the realm of nature all the organisms and the inanimate substances are each other tied closer. The biodiversity is formed with millions of species of plants, worms and insects, birds, animals and humans etc. and the existence and well being of human race are based on it. Forests, hills, water reservoirs, sea are the very essential harbours of biodiversity. So, biodiversity will be sustained if the environment is well conserved. If the environment is well conserved, the basic demands of humans such as food, clothes, dwelling place, medicine, fuel, water etc. will be continuously fulfilled without any disruption. If the environment especially the forests are degraded, the rate of rainfall is reduced, and the cultivation of crops is hampered. The temperature is raised for the increasing amount of greenhouse gases (CO_2 , CO_4 , N_2O etc.) and it is called enhanced greenhouse effect. For the enhanced greenhouse effect sea level will rise and consequently, vast coastal areas will be inundated, weather will be changed, forest will be damaged, crops will be destroyed by different pests and the severity of storm and tornado will raise. If the environment is well conserved, it will be possible to be safe from enhanced greenhouse effect. This is why from now on all the best measures should be taken to conserve the environment.

Nowadays man has raised his voice for the conservation of environment because of his own existence. The whole world has to come forward for the maintenance of a healthy

environment. It is also essential to organise people for the protection of environment. Plantation should not be limited only in a weekly or monthly programme. For cutting a tree, two trees should immediately be planted. Before setting any industry and mills in any locality, their adverse effects on the environment should be first taken into consideration and safe disposal of industrial waste should also be ensure. Urbanisation should be well planned. Massive plantation should be carried out side by side with the rapid urbanisation. Instead of wood, solar energy should be used as fuel. Excessive use of chemical fertilizers and pesticides damage the normal quality of soil and degrades beneficial microorganisms, terrestrial worms and insects, aquatic and terrestrial ecosystems. So the use of bio-fertilizers should be increased. Use of chemical fertilizers and pesticides should be minimized. Excessive population in different ways causes serious desolation on the environment. Population should be controlled and communities of well-educated people should be developed. Public awareness should be raised about negative impacts of environment and to control the environmental pollution. Mass media should play a prime role in this regard. The emission of greenhouse gases, carbon dioxide, methane, nitrous oxide should immediately be reduced. To control the soil erosion in coastal areas, massive plantation must be accomplished. This way soil erosion will be controlled and the tornado and cyclone will be resisted as well. Normal flow of water should be conserved by dredging river and water bodies. This way salinity and water logging will be removed and the aquatic ecosystems will remain in a normal state. It is essential to conserve the biodiversity for the sustenance of healthy environment and with this view all the plant and animal species, which are on the verge of extinciont from nature, should be conserved by special processes. Measures should be taken to control the pollution of air, water, soil and sound. International and national principles and guidelines should strictly be followed.

Work: Find out what the causes are of polluting the environmental components in your locality and prepare a report on it.

Exercise

Short answer question

1. What is symbiosis? Explain it.
2. What is a plankton?
3. What is a parasitic food chain?
4. What is antibiosis?
5. What is mutualism?

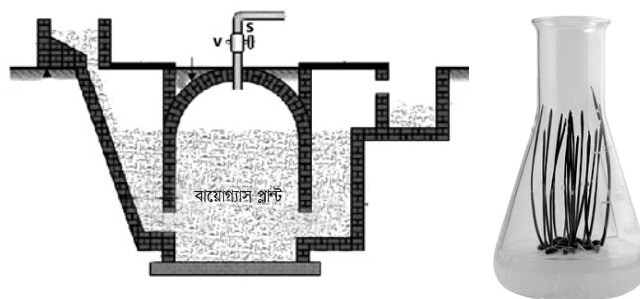
Essay type question

1. The balance of environment is restored through the interaction and interdependence of different organisms. Explain it.

Chapter Fourteen

Biotechnology

Biotechnology is an applied branch of biology. It has opened new horizons in solving many real problems in different branches of science. To improve human health care, to develop advanced type or crops, to increase the quality and amount of crops, to protect the environment, this technology has opened up doors of immense potentials. In this chapter, we will try to know the facts about this technology briefly.



At the end of this chapter, we will be able to:

- Explain the concept and significance of biotechnology.
- Explain tissue culture.
- Describe the use of tissue culture in developing crops.
- Explain the objectives of genetic engineering.
- Describe the use of genetic engineering in developing crops.
- Describe the use of genetic engineering in producing insulin and hormones.
- Evaluate the efficacy of biotechnology.
- Describe the use of biotechnology in curing diseases of animals.
- Draw posters about the use of biotechnology and genetic engineering.
- Understand the contribution of biotechnology in our everyday life.

Biotechnology

The word biotechnology is derived from two words biology and technology. The word biology means special knowledge about organisms and technology means a manner of accomplishing a task specially using technical processes, methods or knowledge. The interrelation between biology and technology is biotechnology. In 1919 Hungarian engineer Karl Ereky first coined the word biotechnology. Through the application of this technology, from a cell of an organism, microorganism or a part of it, any new organism (plant or animal) with new characters is developed or any processed or by-product substance is produced from this organism.

In the advancement of science, biotechnology is not only a new addition. From the dawn of human civilization, man started to apply biotechnology. Man acquired the knowledge of fermentation and brewing about 8000 years ago. In nineteenth century after the discovery of Gregor Johan Mendel's laws of heredity in the field of genetics, biotechnology started its new advancement. With the continuity of the invention of double helix model of DNA by Watson and Crick in 1953, today's biotechnology has emerged.

Now a days, tissue culture and genetic engineering from many methods of biotechnology are being used in multidimensional aspects in agriculture and other fields.

In order to live well in a healthy and beautiful environment in the present world by ignoring the huge pressure of increasing population, there is no alternative to biotechnology. So the use of biotechnology in every field of life is widespread and massive. By using this technology amount of protein has been increased a lot more than the past. By eating super rice, which is recently invented in this process and rich in iron and beta carotene, we can meet up the want of Vitamin A and iron. Through tissue culture the species of potato, tobacco and banana resistant to virus have been invented. Through biotechnology salinity tolerant and drought resistant species of plants have been invented. Microbes such as bacteria, blue green algae and fungus are being used in producing compost. In order to protect crops from the attack of pests, insecticides bacteria, virus and weeds, microbes and biological agents are being used instead of chemicals and pesticides.

An eon making invention is the insulin made by adding human insulin gene to bacteria plasmid and entering them into e-coli bacteria. Interferon is a very precious protein compound which is produced in a very little amount in human body. But this protein is produced so little in human body that it cannot prevent cancer. Russian scientists have been able to produce interferon by using this technology with the help of e-coli bacteria. With the help of this technology, interferon is now being produced commercially and its price is lower than the past. Alexander Fleming when in 1929 invented antibiotic named penicillin, its productivity was quite low. But through this technology, its production has quite gone up. Each cell in human body carries upto 100000 cells. If error is found in any of these cells, disease can attack human body. So far 3500 such disorders in human body have been known. It is hoped that these disorders will be removed through this technology. Besides, identification of viral diseases, cancer detection, production of antibiotic and vaccine are being done through this technology.

Some microbes improve the colour, flavour, nutrition of different crops through their effect on them. This technology is used for producing fermented foods in different industries. Besides there are certain microbes turn certain carbohydrates into alcohol through fermentation. By applying the knowledge of biotechnology, enzymes, extracted from microbes, are being used in different industries such as dairy industries, detergent industries and carbohydrate industries. For enhancing the quantity and quality of different medicines, this technology is applied. By using different microbes, energy is produced from biomass and 60% rich methane gas.

Daily waste matters, industrial discharges are being degraded by microbes for the improvement of environment. Rapid afforestation is done by producing large number of saplings of different plants through tissue culture. If bio diversity of any area is destroyed, it has a serious bad effect on the environment of that area. So biotechnology is being used for preservation of biodiversity. For example efforts are being made for rapid propagation of almost extinct plants through tissue culture in order to maintain ecological balance. Different microbes specially bacteria is being used for extracting different elements from the minerals. For example different bacteria are being used for extracting copper and uranium. Some bacteria keep the environment free from pollution by degrading oil and hydrocarbon from the environment. At present for controlling different pests and insecticides, organic pest control system is being used instead of different chemicals. In organic pest control system different microbes are being used with the help of bio technology which plays an important role in preserving the environment.

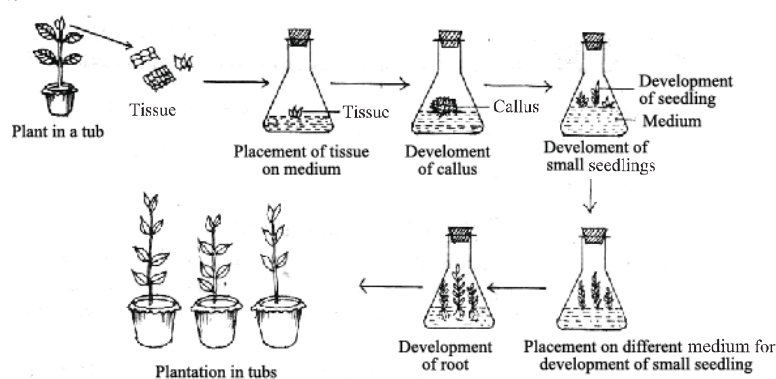


Figure: 14.1 Consecutive steps of tissue culture

Tissue culture: Generally, one or a group of cells of the same type is called tissue. The process of growing a tissue on a nourishing and sterilized medium is tissue culture. Tissue culture is comparatively a new branch of botany. In plant tissue culture, any separate part or part of a part like pollen, apical or lateral bud, node, root is cultured on or in any nourishing and sterilized medium. All the elements for the nutrition and growth of tissue are supplied with the sterilized medium. The part of a plant, being separate with the view of using it in tissue culture, is called 'explants'.

Steps of tissue culture

1. **Selection of mother plant:** The healthy, disease resistant plant with high quality is selected for plant tissue culture.

2. Preparation of culture medium: For the growth of the plant culture, culture media are made by mixing proper amount of essential mineral nutrients, vitamins, phytohormones, sucrose and condensing substance agar to bring the medium to a semi-solid state.

3. Establishment of sterilized medium: Taking the culture medium in a glass container (test tube, conical flask), its opening is usually closed with a cotton plaque. Later in an autoclave machine, keeping it at the temperature of 121°C under 15-lb/sq.-inch pressure for 20 minutes, the medium is sterilized. After the turning of the medium into a cold and semi-solid state, explants are inoculated on it. Then again after closing the mouth or opening the glass container, it is kept in a room with the controlling of light and temperature ($25\pm 2^{\circ}\text{C}$) for the growth of the explants. In this stage, the tissue placed on the medium through repeated cell division turns directly into a plantlet or callus or a cluster of cells without differentiation.

4. Transfer in root developing medium: If no root is developed in the plantlets by this time, then after attaining a definite height, shoots are cut and again placed in the root developing medium.

5. Transfer to natural environment or to field level: After washing with water and putting them outside the room on the tubs, the plantlets are allowed to adapt with the external environment. When the grown up plantlets become fresh and strong, they are once planted in soil in natural environment.

Use of tissue culture: By utilizing the tissue culture, now a days in the reproduction of plants and in field of developing new variety, much achievement has been obtained and new horizons have evolved with the vast hopes. From the plant part in a short period of time, innumerable plantlets can be produced with the same characters. Easily disease free and especially free from viruses, plantlets can be produced. It can be free from the limitation of producing plantlets in the specific season. As the facility of producing plantlets in a short period of time in a very conspicuous place, sufficient number of plantlets can be produced and the problem of storing of seeds can be avoided. The attainment of plantlets of those plants which do not reproduce by seeds and they can be speedily transferred in a short period of time in fresh condition. Tissue culture technology is well accredited for the production and conservation of the species about to be extinct. The plants, which do not produce endosperm, can be developed directly by culturing their embryo. The rapid multiplication of the plants, which do not reproduce through sexual reproduction or of which rate of natural reproduction is low, can be done by culturing their embryo. Tissue culture technology is being used for the development of the plants of new characters. French scientist George Morel (1964) proved that it is possible to obtain 40 thousand plantlets from a meristem of the orchid plant named *Cymbidium* in a year. In natural way, only a limited number of *Cymbidium* plantlets are produced in a year. In Thailand 50 million plantlets, which are mostly orchids, are produced through tissue culture method in a year. By exporting flowers, the countries like Thailand, Singapore, Malaysia etc. earn every year crores of foreign currency. In 1952 the scientist named Martin obtained disease free Dalia and Potato plant by culturing meristems of them. Nowadays, it has become a regular practice to make some plants free from viral diseases by culturing their meristems, such as potato tubers. In Malaysia the reproduction of palm oil is done through tissue culture. It is possible to

obtain 88 crores of plantlets of Garland of Chrysanthemum from a vegetative part of it through tissue culture. By the hybridization in between different species and varieties of Iris, it has become possible to grow more plantlets of it in a year instead of 2/3 years. Commercially the perfume atar is being produced from the suspension of *Jasminum* using this technology in many different countries. For the operation of heavy engine such as airplane, rocket etc. a kind of oil from sperm whale is required. This sperm whale is gradually becoming extinct. In an alternative way, this oil is being derived only from a plant named jojoba but this plant does not grow anywhere except in a special desert environment (such as, in Arizona, California), and their reproduction is also time consuming. Through tissue culture, not only the reproduction of this plant has become possible but also it has been changed to a level to adapt to the climate of India. In Bangladesh by this time much more successes have been made through tissue culture, such as it has become possible to produce the plantlets of different orchids grown in the country and in other countries. Disease resistant and high yielding plantlets of banana, wood apple, jackfruit have been produced. Garland chrysanthemum, gladiolus, lily, garden carnation etc. flower producing plantlets also have been produced. Cadamba, Jarul, epil epil, bakul, teak, nim etc. timber producing plantlets have been produced. Plantlets of different types of pulses, groundnut, jute have also been produced. It has become possible to produce disease free plantlets and seed microtuber of potato applying tissue culture.

Genetic engineering

With the view of changing the body of organism in quality by special technique of biotechnology, changing of gene particle in the centre of a cell is called genetic engineering. In other way it can be said, to develop new characters, changing in DNA of any organism is genetic engineering. Genetic engineering is also called recombinant DNA technology.

With this technology, the transfer of the desired part of DNA from bacteria to human being, from plant to animal and from animal to plant have become possible. The organism with the new characters is called GMO (genetically modified organism) or GE (genetically engineered) or transgenic.

Stages of the preparation of DNA or GMO

- (a) Selection of targetted DNA.
- (b) Selection of a carrier so that the transfer of desired segment of DNA becomes possible.
- (c) Selection of necessary restriction enzyme (special type of enzyme to cut DNA) to chop the DNA molecule at a particular locus.

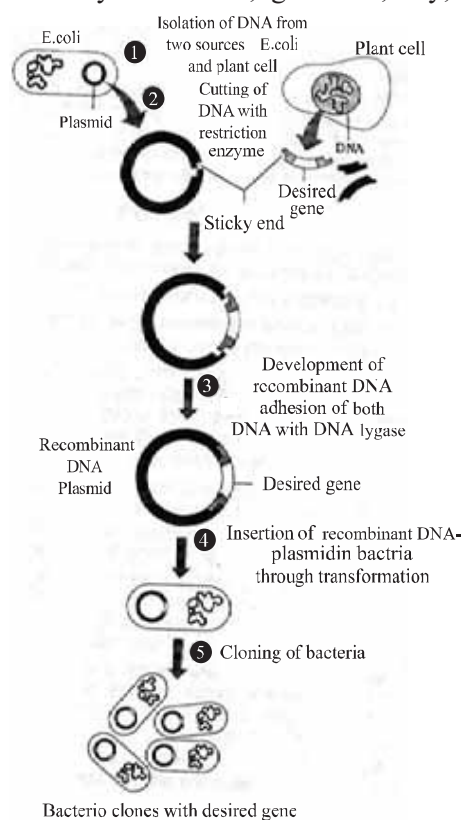


Figure: 14.2 Recombinant DNA technology

- (d) Selection of DNA ligase enzyme to join the segments of DNA chopped.
- (e) Selection of a host for the replication of the carrier DNA with the segment of desired DNA.
- (f) Evaluation of the expression of recombinant DNA prepared with the desired DNA segment.

This technology is being more significantly used by related innovators or investors because in a short period of time very accurately desired characteristic can be transferred by transferring gene through the process of modern biotechnology or genetic engineering.

Genetic engineering is more effective for the development of new crops in comparison with traditional ways of reproduction because transfer of gene is similar or limited to the nearest species through traditional reproduction. But it is possible to transfer directly one or more genes to nearer or distant species through genetic engineering. Moreover, it requires long time to achieve the desired result through traditional way of reproduction. It is possible to obtain plants or animals or microorganisms with desired characteristics in a very short period of time. In case of traditional reproduction, unexpected genes may be transferred with the desired gene and the transfer of desired gene also remains uncertain. In genetic engineering, there is no possibility of transferring unexpected gene and the transfer of desired gene is certain. Traditional reproduction is not controlled by any rules and methods of bio-safety, but in case of genetic engineering it is controlled by internationally accredited rules and methods of bio-safety. Toxicity is not tested in traditional reproduction but test of toxicity is done in genetic engineering.

Genetic engineering in developing crops: Genetic engineering or recombinant DNA technology is the most modern biotechnology. The main objective of the technology is to develop organisms with new and advanced characters and by which human beings can be benefited surpassingly. By this time notable successes have already been achieved through this technology.

Harmful insects resistant varieties of crops have been developed, such as Bt corn, Bt cotton, Bt rice (developed in China) etc. These fruits are resistant to the harmful insects under Lepidoptera and Coleoptera orders. For the insertion of bacterial genes named *Bacillus thuringiensis* into the crops, these genetically modified crops are designated as Bt corn.

Using this technology, virus resistant varieties of crop have been developed, for instance by transferring gene, tomato mosaic virus (ToMV), tobacco mosaic virus (TMV) and tobacco mild green virus (TMGMV) resistant varieties of crop have been developed. The variety of papaya resistant to ring spot virus (PRSV) has also been developed. The research is being carried out for the development of late blight resistant variety of potato by transferring late blight fungus resistant gene.

Varieties of corn and cotton tolerant to herbicides have been produced by genetic modification.

Scientists have become able to develop herbicides tolerant variety of tomato by transferring herbicides tolerant genes into the tomato from a kind of bacteria.

This way herbicides tolerant varieties of soybean, corn, cotton, canola etc. have been produced.

Through genetic engineering more than one trait can be inserted in the same plant. Nowadays, with no trouble this type of transgenic plants is commercially available. For instance, side by side both herbicides tolerant and insect resistant characters have been inserted in corn and cotton.

Through genetic change, nutrition value of some crops has been improved. For example, vitamin i.e. beta-carotene gene has been transferred into rice. Taking efforts to add iron in rice is being continued. The attempts are also being made to develop salinity and drought resistant varieties of different crops through genetic modification.

In animals: In livestock, for example transfer of protein C gene has been done to increase protein in cow-milk though still it is in research level.

Through genetic modification, genetic changes have been accomplished with the sheep by transferring the growth hormone producing gene from human being to it with the view of increasing its size and meat production. To improve the amount and quality of sheep's fur, 2 bacterial genes, such as CysE and CysM have been transferred to the genome of sheep.

In healthcare: Hepatitis b-virus vaccine is being produced from yeast through genetic modification.

From genetically modified *E.coli* bacteria and yeast, insulin is being commercially produced for the treatment of the diabetes disease by using the gene, which produces insulin in human body. Human growth hormone and components of the stimulant for accelerated growth of granulocytes macrophage colony are being produced from genetically modified *E.coli* bacteria and yeast, and these are respectively being used for dwarfism, viral disease, cancer, AIDS etc.

In improvement of fishing: The areas of petroleum industry and refinery and coal mining are free from pollution because this technology is being used with a view to making the environmental management easy and fast, such as management of industrial wastes and sewage. Dr. M.K. Chakraborty, by performing research on genetic engineering, has developed a variety of *Pseudomonas* bacteria which is able to disintegrate immediately oil and hydrocarbon in any environment.

Work-1: Draw a poster on the use of biotechnology and genetic engineering, and present it in the class.
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Work-2: Prepare a report on the scope of educating biotechnology and genetic engineering in Bangladesh, and submit it to your teacher.

Exercise

Short answer question

1. How is culture medium prepared?
2. What is tissue culture?
3. What is explant?
4. What is genetic engineering?
5. What is transgenic?

Essay type question

1. Mention the roles of tissue culture in plant reproduction and developing improved variety.
2. Discuss the roles of genetic engineering in improving crops.

Multiple choice question

1. Which one is the special enzyme to cut DNA?
 - a. ligase
 - b. restriction
 - c. lactase
 - d. lipase
2. **Biotechnology is applied to.....**
 - i. fermentation
 - ii. tissue culture
 - iii. develop transgenic organism

Which one of the following is correct?

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

Pay heed to the following stem and answer the question 3 and 4.

Imtiaz found a very good variety of woodapple visiting his friend's house. To produce the plantlets of exact characters, he brought some lateral buds of the plant, and produced them in his university lab of Botany department.

1. What is the process that Imtiaz followed in the lab?
 - a. transfer of gene
 - b. application of hormone
 - c. use of enzyme
 - d. tissue culture
3. Which one is the consecutive steps of Imtiaz activities?

a.	preparation of culture media	inoculation of explant	development of plantlets
	development of roots	transfer to natural environment	
b.	preparation of culture media	development of plantlets	development of roots
	inoculation of explant	transfer to natural environment	
c.	selection of mother plant	preparation of culture media	inoculation of explant
	development of plantlets	transfer to natural environment	
d.	selection of mother plant	preparation of culture media	development of callus
	development of callus	transfer to natural environment	

Creative question

In the garden belonged to a genetic engineer Dr. Hayder, the lemon plants are dying rapidly being diseased though the lemon harvest is high. He finds that there are some lemon trees of the same species, which live long though they do not produce high yield. From these two varieties of lemon, he developed a new, high yielding and disease resistant variety. He produced the plantlets not by traditional process but by a special process in his lab.

1. What is biotechnology?
2. What is GMO?
3. Explain the technique followed by Dr. Hayder for the development of lemon variety.
4. Explain the causes of developing plantlets through the special process by Dr. Hayder.

The End

2013

Academic Year

9-10 Biology

সমৃদ্ধ বাংলাদেশ গড়ে তোলার জন্য যোগ্যতা অর্জন কর

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