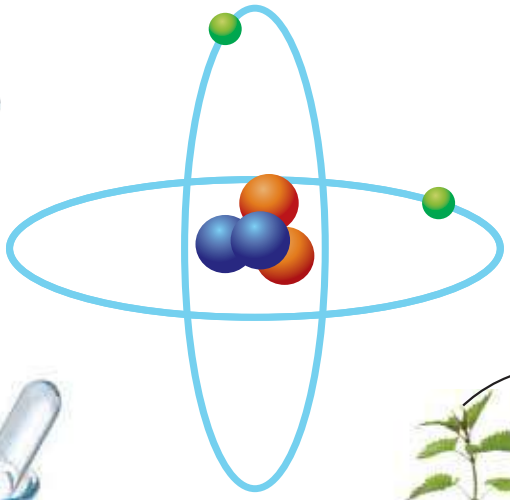
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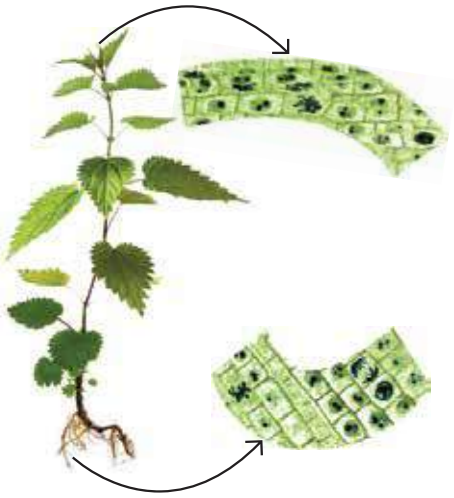
Class Eight











National Curriculum and Textbook Board, Bangladesh

Prescribed by the National Curriculum and Textbook Board
as a textbook for class eight from the academic year 2013

Science

Class Eight

Revised for the year 2026

National Curriculum and Textbook Board, Bangladesh

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Preface

The importance of formal education is diversified. The prime goal of modern education is not to impart knowledge only but to build a prosperous nation by developing skilled human resources. At the same time, education is the best means of developing a society free from superstitions and adheres to science and facts. To stand as a developed nation in the science and technology-driven world of the 21st century, we need to ensure quality education. A well-planned education is essential for enabling our new generation to face the challenges of the age and to motivate them with the strength of patriotism, values, and ethics. In this context, the government is determined to ensure education as per the demand of the age.

Education is the backbone of a nation and a curriculum provides the essence of formal education. Again, the most important tool for implementing a curriculum is the textbook. The National Curriculum 2012 has been adopted to achieve the goals of the National Education Policy 2010. In light of this, the National Curriculum and Textbook Board (NCTB) has been persistently working on developing, printing, and distributing quality textbooks. This organization also reviews and revises the curriculum, textbook, and assessment methods according to needs and realities.

Secondary education is a vital stage in our education system. This textbook is catered to the age, aptitude, and endless inquisitiveness of the students at this level, as well as to achieve the aims and objectives of the curriculum. It is believed that the book written and meticulously edited by experienced and skilled teachers and experts will be conducive to a joyful experience for the students. It is hoped that the book will play a significant role in promoting creative and aesthetic spirits among students along with subject knowledge and skills.

The purpose of science education is to develop observational skills, problem-solving skills, and interest of the students about natural phenomena and various elements of the environment through creating curiosity. In addition to the theoretical aspects of **Science**, this textbook for class VIII also provides different hands-on activities to increase their creativity and imagination, as well as investigative work to develop the student's curiosity and adherence to science. Students will be able to acquire the necessary skills and positive attitudes to secure personal and social safety and overcome various adverse situations through science practice.

It may be mentioned here that due to the changing situation in 2024 and as per the needs the textbook has been reviewed and revised for the academic year 2026. It is mentionable here that the last version of the textbook developed according to the curriculum 2012 has been taken as the basis. Meticulous attention has been paid to the textbook to make it more learner-friendly and error-free. However, any suggestions for further improvement of this book will be appreciated.

Finally, I would like to thank all of those who have contributed to the book as writers, editors, reviewers, illustrators and graphic designers.

October, 2025

Professor Robiul Kabir Chowdhury
Chairman (Additional Charge)
National Curriculum & Textbook Board, Bangladesh

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Chapter One

Classification of Animal World

The world is inhabited by numerous diverse small and large animals. There are various similarities and dissimilarities among them. From microscopic Amoeba to the gigantic whale, all are included in this diverse world of animals The variety of animal depends on the diversity of environment. Different places have different kinds of animals. It is a difficult task to understand the vast animal kingdom. To understand the animal world easily, a systematic arrangement and grouping is necessary. The method of this systematic grouping/arrangement is called classification. Classification makes the way easy to understand animal kingdom.



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

- classify invertebrate animals;
- classify vertebrate animals;
- explain the necessity of classification of the living world.

Lesson 1 : Classification of Animal World

You can see various types of animals – small and large around you. Try yourself to answer the questions below, from the knowledge you have acquired in class six.

Questions:

1. Do all the animals you see look alike?
2. Do all of them have vertebral column?
3. Do they live in same habitat?
4. Do all of them take same food?
5. Do they all move in the same way?

Now match your thoughts to the answers below. The animals which we see around us are not all alike. Their shape, structure as well as other physiological activities are also different. Some have vertebral column and some do not have.

Some of them live on land, some in water and some on trees. Their food is also of different kinds.These animals move in different ways. They use things like fins, legs or wings. Some even use tiny hairs called cilia or other body parts. But some animals do not move at all. They stay in one place.

We do not have sufficient knowledge about the exact number of such diverse animals in the world. So far about 1.3 million species of animals have been discovered and the numbers are increasing day by day. Classification is an easy way to know the structure and nature of such huge number of animals. Morphological characteristics of the animal, similarity and dissimilarity among them and their interrelationship are the basis of classification. Depending on their characteristics they are grouped into different taxons serially. This step-wise grouping of the living world is known as classification. With the growing need of time, taxonomy has become a separate branch of Biology.

Species is the lowest rank of the taxonomic unit. For example; man, pigeon, toad etc. are separate species. To classify an animal, it is arranged step by considering its indigenous characteristics.

Aristotle, John Ray and Carolus Linnaeus are the notable names in the history of classification. Naturalist Carolus Linnaeus is called the father of taxonomy. In the naming of animals, he introduced binomial nomenclature and defined genus and species. Scientific name of an animal, contains two parts. First part indicates Genus and second part indicates Species name. The process of such naming is called binomial or scientific name. For example, *Homo sapiens* is the scientific name of human. Scientific name must be in Latin or Latinized language or in English.

Draw the following chart in your notebook and now fill in the gaps.

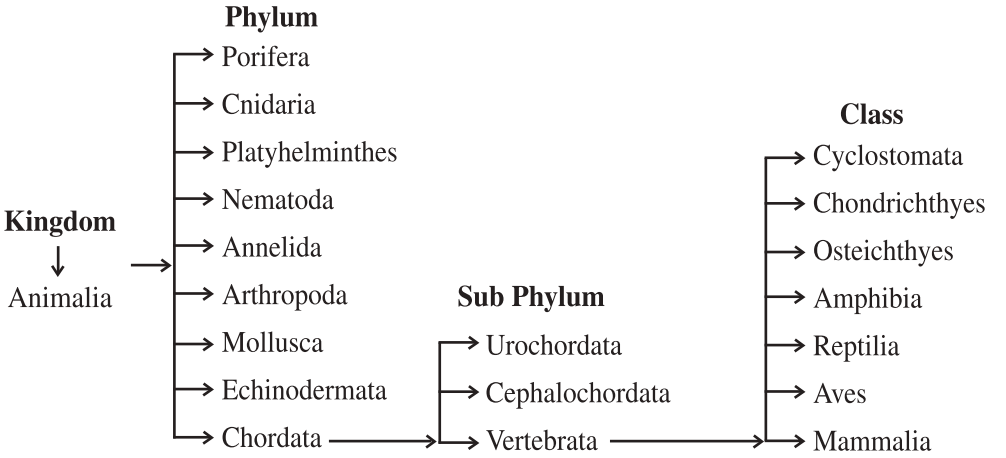
Name of Animal	Habitat	Structure	Usefulness	Harmfulness
Monkey				
Earthworm				
Mussel				
Bird				
Fish				

Lesson 2-5 : Classification of Invertebrate Animals

In the modern classification, all animals belong to the Kingdom Animalia. In this classification system, the previously known phylum protozoa has been placed as a separate subkingdom.

There are total 33 phyla of animals in Animalia world. Among these, nine phyla are called major phyla based on the number of species. The rest are non-major phyla. Animalsin the first eight of these nine phyla are invertebrates and animals in the last phylum are vertebrates.

At a glance the classification of the major phyla of Animalia world.



1. Phylum-Porifera

Habit and habitat: The word 'porus' means hole and 'ferre' means to bear. The word 'porifera' is derived from these two words.The member of the phylum porifera is commonly known as 'Sponge'. They are found everywhere on Earth. Most kinds live in the sea. Most of the species are marine. But some live in fresh water. Usually they live in colonies.

General Characteristics

- They are the simplest multicellular animal. Though they are multicellular, they do not form tissue.
- Their body has many small pores (holes). Water, oxygen, and food go inside through these holes.
- They have no proper tissues, organs, or body systems.



Fig. 1.1: *Spongilla*

Example : *Spongilla, Scypha.*

2. Phylum-Cnidaria This phylum is named from Cnidocyte, a cell of special characteristics. Phylum previously known as Coelenterata.

Habit and habitat: Members of this phylum are present in almost all the regions of the world. They are mostly marine. Many species found in canals, beels, rivers, lakes, fountains, etc. They are diverse in shape, size and colour. Some species live alone (solidarity) and some live in groups which are called colonies. They attach themselves to floating logs, leaves or other objects. Some can also swim freely in the water.

General Characteristics

- Body consists of two embryonic layers. The outer one is ectoderm and the inner one is endoderm.
- Body cavity is known as coelenteron. It helps in digestion and circulation.
- Ectoderm bears a special type of cells called cnidocyte. These cells help in locomotion, self-defence, catching prey.

Example : *Hydra, Obelia.*



Fig. 1.2 : *Hydra*

3. Phylum-Platyhelminthes

Habit and habitat: The word 'Platy' means flat and 'helminthes' means worm. The word Platyhelminthes is derived these two words. The life style of the member of this phylum is very colourful. Many species live on other organism as ecto-parasite (outside the body) or endo-parasite (inside the body). However, some kinds live freely in fresh water. Others live in salty water. *Fasciola* and *Taenia* belong to this Phylum.

General Characteristics

- Body flat and hermaphrodite.
- Eecto-parasites or endo-parasites.
- Body covered with thick cuticle.
- Have suckers and hooks on their body.
- Having special parts in their body called flame cells for helping to remove waste.
- Digestive system is incomplete or absent.



a b

Fig. 1.3 : a) *Fasciola* b) *Taenia*

Example : *Fasciola, Taenia*

4. Phylum - Nematoda (Also called Nemathelminthes)

Habit and habitat: The word 'Nema' means thread.'Nematoda' Phylum is named after this word. Many animals of this phylum are endo-parasite and live in the intestine and blood. These parasitic animals living in human body and animals cause harm to them. However, many are free living animals . They live in water and on land. *Ascaris,* Wuchereria and *Loa loa* belong to under this phylum.

General Characteristics

- Body tubular (cylindrical) and covered with thick skin.
- Complete digestive system with having mouth and anus.
- Respiratory and circulatory system absent.
- Generally unisexual.
- Body cavity without lining and true coelom absent.

Example: *Ascaris, Loaloa.*



Fig. 1.4 : *Ascaris*

5. Phylum - Annelida

Habit and habitat: The word 'Annulus' means ring. 'Annelida' phylum is named after this word. Annelids are found in almost all temperate and tropical regions of the world. Many species live in damp soil, fresh water and some live in deep sea water. Some kinds make holes in rocks and soil to live.

General Characteristics

- The body is long, tube-shaped, and divided into many small segments.
- Each segment has tiny bristle-like hairs called setae, which help the animal move.
- The excretory system has special organs called nephridia, which remove waste from the body.

Example : Earthworm, Leech.

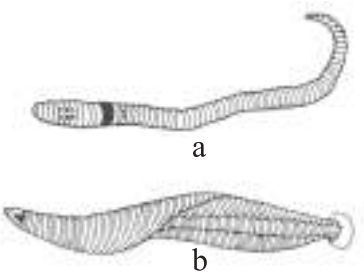


Fig. 1.5 : a) Earthworm, b) Leech

6. Phylum - Arthropoda

Habit and habitat: The word Arthro means joint and Poddos means leg. This phylum is named after these two words. Arthropoda is the largest phylum of the animal kingdom. They can live almost everywhere on Earth in all kinds of environment. Many species of them live as endo-parasite and ecto-parasite. Many of them can survive on land, in fresh water and salty water. Many animals in this phylum can fly using their wings.

General Characteristics

- The body is divided into three main parts: the head, the thorax, and the abdomen.
- The head has one pair of compound eyes and a pair of antennae.
- The soft body is protected by a hard outer covering made of chitin. This is called the exoskeleton.
- Insects have special excretory organs called Malpighian tubules. These help to remove waste from the body.
- The body cavity is filled with blood. This cavity is called the *haemocoel*.

Example: Butterfly, prawn, cockroach, crab.

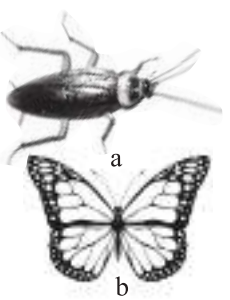


Fig. 1.6 : a) Cockroach b) Butterfly

7. Phylum- Mollusca

Habit and habitat: This phylum is named after the word 'Molluscus' which means soft. This is the second largest phylum of animal world. The members of this phylum show diversity in their body form, habit and habitat. They live in almost every environment on earth. Almost all are marine and live at different levels in the sea. Some live in hills and forest, while some live in fresh water.

General Characteristics

- Soft body, usually covered with hard shell.
- Muscular foot used for locomotion.
- Using lungs or gills for breathing.

Example : Snail, Mussel.



Fig. 1.7 : Snail

8. Phylum: Echinodermata

Habit and habitat: The word 'Echinos' means thorn and 'derma' means skin. This phylum is named after these two words. Echinoderms are all marine. You can find them in all oceans and at all depths worldwide. None of the members is found on land and in fresh water. Most of them live indepenently.

General Characteristics

- The skin has small spines on it.
- The body is divided into five equal parts. This is called a *pentamerous* body plan.
- Echinoderms have a special system called the water-vascular system. They use tube feet for movement.
- Adult echinoderms do not have a clear head. Their upper side (dorsal) and lower side (ventral) are not very distinct.

Example : Starfish, Sea cucumber.

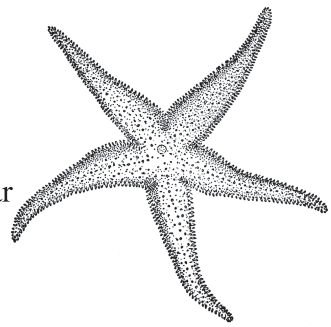


Fig. 1.8 : Starfish

Lesson 6-8 : Classification of Vertebrate Animals

9. Phylum - Chordata

Habit and habitat: The word Chordata originates from chorda which means cord or duct. Chordate lives in all sorts of environment of the world. Many species are terrestrial in habit. Among aquatic chordates, many of them live in fresh water or in ocean. Many species are arboreal, desert dweller, polar, cave-dwelling and flying in nature. There are many ectoparasitic chordate species which live on the bodies of other animals.

General Characteristics

- The notochord is a rod-like unsegmented, semirigid structure. It forms a stiffening body axis throughout life or at some stage in the life cycle of each chordate.
- There is a single, hollow nerve cord. It lies along the back (dorsal side) of the body.
- Pharyngeal pouches (gill slits) present throughout life or at some stages in the life cycle.

Example : Man, Toad, Carp (Rui) fish.

Phylum chordata is divided into three sub-phylum. Such as-

(a) Urochordata

General Characteristics

- Notochord present only in larval stage and restricted to the tail.
- Gill slits and dorsal tubular nerve cord present only in the early stage of the life cycle.

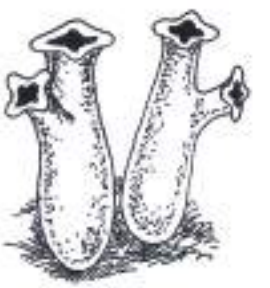


Fig. 1.9 : *Ascidia*

Example : *Ascidia, Salpa.*

(b) Cephalochordata

- Notochord and nerve cord found along the entire length of body and persist throughout life.
- Looking like fish.

Example: *Branchiostoma*



Fig. 1.10 : *Branchiostoma*

(c) Vertebrata

The member of this sub-phylum is known as vertebrate. Notochord is present only in embryonic stage and replaced by vertebral column in adults. Depending on structure and other characteristics, this sub-phylum is divided into seven classes.

(I) Class-Cyclostomata

- The body is long, thin, and shaped like an eel. The skin is smooth and without scales.
- The body looks like a fish.
- They do not have real jaws or paired fins (appendages).
- They breathe through gills.



Fig. 1.11 : *Petromyzon*

Example : *Petromyzon.*

(II) Class-Chondrichthyes

General Characteristics

- They all live in the sea.
- Their skeleton is made of cartilage, not bones. The mouth opening is located on the underside of the head.
- The skin has special small scales called placoid scales. There are 5 to 7 pairs of gills on each side of the head.
- The body is streamlined and has a tail called a *heterocercal* tail. This means the upper and lower parts of the tail are not the same shape. They do not have an *operculum* (a bony cover) over the gills.

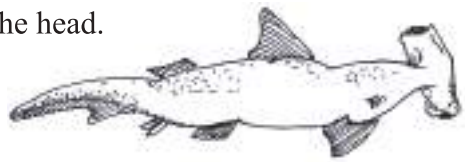


Fig. 1.12 : Hammer fish

Example: Shark, Sword fish.

(III) Class-Osteichthyes

General Characteristics

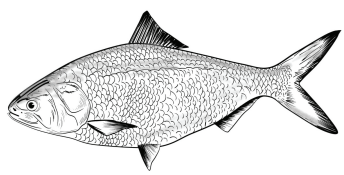


Fig. 1.13 : Hilsa fish

- Mostly fresh water fish.
- The orifice is at the front side of the body.
- Skin with cycloid, ctenoid or ganoid scales; some without scale.
- Respiration primarily by gills. Four pair of gills are present on both side of the head. Gills are covered by operculum.
- Both parts of the tail are similar. That is homocircle.

Task: Collect Loitta, Rupchanda, Poa, Coral, Pabda, Shing (cat fish) and Magur (Cat fish) or pictures of fishes. In which class do they belong? Identify their characteristics.

Example : Hilsa fish, Sea horse.

(IV) Class-Amphibia

These animals can live under water breathing through their skin, but when on land they breathe by lungs. They lay their eggs in water and these hatch into larvae which breathe by gills.

General Characteristics

- Skin without scales.
- Skin thin, soft, moist and with many glands.
- Amphibians are cold-blooded animals.
- Lay eggs in water. A tadpole hatches from the fertilized egg.



Fig. 1.14 : Toad

Example : Frog, Toad.

(V) Class-Reptilia

General Characteristics

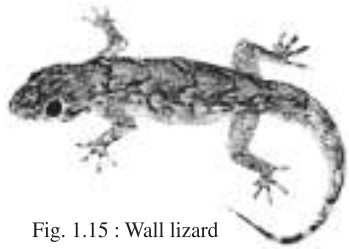


Fig. 1.15 : Wall lizard

- Their skin is dry and covered with scales.
- They move by crawling on the ground.
- Most reptiles have four legs, and each leg has five toes with claws. However, snakes and some types of lizards do not have legs.

Example: Wall lizard, Crocodile, Snake.

(VI) Class-Aves

General Characteristics



Fig. 1.16 : Magpie (Doel)

- Body is covered with feather.
- Two wings, two legs and one beak.
- The presence of air sacs with lung helps in flight.
- All birds are warm blooded.
- Bones are light, strong, delicate and laced with air cavities.

Example : Crow, Duck, Magpie.

(VII) Class-Mammalia

General Characteristics



Fig. 1.17 : Royal Bengal Tiger

- Their body is covered with hair.
- Female mammals feed their babies with milk from special organs called mammary glands.
- Mammals are warm-blooded animals.
- They have a four-chambered heart.
- Their teeth are *heterodont*, which means the teeth are of different shapes and have different jobs.
- Most mammals give birth to live babies. For example: humans, camels, and the Royal Bengal Tiger. But there are some exceptions, like the platypus, which lays eggs.
- Their skin has different types of glands.

Task: Make a group of five. Now, observe the chart of vertebrate and invertebrate animals; identify and note down their characteristics. Now present it to your class. Match the similarity of your findings with those of the other groups.

Lesson 9 : Necessity of Classification

It is impossible to identify millions of animals one by one. Taxon, unit of classification, helps to classify the vast animal world. The seven major taxa are as follows: Kingdom, Phylum, Class, Order, Family, Genus and Species. To identify an animal, taxonomists should match the characteristics of the animals with the above mentioned seven taxa. Sub-phylum is usually added under phylum.

Classification is a scientific approach by which we can gather knowledge about different plants and animals easily. It saves labour, money and time. Classification is essential to identify any animal including the newly discovered one. Interrelationship between different animals can be determined with the help of classification. We can determine the systematic position of the organisms according to the evolutionary trend. Organisms can be arranged into different taxa by following definite rule. This also allows us to trace the affinity of one group of organism to other. It is useful to determine the collective and systematic knowledge about organisms. For example, all acellular (Unicellular) animals are grouped under one phylum and all multicellular animals under nine phylum.

New words: Taxonomy, binomial nomenclature, species, animalia, coelom, coelenteron, setae, notochord, larva, cycloid, ganoid.

What we have learned at the end of this chapter

- Vertebrata are advanced animals. Their notochord is replaced by a vertebral column made of hard vertebrae.
- Respiration by gills in aquatic vertebrate and by lungs in land vertebrate.
- Chordata is a phylum under the kingdom Animalia. Animals that have a notochord, nerve cord and pharyngeal gill slits are known as chordates.
- The anterior part of the nerve cord swells and transforms into brain. The skull houses the brain and protects it.
- Cellular layers of embryo that give rise to different organs are known as germ layers.
- The mantle covers the soft body of molluscs. They use their muscular foot for locomotion.

- Radial symmetry applies to those forms that can be divided into similar halves by more than two planes passing through one main axis. Example-Starfish.
- Cavity surrounded by body wall is known as coelenteron. It acts as digestive as well as circulatory system.
- The space filled with fluid between body wall and the alimentary canal of multicellular animal is known as coelom.
- Haemocoel is filled with blood and acts as a part of circulatory system.
- Arthropoda is the largest phylum of the animal kingdom. Harmful insects are known as pest.

Sample Questions

Multiple Choice Questions

1. Which animal belongs to the phylum Mollusca?

a. Crab
b. Leech
c. Starfish
d. Mussel

2. Both Scypha and Hydra are-

i. Diploblastic
ii. Multicellular
iii. Devoid of well developed organ system.

Which one of the following is correct?

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

Based on the chart below, answer questions no. 3 & 4

m	Animal having wing and haemocoel.
n	Animal having feather and air sacs with lung
o	Cold-blooded animal and lays eggs
p	Animals with scale and paired fins

3. Which animal of the chart is invertebrate?

a. m b. n

c. o d. p

4. Can fly-

i. m & n animal

ii. n & o animal

iii. m & p animal

Which one of the following is correct?

a. i b. i & ii

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

2026

Creative Questions

1. Answer the following questions based on the stem below:



P



Q



R

a. What is classification?

b. What is Coelenteron? Explain.

c. To which phylum does the animal ‘P’ belong? Explain.

d. Analyze why the two animals ‘Q’ and ‘R’ belong to different classes.

2. Answer the following questions based on the given stem below:



M



N



O

a. What is a radially symmetrical animal?

b. What is a flame cell? Explain.

c. To which phylum does the animal 'M' belong? Explain.

d. Although both 'N' and 'O' are parasites, they belong to different phyla — analyze.

Short Answer Questions

1. What is a cnidocyte? Explain.
2. What is the significance of scientific names? Explain.
3. Why is Branchiostoma classified under Cephalochordata? Explain.

Do it yourself

1. Collect some vertebrate animals from your environment/locality and write down their characteristics.
2. Mention the phylum of the following animals – earthworm, prawn, grasshopper, snail, mussel, rui fish and magpie-robin (Doel). Make a list of their identifying characteristics.

Chapter Two

Growth and Heredity of Living Organism

The body of all organisms consists of cells and all cells arise from the division of existing cells. Unicellular organisms multiply by cell division. In this way one cell divides into two, and two transforms into four. They divide further in the same manner and this is how growth of living organisms takes place.

The cells found in most multicellular organisms originate from the divisions of a single cell. The life of a multicellular organism originates from the zygote-the union or the fertilization of an egg and a sperm. Cell division is the basis for growth and it is needed for both sexual and asexual reproduction.



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

- explain the types of cell divisions;
- explain the growth and development of living organism through cell division;
- explain what role cell division plays to restore genetic trait.

Lesson 1 : Types of Cell Division

In living organisms three main types of cell divisions are found, such as, (1) Amitosis (2) Mitosis and (3) Meiosis.

Amitosis: Amitosis cell division occurs in Bacteria, yeast, fungi and in amoeba. Unicellular prokaryotes procreate through amitosis cell division. The nucleus elongates and becomes dumb bell shaped and becomes slender in the middle and gets separated from each other to form two nuclei. At the same time the cytopalsm also elongates in the middle to form two cells. In this kind of cell division, the nucleus of mother cell and cytopalsm get directly separated to form two cells. Hence it is called direct cell division.

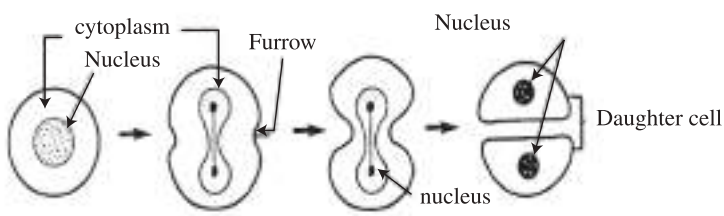


Fig. 2.1: Amitosis (direct cell division).

Mitosis: Somatic cells of higher plants and animals divide in mitosis cell division. The process of cell division by which nucleus and chromo-somes of a eukaryotic cell get divided only once is known as mitosis. In this process, the nucleus of the mother cell divides only once. It produces two daughter cells that have the same characteristics, size, quality, and number of chromosomes. Mitosis ensures increase of height and breadth of the body of animals and plants. The cells of the meri-stematic (apex of branch and roots) tissue of plant increase their number by mitotic division.

Meiosis: Meiosis (meiotic cell division) occurs during the formation of reproductive cells from the reproductive mother cells. The characteristics of meiotic cell division are that the nucleus is divided twice and chromosomes divide once. As a result of cell division by meiosis the number of chromosomes of the daughter cells becomes half of the number of chromosomes of mother reproductive cells. In this process four new cells are produced which contain half of the chromosomes of the mother cell, hence called reduction division. Generally meiosis occurs in the reproductive mother cell during the formation of gametes.

Mitosis

Features of Mitosis

1. Mitotic cell division is the division of somatic cell.
2. In this process the nucleus of the mother cell is divided only once.
3. Mother cell is divided into two cells of same quality.
4. The number of chromosome of daughter nucleus and mother nucleus remain identical after mitotic cell division.
5. In mitosis division, each chromosomes equally divided lengthwise along the centromere. As a result the number of chromosomes of the two new cells remain same as the number of chromosomes of the mother cell. So, mitosis is also known as equational division.

Where mitosis occurs ?

Mitosis takes place in the somatic cells of all eukaryotic organisms. The meristematic tissue of the growing part of the plant, viz, apex of stem and roots, growing leaves, buds etc. show this type of cell division. Mitosis occurs in somatic cells of the animal body, developing embryo and during asexual reproduction of lower animals and plants.

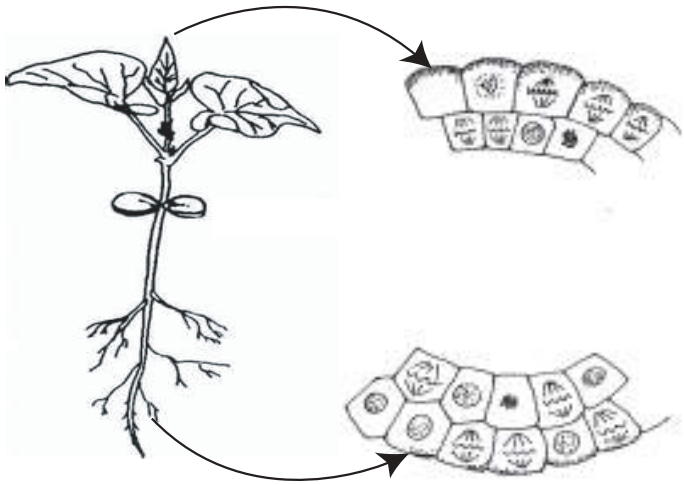


Fig. 2.2: Cell division in root tip and shoot tip.

In which cells mitosis does not occur?

In case of animals the nerve cells (neuron) of the nervous tissue, matured red blood corpuscles (RBC) and platelets of mammals and the cells of permanent tissue of plants does not show mitosis cell division.

Lesson 2 : The Process of Mitosis Cell Division

The process of mitosis takes place in two phases. The nucleus divides in the first phase and the cytoplasm in the second phase. The division of the nucleus is known as caryokinesis, and the division of the cytoplasm is cytokinesis. Mitosis is a continuous process in which caryokinesis (division of nucleus) occurs first and then cytokinesis (division of cytoplasm) takes place. Before starting caryokinesis and cytokinesis, the nucleus of the dividing cell needs to take some preparations. This intermediary stage between the two consecutive cell divisions is known as interphase or the resting stages.

Division of nucleus or caryokinesis

The nucleus of the dividing cell passes through a continuous complex process and completes caryokinesis. As cell division is a non-separable, continuous process, it is not right to divide it into different stages. Still for the benefit of description, it is divided into five stages. These are (1) Prophase (2) Pro-metaphase (3) Metaphase (4) Anaphase and (5) Telophase.

Prophase: This is the longest stage of mitosis cell division. At this stage the following events occur.

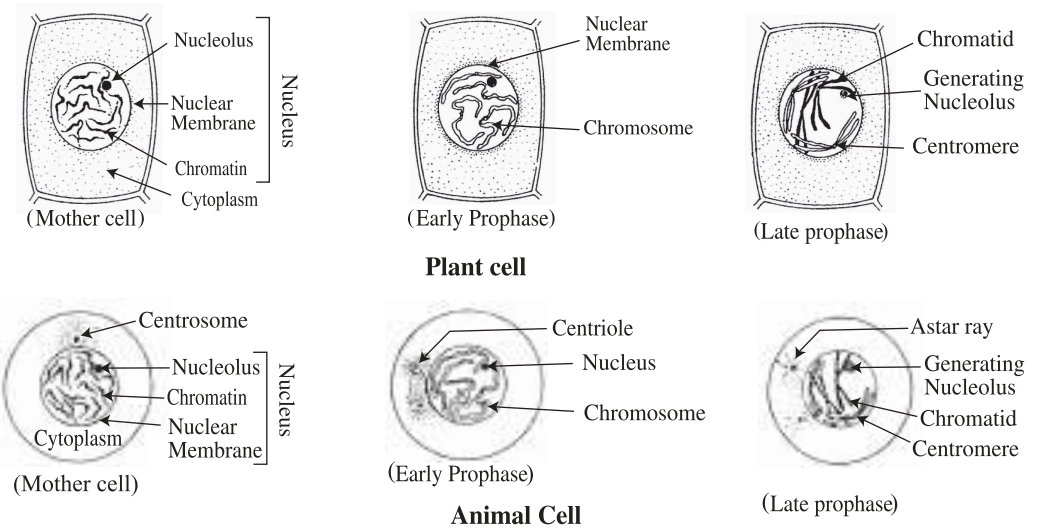


Fig. 2.3: Prophase

1. The nucleus becomes bigger in size.
2. Due to continuous dehydration nuclear chromatin condenses to form visible thread like structures, known as chromosomes. Then each chromosome divides longitudinally into two chromatids. The sister chromatids are joined together at their centromere.

Lesson 3 : Pro-metaphase, Metaphase, Anaphase and Telophase

Pro-metaphase: This phase is very short. In this phase-

1. The nuclear membrane and nucleolus almost disappear.
2. At the end of prophase, the spindle apparatus is formed by the accumulation of some protein fibres in the cell. The middle area of two poles of the spindle apparatus is known as the equator. The fibres of the spindle spread from one pole to another. These are known as spindle fibres. In animal cells, in addition to formation of spindle apparatus, centriole divides earlier and reaches the two poles from where aster fiber radiates. Each part of the spindle apparatus is called a spindle unit. The fibres that connect to the centromere of the chromosomes are called traction fibres or attraction fibres.

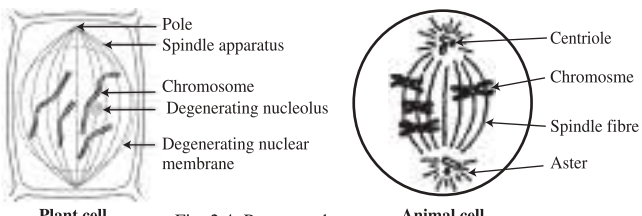


Fig. 2.4: Pro-metaphase

Metaphase : In this step-

1. All the chromosomes line up at the equator of the spindle apparatus and attach to the spindle fibres by their centromeres.
2. At this stage the chromosomes are found shortest, quite thick and clear.

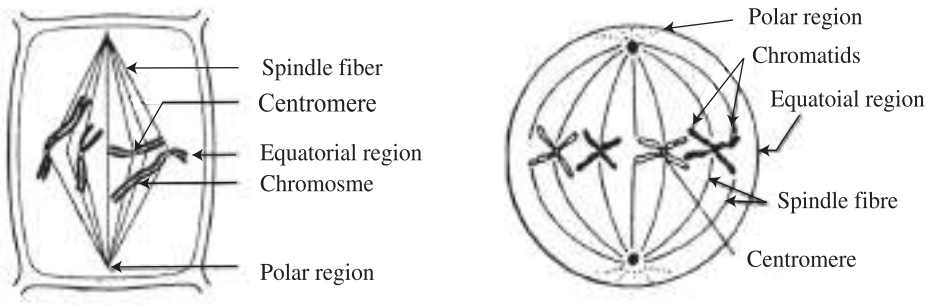


Fig. 2.5: Metaphase

Anaphase : In this stage-

1. The centromere of the chromosome now splits so that two independent daughter chromosomes, each with its own centromere, are formed.
2. The chromatids get separated from each other. At this stage each chromatid is called daughter chromosome.
3. Then, the contraction of the traction fibres pulls half of the daughter chromosomes toward one pole and half toward the other pole. In this time, the chromosomes take the shape of English letter V, L, J or I according to the position of centromere.

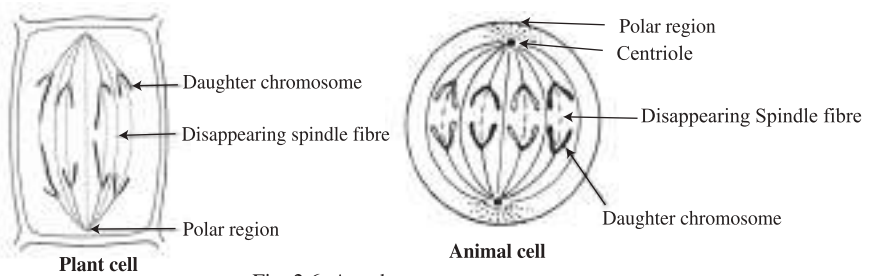


Fig. 2.6: Anaphase

Lesson 4 : Telophase : In this stage-

1. Daughter chromosomes reach their opposite poles.
2. The spindle fibres disappear, and the chromosomes become thin again, turning back into a network of chromatin.
3. Finally, nuclear membrane reappears around the two daughter nuclei. Nucleolus also reappears. In this way, two daughter nuclei are formed at two poles and signal the end of karyokinesis.

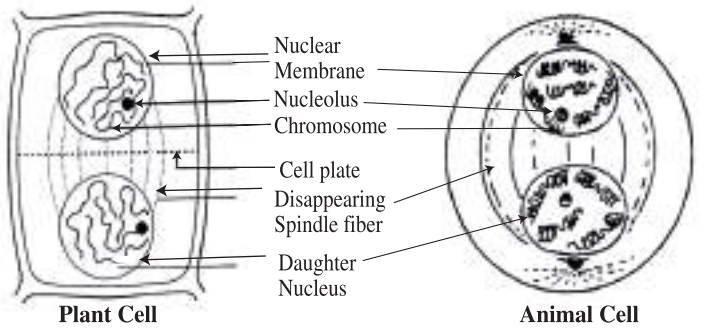


Fig. 2.7: Telophase

Cytokinesis

At the end of telophase, cytokinesis begins. In plant cells, the middle part of the spindle apparatus widens, touches the cell wall, and then the fibres disappear. At the equatorial region the fragmoplast of the endoplasmic reticulum is deposited, and they combine together to form a membrane called plasmalema. When more materials are added to the plasmalema, a cell plate is formed. The cell wall is developed by the deposition of hemicellulose and other components on the cell plate. By the development of the cell wall, the mother cell divides into two daughter cells.

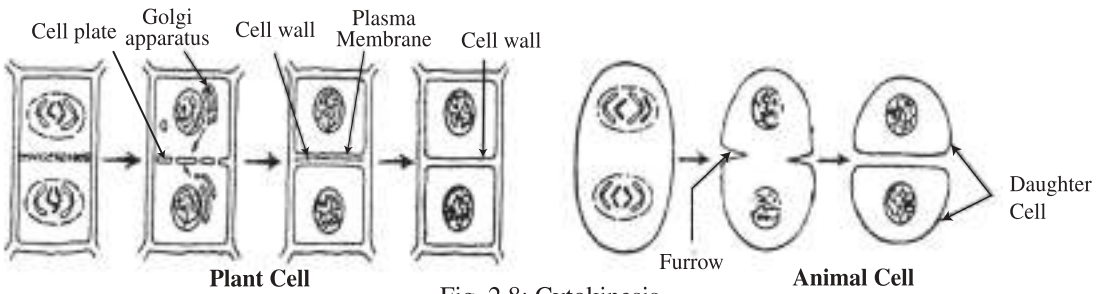


Fig. 2.8: Cytokinesis

In animal cells, a cleavage furrow appears on the surface of the dividing cell and encircles it at the midline of the spindle. The cleavage furrow becomes deeper and squeezes the plasma membrane, like an invisible rubber band, pulling the furrow inward. Finally, the infolding edges of the plasma membrane meet and fuse, completing cell division.

Lesson 5 & 6 : Meiosis

At the beginning of this chapter we have learnt what Meiosis is. Now the question is: why does meiosis occur?

In mitosis, the mother cell divides and produces two daughter cells with the same number of chromosomes as the mother cell. Mitosis is essential for growth and asexual reproduction. In case of sexual reproduction two gamete (male & female) cells unite together to form a zygote. So, if the number of chromosomes in the gamete cells does not reduce to half, then the number of chromosomes will double when the two gametes unite. In case of meiosis mother cell divides and produces daughter cells bearing half the number of chromosomes of mother cell. The number of chromosomes remain same, as the mother cell, in the newly formed zygote resulted from the union of such two gamete cells. As a result of cell division by meiosis the number of chromosomes of a species remains constant generation after generation. This happens during the formation of gametes and at certain stages in the life cycle of lower plants. This stage of chromosomes are called haploid (n). When two haploid cells unite, the state of chromosomes is called diploid.

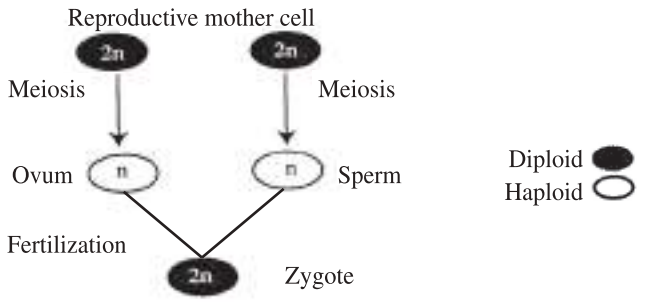


Fig. 2.9 : Formation of zygote due to meiosis cell division.

So, the characteristics of the organism are maintained in each new generation by meiosis.

Features of Meiosis

1. Meiosis takes place in the reproductive mother cell of diploid organism and in the zygote of haploid organisms (lower plants).
2. Four haploid daughter cells are produced from a single cell.
3. In this process the nucleus divides twice and chromosomes divide once.
4. The four daughter cells thus formed contain half the number of chromosomes of the mother cells.

Where does meiosis take place?

Meiosis takes place in the diploid (2n) reproductive mother cells during formation of gametes. Meiosis occurs inside the pollinator and womb of flowering plants and in the testes and ovary of higher animals.Meiosis occurs in the zygote of haploid (n) organisms.

Meiosis Cell Division

During meiosis cell division, a primordial germ cell is divided into two successive phases. The first phase is called meiosis-I, and the second phase is called meiosis-II. During the first division, the chromosomes of the daughter cells become half of the mother cells. The second division is the same as mitosis. This means that each cell produced in the first division divides again to form two daughter cells. As a result, four daughter cells (n) are produced from a primordial germ cell (2n).

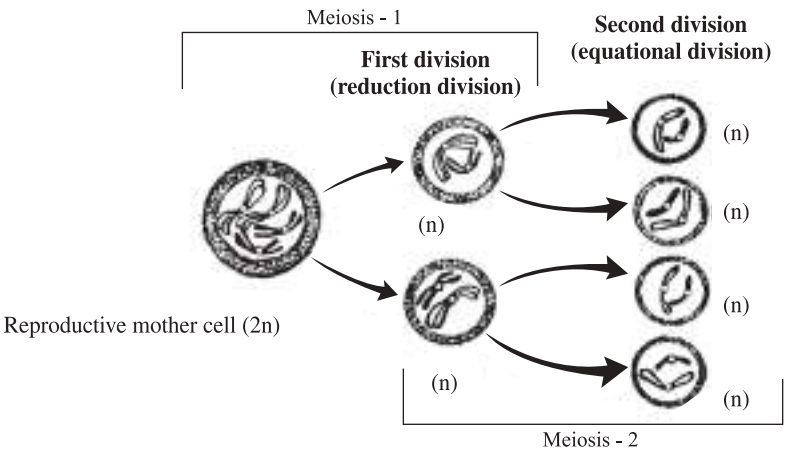


Fig. 2.10: Concept of meiosis cell division.

Lesson 7-9 : The Role of Chromosome, DNA and RNA in Determination of Heredity

Children inherit some characteristics of their parents. The process by which characteristics from parents are passed to the offsprings is called heredity. The characters passed on to children are called hereditary characters. Once, the knowledge of heredity was imaginary. Later, scientists explained how these characters are passed to offspring from their parents.

During the second half of the nineteenth century, Gregor Johann Mendel first postulated two laws about how the traits of the parents are passed on to the offsprings. The research of Mendel and his laws of genetics are now well established as an important branch of life science. The modern theory of heredity is based on the discoveries made by Mendel. This is why Johann Mendel is called the father of heredity.



Gregor Johann Mendel
(1822-1884)

The nucleus of a cell contains a fixed number of thread-like objects that carry the hereditary traits of the organism. These objects are called chromosomes. They are only visible when a cell is about to divide, for example during the prophase stage of meiosis. Each chromosome has two parts: the chromatid and the centromere. At prophase stage of meiosis cell division, each chromosome divides longitudinally into two equal parts, known as chromatid. The point where sister chromatids are joined is called centromere. During cell division, the spindle fibres are attached to centromere.

Nucleic Acid

Nucleic acids are of two types-namely DNA (deoxyribonucleic acid) and RNA (Ribonucleic acid). DNA is the main component of chromosome. DNA & RNA play vital role in transmission of hereditary traits.

It is well known that the genes found in chromosomes control the traits of living things. It is proved from different experiments that, parts of DNA act as gene, i.e. DNA itself is gene. DNA is directly transmitted from the parents to the progeny.

In case of some virus, DNA is absent (eg.TMV). But in place of it, there is RNA. In these cases, RNA is the hereditary material. A character of an organism may be controlled by more than one gene, again a single gene may control several characters. The eye colour, hair pattern, skin colour etc. of man are controlled by gene. Like man, characters of other animals and plants are also controlled by gene. A chromosome acts as a carrier and transmits genes from one generation to the next, maintaining the continuity of hereditary traits.

The continuity of such hereditary trait is maintained through meiosis cell division. To maintain hereditary traits, chromosomes carry genes directly from parents to offspring during cell division. For this reason, chromosome is known as the physical basis of heredity.

So, from the above discussion we understand that the hereditary trait is maintained by meiosis and through reduction of chromosome number, the individuality of every species is restored.

In human body, each somatic cell bears 46 chromosomes. How many chromosomes do germ cell and embryo (embryonic) cells contain?

New words : Amitosis, mitosis, meiosis, haploid, diploid, spindle fibre, cytokinessis, DNA, RNA, daughter cell, zygote

What we have learned at the end of this chapter

- Growth of an organism occurs by cell division.
- How many types of cell division are there, and where do they occur?
- How does the chromosome number in an organism remain constant?
- What do we mean by haploid and diploid?
- Genes are the units of heredity, and chromosomes carry them from one generation to the next.
- Gregor Johann Mendel is the father of genetics.

Sample Questions

Multiple Choice Questions

1. In which stage of mitosis chromosomes becomes shorter and thicker?
   a. Prophase
   b. Pro-metaphase
   c. Metaphase
   d. Anaphase
2. Which of the following controls eye colour?
   a. DNA
   b. RNA
   c. Nucleolus
   d. Centromere

Read the following paragraph and answer questions no. 3 & 4

Aronb was examining the leaf cell of onion under a microscope. In a cell division stage he found that there is no nuclear membrane and nucleolus, but chromosomes are located right in the middle.

3. Which stage of cell division Aronb observed?
   a. Prophase
   b. Pro-metaphase
   c. Metaphase
   d. Anaphase
4. In the next phase of Aronb's observation-
   i. chromosomes get detached from certromere
   ii. chromatid segregates from each other
   iii. centromere divides into two sections

Which one of the following is correct?

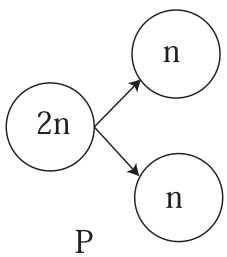
a. i & ii
b. i & iii
c. ii & iii
d. i, ii & iii

Creative Questions

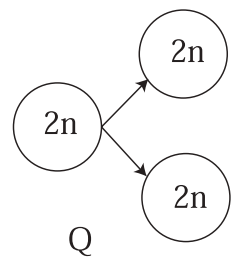
1. Mr. Farabi Sir, the class teacher, was explaining cell division during science class. He said that during a specific stage of cell division, the thread-like thing centromere in the nucleus divides into two equal parts. As a result, the number of chromosomes remains unchanged in the divided cells.

a. What is meiosis?
b. What ensures the continuity of hereditary traits? Explain.
c. Describe with a diagram the specific stage of cell division mentioned by Mr. Farabi.
d. Analyze the function of the thread-like structures mentioned by Mr. Farabi.

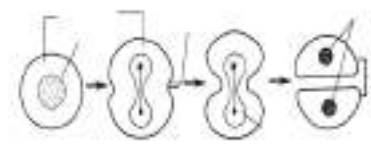
2. Answer the following questions based on the given stem below:



P



Q


R

a. What is karyokinesis?
b. Which type of cell division results in a reduction of chromosome number? Explain.
c. Describe the cell division process labeled ‘R’.
d. Compare and analyze the cell division processes labeled ‘P’ and ‘Q’ in the context of higher organisms.

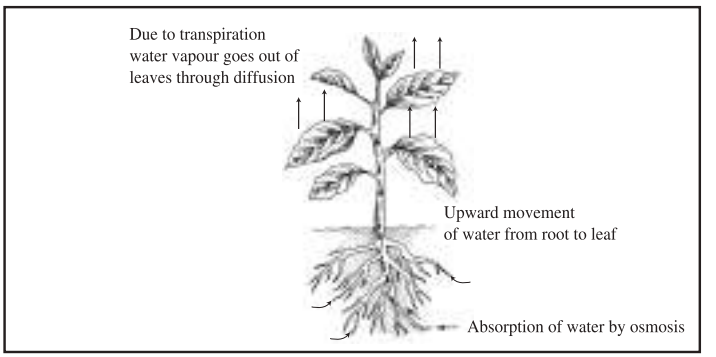
Short Answer Questions

1. Which type of cell division is known as equational division? Explain.
2. Which type of cell division ensures the stability of chromosome number in living organisms? Explain.
3. What would happen if meiosis does not occur in reproductive mother cells?Explain

Chapter Three

Diffusion, Osmosis and Transpiration

The roots of plants absorb water and minerals from the soil. These substances are transported up the stem to the leaves, where this water evaporates from the surface. Intake of carbon dioxide, release (expel) of oxygen gas, absorption of water and minerals and transport of these substances to the roots and leaves and evaporation of water occurs through diffusion, osmosis, absorption, transportation and transpiration processes.



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

- explain diffusion process;
- explain process of osmosis;
- explain loss of water through transpiration;
- explain absorption of water by plants.

Lesson 1-2 : Diffusion

We know, matters (substances) are made up of small molecules. These molecules are always in motion. In liquids and gases, the molecules move very fast. They move from areas with more molecules to areas with fewer molecules. This movement of molecules continues as long as the concentration of the two regions becomes equal. Diffusion stops at once when the concentration of molecules becomes equal in two regions. This type of movement of molecules is called diffusion.

Because of the kinetic energy of molecules, a kind of pressure is created. This pressure causes molecules in liquids or gases to move from a region of higher concentration to a region of lower concentration. This type of pressure is called diffusion pressure.



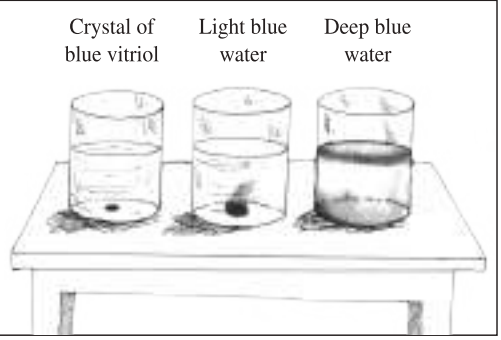
Fig. 3.1: Diffusion test of Scent

We can understand the meaning of diffusion through some experiments. By doing experiments and discussing them, we can gain practical knowledge about diffusion. A few experiments on diffusion are discussed below. We can see many examples of diffusion in our surroundings. For example, the smell of perfume, attar or burning incense spreads around the room. It happens due to diffusion.The high density of particles from the incense spreads into the low-density air throughout the room. As a result, the whole room becomes scented.

Activity: Observing diffusion of copper sulphate in water.

Requirements: Copper sulphate, beaker, water, etc

Method: Take some copper sulphate (blue vitriol) and pour them into the water of a beaker. Copper sulphate is soluble in water and water will take the colour of copper sulphate. Explain why it happens. Finally prepare a list of diffusion activities which occur around us.



Importance of diffusion: Diffusion happens in almost every life process in living things. During photosynthesis, plants absorb carbon dioxide and release oxygen as a by-products. Diffusion makes this essential task possible. Living cells use oxygen to break down glucose. Oxygen enters into the cells through diffusion and the release of carbon dioxide also occurs in the same way. Loss of water in the form of water vapours through transpiration is the result of diffusion. In case of animal respiration, exchange of oxygen and carbon dioxide, carrying of food, oxygen etc. from blood to lymph and from lymph to cells occurs through diffusion.

Lesson-3 : Osmosis

To understand the process of osmosis, we need to know the characteristics of the membrane separating two differently concentrated solutions. A membrane can be of three types: impermeable, permeable, and semi-permeable.

Impermeable membrane: A membrane that does not allow either solute or solvent molecules to pass through. Example- polythene, cell wall made up of cutin.

Permeable membrane: A membrane that allows both solute and solvent molecules to pass easily. Example- cell wall.

Semi-permeable membrane: A membrane that allows only solvent molecules (like water in plants) to pass, but not solute molecules. Example- cell membrane, membrane inside the egg shell, membrane of fish potka (swim bladder/air bladder), gallbladder membrane of animal etc.

We can see this when a raisin (dried grape) is kept in water for some time it swells up. It happens because dry grape absorbs water and the absorption of water occurs through osmosis. Osmosis is one kind of diffusion. Osmosis occurs only in case of liquid and a semi-permeable membrane keeps the two liquids separate. For our understanding, the example of dry grape is cited here.

We know, when two differently concentrated solutions are kept together, diffusion happens naturally. Look, raisins or dry grapes shrink because the water inside them has dried up. Now, if dry grapes are placed in water, water molecules move into them because the inside has a concentrated sucrose solution. As a result, only water molecules pass through the membrane into the dry grape;

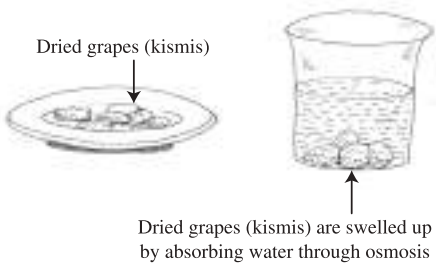


Fig. 3.2: Osmosis experiment with dried grapes (kismis)

the sucrose molecules do not pass through. This type of membrane is known as semi-permeable membrane. So, a semi-permeable membrane is a special barrier that lets only solvent molecules (like water) pass through, but not solute molecules (like sugar or salt). When there are two solutions with the same solvent but different concentrations, and they are separated by a semi-permeable membrane, the solvent moves from the dilute solution (less concentrated) to the concentrated solution (more concentrated). This movement of solvent through a semi-permeable membrane is called osmosis.

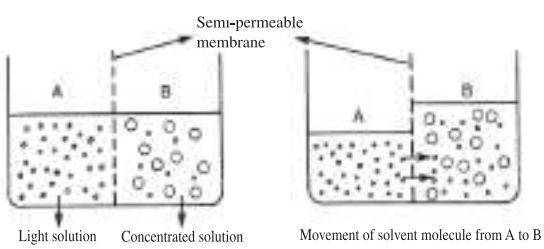


Fig. 3.3: Process of osmosis

Lesson 4 : Importance of Osmosis

The cell membrane or plasma membrane of a living organism acts as a semi-permeable membrane. Mineral salts dissolved in water enter and leave the cell through the plasma membrane. The water and mineral salt solution inside the cell is called cell sap, or simply sap. So, osmosis plays a very important role in maintaining different physio-chemical processes of the cell. By this process, plants absorb water and minerals dissolved in water from soil, through unicellular root hair.

Due to osmosis, the turgidity of the cell is increases which keeps the stem and leaves fresh and straight. Also, plants can open and close their petals. In the intestine of animals, digested food is absorbed.

Activity : Experiment of osmosis.

Requirements : Thistle funnel, swim bladder (air bladder), beaker, concentrated sugar, stand, clamp

Method: After covering the wide mouth of the thistle funnel by fish potka, it should be tied tightly with the help of a thread. Beaker to be filled half with water. The funnel to be filled with sugar solution and placed in a water-filled beaker clamped with a stand. The height of sugar solution to be marked with the help of marker pen. Keep the experimental set in a place.

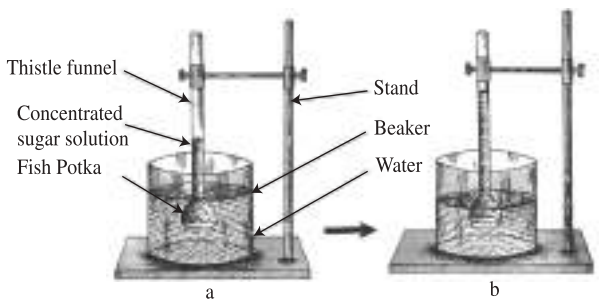


Fig. 3.4 : Experiment of osmosis
(a) At the begining of the experiment (b) After few hours of the experiment.

Observation: After sometime, we can see the height of the solution in the thistle funnel tube has gone up. Sometime later, we can see the level of the solution does not rise further.

Now answer the following questions in the light of what you have observed from the experiment.

1. What type of membrane does the fish potka have?
2. Why did sugar solution rise inside the funnel tube?
3. Why did the solution of the funnel become static without rising upwords?

Lesson 5 : Absorption of Water and Mineral Salts

Mechanism of water absorption in plants: The process by which living cells of a plant take in water and mineral salts dissolved in water is called absorption. Terrestrial (land) plants absorb water from soil through root hairs. Submerged plants absorb water through their whole body. The root hairs of the terrestrial plants absorb capillary water from soil particles through osmosis.

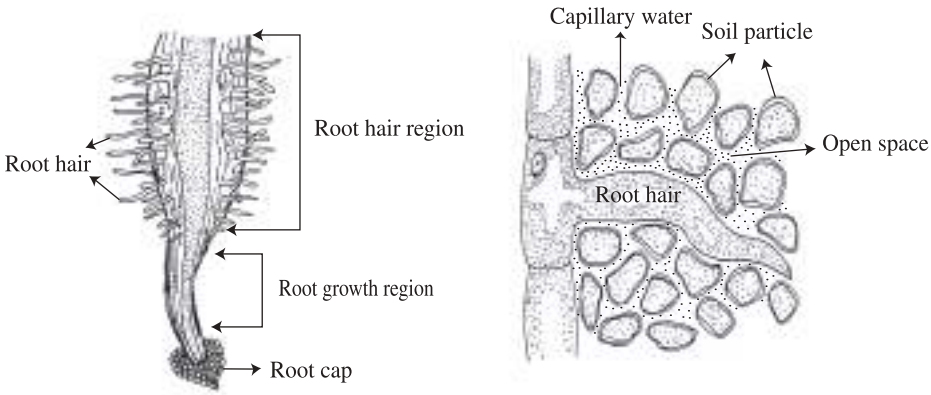


Fig. 3.5: Different regions of root

The wall of the root hair is permeable. So first, it absorbs water through imbibitions, and the absorbed water then touches the semi-permeable plasma membrane below the cell wall. The concentration of the central solution of the root hair is higher than that of its environment and thus water (solvent) enters into the cell through endosmosis. The concentration of the cell sap from the outer membrane to the centre of the root cells is not the same. Consequently, due to inter cellular osmosis, water flows from one cell to another and finally reaches the leaves through xyleme vessels of the stem.

Imbibition: Most of the colloidal substances are hydrophilic. Plant body contains various colloidal substances, such as starch, cellulose, gelatine, etc. These substances can absorb water because of their colloidal nature. The process by which colloidal substances (cell wall in plants) absorb different liquid (water in case of plants) is called imbibition. And the absorbing substance is called hydrophilic substance.

Absorption of Mineral Salt by Plants

Plant absorbs a large amount of mineral salt from the soil for their growth and physiological needs. Mineral salt remains in solution form in the soil.

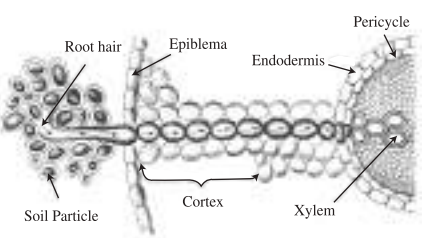


Fig. 3.6: Absorption of water by root cell through osmosis

Mineral salts remain dissolved as solutes in the capillary water of the soil, but the absorption processes of water and mineral salts are different and not directly related. Plants cannot absorb whole salt molecules. They absorb salts only in the form of ions. However, the process of salt absorption is divided into two types: 1) Inactive absorption and 2) Active absorption.

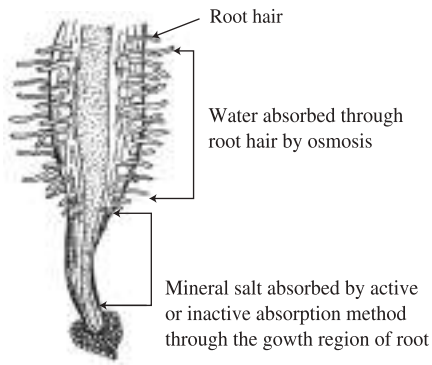


Fig. 3.7: Absorption of water and mineral salt through root.

Lesson 6 : Transpiration

Transpiration is a special physiological process of plants. We learned from the earlier lesson that, water is essential for different physiological processes of plants. For this, plants absorb a large amount of water from soil through root hairs. Plants use a part of this water in different metabolic activities and the rest of it goes out in the form of vapour to the atmosphere. The loss of water as vapour by evaporation from the moist surfaces inside the aerial parts of the plant, especially the leaves, is called transpiration.

There are three kinds of transpiration, based on the outlet of the plant through which water is lost. Such as-

1. Stomata transpiration: This is the major form of transpiration.
2. Cuticular transpiration: This occurs through the cuticle of the leaves and stem.
3. Lenticular transpiration: Some water vapour escapes through the lenticels in the stem.

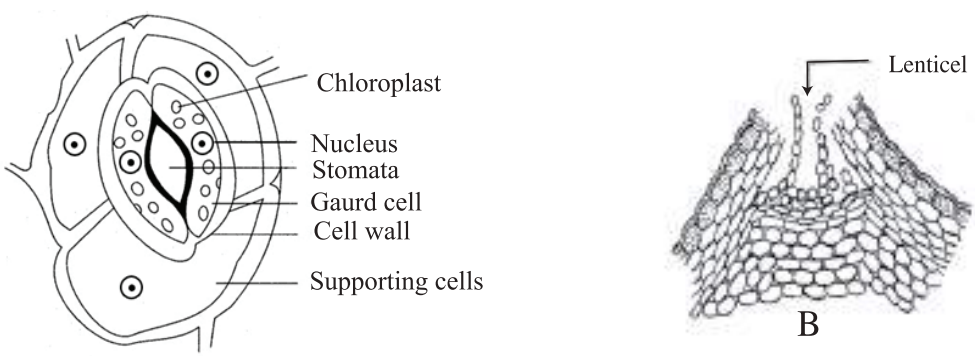


Fig. 3.8: Site of transpiration

The stomata under simple microscope and lenticels of stem in naked eyes can be seen easily.

Activity : Experiment of transpiration.

Requirement : Potted plants, table, water, polythene, thread, vaseline

Method: Take two plants grown in tubs, place them on the table and pour necessary water. Wrap one plant bearing leaves with polythene. Tie the polythene with the help of a thread at the base of the plant and smear vaseline over there to prevent air and water to pass. Cut all the leaves of the other plant and wrap it with polythene in the same way. Keep both the plants in the sunlight.

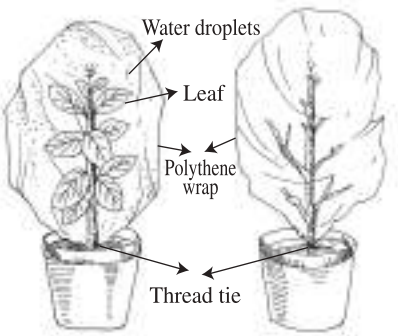


Fig. 3.9: Transpiration experiment with polythene wrap

Observation: After sometime you will see inside the polythene of the plant with leaves water droplets appear but they do not appear on the plant without leaves.

Why does water appear inside the polythene of the plant with leaves and not in plant without leaves? What can you prove from this experiment? What do you decide from your observation?

Lesson 7 : Significance of Transpiration

Transpiration is a very essential and unavoidable process for plants. A high rate of transpiration is harmful for the plants. This is why transpiration is known as the 'necessary evil' for the plants. Nevertheless, transpiration is very much useful for plants because, due to transpiration, excess water is released into the atmosphere, which lowers water pressure of the plant body. The concentration of cell sap is increased due to transpiration. This creates the right condition for endosmosis. Transpiration prevents plants from overheating and also maintains proper humidity of the leaves. Water is very much essential for photosynthesis, the process for manufacture of food; transpiration ensures continuous supply of water to the leaves. Due to transpiration, a pulling force develops in the transport tubes, which helps lift water through the xylem vessels from the roots to the leaves through the stem.

Like photosynthesis and respiration, transpiration also shows effect on the environment. But in water cycle, terrestrial plants convert land water into water vapours that go out in the atmosphere through transpiration. During transpiration a huge amount of water is released in the atmosphere in the form of water vapours. Which helps to rain.

Lesson 8-10 : Transportation of Water and Mineral Salts

We already know that plants absorb water and mineral salts from the soil through root hair of the root. This water and the dissolved mineral salts must reach the leaves, because leaves use them as raw materials to make food during photosynthesis. The leaves then send manufactured food to stem and branches. The process by which water from root hairs reaches leaves and food from leaves reaches different parts of the plant body is known as transportation. Like absorption, transportation process is very important. Transportation takes place through vascular tissue-xylem and phloem. Water absorbed by the roots is carried up to the leaves through xylem tissue, and liquid food materials from leaves reaches different parts of the plant through phloem tissue. So vascular tissues-xylem and phloem are the transporting channels of the plant body. The transporting process is works in the following way-

Water enters into the body through root hair by osmosis, and the mineral salts dissolved in water are absorbed by inactive and active absorption and reach xylem tissue. Xylem is responsible for the upward transport of sap. The liquid food made in the leaves moves downward through the phloem tissue. This upward and downward transportation is called transportation in plants. That water and minerals absorbed by root hairs and transported to the leaves through xylem vessels can be proved by an experiment. For this we need Peperomia plant. The stem and the midrib of the leaf of this plant are transparent.

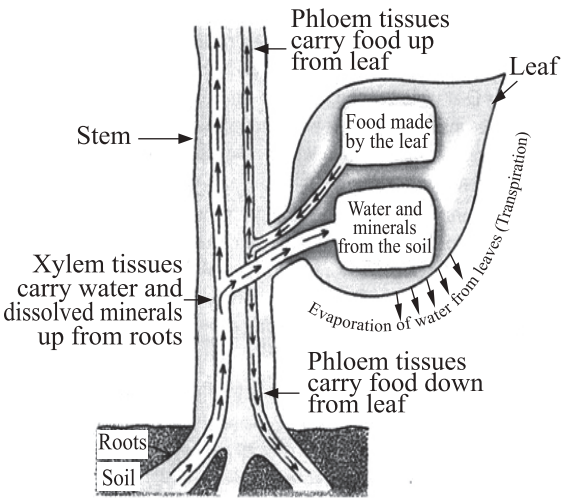


Fig. 3.10: Transportation in plant (reversible)

Activity : Experiment of water transportation.
Requirements : Dopati or Peperomia plant, bottle, cotton, red dye, water

Method: Uproot a Peperomia or Dopati plant and wash the root thoroughly in water. Now take a bottle and pour some water and finally drop a few drops of red dye in it. Put the root part of the plant into the bottle and set the experiment as in figure 3.11.

After a few hours it will be found that, the stem and leaf vein becomes red. Take the plant out of the bottle. Make a cross or longitudinal section and put it under a microscope and note what you have found. After the observation what would be your conclusion and what would be proved from this?

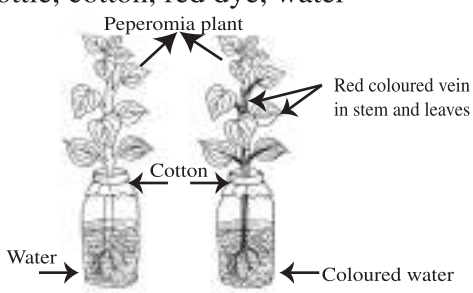


Fig. 3.11: Experiment of water transportation

New words : Diffusion, semi-permeable membrane, permeable membrane, endosmosis, exosmosis, ion, cell sap, active absorption, osmosis, inactive absorption, transpiration

What we have learned at the end of this chapter

- Process of diffusion and osmosis.
- Plants absorb water by diffusion and osmosis, and they absorb mineral salts from the soil's capillary solution by active and inactive transport through the root hair.
- Water and mineral salts reach the leaves through xylem vessels.
- Phloem carries food materials from the leaves to different branches and twigs.
- Water is essential for the manufacture of food materials, and osmosis ensures a continuous flow of water to the leaves.
- Transpiration creates a pull in the xylem vessels, which helps with the absorption of water through the root hairs.

Sample Questions

Multiple Choice Questions

1. What do you mean by the process of release of body water of plants through leaves?

   a. Diffusion b. Osmosis
   c. Transpiration d. Imbibitions

2. During osmosis-

   i. semi- permeable membrane is necessary.
   ii. solute moves from lower concentration to higher concentration.
   iii. solvent moves from lower concentration to higher concentration.

Which of the following is correct?

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

Read the following paragraph and answer questions no. 3 and 4.

Ms. Anowara kept some rajanigandha in the flower vase for her room decoration. In the evening she found the room was full of fragrance of flowers.

3. What is the special process by which the fragrance of flowers spread in the house.

   a. Diffusion b. Osmosis
   c. Transpiration d. Respiration

4. In the cited process-

   i. oxygen enters into the cell.
   ii. water releases from plant body.
   iii. plant absorbs carbon dioxide for photosynthesis.

Which of the following is correct?

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

Creative Questions

1. One day, Zarif's mother soaked some raisins (Kismis) in water to cook vermicelli (Semai). After a while, Zarif noticed that the raisins had swollen. Meanwhile, Zarif's sister was painting a picture using a brush and some paint. Suddenly, a few drops of paint from her brush fell into a glass of water and started spreading through it.

a. What is permeable membrane?
b. Why do raisins swell when soaked in water? Explain.
c. Through which process did the paint spread in the water? Explain.
d. Why is the swelling of raisins, as observed by Jarif, important for plants? Analyze.

2. Arif returned home after spending 4–5 days of winter vacation at his uncle's house. He noticed that most of the leaves of one of his plants had fallen off. In contrast, some of the potted plants had wilted. However, a few hours after being watered, those wilted plants regained their freshness.

a. What is diffusion?
b. How does our intestine absorb food? Explain.
c. Explain why most of the leaves of the plant mentioned in the passage had fallen off.
d. Analyze, with a labeled diagram, how the plants in the passage regained their freshness.

Short Answer Questions

1. Why do tree leaves fall in winter? Explain.
2. How do we smell the fragrance of flowers? Explain.
3. Why is transpiration called a "necessary evil"? Explain.
4. How is oxygen transported through lymph? Explain.

Project: Plant a chilli/tomato sapling in a tub. Add concentrated urea solution after the sapling becomes afresh. See what changes take place in the sapling in a few days. Write down your observation and note down also the cause behind it. Discuss with your teacher what it proves. In the light of your observation what suggestions do you have for the farmers of your area?

Chapter Four
Reproduction in Plants

If you observe you will see a great deal of seeds is produced from a plant. From these seeds more new plants are produced. Besides, many plants are produced from different parts of plant. These all are examples of reproduction of plants.





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

- differentiate between sexual and asexual reproduction ;
- differentiate between different types pollinations;
- identify self-pollination and cross-pollination in nature and explain the reason behind it ;
- explain pollinations;
- explain the process of fertilization ;
- demonstrate germination through experiment.

Lesson 1-3 : Reproduction

Every organism in the world tries to produce offspring before it dies. This is a natural phenomenon. The complex process by which an organism produces its offsprings is known as reproduction. Reproduction is of two types: sexual reproduction and asexual reproduction.

Asexual Reproduction

Asexual reproduction is a type of reproduction in which offspring come from a single parent and inherit only that parent's genes; it does not involve meiosis or fertilization. The offspring will be exact genetic copies of the parent. Asexual reproduction is mostly found in lower organisms. Asexual reproduction is of two types; for example, spore production and vegetative reproduction.

(a) **Formation of spores:** Asexual reproduction by making spores mostly happens in simple plants. Some special body cells make small parts called spore cases that hold the spores. These are called spore cases or sporangia. A mature sporangium usually has many spores, but sometimes it can have just one spore. Spores can also grow outside the sporangium. These are called exospores. Some exospores are called conidia. *Mucor* reproduces asexually by forming enormous numbers of microscopic spores inside sporangium. *Penicillium* reproduces by formation of conidia.

(b) **Vegetative reproduction:** Vegetative reproduction means asexual reproduction without making spores or gametes. This type of reproduction is known as vegetative reproduction. In this process, any part of the plant can change or break to form a new plant. If vegetative reproduction happens by itself, it is called natural vegetative reproduction. If humans help it happen, it is called artificial vegetative reproduction.

Natural Vegetative reproduction: Vegetative reproduction that takes place naturally by different methods.

1. **Segmentation:** This happens mostly in simple plants. For example, if you cut Spirogyra or *Mucor* into pieces, each piece can grow into a new plant.

2. **Through root:** Some plants can grow from roots, like Segun (teak) and Patol. Some roots are thick and store food. Buds grow on them and new plants come from these buds. For example, sweet potato.

3. **Modified stem:** You must know which part of the plant body is known as stem. Sometimes stems change their shape. These modified stems may look very different from normal stems. These changes help the plant store food, stay safe, or reproduce. These modifications are given below-

(a) **Tuber:** Stem tubers grow from small buds at the bottom of the plant. These parts grow down into the soil. The end of the stem stores starch and becomes swollen to make a tuber. Tubers have special buds called ‘eyes’ on their surface. Each eye can grow into a new plant. For example- Potato.

Task: Show how vegetative reproduction takes place in potato and ginger.

(b) **Rhizome:** A rhizome grows underground, parallel to the ground. The internodes have scale leaves and axillary buds. They become thick and store food. In favourable condition these buds grows into individual plants. For example- Ginger.

(c) **Bulb:** A bulb is a small stem. New plants grow on its axillary and terminal buds. Example- Onion, Garlic etc.

(d) **Stolon:** You may have seen stolon on arum. These are branches from arum (kochu) and modified for reproduction. Stolon produces buds at the terminal end and thus helps in reproduction. Example-Arum, Minit (pudina).

(e) **Offset:** Plants like water hyacinth and Spirodela make a short runner called an offset. Offsets grow sideways from buds and form new plants. After some days the daughter plants are detached from mother plants and grow individually. Example- Water hayacinth.

(f) **Bulbil:** In some plants, axillary buds grow into small round structures called bulbils. After sometimes, bulbil is separated from the plant and drops on soil and finally produces new plants. Example-Yam.

4. **From leaves:** Many new Bryophyllum plants can grow from a single leaf that touches the ground. Example- Bryophyllum (Stone-chips). All the process of vegetative reproduction cited above occurs naturally. The daughter plant that grows from vegetative reproduction has the same characteristics as the parent. So, no new character appears. So, for production of better quality cash crops, artificial vegetative propagation method is used.

Artificial vegetative reproduction: You have seen the grafting of good variety of mango, orange, lemon, guava etc. Can you say why we do grafting? Plants grown from seeds sometimes have lower yield and poor quality. Artificial vegetative propagation helps keep the good qualities of the parent plant. In these plants artificial vegetative propagation is a useful tool to restore the parental quality. Let us know about artificial vegetative propagation.

1. **Grafting:** The process by which a straight, young and fresh stem develops root and thus enables the stem to live individually is known as grafting. A cut is made in the bark of the stem, where roots to be developed. Now the cut is to be covered by soil and cow dung, and finally with the help of cellophene tape or polythene to protect the fall off soil and cow dung. This part of the stem should be kept moist by regular watering. If kept in this condition, root will grow in a couple of days. The stem with root, separated from mother plant, grows into new plant after planting.

2. **Cutting:** You have observed that stem cuttings of rose if put into moist soil grows new leaves after a few days. Each stem cutting grows into a new rose tree.

Task: Take a rose stem and show how stem grafting or cutting is made.

Lesson 4 : Sexual Reproduction

Fruits grow from flowers, and seeds grow inside fruits. Seeds produce the next generation. A flowering plant produces offsprings throguh sexual reproduction. So, flower is an important organ of plant.

Flower : There are many flowers blooming near your school and house. First you pick some flowers among it and observe carefully. Have you seen total five parts in every flower? The parts are receptacle, calyx, petal, stamen (androecium) and carpel (gynoecium). If you get all those parts then the flowers are known as typical flower or complete flower and you do not get one or two parts then the flowers are known as incomplete flower. Some flowers may have extra parts under the calyx, such as chaina rose (joba). This extra parts is called epi-calyx.

Some flowers may or may not have stalks (pedicel). Flower with stalk is known as stalked and without stalk is known as unstalked flower.

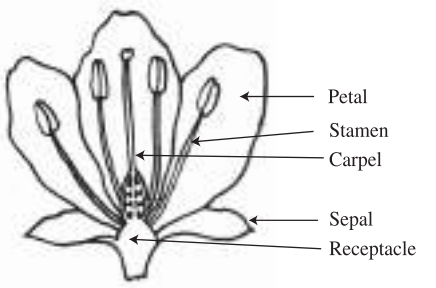


Fig. 4.1: Different parts of a typical flower

Different Parts of a Flower

Sepals: In many flowers there is an outermost whorl (ring) of sepals, known collectively as the calyx. Sepals are usually green and look like small leaves. Sepals may be segmented or joined. They enclose and protect the central region of the flower (from sunlight, rains and insects) when it is in its budding stage.

Petals: In most of the flowers the reproductive organs are surrounded by a whorl of petals. Petals are known collectively as the corolla of the flower. Petals may be joined, as in Datura, or separate, as in China rose. Some flowers have different colour.

Petals of this type attract insects which come to collect the nectar and by doing so transfer pollens from flowers to flowers. This is the second whorl of the flower.

Stamens: Surrounding the gynoecium is a whorl of stamens. Stamens are known collectively as androecium. These are the male reproductive organs. A stamen consists of a stalk (filament) bearing an anther. Each anther is made up of four pollen sacs in which pollen grains are formed. Pollen grains contain the male gametes. They take part in reproduction directly. This is the third whorl of the flower.

Carpels: The gynoecium is at the centre of a flower. A gynoecium may be structured with one or more carpels. When a gynoecium has many fused carpels, it is called syncarpous; when the carpels are separate, it is called polycarpous.The gynoecium is typically made up of an ovary, style and stigma as in the centre of flower. One or more ovules are in a flower, arranged inside the ovary. Inside the ovule, the female reproductive cell, called the ovum, is produced. This ovum, like an androecium, is directly involved in the process of reproduction.

Task: Collect a china rose and a datura flower. Separate different parts and show them to the class.

Sepal and petals are known as the accessory whorl while the stamens and carpels are known as the essential whorl of a flower.

Thalamuth and the Flower-sheet: This section holds all the above tuft.

Inflorescence

You all have seen inflorescence. The mode of arrangement of flowers on the floral axis is known as inflorescence. The inflorescence is of two types. For example-

(a) Recemose-The growth of the floral axis is unlimited.
(b) Cymose-The growth of the floral axis is limited.

Inflorescence is very important for pollination.

Lesson 5 - 6 : Pollination

Pollination is also known as pollen transfer. Pollination is the precondition of fruit and seed production. Rub your finger on the stamens of androecium of a flower and observe. A kind of yellow or orange coloured powder must stick to your finger. These powders are pollen or pollen grains.

Pollination is the transfer of pollen grains from anthers to stigmas. Pollination is of two types-self pollination and cross pollination.

Self pollination: Self pollination is the transfer of pollens from anthers to stigmas in the same flower or between flowers on the same plant. Example- Mustard, Pumpkin, datura etc.

Cross pollination: Cross pollination is the transfer of pollens from one plant to the stigmas on another plant of the same species. Shimul, Papaya etc. show cross pollination.

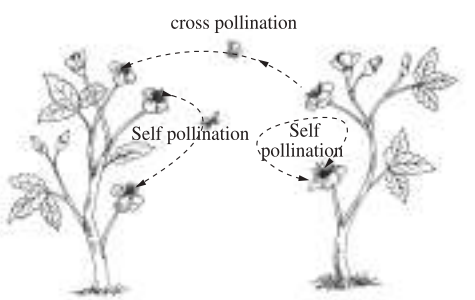


Fig. 4.2: Self pollination and cross-pollination

Agents for pollination: In most cases the transfer of pollen occurs through an agent. The carrier that brings pollen to the stigma is called an agent of pollination.

Wind, water, insects, birds, snails as well as man also act as agents of pollination. Insects and birds fly from flower to flower looking for nectar or attracted by bright colours. During this act pollen grains get stuck to the body of the carrier. As insects and birds do this, they transfer pollen from one flower to another unknowingly.

To attract pollinators, flowers have special structural changes. These modifications are known as adaptation. The adaptations are different for various pollinating media. The adaptations are as follows-

Adaptation of insect-pollinated flowers: Flowers, large, brightly coloured and scented petals with nectars. Pollen grains and stigmas are sticky. Example- China rose, Pumpkin, Mustard etc.

Adaptation of wind-pollinated flowers: These flowers do not have scent, nectar or coloured petals. They are small. Stigmas are sticky, branched and sometimes feathery. Anthers are on long stalks. For example-Paddy.

Adaptation of water-pollinated flowers: Flowers are small, light-weight and can float in water. These flowers do not have scent. Female flowers have long stalks whereas male flowers are with short stalks. Matured male flowers get detached from stalks and float on water.

Adaptation of animal-pollination flowers: These flowers are moderately large. If small they arranged in inflorescence. Brightly coloured, may have scent or not. Example- kadom, shimul, arum etc.

Lesson 7 and 8 : Fertilization and fruit formation

Formation of gamete is the precondition for fertilization. The sexual union of the motile and small male gamete with the comparatively bigger, non - motile female gamete is known as fertilization.

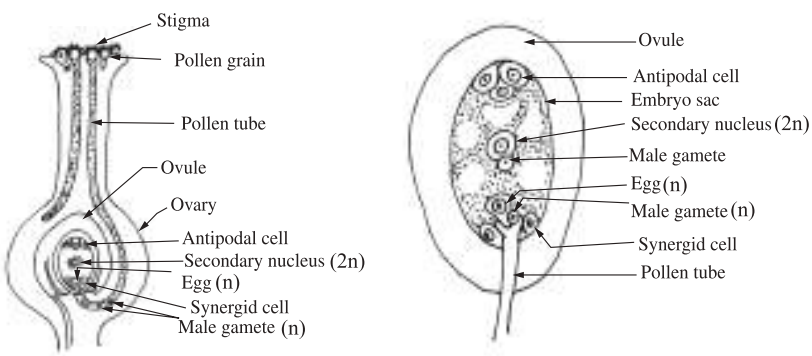


Fig. 4.3: The process of fertilization

Pollen grains are transferred to the stigma by pollination. The stigma produces a sticky fluid that nourishes the pollen grains and makes each one burst open and grow a long, hollow tube called a pollen tube. This tube moves through the style, grows toward the ovule, and finally reaches the embryo sac.

By this time, two male gametes are formed inside the pollen tube. The apex of the pollen tube ruptures (bursts open) releasing male gametes. Ovule contains embryo sac. Female gamete or ovum develops inside embryo sac. One of the two male gametes discharged from the pollen tube unites and fertilizes the egg. The other male nucleus (gamete) joins with the secondary nucleus and forms the endosperm that feeds the seed.

Formation of fruits: Mango, Jackfruit, Litchi, Banana, Grape, Apple, Guava, Safeda etc. are considered as fruits. These fruits may be eaten without cooking. Vegetables like Gourd, Pumpkin, Ribbed gourd (jhinga), Palwal (patol) etc. that we eat after cooking are also fruits. In fact these all are fruits. The process of growing these fruits starts with the transformation of the ovary of the flower's gynoecium. The transformation occurs in the ovary after pollination and fertilization. The ovules transform into seeds. After fertilization, the ovary alone or in combination with other floral parts turns into fruits.

When only the ovary turns into fruit, it is known as true fruit, eg, Mango, Jackfruit etc. When the fruits are developed from different floral parts other than the ovary, they are called false fruit, eg, Apple, Dellenia (chalta) etc. All (both true and false) fruits are divided into three main classes on the basis of their origin and nature. These are - simple fruit, aggregate fruit and multiple fruit.

(1) **Simple fruit:** When the ovary of a single carpel or more than one united carpels of a flower develop into a fruit, it is known as simple fruit, eg, Mango. Depending on the nature of pericarp, simple fruits are again divided into two groups- dry fruits and fleshy fruits.

Dry fruits: Fruits having thin and dehiscent pericarps when they are ripe, are known as dry fruits. Example- Bean, Lady's finger, Mustard etc.

Fleshy fruits: Fruits with thick and succulent pericarps are known as fleshy fruits. The pericarp of fleshy fruit does not split open when it ripens. Example- Mango, Black berry, Banana etc.



Fig. 4.4: Simple fruit



Fig. 4.5: Aggregate fruit



Fig. 4.6: Multiple fruit

Aggregate fruit: When the fruit develops from the merger of several ovaries with many free carpels of a flower, it is known as aggregate fruit. The number of fruitlets formed corresponds with the number of carpels present in the gynoecium of the flower. A cluster of fruitlets is produced at a time and placed on a single stalk. For example -Custard apple, Champa, Nayantara, Akanda etc.

Multiple fruit: When all the flowers of an inflorescence together form a fruit, it is known as multiple fruit. Examples of such fruits are- Pineapple, Jackfruit etc.

Task: Collect some fruits and write down their types in your notebook.

Lesson 9 - 10 : Structure of Seeds and its Germination

Structure of seeds: Place a filter paper inside a bowl and soak it with water and then put 8-10 wet gram seeds on it and keep it covered for 3-4 days. They will germinate. There is a small pore, called micropile, near the pointed part (end) of the seed. Radicle comes out through it. The seed at this stage may be peeled off by gently pressing it with your fingertips. The peeled seed is yellow in colour. The two cotyledons of the seed will open if you press a little more. At the junction of two cotyledon there is a white coloured structure, known as embryonal axis.

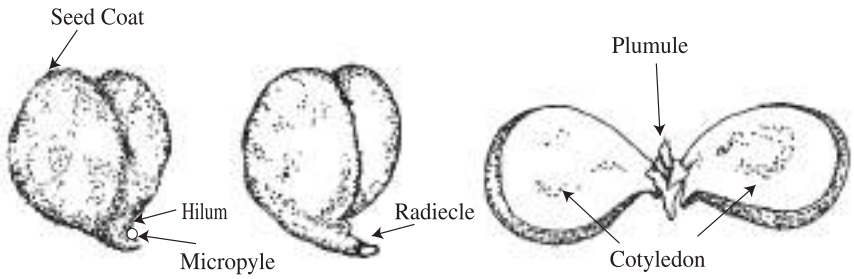


Fig. 4.7: Different parts of a gram seed.

The area of embryonal axis which is attached to the cotyledons is known as nodal zone. The part of embryonal axis above the nodal zone is called epicotyle and the part below the nodal zone is known as hypocotyle. The upper apex of the embryonal axis is known as plumule while the lower end of embryonal axis is called radicle. Radicle, plumule and cotyledon are collectively known as embryo and their outer covering is called seed coat. Seed coat consists of two layers, such as-

Outer layer: The outermost layer of seed coat is hard and thick. It is known as testa.

Inner layer: The innermost thin layer of seed coat is known as tegmen.

Task: Show different parts of a pea seed through an experiment.

Germination: The development of a seedling from a seed is called germination. In order to germinate, seed requires water, warmth and air. The germination in which the epicotyle grows up rapidly and as a result, the plumule comes out of the soil leaving the cotyledons underground, is known as hypogeal germination. This type of germination takes place in gram, paddy, mango etc. Sometimes the plumule with colyledons comes out of the soil; this is called epigeal germination. Tamarind, Castor, Pumpkin etc. shows this type of germination.

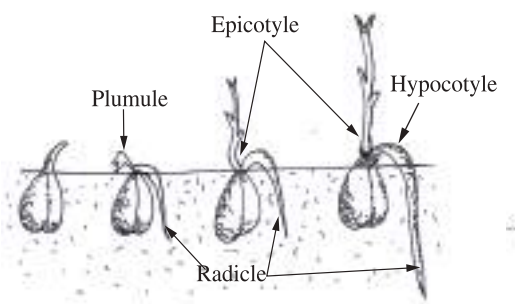


Fig. 4.8: Hypogeal germination

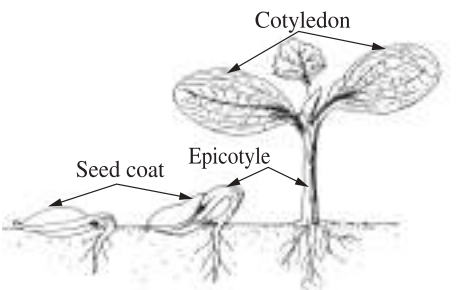


Fig. 4.9: Epigeal germination

Germination of gram seed: Here hypogeal germination takes place. In this type of germination plumule comes out of the soil leaving the cotyledons underground. Excess growth of epicotyle is responsible for this. Gram is a non-endospermic dicot seed. After sowing gram seeds and soil is supplied with required quantity of water, temperature and air, they germinate and come out of the soil in 3-4 days. First, the seeds swell up by absorbing water and the radicle comes out through the micropile. Gradually, it develops into tap root. In second step plumule comes out of the soil. In this case the two cotyledons remain under the soil. Initially, the embryo gets nourished by the food stored in the cotyledons.

New words : Asexual and sexual reproduction, spore, tuber, rhizome, bulb, bulbil, hypocotyle, epicotyle, tegmen

What we have learned at the end of this chapter

- Reproduction is mainly of two types: asexual and sexual.
- The flower is the reproductive organ of higher plants.
- An ideal flower has five parts.
- Fruit is mainly of three types: simple, aggregate and multiple.
- Germination is of two types: hypogeal and epigeal.

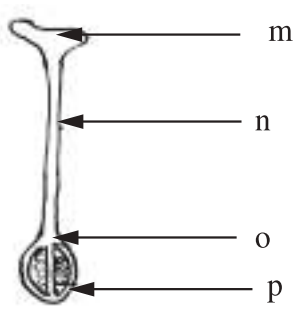
Sample Questions

Multiple Choice Questions

1. Which one of the following is aggregate fruit?
   a. Mango
   b. Custard apple
   c. Jackfruit
   d. Pineapple

2. Which one is the characteristic of insect- pollinated flowers?
   a. They are colourless
   b. They are scentless
   c. They are very light
   d. The are colourful and bears nectargland.

From the figure below answer questions no. 3 and 4



3. Which part receives pollen grains?
   a. m b. o
   c. n d. p

4. p part of the figure-
   i. develops into fruit
   ii. develops into seed
   iii. helps in reproduction.

Which one of the following is correct?

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

Creative Questions

1. Answer the following questions based on the given stem below:



M



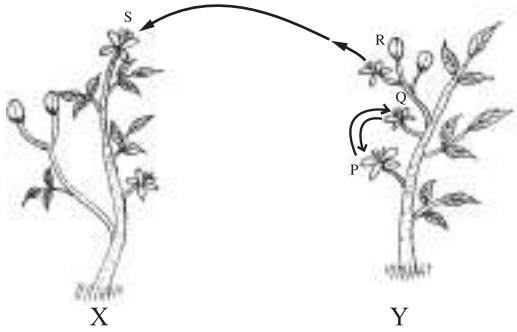
O



P

a. What is reproduction?
b. Why are grafted saplings used in lemon cultivation? Explain.
c. What type of germination occurs in plant 'M'? Explain.
d. Explain with reason why both 'O' and 'P' play more important role in plant reproduction.

2.



a. What is vegetative reproduction?
b. What type of fruit is okra (dherosh)? Explain.
c. Explain the process 'P'.
d. Of X and Y, which one contributes to the development of new characteristics? Give your opinion through a comparative analysis.

Short Answer Questions

1. Why is asexual reproduction important for plants? Explain.
2. Why is grafting done in mango trees? Explain.
3. What type of pollination occurs in rice? Explain.
4. What type of reproduction occurs in sweet potato? Explain.

Do yourself

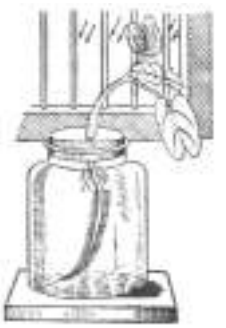
1. Collect gourd, pumpkin, datura, brinjal, kolke flower, china rose and bean flower and examine which of these flowers have five parts.

2. Take a tamarind seed and examine its germination. Note down the changes.

Chapter Five

Co-ordination and Secretion

Co-ordination is very important for living organisms. Like animals, plants also need co-ordination among their different functions. Growth, reproduction, sensitivity, and reflex action are characteristics of living organisms. Hormone plays essential role in doing these functions. Unlike animals, plants have no specialized system. Except for lower animals, all higher animals have a specialized system for performing different physiological activities of the body. The co-ordination and integration among different organs of the body and to respond to stimuli in order to keep harmony with the environment are the main function of nervous system.





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

- explain co-ordination in plants and human;
- expla in the function of nervous system with a flow chart ;
- explain with example the stimulating activity of plants;
- explain with example the stimulating activity of human;
- explain the excretion of plants and animals.

Lesson 1-3 : Co-ordination in Plants

Inside each plant cell, different physiological activities occur under some rules and regulations. So, co-ordination is an essential activity of the organism. In absence of this co-ordination, life of living beings will be disorganized. Different stages of life cycle of a plant, such as- germination, flowering, fruit formation, decaying, dormancy etc. maintain an order. The influence of weather and climatic factors are notable here.

Different physiological activities of plants, including growth and movement, are performed systematically following some specific orders. One activity does not hamper another activity. Scientists tried to know how plants co-ordinate all these activities. They opined that growth and development, origin of different organs etc.

of plants are controlled by some intrinsic secretion of plants. This organic compound is known as phytohormone or growth regulating substance. It controls all the physio-chemical activity of the plant. Plant hormones are the natural growth substances, which are usually synthesized in one part of a plant and are translocated to other parts where they exert their influences. Hormones found in plants are- auxins, gibberellins and cytokinins which enhance growth. Abscisic acid and ethylene act as growth-retarding agents. Florigen is synthesized in leaves and translocated to leaf base(stalk) and it transforms buds into flower buds. So, it is found that florigen influences the initiation of flowers.

Auxin: Charles Darwin first discovered this hormone. He observed the effect of light on the plumule membrane. When light falls obliquely on one side, the plumule grows towards the light source by bending gradually. In fact, the substance of the apical part of the plumule was a growth hormone auxin. Auxins can induce adventitious roots in stem cutting and plays an important role in inhibiting the process of abscission of fruits.

Gibberellin: It is found in seedlings, cotyledon and growing parts of leaves. Due to its effect the internode of the plants elongate. For this reason, when applied to a dwarf plant it grows in height. Gibberellins are known to overcome the dormancy of seeds.

Ethylene: This gas has been found to be very significant as it is produced by almost all the fleshy fruits during the process of ripening. For this reason, ethylene is now regarded as a gaseous phytohormone. This hormone is also present in fruits, flowers, seeds, leaves and roots. Ethylene can stop the normal geotropic responses of seedlings, which can produce deformed seedlings.

Movement: Like other living organisms, plants also have sensitivity. Due to this, the effect of internal or external stimuli on the plant body creates sensation, and consequently, the plant moves and grows. This type of movement is known as tropic movement.

Experiment on Phototropism of Plants

Requirements: A transparent bottle with wide mouth, nutritive solution, cork with a hole, a fresh seedling.

Experiment: Take a bottle and fill it with a nutritive solution. Fix a cork with a hole so that the roots of the seedling remain submerged in the solution. Now keep the bottle on a window sill.

Observation: After four or five days it will be observed that the stem and leaf stalks respond by growing towards the light i.e. they bend so that the leaves face the light. The roots bend in opposite direction of the light source.

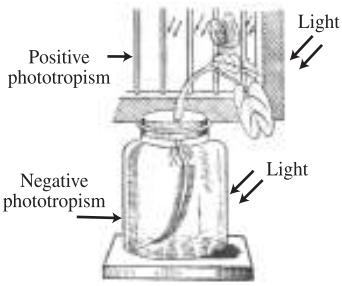


Fig. 5.1: Plant responses to light.

Inference: From this experiment it is proved that the stems generally show a curvature towards the source of light but the roots grow away from the source of light.

> **Task:** After discussion with your teacher set an experiment to verify that gravity affects the growth of plant.

Use of hormone: Auxin and other artificial hormones induce root in stem cutting. Indole acetic acid (one type of auxin) helps in repair of wear and tear. Application of auxin delays the abscission of fruits. Different stimuli like light, water, gravity etc. influence the growth of plants.

Lesson 4 - 5 : Nervous System

In class six, you learned about the characteristics of unicellular and multicellular organisms. There are different structures of tissue, organ and organ system etc. in multicellular organism. In different organs, there is an assemblage of various functions of numerous cells. To coordinate these functions and keep harmony with the environment, the body needs a quick coordinating system. Such as-someone's evil news makes you cry but good news makes you cheerful, your good result in examination makes you delightful. Various stimuli provoke all these activities. To carry stimuli from different parts of the body, coordinate the activities of the different organ systems of the body and to keep harmony with the environment are the main functions of nervous system.

The system in an animal's body that maintains communication between different organs, coordinates all other systems, and responds to stimuli to keep harmony with the environment is called the nervous system. The brain of man is the most developed one amongst all animals and man is therefore known as the best creature of the universe. The brain is made up of numerous specialized cells called neurons or nerve cells.

Nerve Cell or Neurone

The structural and functional unit of nervous system is the neurone. A neurone is the longest cell of the human body.

A typical neurone is mainly divided into two parts, namely- 8 1. Cell body and 2. Processes.

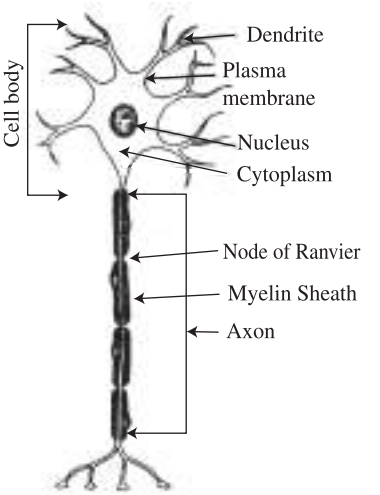


Fig. 5.2: Neurone

1. Cell body: The cell body is the main part of the neurone. The cell body may be of different shapes, for example, round, oval or star-shaped. The cell body is composed of cell membrane, cytoplasm and nucleus. Nerve cells have no centriole, so they cannot divide like other cells.

2. Processes: The branched, tree like structures that extend from the cell body are called processes. The processes are of two types: (a) Axon and (b) Dendron.

a) Axon: The long, thread like structure originated from the cell body is called axon. There is usually only one axon per neurone. The end (opposite to the cell body) of an axon breaks up into many fine branches.

b) Dendron: The branched structures originated around the cell body are termed as dendron. They are small, relatively wide, and break up into fine terminal branches called dendrites. They conduct impulses towards the cell body.

Synapse: The junction between the two neurons where axon of one neurone ends and the dendrons of another neurone arises known as synapse. Synapses allow information to pass from one neurone to another.

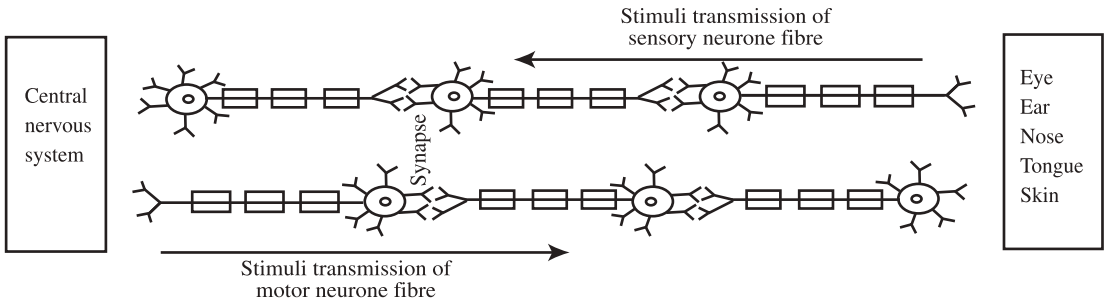


Fig. 5.3: Flow chart of the transmission of an impulse of the nervous system.

Carrying stimuli, maintaining communication between the body's internal and external environment, coordinating the activities of organ systems, retaining memory, thinking, and passing instructions for work are the functions of a neurone. The transmission of impulses through the synapses of nervous system (neurone) are shown in the figure.

The nervous system consists of mainly three parts, namely, (1) Central nervous system (2) Peripheral nervous system and (3) Autonomic nervous system.

Lesson 6 - 7: Brain

Central Nervous System

The central nervous system consists of brain and spinal cord. Brain is the sole controlling agent of the whole nervous system. Human brain is contained and protected within the skull. Brain is covered by three layers of membranes called meninges. Human brain has three major parts - (1) Cerebrum (Fore brain), (2) Mid brain and (3) Hind brain.

1) Cerebrum: The cerebrum is the main part of the human brain. It consists of two incompletely divided lobes, the right and the left cerebral hemisphere (lobe). The two hemispheres are connected to each other by broad tract of nerve fibres. The human cerebrum is comparatively more developed than in any other animals. The outer surface of the cerebrum, called the cerebral cortex, is a convoluted (folded), greyish layer of neuron cell bodies known as the grey matter. The grey matter covers an underlying mass of fibres or axon called the white matter. Only nerve fibres or axons are present here and no cell body is found. As the nerve fibres are white in colour, the layer beneath the cortex is known as white matter. Grey matter has many layers of nerve cells. These nerve cells, by accumulation, forms nerve centre in different parts of the cerebrum. These centre act as functional site for specialized activities. Vision, hearing, smell, thinking, memory, knowledge, conscience, intelligence, and movement of muscles are controlled by these nerve centre.

The lower part of the cerebrum constitutes the thalamus and hypothalamus. These are the collection of grey matter. Anger, shame, hot, cold, sleep, temperature regulation and movement of the body are controlled by this region.

2) Mid brain: The area between cerebrum and pons is called mid brain. It acts as centre for auditory and visual reflexes.

3) Hind brain: It is located at the lower back of the cerebrum. It is smaller than cerebrum. The main function of the hind brain is to maintain the balance of the body. It also controls speech and movement of the body. The hind brain consists of three parts:

Cerebellum: Cerebellum is located at the back of the brain and behind pons. It remains suspended. Cerebellum is divided into right and left part.

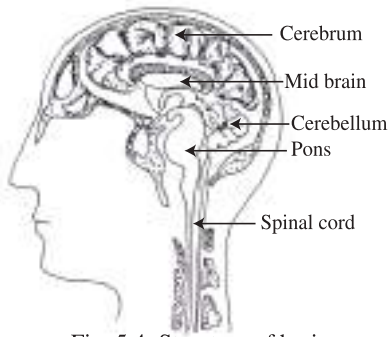


Fig. 5.4: Structure of brain

Pons: It is located in front of and under the cerebellum, connecting medulla oblongata with the upper parts of the brain.

Medulla oblongata: The long stalk-like lowermost portion of the brain stem is called the medulla oblongata. Starting from the lower end of pons the medulla oblongata extends up to spinal cord. It connects the brain with the spinal cord. So, it is called the stalk of the brain. Medulla oblongata controls various reflexes like breathing, swallowing, heart beat etc.

Task: Look at the chart and draw the figure of brain. Write the function of different parts besides the located part of the picture.

Lesson 8-10 : Spinal Cord

The spinal cord is protected by vertebral column. In spinal cord the positions of grey matter and white matter are reversed i.e., grey matter inside and white matter outside. A large number of nerve fibres (sensory and motor) ascend or descend along the white matter of the spinal cord.

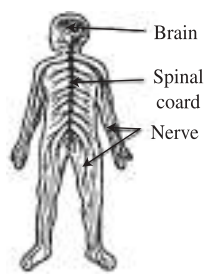


Fig. 5.5: Human nervous system

Reflex Action

What will you do when a mosquito sits on your hand? You must try to kill the mosquito. How do you feel that mosquito is on your hand? You feel the mosquito bite, so you react. You feel mosquito bite through nerve impulse and your response to this stimulus is also due to nerve impulse. A mirror reflects light instantly when it receives it; a reflex action works in a similar way.

A reflex action is the result of the immediate response of a nerve impulse. What is a nerve impulse? Information that travels through the nerve cell as an electrical signal is called a nerve impulse. When a mosquito sits on our hand, we quickly drive it away, or when a pin pricks our hand or foot, we pull it back immediately. How does this happen? The mosquito on the hand stimulates a sense organ. This sensation travels from the sense organ to the spinal cord through sensory nerve fibres. In response, the central nervous system sends back a message through motor nerve fibres to the muscle of hand and as a result we drive away or kill the mosquito.

A reflex action happens automatically, without conscious thought. It can be defined as an inborn, automatic response of the body that does not require thinking or use of the brain. Thus these actions are immediate and spontaneous and may be described as automatic response to stimuli. Reflex actions are usually conveyed through spinal cord by a path called reflex arc. A reflex arc has the following constituents: (1) receptor (sensory organ) (2) sensory (afferent) nerve (3) intemeurones (4) motor (efferent) nerve and (5) effector organ.

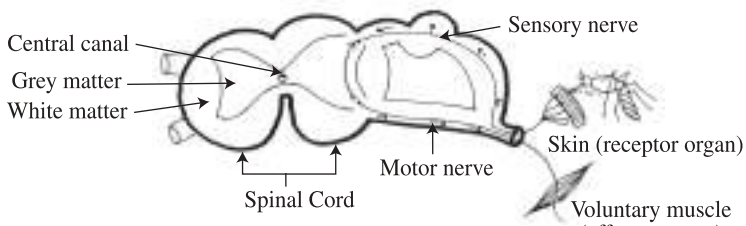


Fig. 5.6: A reflex arc of human body

Explanation: Immediately after a pin pricks the skin, the receptor senses the pain. This painful stimulus travels to the spinal cord through sensory nerves. Interneurons pass the impulse from the sensory (afferent) neurons to the motor (efferent) neurons. The motor nerve then carries the message from the spinal cord to the muscles. The effector organ responds to the stimulus and the muscle contracts, so we withdraw our hand from the painful object.

It is important to remember that figure 5.6 shows a very simple version of a reflex action. In a reflex action, a sense organ is first stimulated by a pin prick. This sensation travels to the spinal cord through the afferent (sensory) nerve fibres. In response, the central nervous system sends back a message through the efferent (motor) nerve fibres to the muscle, and as a result, the part of the body moves away from the pain.

Apparently, a simple reflex action is in fact a very complex events. The nerve fibres conduct impulses from the sensory side of a reflex arc to the brain, and other fibres conduct impulses from the brain to the opposite side of the spinal cord. These connections with the brain allow a person to be aware of certain spinal reflexes and, to some extent, control them. Reflex action is a combined act. If any of the five parts that make a reflex action effective are missing, it will not work properly.

Task: What will you do if a pin pricks your hand or if you touch a hot chimney of a lantern (Hurricane)? Why do you do so? How do you do so? Explain it with a diagram.

Lesson 11- 12 : Excretory System

Through nose we take and expel air. We sweat during excess heat. These are all excretory products. What is an excretory product? Excretory products are those substances which are harmful and unwanted for the body. Excretion is the process by which organism removes harmful, unwanted waste products from the body. Water, carbon dioxide, urea, etc. are waste products of human metabolism. The regular removal of these waste products are necessary because, if they are accumulated, they would affect the metabolic activities. Moreover, they are toxic and their retention in the body may cause intoxication and even death of the organism. These waste products are expelled from the body mainly through expelled air, sweat and urine. Lung, skin and kidney are the three main organs of excretion. Lung eliminates carbon dioxide and skin eliminates harmful salt substance from the body. The liquid nitrogenous waste products of the body are excreted through kidney.

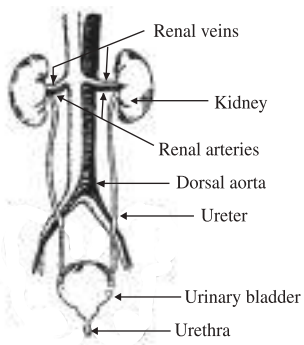


Fig. 5.7 : Excretory System

Waste products are removed from the body by the kidneys, skin, and lungs. About 80% of nitrogenous waste is removed as urine. So, kidney is called as the main excretory organ of the body. The system which performs the function of excretion is called excretory system.

Activity : Observing the presence of carbon dioxide in breath.

Requirements : Test tube, glass/plastic pipe, lime water

Method : Take some clear lime water in a test tube. Put a plastic pipe or glass pipe in to the test tube. Now blow air through the pipe. Observe what happens. After blowing air for sometime, you will see that the lime water becomes turbid. Why does it happens?

We know that carbon dioxide makes lime water cloudy. This experiment proves that the air we breathe out contains carbon dioxide.

A small amount of carbon dioxide is not harmful to health. But a large amount is toxic and harmful to the body. Our body cells produce this gas as a by-product during respiration. Blood carries carbon dioxide from the cells to the lungs. The exhaled (breathing out) air contains 4% carbon dioxide. It also contains water vapour and carbon dioxide.

Activity : Observing the presence of water vapour in breath.

Requirements : A piece of glass or a mirror

Method: In a winter morning keep your mouth in front of a glass plate or mirror and exhale air through mouth (not nose). What do you see on the glass? The exhaled air contains carbon dioxide and water vapour. The water vapour produces water droplets on the cold glass and the mirror or glass plate becomes rather turbid and somewhat opaque. After sometimes water droplets evaporate from the mirror and the mirror becomes transparent again.

We see from this, the exhaled air contains water vapour.

Sweat

The outer layer of human body is known as integument or skin. Skin bears numerous tiny pores. These are hair follicles. Sweat comes out through this hair follicle. Sweat contains water, salt and a small amount of carbon dioxide. Besides, there are some other harmful or useless substances in the sweat.

Urine

The kidney is called as the factory of urine production. They lie at the back of the abdominal cavity, one on each side of the vertebral column just below the diaphragm. Kidney acts as filter. During the breakdown of excess amino acids in the liver, nitrogenous waste products like ammonia, urea and uric acid are formed. These are harmful for the body. The kidney extract these harmful substances from the blood, and remove them from the body as part of a liquid called urine. Urine is a transparent, pale-yellow coloured aqueous fluid.

Urine is retained in the urinary bladder for a particular period of time. During filling of the urine, the urinary bladder expands. When enough pressure builds up in the bladder, a reflex is triggered. The smooth muscles of the bladder wall contract and the urethral sphincters relax. As a result, urine flows out of the bladder through the urethra.

New words: Auxin, hormone, gibberellin, ethylene, cytokinin, neurone, axon, dendrite, synapse, cerebrum, grey matter, white matter, pons, medulla, oblongata, motor nerve, sensory nerve, reflex arc, reflex action

What we have learned at the end of this chapter

- A centriole is absent in a neurone.
- The structure of a neurone is different from that of a somatic cell.
- A junction between two neurones, where the axon of one nerve cell ends and the dendron of another nerve cell begins, is called a synapse. A nerve cell transmits impulses from one nerve to another through this synapse.
- The grey matter of the cerebrum has many layers of nerve cells. These nerve cells form clusters in different regions of the cerebrum. These clusters are called nerve centres.
- In the spinal cord, grey matter forms the central core, while white matter forms the outer layer.
- The autonomic nervous system controls and maintains organs like the heart, lungs, and secretory glands.

Sample Questions

Multiple Choice Questions

1. Which one of the following helps flowering (blooming)?
   a. Gibberellin b. Cytokinine
   c. Florigen d. Auxin
2. Which organ of the human body plays the key role in eliminating nitrogenous waste products?
   a. Kidney b. Skin
   c. Nose d. Anus

Read the following paragraph and answer questions no. 3 and 4

Fariha planted a money plant in a tub near the window of her room. As the plant grows fast, the twigs and tendrils bend towards the window. She brought the vine inside the room but the same thing happened again.

3. Why does Fariha's money plant creep towards the window?
   a. Air b. Water vapour
   c. Light d. Heat
4. The chemical substance that causes the change in the condition of the Fariha's Moneyplant is-
   i. Gibberellin
   ii. Auxin
   iii. Ethylene

Which one of the following is correct?

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

Creative Questions

1.



a



b

Farmer Rahim Mia's bottle gourd plant had many branches and stems but very few flowers and fruits. After applying an organic chemical substance (image a and image b), the production increased 3–4 times.

a. What is a hormone?
b. Which hormone is used in cutting? Explain.
c. How did Rahim Mia's substance help increase yield? Explain.
d. Of a and b in the stimulus, which organ acts as the main excretory organ? Analyze.

2. Zahid was very attentively drawing the structure of the nervous system. At that time, Jariya poked his back from behind. Without looking back, Zahid immediately caught hold of Jariya's hand. Zahid then told Jariya that there is a relationship between his drawing and his being able to catch his hand.

a. What is a synapse?
b. Which part of the nervous system is called the connector of the brain? Explain.
c. Draw a labeled diagram of the structure that Zahid was drawing.
d. "Zahid's ability to catch Jariya's hand without looking back, and the picture he was drawing shows a coordinated activity." – Analyze.

Short Answer Questions

1. What is tropic movement? Explain.
2. Why does a tree planted or placed near a window grow outward? Explain.
3. Explain the function of florigen.
4. Which is a growth-inhibiting hormone? Explain.

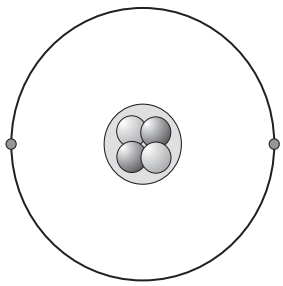
Do yourself

1. Why do you close your eyes when a light falls upon them? Explain with reasons.
2. Cut a twig of a patabahar plant. Observe it for a few days. Explain what happened and why it happened so?

Chapter Six

The Structure of Atoms

Everything you see around you is made of tiny particles called atoms. Atoms are far too small to be seen, yet scientists have developed ideas about their structure through various experiments and observations. Different particles have different chararacterestics because they are built by different types of atoms which have different numbers of electrons, protons and neutrons.



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

- explain the structure of the atom;
- explain the atomic number and mass number;
- explain what is isotope;
- explain the distribution of electrons in atoms;
- explain how ions are formed;
- distinguish between cation and anion;
- formulate the chemical formula by using anion and cation;
- describe the use of isotope;
- appreciate the importance of isotopes in our life.

Lesson 1-3 : The Evolution of the Idea of Atoms and Their Structure

By now you know that all materials are made up of tiny particles. These particles can exist in two forms: one is an atom, which is the smallest particle, and the other is a molecule, where two or more atoms form a stable structure. Over time, different scientists and philosophers have shared various ideas about these tiny particles. The Greek philosopher Democritus first suggested, around 400 BC, that all matter is made of tiny particles. According to him, these particles are indivisible and cannot be divided further. He called it atom. The word atom was chosen from the Greek word atomos which means indivisible. Two of his contemporary philosophers Plato and Aristotle

expressed different opinions. According to Aristotle, matter is continuous and can be divided into smaller and smaller parts without limit. Based on experimental evidence, in 1803 the English scientist John Dalton said that the smallest particle of an element is an atom, which cannot be divided any further. Dalton's idea was accepted and Aristotle's idea was rejected. In fact, atoms are not indivisible and are not the smallest particles of matter. They can be divided. Atoms are made up of smaller particles: electrons, protons, and neutrons.

To remove the limitations of the atomic concepts of Dalton, later others proposed alternate models of atom. Out of these models the most accepted atomic model is the model proposed by Rutherford and Bohr.

Rutherford and his co-workers carried out an important experiment to discover the true structure of the atom. From the results of the experiment, Rutherford arrived at the conclusion that the whole of the positive charge and mass is confined to a small area at the center of the atom. This is now called the nucleus. He also explained that most of the space in an atom is empty and the negative charge is carried by the electrons, which have negligible mass and revolves around the central positive charge. Rutherford's model is similar to the solar system model, but he did not explain the exact paths of the electrons. In 1913, Niels Bohr suggested that the negatively charged particles revolve in specific allowed orbits.

From the above discussion, we can say that atoms are not indivisible. They are made up of electrons, protons, and neutrons. At the centre of the atom is the nucleus. In the nucleus there are protons with positive charges and neutrons which are without charge. Most of the mass of the atom is concentrated at the nucleus. The space between the electrons and the nucleus is empty. In fact most of the space in the atom is void.

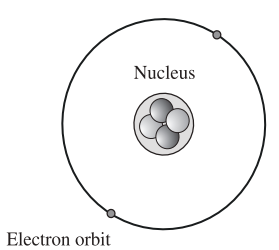


Fig. 6.1: Electron, Proton and Neutron in Helium Atom

Lesson 4-6 : Atomic Number, Mass Number and Isotopes

Different elements have different types of atoms. For example, a hydrogen atom is different from an oxygen atom. The atom of one element differs from that of another in terms of atomic size, atomic mass, and properties. Why is there this difference? The difference in the behavior of atoms comes from the difference in the number of protons and electrons. We know that in a normal atom the net charge is zero. Therefore, the number of electrons is equal to the number of protons. To explain the behaviour of an atom, the number of protons is usually used. The number of protons in the nucleus of an atom is its atomic number. There is only one proton in the hydrogen atom, therefore the atomic number is 1. There are 8 protons in an oxygen atom and its atomic number is 8. What information can you get from the atomic number?

Carbon has atomic number 6. Since the atomic number indicates the number of protons in the atom of a particular element and the number of protons is equal to the number of electrons in each atom, we can understand that Carbon atom must have 6 electrons.

Is it possible to know how many neutrons are there in an atom from its atomic number? No, it is not possible to know the number of neutrons in an atom from its atomic number. To know the number of neutrons in an atom one has to know the atomic number and the mass number of the atom.

The mass of the electrons in an atom is negligible. Most of the mass of an atom is due to the mass of the nucleus. Again the mass of a proton is nearly equal to the mass of a neutron. The mass number of an atom of an element is expressed as the total number of protons and neutrons in the atom. Thus the mass number of an element is equal to the number of protons in an atom of the element plus the number of neutrons in the atom.

For example, there are 8 protons and 8 neutrons in the nucleus of an oxygen atom; therefore, the mass number of oxygen is 16. In the case of sodium, there are eleven protons and twelve neutrons. So the mass number of sodium is 11 + 12 = 23. As discussed earlier, if the atomic number and mass number are known, the number of neutrons in the atom can be found. You will see it clearly from the following example.

Example: For an element A the atomic number is 17 and the mass number is 35. Find the number of protons and neutrons in an atom of this element?

Solution: The atomic number of element A is 17. Since the atomic number is equal to the number of protons the number of protons in the atom of the element is 17. Also the number of electrons in an atom equals the number of protons. So, the number of electrons is 17.

In an atom, number of protons + numbers of neutrons = mass number of an atom.

Therefore, the number of neutrons in an atom of element 'A' = Mass number of the element 'A' the number of protons in the atom of element 'A'

Thus, the number of neutron of an atom of element 'A' = 35-17=18

Isotope: You have learned that an atom of an element has a definite number of protons and electrons, but an element may have different mass numbers. This is because the atoms of the same element can have different numbers of neutrons.

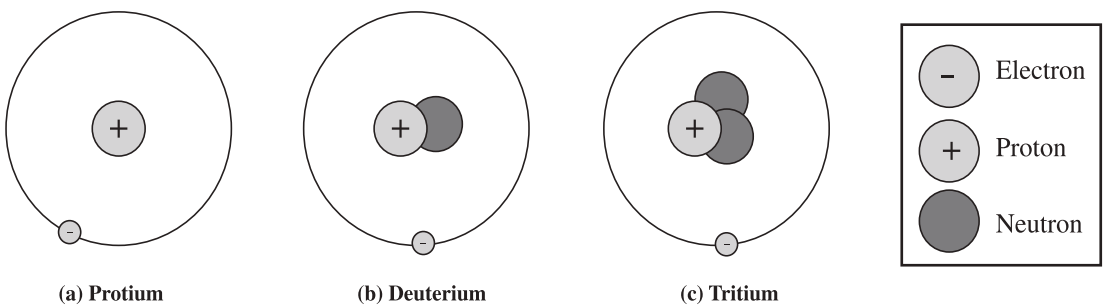


Figure 6.2: Hydrogen isotope

For example, every hydrogen atom has one electron and one proton. Most of hydrogen atoms (protium) have no neutrons. But some hydrogen atoms have one neutron; these have a mass number of 2. Others have two neutrons, giving them a mass number of 3. These isotopes are shown in Fig. 6.2. In the same way, different atoms of an element that have the same number of protons and electrons but different mass numbers are called isotopes of that element. Most of the carbon atoms have 6 protons and 6 neutrons in their nuclei. But some atoms have 7 or 8 neutrons in their nuclei. Thus, carbon mainly has three isotopes.

Lesson7 and 8 : The Properties and Application of Isotopes

Since the number of protons and electrons in different isotopes of an element is the same, there is no difference in their electrical and chemical properties. This is because the distribution of electrons in the atom is responsible for its electrical and chemical properties. However, isotopes can be separated because of the differences in their masses.

Usually, one particular isotope of an element is more abundant because it is more stable than the other isotopes. Unstable isotopes release radiation and particles due to radioactive decay. These are called radioactive isotopes. The properties of radioactive isotopes are used in different fields. Some of the uses of radioactive isotopes are described below:

Medical uses of isotopes: Isotopes are used for diagnosing and treating diseases. If there is a defect in a narrow artery, it can be detected by passing a radioactive isotope through the blood. In the same way, the affected cells of a cancer patient can be located using radioactive isotopes. These isotopes can also be used to destroy cancer cells. Another use of radioactive materials is to sterilize medical instruments using their radiation.

Application in agriculture: In agriculture, radiation from isotopes is used to control insects. It can be used to determine when, what type and what amount of fertilizer is needed for a specific crop.

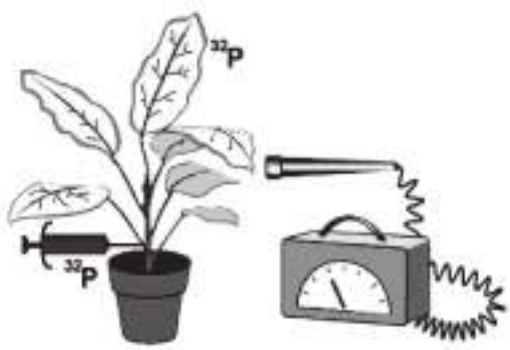


Fig. 6.3: The use of isotopes in agriculture

Food preservation: Radiation from radioactive isotopes can kill germs and bacteria. Therefore, radioactive isotopes can be used to make food and fruits free from germs.

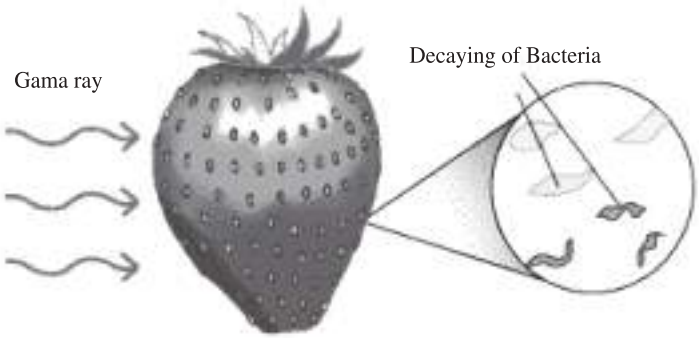


Fig. 6.4: Use of rays from radioactive materials for bacteria free food.

Use of Isotopes in geological research: You have often heard the news that fossils have been discovered which are millions of years old. How do scientists find out the age of these fossils? This can be determined from the decay of isotopes. By studying the ratio of stable to unstable isotopes, scientists can find out how old a fossil is.

Lesson 9-11 : The Way the Electrons are Distributed in an Atom

You known that electrons revolve around the nucleus. The electron hasdefinite orbits. Now the question is: how many electrons can stay in an orbit? Look at the diagram 6.2, which shows a hydrogen atom. In the hydrogen atom there is one electron in its orbit. In helium atom (Fig. 6.1) two electrons revolve around the nucleus in a single orbit. The rule for finding the maximum number of electrons in each orbit is $2n^2$ (where n = 1, 2, 3, ... are the orbit numbers). This is the rule for the allowed orbits. Some of these orbits can be filled and the rest can be empty. According to this, a lithium atom has three electrons: two in the first orbit and one in the second orbit. Similarly, a carbon atom has six electrons: two in the first orbit and the remaining four in the second orbit. According to the rule, the first orbit can hold a maximum of two electrons, the second orbit can hold eight, and the third orbit can hold eighteen. These orbits are called energy levels because each orbit corresponds to a definite energy for the electron in it. Although an orbit is a path, an energy level describes the energy state of the electron.

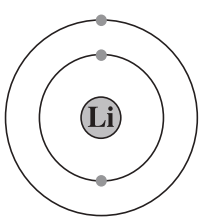


Fig. 6.5: Lithium atom

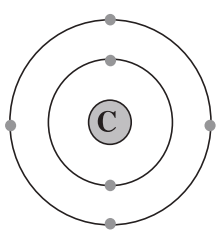


Fig. 6.6: Carbon atom

Now electron distribution of Sodium atom may be seen. There are eleven electrons in a sodium atom. How these electrons are distributed in different orbits? They must be in the order 2, 8, 1. This means in the first orbit there will be 2 electrons, in the second orbit there will be 8 electrons and in the third orbit there will be 1 electron.

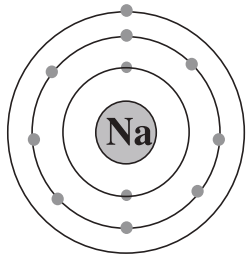


Fig. 6.7: Sodium atom

In the above diagram we have shown the distribution of electrons which is easy to visualize. But to write down the distribution of electrons in a sodium atom, we can express it as 2, 8, 1. We have shown below the distribution of electrons in the first 18 elements. Starting from the lowest atomic number

Element	Atomic Number	Symbol	Electronic configaration
Hydrogen	1		
Helium	2		
Lithium	3	Li	2, 1
Beryllium	4		
Boron	5		
Carbon	6		
Nitrogen	7	N	2, 5
Oxygen	8		
Fluorine	9		
Neon	10		
Sodium	11	Na	2, 8, 1
Magnesium	12		
Aluminium	13		
Silicon	14		
Phosphorus	15		
Sulphur	16		
Chlorine	17	Cl	2, 8, 7
Argon	18		

Lesson 12-13: The Electron Distribution and Properties of Elements

The properties of elements are mainly determined by the distribution of electrons in their orbits. Generally, atoms become active, inactive, or charged due to differences in electron distribution.

If the last orbit has the maximum number of electrons allowed in that energy level, then that orbit is completely filled. Atoms like this are inert. For example, a helium atom has two electrons. The first orbit can hold two electrons, so the helium atom is inert and stable. Every atom tends to reach such a stable state.

If the number of electrons in the last orbit is such that it can become complete by gaining or losing electrons, the atom will tend to do so. This is because, when the outermost orbit is complete, the negative charge of the electrons shield the equal number of protons in the nucleus. This reduces the energy of the system and the atom becomes more stable. This redistribution of outer electrons often happens by sharing the electron with the neighbouring atoms. For example consider the case of Sodium atom, it has 2 electrons in the first orbit, 8 electrons in the second orbit and 1 electron in the third orbit. Is this a fully stable state? Surely not. If the sodium atom loses its single electron in the third orbit, its outermost second orbit becomes full, making the atom stable.

The sodium atom will easily lose one electron from the third orbit if some neigh-bouring atom has the tendency to grab an electron to fill its outermost orbit. But when the sodium atom lose one electron, it is no longer electrically neutral. Normal sodium atom is charge neutral, because it has the same number of protons in the nucleus as the number of electrons in the orbits. By losing one electron, the sodium atom becomes positively charged. This charged atom is called an ion. If the charge is positive, it is called a cation. Thus, a sodium atom losing an electron becomes a cation.

Now let us take another example. A fluorine atom has electron distribution as 2,7. Is this a fully stable state? Surely not. For stability it needs 8 electrons in the outermost orbit. It can either lose 7 electrons from the second orbit or gain one extra electron to complete the second orbit. From an energy perspective, it is much easier to gain one extra electron to complete the second orbit. Near sodium atoms, it can easily take one electron from a sodium atom. After gaining an extra electron, the fluorine atom becomes negatively charged. This makes it a negatively charged ion, called an anion.

Thus by receiving or losing electron, atoms become ionized. Of the two atoms, the one which lose electron becomes cation. The atom which grabs electron becomes anion or negatively charged ion. As a result an attractive force works between these oppositely charged ions. If two opositely charged ions come closer to each other, they form a bond. In this way atoms of elements form molecules of compounds. You will know more about in higher classes.

$$Na \longrightarrow Na^{+} + e^{-}$$
$$F + e^{-} \longrightarrow F^{-}$$
$$Na + F \longrightarrow Na^{+} F^{-} \text{ or } NaF$$

What we have learned at the end of this chapter-

- Atoms are not indivisible. Atoms are made up of electrons, protons, and neutrons.
- At the center of an atom is the nucleus. The nucleus contains positively charged protons and neutral (uncharged) neutrons. Most of the mass of an atom is in the nucleus.
- Negatively charged electrons revolve in definite orbits or shells around the nucleus at the center. The space between the electrons and the nucleus is mostly empty. In fact, most of the space in an atom is empty.
- The first orbit can hold a maximum of 2 electrons, the second orbit can hold up to 8 electrons, and the third orbit can hold up to 18 electrons. These orbits are also called energy levels.
- If the outermost orbit has the maximum number of electrons allowed, then the orbit is completely full and the atom is inert.
- Atoms become more stable and can become ions by gaining or losing electrons.

Sample Questions

Multiple Choice Questions

1. How many electrons can stay in the second orbit of an atom ?
   a. 2 b. 8
   c. 18 d. 32

2. It can be concluded from the experiment of Rutherford that–
   i. atoms are indivisible.
   ii. electnons move in certain orbits
   iii. most of the space in an atom is empty.

Which of the following is correct?

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

After reading the sentence below, give answers to questions no. 3 and 4.

In an atom of an element there are 10 proton and 8 neutrons .

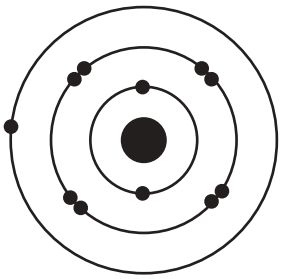
3. What is the mass number of the atom?
   a. 10
   b. 16
   c. 18
   d. 26

4. Which element is this ?
   a. Oxygen
   b. Sulphur
   c. Sodium
   d. Neon

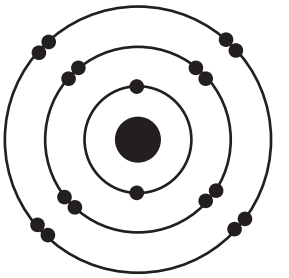
Creative Questions

1. The atomic number of atom X is 11. On the other hand, atom Y has an atomic number of 17 and neutron number of 18.
   a. What is an isotope?
   b. Explain why Na^+ is a cation.
   c. What is the mass number of atom Y?
   d. Show the electronic configuration of atoms X and Y and explain their ability to form bond between them.

2. Answer the questions based on the stem below:



(Figure 1)



(Figure 2)

a. What is mass number?

b. What does it mean if oxygen's atomic number is 8? Explain.

c. Describe the atomic structure shown in Figure 1.

d. Make a comparative discussion of the reactivity of the atoms in Figures 1 and 2.

Short Answer Questions

1. Why does a Na atom turn into a positively charged ion? Explain.
2. Why is a helium atom inert? Explain.
3. Into which ion does a Cl atom turn? Explain.

Chapter Seven

The Earth and Gravitation

Newton put forward the law of gravitation which states that all particles in the universe attract each other with a force that is proportional to the product of their masses and inversely proportional to the square of the distance between them. Does this force of attraction vary from place to place? What factors does this force depend on? In this chapter, we will discuss gravitation, gravity, acceleration due to gravity, mass, and weight.









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

- explain gravitation;
- explain the distinction between gravitation and gravity;
- explain the acceleration due to gravity;
- distinguish between mass and weight;
- explain the change of weight of an object due to the influence of gravitational acceleration;
- realize the impact of gravitational acceleration in our life.

Lesson 1 : Gravitation

If we jump we cannot go up very much. We fall back to the surface of the earth. Fruits fall from trees to the earth. Why do all these happen? The reason is that the earth attracts these objects towards it. It is not only the earth that attracts us. In fact, all objects in the universe attract each other. This universal attractive force is called gravitation force.

You might have heard the story of Newton and the fall of an apple from the tree on the ground. As the story goes, Newton was sitting in his garden and was engaged in thought. Suddenly he saw an apple fall to the ground. The question came to his mind, why did the apple fall towards the ground? Something must be attracting it towards the ground. After much speculation, he came to the conclusion that the earth attracts every object towards it. Later on, he reached a more specific conclusion: not only the earth, but all objects in the universe attract each other towards their centre. The attractive force that exists between any two particles in the universe is called gravitational force.

Newton's Law of Gravitation and Gravitational Force

Each particle in the universe attracts every other particle with a force which is proportional to the product of their masses and inversely proportional to the square of the distance between them. Newton developed an important theorem: the gravitational attraction between two uniform spheres is proportional to the product of their masses and inversely proportional to the square of the distance between their centres. This is because for spherical bodies, the whole mass of the sphere can be assumed to be at the centre of the sphere, provided the observer is outside the sphere and the sphere is homogeneous.

If we assume that the two point objects or spherical bodies have masses m_1 and m_2 and the distance between them is d. Then the gravitational force F acting between them is given by

$$F = G\frac{m_1 m_2}{d^2}$$

Here, G is the constant of proportionality. It is called the universal gravitational constant. This means that if two spherical bodies each have a mass of one kilogram and the distance between them is one meter, the attractive force between them equals G. If the bodies are spherical the distance is measured from the centres of the spheres.

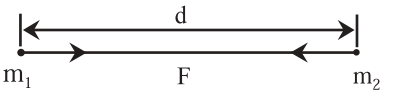


Fig. 7.1 : Gravitational force

From the formula of gravitation, we see that if the distance between the two objects is fixed and the product of their masses is doubled, the gravitational force also doubles. When the product of the masses is tripled, the corresponding force will be three times greater. If the distance between the objects is doubled, while keeping the product of the masses constant, the force becomes one-fourth. If the distance is tripled, the force becomes one-ninth of the original force. The earth moves around the sun due to the gravitational force, just as a ball tied to a string can be made to revolve because of the tension in the string. Now answer: why do the planets revolve around the sun?

Lesson 2-3 : Gravity and the Acceleration due to Gravity

Gravity: We know that every material or particle in the universe attracts each other. When this mutual attraction involves any two objects in the universe, we call it gravitation. If one of the objects is the earth and the attraction on the object is due to the earth, we call it gravity. When a cricket ball is thrown upward, it falls back to the earth, because the earth attracts it.

Just as the earth attracts the cricket ball towards it with a downward force, the cricket ball attracts the earth with the same upward force. But since the earth is very heavy compared to the cricket ball, it moves very little towards the cricket ball. On the other hand, the cricket ball, having little mass compared to the earth, accelerates toward the earth. The accelerating force due to the earth on any object near to it is called gravity. Thus the attractive force between sun and the moon is called gravitation. But the attractive force that acts between you and the earth or between your science book and the earth will be called gravity.

Acceleration due to gravity: We know that when a force is applied on an object its velocity increases. The rate at which velocity increases with time is called acceleration. Gravity also causes acceleration. This is called acceleration due to gravity. The acceleration due to gravity is indicated by 'g'. Since 'g' is a form of acceleration, its unit is that of acceleration, that is meter/second^2.

Let us assume that M = the mass of the earth, m = the mass of an object near the earth, d = the distance between the object and the centre of the earth From the formula of gravitation, the gravitation force, $F = G\frac{Mm}{d^2}$.

Again we get from the relation between force and acceleration, the force of gravity = mass × acceleration due to gravity. That is F = mg.

From the above relation we get,

$$mg = \frac{GMm}{d^2}$$

$$\text{or, } g = \frac{GM}{d^2}$$

In this equation 'm' is absent on the right side. This means that the acceleration due to gravity does not depend on the mass of the body subjected to gravity. Since G and the mass of earth 'M' is constant, so the value of 'g' depends on the distance of matter 'd' from the centre of earth. Thus the value of 'g' is independent of the mass of the object but is not independent of its position. It means that if the distance of different places 'd' is different from the center of the earth, the value of 'g' will also be different at different places.

Variation of the acceleration due to gravity: The distance of the surface from the center of the earth, that means if the earth is considered round, its radius will be = R, then $g = \frac{GM}{R^2}$.

Since the earth is not a perfect sphere, R is not really constant. So the value of 'g' is not equal everywhere at the surface of the earth. As we move from the pole to the equator, the value of R increases and the value of 'g' decreases. At the equator the value of 'g' is minimum. It is 9.78 meter/sec². The value of 'g' in the polar region is 9.832 meter/sec² at the surface of the earth. For the convenience of calculation the value of 'g' is taken as 9.8 meter/sec². At the surface of the earth, the value of 'g' is 9.8 meter/sec². This means that for a freely falling body near the earth's surface, its velocity increases by 9.8 meters per second every second.

If a body is allowed to fall from a height, it reaches the earth's surface due to gravity. If we drop a stone and a piece of paper from the same height, will they reach the ground at the same time? Since the acceleration due to gravity does not depend on mass, the same acceleration acts on both the stone and the paper. As a result both of them should be expected to reach the surface of the earth at the same time. But in reality the stone will reach the surface of the earth before the paper. This is because of the air resistance. Air obstruction is relatively high on a piece of paper. So, it falls slowly downwards. The stone and the paper would have reached the ground at the same time if there were no wind obstruction.

Lesson 4: Mass and Weight

In our daily language, we often do not make a clear distinction between mass and weight. But in physics the two words mean different entities. For example, when we say that the weight of a bag of rice is 50 kg, we actually refer to its masses. In this respect the use of the word weight of an object is scientifically wrong. But what is the difference between mass and weight?

Mass: All objects are made of materials. Mass of an object refer to the amount of material it contains. This property of the material does not depend on location, shape or state of motion, according to Newtonian physics. The mass of the objects depends on the number and kind of atoms and the bonds by which the object is formed. The international unit of mass is kg. A heavy mass is expressed in units of tones. One ton is 1000 kg. Small masses are expressed in units of gram. Thus the mass of your pencil is 5 gram. One thousand grams make one kilogram (kg). More appropriate meaning of mass comes from Newton's law $F = ma$.

Thus, the mass of an object is the ratio of F and acceleration. If the mass is greater it resists the increase of velocity more for the same applied force. Mass is thus related to inertia of motion.

Weight: We know that if a body is thrown upward, it comes back to the earth. This is due to the weight of the body, which pulls the object towards the earth. We can say the force of gravity causes this downwards pull.

The force with which the earth attracts an object is called its weight. If only gravity acts on an object, and the gravitational acceleration is 'g' at some point on earth, then if the mass is 'm', the weight W at that point is $W = mg$.

The unit of weight is newton. The weight of an object with mass 10 kilogram is, $W = 10 \times 9.8$ newton $= 98$ newton.

Generally, we can determine the weight of an object by using a spring balance.

Lesson 5 : The Relation between Mass and Weight

We know that the amount of material in an object is its mass. It is a constant value, which does not change due to change of its location to any height above the earth. If an astronaut has a mass 75 kg, it will remain unchanged when he is on the surface of the earth or on the surface of the moon or in an orbit of the moon or earth. The amount of material that makes up the astronaut does not change with position, so his mass stays the same. Since the mass of an object is constant, its weight changes due to change in the

value of ‘g’. As one goes more and more above the surface of the earth, the weight of an object becomes less and less. The reasons why the acceleration due to gravity changes are also the reasons why an object’s weight changes. The weight of an object is not a fundamental property. For example, an object may have weight at one place but may have no weight at another. At the centre of the earth, the value of acceleration due to gravity is zero and therefore, the weight of an object there must also be zero. In distant space, where there is no gravitational force, the weight of an object must be zero.

The value of the gravitational acceleration of the moon is about $\frac{1}{6}$ of the gravitational acceleration on the earth. So, the weight of a 1kg object will be about $\frac{9.8}{6}$ newton (N) = 1.63 N.

The weight of an object at a location depends on its distance from the centre of the earth. If the distance is increased, the force of gravity due to earth at that point decreases. As a result, the weight of an object there decreases. At the surface of the earth the weight of mass 1 kilogram is 9.8 newton. But at a distant point from the earth, its weight decreases with the increase of distance.

The weight of an object vary slightly also at different positions on the surface of the earth. One reason for this is that, the earth is not a perfect sphere and the acceleration due to gravity is not same at all the points on the earth's surface. However, this difference is so small that it can only be detected by a very sensitive balance. We ignore this variation in most calculations. An object will weigh maximum at the two poles. At these places one kilogram will weigh 9.83 newton. At the equator, this weight will be least with a value of 9.78 newton. At the equator, the weight is 9.79 newton.

The weight of a body increases in proportion to its mass. Therefore, the instruments used to measure weight can also be used to measure the mass of the object. Often spring balance is calibrated in units of kilogram. Balances and weighing instruments are calibrated in such a way that we sometimes use the kg unit for measuring both mass and weight. It is of course a wrong practice. Weight is a form of force and for scientific calculation it should be expressed in units of newton. When we buy a packet of rice or milk on which one kg is marked, we understand that each of these packets has one kilogram mass. But their weights are not 1 kg. On the surface of the earth they will weigh 9.8 newton. These packets will have different weights on different planets or on the moon, although their masses remain unchanged.

Lesson 6: The Acceleration due to Gravity and the Weight of an Object are Different at Different Places on the Earth

The weight of an object depends on the acceleration due to gravity 'g'. The reasons why 'g' changes are also the reasons why an object's weight changes. The weight of an object is not an invariant quantity. Its value changes from place to place on earth. The reasons, for which the weight of an object changes are described below—

(A) At different places on the surface of the earth: The weight of an object is different at different locations on the earth because of the shape of the earth and its different locations.

(1) For the shape of the earth: Since the earth is not a perfect sphere,all points on the surface of the earth are not at equal distance from the centre of the earth. As the value of g at a point depends on its distance from the centre of the earth, the value of g becomes different in different places on the earth's surface. At the equilateral area, the radius of the earth is largest and the value of g is lowest (9. 78 meter/ sec^2) there. This is why weight of an object is minimum in this region. As we move from the equator to the poles, the radius of the earth decreases and the value of g increases (9.83 meter/ sec^2). Because of this the weight of an object also increases. At the poles the radius of the pole is minimum and the value of g is maximum. As a result, the weight of an object is highest in this region.

(2) For the diurnal rotation of the earth: Gravitational acceleration decreases because of the earth's rotation around its own axis. If the earth did not rotate (meaning no day and night), the value of gravitational acceleration would be slightly greater than it is now.

(3) For angular distance (latitude) from pole: Gravitational acceleration increases progressively from equatorial region to polar region. This also increases the weight of the object.

(B) For the increase of height from the earth's surface: As we go to higher altitudes, the acceleration due to gravity decreases. Because of this greater height, the weight of an object also becomes less. Thus the value of 'g' is less at the top of a mountain.

(c) At a point inside the earth: As we go deeper inside the earth, the acceleration due to gravity keeps decreasing. Because of this, the weight of an object also decreases the deeper we go. Thus the weight of an object is less inside a mine. At the centre of the earth the value of the acceleration due to gravity is zero. Therefore, if we take an object to the earth's centre, there will be no force of attraction on it, and its weight will be zero.

Lesson 7 - 8 : The Variation of Weight in a Lift and in Space: Weightlessness

The value of 'g' is constant at any fixed place on Earth. So, a person's actual weight is also constant at that place. However, a person can feel changes in weight, and in some cases, may even feel weightless. This happens because actual weight and felt (apparent) weight are not the same. A common example is what we feel inside an elevator.

(1) Perceived weight inside a motionless lift: A rider inside a stationary elevator exerts a force on the floor equal to the actual weight (w = mg). The elevator floor, in turn, exerts an equal and opposite reaction force on the rider, which the rider perceives as his weight. In this situation, the perceived weight is equal to the actual weight.

(2) Perceived weight in an elevator moving at constant velocity: A rider in an elevator moving up or down at constant speed moves with the elevator at the same speed. So, only the rider's actual weight (gravity) acts on him. The floor pushes back with an equal force. Therefore, the perceived weight is the same as the actual weight.



Fig. 7.2 : Lift

(3) Weight in an upward-accelerating elevator: To start an elevator moving upward from a stationary position, an additional upward force-greater than the combined weight of the elevator and the rider-must be exerted by the elevator's cable. This causes the floor of the elevator to exert a force on the rider that is greater than his actual weight, resulting in a perceived weight that is higher than his actual weight. This perceived weight can also be considered a reaction force.

(4) Weight in a downward-accelerating elevator: To move a stationary elevator upward, the tension in the elevator cables must be reduced from the total weight of the elevator and the rider. When the elevator moves downward, the floor of the elevator exerts a force on the rider that is less than their actual weight. So, the rider's perceived weight is less than his actual weight.

(5) Weight inside a free-falling elevator: If the lift's supporting cable or wire breaks, the elevator will fall freely downward with the rider, ignoring air resistance and other friction. When the cable breaks, there is no tension to hold the elevator. The floor no longer pushes up on the rider. So, the rider feels weightless.

The free fall of an elevator is similar to a spacecraft orbiting Earth or the Moon. Astronauts move in a circular path at a fixed height. The spacecraft's weight (W = mg) and the astronaut's weight (W = mg) cause this motion, and both have the same acceleration. So, the astronaut does not push on the walls or floor, and feels no reaction force. This is why the astronaut feels weightless. In this condition, if an object is released from the spacecraft, it will not fall; even if a glass of water is turned upside down, the water will not fall either. Everything will appear weightless. However, nothing is truly weightless. The astronaut still has mass, and there is still gravity acting. This feeling of weightlessness happens because the spacecraft is falling freely at the same acceleration, 'g'. If the spacecraft were not in orbit or free-falling, the astronaut would feel his weight again.

New words: Gravity, gravitational constant, acceleration due to gravity, mass, weight, weightlessness, lift.

What we have learned at the end of this chapter

- The attractive force that exists between any two material particles in the universe due to their masses is called the gravitational force.
- Every material particle in the universe attracts every other particle, and the value of this mutual force is proportional to the product of their masses and inversely proportional to the square of the distance between them. This force acts along the line joining the two masses.
- The attractive force between the earth and any other material object is called the force of gravity.
- The rate at which the velocity of a freely falling body changes due to gravity is called the acceleration due to gravity.
- The standard value of 'g' (acceleration due to gravity) is 9.8 meters per second squared (m/s^2).
- The amount of material present in an object is called its mass.
- The force with which the earth pulls an object towards its centre is called the weight of the object.

Sample Questions

Multiple Choice Questions

1. What is the unit of weight?

   a. gram b. kilogram

   c. quintal d. newton

2. Which of the following comments is correct with reference to the mass of an object?

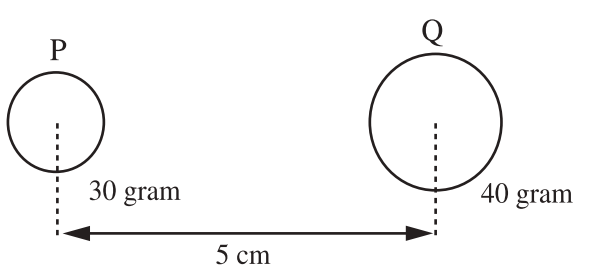
a. The mass of an object changes with the change in its location.

b. The attractive force on an object due to the earth is nothing but mass.

c. The net amount of material in an object is its mass.

d. The unit of mass is newton.

From the figure given below, give answer to questions no. 3 and 4



3. The attractive force between P and Q depends on–
   i. the masses of the object.
   ii. the distance between the objects.
   iii. the nature of the medium.

Which one is correct?

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

4. If the product of the masses of the two objects becomes 3600 gram^2, what will be the change in the force of attraction between them?

a. Will be half
b. Will be double
c. Will be three times
d. Will be four times

Creative Questions

1. Nuha went to the roof of their five-storied building, and dropped a stone of 50 gram mass and a piece of paper at the same time. Her younger brother noticed that the stone hit the ground before the paper.

a. What is gravity?
b. What does gravitational acceleration 9.8 m/s^2 mean? Explain.
c. Calculate the weight of the stone.
d. Analyze why the stone hit the ground before the piece of paper.

2. The mass of an object is 120 kg. It was carried to the moon by a rocket. There it was observed that although the mass did not change, its weight did.

a. What is mass?
b. Why does an object's weight gradually decrease with height from Earth's surface, even though the mass remains the same? Explain.
c. Calculate the weight of the object on the moon.
d. If the object is dropped from the same height on Earth and the Moon, where will it hit the ground first? On Earth or on the Moon? Analyze.

Short Answer Questions

1. What happens to the gravitational force between two objects if the distance between them is tripled? Explain.
2. Why does an object have the same mass on both Earth and the Moon when measured with a balance scale? Explain.
3. Why does the weight of an object vary between the poles and the equator? Explain.

Chapter Eight

Chemical Reaction

Different types of chemical reactions are going on around us. These chemical reactions are some times releasing energy, sometimes creating useful new materials and sometimes helping us cure diseases.





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

- explain different types of chemical reactions ;
- explain different types of energy transformations through chemical reactions;
- explain the transformations of energy in dry cells;
- explain electrolysis;
- use properly the chemicals and different instruments in chemical experiments.
- appreciate the contributions of chemical reactions in our life;

Lesson 1-2 : Symbol, Formula and Valency

In class seven, you have got some ideas about symbol and formula. According to structure, chemists have divided all the substances of the world as elements and compounds. Till now, 118 elements have been found out. Generally, symbols are expressed by the first one or two letters of he English or Latin name of the elements. The short expression of the element is called symbol. For example :

H for Hydrogen, O for Oxygen, Ca for Calcium etc.

Again, the short expression of molecule of compound is called formula. For example : formula of hydrogen molecule H_2 , Oxygen molecule O_2, Hydrogen chloride molecule HCl etc.

To write the formula of compound, we need to know the valency of the element. According to the number of valency of the element, elements form compounds by chemical bondage. We can compare the valency of elements with our hand. The elements having valency one, means it has one hand. Hydrogen and chlorine both are one handed elements. So, their valency is one. Therefore, the formula of hydrogen chloride is HCl. The valency of oxygen is two. It means, the one atom of oxygen has two hands. Through these two hands, oxygen can be attached with two atoms of one handed hydrogen. For this reason, the formula of water is H_20.

The valency of nitrogen and carbon are 3 and 4 respectively. So, the formula of ammonia is NH_3 and methane is CH_4. The formula of hydrogen chloride, water, ammonia and methane can be shown in the following :



Hydrogen chloride Water Ammonia Methane

It may be mentioned here that some elements have more valencies: the valency of sulphur is 2 and 4, Iron is 2 and 3 etc.

Therefore, the valency of the element means the number of hydrogen atom attached to that element. At the time of formation of a compound, it is to be considered that all the hands or valency of an element are satisfied.

Table : The valency of some elements and radicals

Element	Valency-1	Valency-2	Valency-3	Valency-4
Non-metal (Element)	Hydeogen (H) Fluorine (F) Chlorine (Cl) Bromine (Br) Iodine (I)	Oxygen (O) Sulphur (S) Carbon (C)	Nitrogen (N) Phosphorus (P)	Carbon (C) Sulphur (S)
Metal (Element)	Sodium (Na) Potassium (K) Copper (Cu) (ous) Silver (Ag) Gold (Au) (ous)	Calcium (Ca) Magnesium (Mg) Zinc (Zn) Iron (Fe) (ous) Copper (Cu) (ic) Tin (Sn) (ous) Lead (Pb) (ous)	Aluminium (Al) Iron (Fe) (ic) Gold (Au) (ic)	Tin (Sn) (ic) Lead (Pb) (ic)
Radicals	Ammonium (NH_4^+) Hydroxyl (OH^-) Nitrite (NO_2^-) Nitrate (NO_3^-) Bicarbonate (HCO_3^-)	Carbonate (CO_3^{2-}) Sulphate (SO_4^{2-}) Sulphite (SO_3^{2-})	Phosphate (PO_4^{3-})	

In the above table SO_4^{2-}, CO_3^{2-}, NO_3^-, NH_4^+ etc. group of atoms do not stay independently. They participate in compound formation like elemental atom. This group of atoms is called radical.

To write the molecular formula, the following rules are to be mantioned.

1. If the valency of the element or radical is same, it is not necessary to write valency in the formula. Only element and radical are to be written together. For example: CaO (calcium oxide), NH_4Cl (ammonium chloride), NH_4NO_3 (ammonium nitrate) etc.
2. If the valency of one element is multiple of valency of another element, the valency of both elements is divided by that multiple. Then the divided result is exchanged and is written as suffix. For example: carbon dioxide $C_2O_4 \rightarrow CO_2$. Here the valency of carbon and oxygen is respectively 4 and 2.
3. If the valency of both elements is different and not multiple like valency of A is x and the valency of B is y then the formula of compound formed- with A and B is Ay Bx. The valency of element A is written at the suffix on B and the valency of element B is written at the suffix of A. For example alluminium oxide (Al_2O_3).

Lession 3-4 : Chemical Equation

To describe the chemical reaction we need to know about chemical equation. A chemical reaction can be divided into two parts.

One part contains the reactants and in the other part, the prodcuts or the newly formed substances. For example :

S	+	O_2	⟶	SO_2
Sulphur		Oxygen		Sulphur dioxide

Reactants represent the prior state of the reaction and products the resultant state of the chemical reaction. In any chemical reaction, atoms cannot be created or destroyed; but they are rearranged only. The total number of atoms present in the reactants before the reaction always equals the total number of atoms of the product after the reaction. So the reactants and their product have the same number of atoms of a specific element. In the light of the above discussion, chemical equation may be defined as follows:

A chemical equation is a shortened expression of a chemical reaction. It uses some symbols, formulas and some mathematical signs to denote the reactants and the products. For example :

Zn	+	H_2SO_4	⟶	$ZnSO_4$	+	H_2
Zinc		Sulphuric acid		Zinc sulphate		Hydrogen

The Rules of Writing Chemical Equations are as Follows

1. In a chemical equation the formula or symbols of the reacting substances or reactants are written on the left of the sign of euqality (=) and the symbols or formulas of the products are written on the right of it.
2. If the reactants or products are more than one, a plus (+) sign is put between the formula and the symbols.
3. If the number of molecule is more than one then the number is used before the formula.
4. An arrow sign ($\longrightarrow$) is used to indicate that the reaction moves towards the products from the reactants. Instead of an arrow sign, an equals sign (=) may also be used. However, the equation has to be balanced on both sides.
5. The number of atoms of different elements present in the reactants before chemical reaction must be equal to the number of atoms of different elements in the prodcuts formed after the reaction. So, to make balance the symbol or formula must be multiplied by the required number.

To Balance the Chemical Equation

The reaction of hydrogen and oxygen produces water. So the formula of hydrogen and oxygen is to be written on the left of the equals sign (=) and the formula of the product will be written on the right. The reaction may be expressed as follows :

$$H_2 \quad + \quad O_2 \quad \longrightarrow \quad H_2O$$

The number of H and O atoms before the reaction and their numbers after the reaction should be same. To make the number equal it will have to multiplied on the right side by 2. The equation now stand as :

$$2H_2 \quad + \quad O_2 \quad = \quad 2H_2O$$

From the above equation the total number of oxygen and hydrogen atoms before and after of the reaction can be calculated :

	$2H_2$	+	$1O_2$	=	$2H_2O_1$
	(2×2)	+	(1×2)	=	$2 \times (2+1)$
or,	4	+	2	=	2×3
or,	6			=	6

Therefore, the number of atoms before and after the reaction is equal.

Lesson 5 : Chemical Reaction: Addition

Activity: Understanding addition reaction
Necessary components: test tube, mortar, spirit lamp or burner, iron powder, sulphur, balance
Methodology: Properly clean the test tube and dry it. Using the balance measure 1 gram of iron powder and 4 gram of sulphur (keeping the ratio same and different amounts of iron and sulphur can be taken) and grind them together in the mortar. Put the powders in the dry testtube. Now heat the bottom of the test tube using the flame low while heating. When the mixer in the test tube becomes red hot, stop heating. Keep the test tube above the mortar so that in case the test tube breaks the materials in it will not be spoiled. After cooling the test tube, break it and separate out its contents.
Instruction: The activity will be completed with the help and guidance of the teacher.

The material that you obtain from the test tube will look deep grey. You will see that the light yellow sulphur or iron in it, became the iron powder and the sulphur chemically combined to produce a new material called ferrous sulphide.

$$\underset{\text{Iron}}{Fe} + \underset{\text{Sulphur}}{S} \longrightarrow \underset{\text{ferrous sulphide}}{FeS}$$

This type of chemical reaction in which more than one element combined to produce a new kind of chemical substance is called synthesizing reaction. In the same way zinc and sulphur can chemically react to produce zinc sulphide.

$$\underset{\text{Zinc}}{Zn} + \underset{\text{Sulphur}}{S} \longrightarrow \underset{\text{Zinc sulphide}}{ZnS}$$

It is to be mentioned here that in the above two reactions compounds are formed from elements. However, it is also possible that two compounds can chemically combine to form a new compound. For example, ammonium chloride is produced by adding hydrogen chloride with ammonia.

$$\underset{\text{Ammonia}}{NH_3} + \underset{\text{Hydrogen Chloride}}{HCl} \longrightarrow \underset{\text{Ammonium Chloride}}{NH_4Cl}$$

Lesson 6-7 : Combustion Reaction

Activity: Observation of combustion reaction between sulphur and oxygen.

Necessary components: A combustion spoon with a long handle, some amount of sulphur, spirit lamp or burner
Methodology: Take some sulphur in your combustion spoon. Keep heating the spoon with the flame of your burner. What do you find?
Instruction: The activity will be completed with the help and guidance of the teacher.

First you will see sulphur to melt and then you will see blue flame and smell a pungent smell. The heating of sulphur reacts with oxygen in the air and produces sulphur dioxide (SO_2) gas which gives pungent smell.

$$\underset{\text{Sulphur}}{S} + \underset{\text{Oxygen}}{O_2} \xrightarrow{\text{Heat}} \underset{\text{Sulphur dioxide}}{SO_2}$$

Activity: Observation of combustion reaction between magnesium and oxygen.
Necessary components: Magnesium ribbon, forceps (eight centimeter), Spiritlamp or bunsen burner, lighter.
Methodology: Wear protective spectacles. Hold the end of the ribbon on the flame you can do it by a lights also. Observe carefully, what happens?
Instruction: The activity will be completed with the help and guidance of the teacher.

The ribbon catches fire and a bright flame is seen. It happens because magnesium bums due to the reaction with the oxygen of the air and we see the flame. When all the magnesium is burnt out, the flame will extinguish automatically. Do you find anything like ashes? It is actually magnesium oxide which has been formed through the burning of magnesium in oxygen.

$$\underset{\text{Magnesium}}{2\,Mg} + \underset{\text{Oxygen}}{O_2} \longrightarrow \underset{\text{Magnesium oxide}}{2MgO}$$

Activity: To know the process of burning of a candle.
Necessary components: Candle, match
Methodology: Ignite the candle using a match stick. Observe carefully what is happens? With the passage of time the size of the candle reduces. What is the reason behind it? The wax melts because of the heat from lighting the candle. A small part of the melted wax flows down the candle, but most of the melted wax turns into vapour by being sucked up through the wick of the candle. This vapour, by combustion process, reacts with the oxygen in the air and produce heat and light.
Instruction: The activity will be completed with the help and guidance of the teacher.

Lesson 8-9 : Substitution or Displacement Reaction

Activity: Observing the reaction between iron and copper sulphate.
Necessary components: Iron powder, copper sulphate, water and test tube
The procedure: Fill the test tube with water to one forth its volume. Take some copper sulphate in it and shake to make a solution of copper sulphate. Now put in some iron powder in this blue solution of copper sulphate and shake thoroughly. Do you find any change? The blue colour of solution is gradually turning into green and small particles are forming at the bottom of the test tube. Why dose the blue colour of the solution turn green?
Instruction: The activity will be completed with the help and guidance of the teacher.

Here a chemical reaction has taken place, as a result ferrous sulphate and copper have been formed. The colour of iron sulphate is light green which turns the blue colour of the solution into light green.

$$\underset{\text{Iron}}{Fe} + \underset{\text{Copper sulphate}}{CuSO_4} \longrightarrow \underset{\text{ferrous sulphate}}{FeSO_4} + \underset{\text{Copper}}{Cu}$$

In this reaction iron is removing copper from copper sulphate and occupying its place to form ferrous sulphate and pure copper.
This type of chemical reaction, where an element replaces another element from a compound and occupies its place producing a new compound is called displacement reaction.
You can add zinc, magnesium etc. and see what type of change occurs.

Decomposition Reaction

Activity: Observing the decomposition reaction of limestone.
Necessary components: Limestone, spatula or spoon, test tubes, lime water, outlet tube, bunsen burner or spirit lamp, clamp, stand, cork and hand gloves
Methodology: Wear the hand gloves and with the help of the spatula take 5 gram of limestone in the test tube. Now heat the bottom of the test tube with the flame of the burner. Observe carefully.
Instruction: The activity will be completed with the help and guidance of the teacher.

Carbon dioxide is being produced. The limestone which was taken in the test tube decomposed into carbon dioxide gas and formed calcium oxide due to heating ..

$$\underset{\text{Calcium carbonate (limestone)}}{CaCO_3} \xrightarrow{\text{heat}} \underset{\text{Calcium oxide}}{CaO} + \underset{\text{Carbon dioxide}}{CO_2}$$

Now you can examine whether the gas is carbon dioxide or not. Take 1-2 milliliter of lime water in the other test tube and fix it as shown in the figure. You will see that the lime water is turning opaque. The carbon dioxide thus produced passed through the outlet tube to the second test tube and caused reaction there between lime water and carbon dioxide. The lime water becomes opaque due to the formation of calcium carbonate.

CO_2 + $Ca(OH)_2$ ⟶ $CaCO_3$ + H_2O

Carbon dioxide — Calcium hydroxide (Lime water) — Calcium carbonate — Water

A few more examples of decomposition reactions are given below:

If copper carbonate is heated, it breaks and produces copper oxide and carbon dioxide.

$CuCO_3 \xrightarrow{heat} CuO + CO_2$

Copper carbonate — Copper oxide — Carbon dioxide



Fig. 8.1:Decomposition

On the other hand, when potassium chlorate is heated it decomposes into potassium chloride and oxygen gas.

$2KClO_3 \xrightarrow{heat} 2KCl + 3O_2$

Potassium chlorate — Potassium chloride — Oxygen

Lesson 10-11 : Transformation of Energy through Chemical Reaction

Your Activity: You have known what type of chemical reaction goes on when a candle burns. Can you say now if any energy transformation occurs here? If you put your hand near the candle you feel hot. Again, if the candle is ignited in the dark things become visible. We can therefore say that we feel hot because the burning candle produces heat and we can see things around the candle because it produces light. Candle is a chemical substance. When it is burned, the chemical energy stored in it transforms into heat energy and light energy. We use heat energy for cooking. Thus we find that chemical reaction causes transformation of energy.

Activity: The reaction between baking soda and lemon juice.
Necessary components: Baking soda, lemon juice, dropper
Methodology: Take some baking soda in a test tube. Gradually add lemon juice to it by using the dropper. What do you find? There will be lot of bubbles. Touch the bottom of the test tube. Do you feel cold?
Instruction: The activity will be completed with the help and guidance of the teacher.

Lot of citric acid is present in the lemon juice which reacts with the baking soda to produce sodium citrate, carbon dioxide gas and water. The bubbles you see are nothing but carbon dioxide gas.

Baking soda + Citric acid ⟶ Sodium citrate + Carbon dioxide + Water

Why is the test tube felt cold? The reason is that the reaction absorbed heat.

Now you can add vinegar to baking soda instead of lemon juice. What is happening now?

Activity: Experiment for the reaction between lime and vinegar.
Necessary components: lime, vinegar, beaker, hand gloves, dropper
Methodology: Using the hand gloves put some lime in the beaker. Now gradually add vinegar with the help of the dropper. Touch the beaker by your hand. Do you feel it hot? What is the reason? Here, due to the reaction between lime and vinegar. Calcium acitate and water are formed and lot of heat is released. Due to the generation of heat the beaker is felt hot.
Instruction: The activity will be completed with the help and guidance of the teacher.

$$\underset{\text{Calcium oxide}}{CaO} + \underset{\text{Acitic acid}}{CH_3COOH} \longrightarrow \underset{\text{Calcium acitate}}{(CH_3COO)_2Ca} + \underset{\text{Water}}{H_2O}$$

Here lime is alkaline substance and acitic acid is acidic substance. This type of reaction where substances of opposite characteristics react with each others and produce neutral substance is called neutralization reaction.

Now you can add lemon juice instead of vinegar. What type of reaction does occur?

Activity: Observation of the reaction between lime and water.
Necessary components: Lime, water, beaker, hand gloves, spatula, dropper
Methodology: Take five gram of lime (different amount can also be taken). Add 40 gram of water drop by using the dropper. Touch the beaker with hand gloves on. Do you find any difference after adding water?
Instruction: The activity will be completed with the help and guidance of the teacher.

The beaker is getting very hot and the solution is bubbling as happens to boiling water. Here due to the addition of water into lime, there is a chemical reaction between them and calcium hydroxide is formed.

$$\underset{\text{Calcium Oxide (Lime)}}{CaO} + \underset{\text{Water}}{H_2O} \longrightarrow \underset{\text{Calcium hydroxide}}{Ca(OH)_2}$$

The product $Ca(OH)_2$ is well known as slaked lime. Slaked lime or $Ca(OH)_2$ dissolves in water very slightly. Huge heat-energy is produce in this reaction. As a result, water evaporates. The saturated solution of $Ca(OH)_2$ in water is called lime water.

Keep the suspensions that you get from the above experiment for some time. The clean water that you get at the top is lime water.

Lesson 12-14 : Dry Cells

Dry cells are portable source of electrical energy. We use dry cells in torch light, remote controller, toy cars and in many electric machines. We will discuss how this cell is made and how it works.

To make such a dry cell first of all, ammonium chloride (NH_4Cl), charcoal powder and manganese dioxide (MnO_2) to be mixed thoroughly with little water added to make a paste. This mixture is taken in a cylindrical shaped zinc container. A carbon rod is introduced at the centre of the container in such a way that it does not touch the zinc container. At the top of the carbon rod there is a metal cup. The upper part of the cell is covered by a layer of pitch. The surface of the zinc cylinder acts as the negative electrode or as the anode. The carbon rod with the metal cap acts as the positive electrode or cathode.

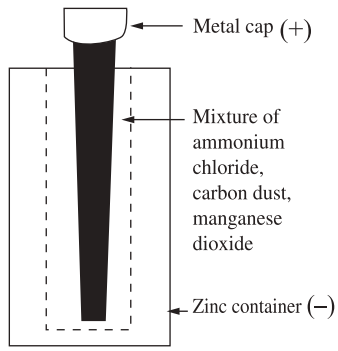


Fig. 8.2: Dry cell

Now let us see how dry cell works-

Activity: To make a electric circuit using a dry cell and observe the energy transformation.
Necessary components: An electric bulb, dry cell, two copper wires
Methodology: Connect one end of a copper wire to the anode and the other copper wire with the cathode of the dry cell. Now connect the free ends of the copper wıres through the bulb as shown in the figure. The bulb will light up. This is because an electric circuit is completed through the cell, bulb and the wires.
Instruction: The activity will be completed with the help and guidance of the teacher.

What type of energy transformation does take place here? The completion of the electric circuit causes the bulb to give light. This light is coming from the battery. The cell's energy sources are chemicals such as zinc, charcoal powder, ammonium chloride, and manganese dioxide. We can say chemical energy stored in the chemicals within the cell is the source of light energys. So here chemical energy transform tolight energys.

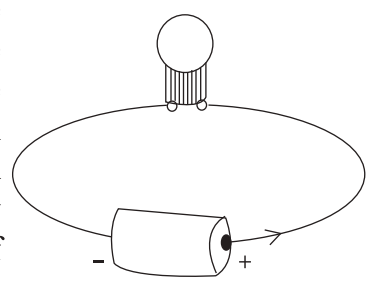


Fig. 8.3: Dry cell circuit

Electrolysis

Activity: To know about electrolysis.

Necessary components: Battery, two copper wires, two zinc rods (electrode), water, salt, one glassware.

Methodology: Take 300 milliliter of water, 30 gram of sodium chloride in a glassware and stir them thoroughly. Now connect the two zinc rods to the battery using the copper wires as shown in the figure. Observe carefully at the zinc rods. Do you find bubbles of gas on the body of both the rods?

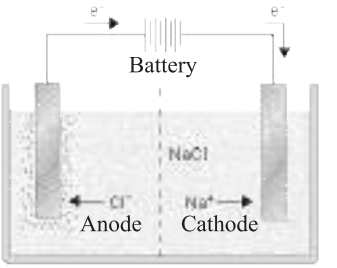


fig 8.4 : Electrolysis

Instruction: The activity will be completed with the help and guidance of the teacher.

Yes, the reason is that sodium chloride gets dissociated in aqua solution to produce sodium ion (Na^+) and chloride ion (Cl^-)

$$NaCl \rightleftharpoons Na^+ + Cl^-$$

This is how water dissociation produces hydrogen ions and hydroxide ions.

$$H_2O \rightleftharpoons H^+ + OH^-$$

When electricity flows through dissolved salt connected to a battery, hydroxide ions and chloride ions move toward the anode. When chloride ions reach the anode, they undergo a chemical reaction to produce chlorine (Cl_2) gas. This is why bubbles form on the anode. Meanwhile, sodium ions (Na^+) and hydrogen ions (H^+) move toward the cathode, where they react chemically to produce hydrogen gas (H_2). As a result, bubbles of hydrogen gas become visible on the cathode, while sodium ions (Na^+) and hydroxide ions (OH^-) remain in the solution.

Cl^-	+	e	→	Cl
Chloride ion		electron		Chlorine atom
Cl	+	Cl	→	Cl_2
Chlorine atom		Chlorine atom		Chlorine gas
H^+	+	e	→	H
Hydrogen ion		electron		Hydrogen atom
H	+	H	→	H_2
Hydrogen atom		Hydrogen atom		Hydrogen gas

As electricity passes through a sodium chloride solution, chlorine gas forms at the anode, hydrogen at the cathode, and sodium hydroxide stays in the solution.

The solutes that carry electricity when dissolved and produce different solutes through chemical reactions due to electricity are called electrolytes. For example: salt.

All materials do not produce chemical reaction due to electric current. The materials which do not allow electric current to pass through in their dissolved state or in the melted form do not take part in chemical reaction. These materials are called non electrolyte. Sugar, glucose are such examples.

New words : Valency, radical, addition, combustion, displacement, neutralization, anode, cathode, electrolysis, electrolyte , slack lime.

What we have learned at the end of this chapter

- According to the number of valency of the element, elements form compounds by chemical bondage.
- In a chemical equation, the reactants are on the left side of the arrow, and the products are on the right side.
- More than one substance can combine through addition reactions to form a new material.
- By combustion reaction a substance can burn with the help of oxygen in the air and produce lot of energy as heat and light.
- In a substitution reaction, an element can replace another element in a compound and produce a new substance.
- A chemical reactions in which a compound is broken down into more than one new substance is called a decomposition reaction.
- By chemical reaction there is transformation of energy.
- In a neutralization reaction, substances with opposite properties react to transform each other into neutral substances. In the combustion reaction, the chemical energy generally transforms into heat and light energy.
- When dry cells are used, the chemical energy transforms into light or other forms of energy.
- When dissolved or melted materials that allow electricity to pass through them are called electrolytes.
- When melted or dissolved materials that do not allow electricity to pass through them are called nonelectrolytes.

Sample Questions

Multiple Choice Questions

1. Which one is slaked lime?

   a. CaO b. $CaCO_3$

   c. $CaCl_2$ d. $Ca(OH)_2$

2. From which of the decomposition reactions given below does a diver gets his oxygen.

   a. $CaCO_3$ b. $CuCO_3$

   c. $KClO_3$ d. NH_4Cl

In the light of the paragraph below, answer the questions no. 3 and 4

Shapna took some lime in a beaker in the lab. Then some vinegar is added by a dropper. After some time she touched the beaker to find out the change of temperature.

3. What type of chemical reaction will occur between the compounds?

   a. Combustion b. Neutralizing

   c. Addition d. Substitution

4. The reaction between the compounds will produce –

   i. calcium acetate

   ii. calcium carbonate

   iii. water

Which one of the following is correct?

   a. i & ii b. i & iii

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

Creative Questions

1. A student completed the following reactions in the chemistry laboratory:

i. Carbon + Oxygen $\xrightarrow{\text{Heat}}$

ii. Limestone $\xrightarrow{\text{Heat}}$

iii. Hydrogen + Oxygen $\longrightarrow$

iv. Zinc + Sulfuric Acid $\longrightarrow$

a. What is an electrolyte?

b. "NH_4^+ is called a compound radical." - Explain.

c. In which reaction from the stimulus was an elemental gas produced? Explain.

d. Though both reactions i and iii are combination/addition reactions, they have differences. – Analyze.

2. Tamanna was watching her doll dance using battery power. At that moment, electricity went off, and her younger sister Tahsina lit a candle.

a. What is a neutralization reaction?

b. What is meant by lime water? Explain.

c. Explain the structure of the battery used in Tamanna's doll.

d. What kind of energy transformation occurs in the doll and the candle? Analyze.

Short Answer Questions

1. Turning carbon into carbon dioxide by burning—what kind of chemical reaction is this? Explain.
2. What happens when water is added to lime? Explain.
3. What happens when potassium chlorate is heated? Explain.

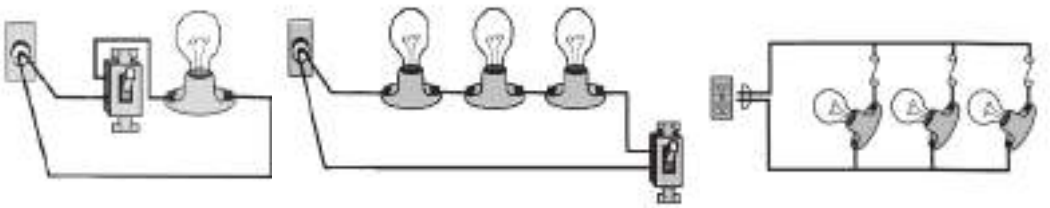
Project: Form a group of 4 to 5 and identify 5 chemical reactions which are closely related to our day to day life. Think whether there is transformation of energy in these reactions. If there are transformations of energy, try to find out. Make a report, what kind of transformation occure during the translformation of energy.

Chapter Nine

Electric Circuits and Current Electricity

As we know, the electrons are arranged outside the nucleus of the outermost atom. The outermost electrons of the atoms in some substances are weakly bound to the nucleus. In these materials, electrons can move easily, so they are called conductors. Electric current is the flow of electrons. An electric circuit is a closed path made of conductive material through which electrons can flow. In this circuit, electrical devices and equipment can be connected in two main ways: series and parallel connections.

For current to flow through the components of a circuit, an electric potential difference must be created between its two ends.



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

- explain the concepts of electric potential and potential defference;
- explain the idea of AC and DC flow;
- explain the use of resistance, fuse and key in an electric circuit;
- explain the difference between current flow and voltage difference graphically;
- show the difference between current and voltage in series and parallel circuits;
- make proper use of ammeter and voltmeter in the measurements of current and voltage;
- be aware and raise awareness in others about the effective use of electricity and protection against its wastage.

Lesson 1: Electric Potential and Electric Current

According to modern electron theory, every metal contains some free electrons that can move freely within the material. When two dissimilar metals are connected by wires, the flow of negatively charged electrons from one metal to the other depends on a property of the metals known as potential. For this flow of electrons to occur, there must be a difference in potential between the two

metal objects. This flow of electrons continues as long as there is a potential difference between the two metals. We refer to the flow of charge as electric current. Current flows in metals due to the movement of negatively charged electrons.

Electric Current

The amount of charge that flows through any cross-section of a conductor in a given time is called electric current.

The direction of conventional electric current is opposite to the flow of electrons. Unit of electric current: The unit of electric current is the ampere, usually denoted by the symbol A.

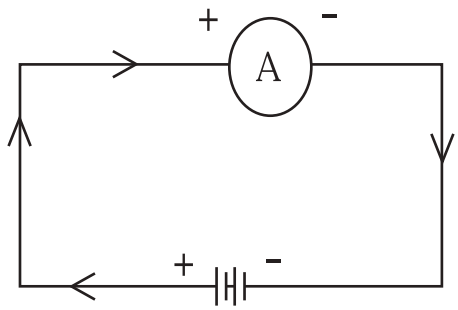


Fig. 9.1 : Electric circuit

Electric Potential: The amount of work required to move a single positive charge from an infinite distance to a point next to a charged object is called electric potential.

Electric Potential Difference

Electric potential difference is the amount of work required to move each unit of positive charge from one point in an electric field to another. If there is no potential difference between two points, no current will flow, and no work will be done.

Lesson 2-3 : Different Types of Current Flow

There are two types of current flow. (a) Unidirectional current and (b) Alternating current.

(a) Non periodic or unidirectional current (DC): If there is no change in the direction of the flow of current over time, it is called unidirectional or direct current. We get unidirectional current from an electric cell or battery.

Also we can get unidirectional current from a DC generator.

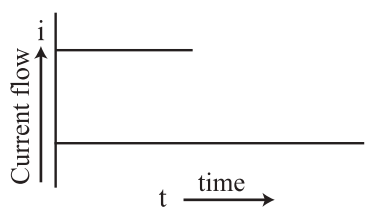


Fig. 9.2: Unidirectional current

(b) Alternating Current (AC)

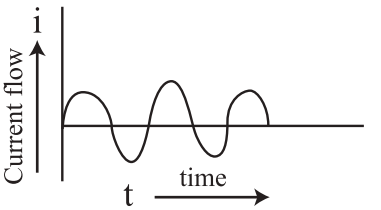


Fig. 9.3: Alternating current

If the direction of current flow changes repeatedly over time, it is called alternating current (AC). When the time interval between changes of direction is constant, it is referred to as periodic alternating flow or simply periodic flow. AC is the standard current flow in most countries worldwide because it is relatively easy and affordable to generate and distribute. The source of alternating current is typically a generator or dynamo, and it is produced in power-generating stations across the country. The rate of directional change in periodic flow, known as frequency, varies by country. For example, in Bangladesh, the frequency is fifty times per second (50 Hz), while in the United States, it is sixty times per second (60 Hz).

Lesson 4-5 : Resistance

The electric current is produced by the flow of electrons. When there is a difference in the potential between two points of a conductor the free electrons are subjected to an electric force and electrons move from the low potential to high potential. However, during this journey the electrons come into collision with the ions in the metallic conductor. As a result, the movement of electrons is hampered and consequently the flow of current is also hampered. The property of creating obstacle by conductor is resistance. The property of creating obstacle to the flow of current is called resistance.

Ohm's law: The flow of current through a conductor is determined by the difference in the voltage between its two ends. The magnitude of the current also depends on the dimensions and composition of the conductor and also its temperature. At a specific temperature the current flowing through a conductor depends only on the potential difference between its two ends. The resistance of a conductor is determined by the ratio of the current flowing through it to the potential difference between its two ends at a specific temperature. Additionally, in the case of some conductors a relationship exists maintains between the current flowing through a fixed size conductor and the potential difference between its two ends at a definite temperature. The relation between voltage and current for a conductor of definite composition was established by George Simon Ohm (1789-1854). This is known as Ohm's law. Conductors that follow Ohm's formula are called Ohmic Conductors.

Ohm's law: At a fixed temperature the current flowing through a particular wire or conductor is proportional to the voltage difference between the two ends of the conductor.

From Ohm's law, we can see that if the voltage between the two ends of a conductor is high, the current flowing through the conductor will be large and if the voltage is low, the current will be low (Fig. 9.4).

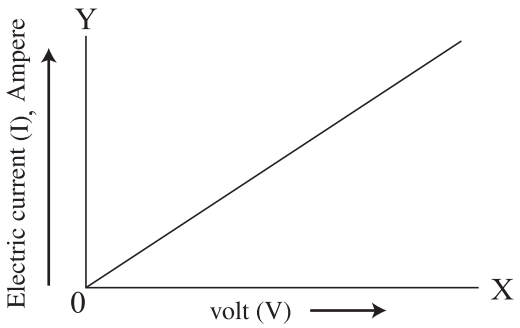


Fig. 9.4: Graphical representation of Ohm's law.

We can write Ohm's law as $I \propto V$ and $I = \frac{V}{R}$, where I is the current, V is the voltage and R is the resistance of the conductor.

Thus in a particular conductor the current flowing through it is inversely proportional to the resistance of the conductor.

The Unit of Resistance

The unit of resistance in SI unit is the ohm. If the voltage difference between the two ends of a conductor is one volt and the current flowing through it is 1 ampere, the resistance of the conductor will be 1 ohm.

Lesson 6-8 : Electric Circuit

Just as people need a path for walking, electricity also needs a specific path. This complete or closed path for current flow is called a circuit. When the two ends of a current source are connected to one or more resistors, electrical devices, or equipment, an electrical circuit is formed. The circuit can be closed or opened with the help of a key or switch. If the key is closed, the circuit will be complete and current will flow. If the key is open, the circuit will not be complete and current will not flow.

In ordinary circuits the electrical equipment can be connected in two different ways. They are

a) series of circuit and b) parallel circuits.

a) A Series of Circuit

If in a circuit the resistance electric equipment or components are connected in such a way that one end of the first is joined to one end of the second and the other is joined to one end of third and so on and the successive connections made a complete circuit, then we get a series of circuit.

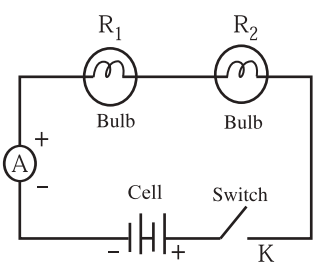


Fig 9.5: Series Circuit

In the figure, resistance Rl and R2, ammeter A and key K are successively connected. The ammeter is used to measure the current and it is connected in series with the other components of the circuit. If the ammeter terminals are marked as + and -, then the positive terminal marked as (+), must be connected to the positive terminal of the cell. In this circuit the same current flows through all the components of the circuit. However, the potential difference across each part may be different.

b) A Parallel Circuit

If in a circuit more than one resistance or electrical components are connected in such a way that one end of each of them are connected to one common end of a battery and the other ends of all the components are connected to the other end of the battery. Then such an arrangement forms a parallel circuit. In a parallel circuit different currents may flow through the individual components but the voltage will be the same between the two terminals of each components.

In the figure the resistance R_1, R_2 and the voltmeter are - v + parallely connected to each other. A voltmeter is used to measure the difference of voltage between the two terminals of a resistance. This is why a voltmeter is connected to the two terminals in Parallel to a resistance. The positive terminal of the voltmeter marked + must be connected to the positive end of the battery; otherwise you may damage the instrument. If you connect two bulbs in series to a battery, will both bulbs glow the same way as when only one bulb is connected to the battery?

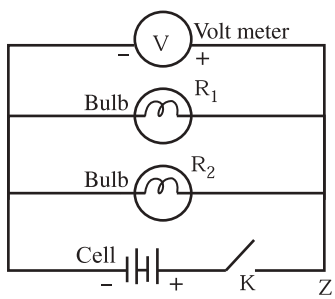


Fig. 9.6: Parallel Circuit

When the bulbs are in series the same current flows in both the bulbs but this current is lower than the case when one bulb is connected. As a result, the brightness of light will be less when the two bulbs are in series compared to when just one bulb is used.

When the bulbs are connected in series and one of the bulbs is fused, the circuit will be broken and the other bulb will go off. In case the two bulbs are connected in parallel and one of the bulbs is fused, the circuit will not be broken and other bulbs will not go off. Thus in parallel connection we can put off any of the bulbs without disturbing the other bulbs. The voltage difference of the terminals of each bulb will be the same. That is, each bulb will experience the full voltage of the electric cell. As a result, the brightness of both bulbs will be the same. The brightness of the bulbs will be same whether they are connected in parallel or individually to electric cell. In our domestic uses, it is more convenient to use parallel circuits.

Activity: Draw the diagram of series circuit and parallel circuit on a white paper and show the direction of current flow.

Lesson 9-10 : Ammeter and Voltmeter

Ammeter

An ammeter is an electrical instrument that allows us to directly measure the current in a circuit. It is connected to a circuit in series. In this instrument there is a moving coil galvanometer. The galvanometer is an instrument by which one can identify and measure the current in a circuit. You will learn in detail about it later.

To see the direction in the moving coil of the galvanometer there is a needle or pointer. The pointer is calibrated in units of ampere, milliampere or microampere and can move along a scale. Like an electric cell, there are two connecting terminals on an ammeter, marked as positive and negative terminals. Usually, the positive end is indicated in red and the negative end is indicated in black. The symbol of ammeter is  .



Fig. 9.7: Ammeter

Voltmeter

The instrument by which the potential difference between two points in a circuit can be measured in ampere is called a voltmeter. The voltmeter is connected in parallel between the two points where we want to measure the potential difference.

There is a galvanometer in this instrument.To observe its deflection a needle or pointer is connected to it. The pointer moves over a scale which is marked in volts. The voltmeter is connected in parallel between the two points where the voltage difference is to be measured. As in the electric cell or the ammeter there are two terminals in the voltmeter. One of which is positive and the other is negative. Usually the positive end is marked red and the negative end is marked black. The symbol of voltmeter is  .

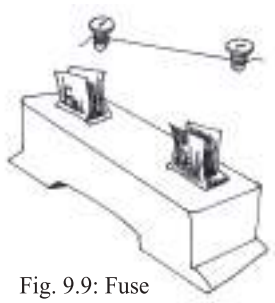


Fig: 9.8: Voltmeter

Lesson 11: Fuses

If the current in an instrument that we use in our day to day life exceeds a certain limit, the instrument will be damaged. In case, the current in the electric circuit of our house flows too high, it can cause even fire. To avoid such accidents some special arrangements are made in the circuit. The special arrangement is the use of fuse. A fuse is usually made of a thin wire of an alloy of tin and lead. It is fixed over a ceramic structure. The wire is thin and its melting point is low. If the current flows

through it beyond a certain limit, it gets very hot and melts. As a result, the circuit goes off. This is how, by stopping the current, the fuse protects our instruments. The fuse is connected in series in the circuit.


Fig. 9.9: Fuse

The fuses can be with different current carrying limits. Usually, fuses of 5 ampere, 15 ampere 30 ampere and 60 ampere are used depending on the necessity. A ten ampere fuse means, no current above 10 ampere can pass through it because it will then melt and make the circuit off. For different types of instruments different fuses are used. For electric lamps, fans, televisions etc. a 5 ampere fuse is used. For electric kettle or calendar a 15 ampere fuse is used. The main fuse of the house may be 30 or 60 ampere.

Try to understand the matter a little more. Television may be damaged if currents above 5 ampere flows. Can you imagine what will happen if you use a 30 ampere fuse for television? It will not serve the purpose. What will happen if a fuse of 5 ampere is used for electric kettle where more than 5 ampere is needed? When you put the current on, the fuse will burn. The Standard of fuse must be according to the necessity. The use of fuse greater than the needed will not serve the purpose of avoiding accidents. If we use a fuse of value lesser than the needed, it will burn too often. Some people use a number of fuse wires when the fuse wire bums. This should not be done. Because the value of the fuse then increases. For example, the use of two fuses of 10 amperes will make the fuse work as a 20 ampere fuse.

Lesson 12: The Effective Use of Electricity and to Stop Its Wastage

In our country, the demand for electricity is going on increasing. Although plans are being made based on the demand, we are failing to meet it. In addition to this there is additional threat of climate change. This has created additional pressure on the demand of electricity. There is an increase in the number of offices, houses, and shopping centers. In big buildings there is demand for air-conditioners and elevators. There is also demand for electricity in construction works. To meet the challenge there is need for efforts on the part of the government as well as on the individual level. Everybody should come forward to ensure the effective use of electricity and to stop its wastage.

To make proper use of electricity and to stop wastage of energy we can take the following steps:

- Be aware of turning off the lights, fans, and air-conditioners in houses and offices unless their use becomes essential.
- To use fluorescence or energy saving bulbs to save electricity.

- To avoid the use of electricity for cooking and use pressure cooker which saves 25% energy.
- Avoid using the air conditioner unnecessarily.
- When buying refrigerators, one should avoid larger ones than necessary.
- Large factories can generate their own electricity with generators, reducing energy transmission expenses.
- Take initiative to use solar energy, which is renewable.

New words : Electric potential, electric current, resistance, Ohm's Law, Alternating flow, electric circuit, ammeter, unidirectional flow, voltmeter, fuse

What we have learned at the end of this chapter-

- When two conductors with a potential difference are connected the electrical state that determines the direction of the flow of charge is what we call electrical potential.
- As long as there is a difference of potential between two points on a conductor, the current will flow.
- If we can maintain the potential difference between the points in the conductor, the current will continue to flow.
- The property of a conductor that opposes the flow of current through it when a voltage is applied is called its resistance.
- At a constant temperature, the current flowing through a conductor is proportional to the potential difference between its two ends.
- When the current flows in a single direction all the time, it is called direct current.
- When the current changes its direction periodically, it is called alternating current.
- There are two ways of connecting electrical equipment in a circuit.. These are called series connections and parallel connection.
- With the help of an ammeter the current in a circuit can be measured directly in the units of ampere.
- The instrument used to measure the potential difference between two points in a circuit in units of volts is called a voltmeter.
- Fuse is a special device in the circuit designed to prevent accidents.
- Everyone must be aware of the proper use of electricity and work to stop wasting it.

Sample Questions

Multiple Choice Questions

1. What is the unit of electric current?

   a. Coulomb b. Ampere

   c. Volt d. Ohm

2. What is the source of alternating current?

   a. Battery b. DC Generator

   c. Generator d. Electric Cell

After reading the following paragraph answer questions no. 3 and 4

There are two bulbs and a fan which are connected in the study room of Mina. On the other hand in their dining room two tube lights, a fan and an electric kettle are connected to the circuit.

3. Fuse of which ampere value is to use in the study room of Mina?

   a. 5 b. 10

   c. 15 d. 30

4. If a fuse of 5 ampere is used in dining room of Mina's family -

   i. there will be saving of electricity.

   ii. there will accidents occurring quite often.

   iii. the fuse will melt, the moment the switch will be made on.

Which of the following is correct?

   a. i & ii b. i & iii

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

Creative Questions

1. Mr. Haque connected two 880 ohm bulbs in series at a potential difference of 220 volts in his office. However, he connected one fan and one television in parallel.

a. What is electric current?
b. What does a 5-ampere fuse mean? Explain.
c. Calculate the amount of current flowing through the bulbs.
d. Between the two types of circuit connections mentioned, which one is more advantageous? Provide a comparative discussion and give your opinion.

2. Recently, there have been frequent minor issues in Mr. Kafi's home electrical circuit, such as getting shocked when switching on devices and bulbs blowing out. When an electrician was called, he used two instruments to test the current and voltage and found some faults. He advised the family members to use electricity more responsibly.

a. What is resistance?
b. What does 10 kiloohms mean? Explain.
c. With the help of a diagram, explain the connection process of the two instruments used by the electrician to detect electrical faults.
d. Analyze the importance of the last sentence in the stimulus in our personal and national life.

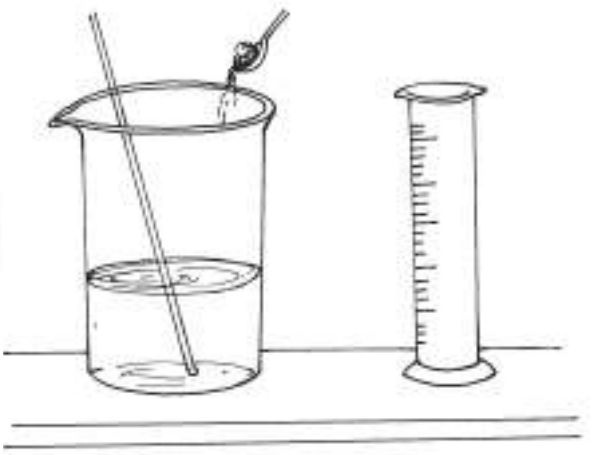
Short Answer Questions

1. What type of electric current is used in households? Explain.
2. Why does the V-I graph pass through the origin and form a straight line? Explain.
3. Why does the current decrease when a conductor's resistance increases? Explain.
4. What does it mean if a conductor has 1 ohm of resistance? Explain.
5. Why is a parallel circuit used in household wiring? Explain.

Chapter Ten
Acid, Base and Salt

Lemon juice, vinegar, lime, antacid medicine, and common salt all are very useful materials for us. Some of these are sour or acids, some of these are bases and some are salts. The chemical properties of these are different depending on their properties they are used for different purposes.





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

- explain the properties of bases and acid;
- explain the properties of bases;
- explain the properties of salts;
- explain the neutral substances;
- use instruments properly for experimental works;
- appreciate the importance of acids, bases and salts in our lives;
- create awareness among group members about the importance of safety measures during the experiments.

Lesson 1-4: Acid, Base and Indicators

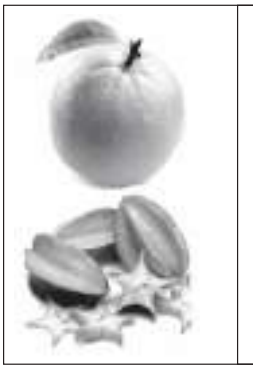
Activity: To know about acid.
Necessary components: Lemon juice, litmus paper, beaker, forceps
Methodology: Take 2-3 mililitre of lemon juice. First dip the red litmus paper into the lemon juice holding it by forceps. Did the colour of the paper change? No, it did not. Now dip the blue litmus paper. Is there any change of colour? Yes, the colour of the litmus paper changed from blue to red.

Instruction: The activity will be completed with the help and guidance of the teacher.

Do You Know the Reason for the Change

Are you aware of the reason for the change? Litmus paper is made from ordinary paper using the color from the leaves of a tree called lichens. Litmus paper prepared this way appears red. When the litmus paper is tested in an alkaline solution, it turns blue. Conversely, when blue litmus paper is treated with acid, it turns red.

In lemon juice, there is Citric acid. When red litmus paper is dipped, no chemical reaction takes place, and consequently no change of colour of the litmus paper is observed. On the other hand, if you dip blue litmus paper in Citric acid, chemical reaction takes place and consequently there is change of colour.



Activity: Divide yourselves in groups. Take some vinegar, Carambola or Orange juice instead of lemon juice. Examine them with red and blue litmus paper. Observe the change of colour.

Thus we can say that one of the properties of acids is to change the blue litmus paper into red. Do you know why just like lemon juice amloki, koromcha, carambola, lime, grape juices are sour?

The reason is that those fruits have different types of acids in them. Thus we can say acids taste sour.

A list of fruits and the acid present in each are given in the table below:

Name of the Fruits	The type of acid present
Grapes, Orange, Lemon	Citric acid
Tamarind	Tartaric acid
Tomato	Oxalic acid
Amloki	Ascorbic acid
Apple, Pineapple	Malic acid

Activity: To know about bases.
Necessary components: Lime, beaker, water, red and blue litmus papers, hand gloves, stirrer, forceps, dropper, spatula
Methodology: Put on the hand glove and take 5 to 10 gram of lime in the beaker using spatula. Now slowly add 100 milliliter of water to it by the dropper. Shake the mixture with the stirrer properly. Keep the mixture for ten minutes, separate the clean solution from the top of the mixture carefully. This clear solution is lime water. Now dip in the red and blue litmus paper in turn. What change do you see in the colour of the litmus papers?

Instruction: The activity will be completed with the help and guidance of the teacher.

You will see that the red litmus paper turns blue in colour, but the blue litmus paper does not change its colour. Later you will know about colour change in detail. Materials that contain chemicals in lime water, {like $Ca(OH)_2$} which turn red litmus paper blue, are called bases. Sodium hydroxide (NaOH) is a base used in soap manufacturing. It is also used in the paper and rayon industries.

Indicator: The litmus paper you used above can show whether a substance is an acid or a base by changing color. Materials like litmus paper, which identify whether a substance is an acid, base, or neither, are called indicators. Examples include litmus paper, methyl orange, phenolphthalein, and methyl red. These can determine whether an unknown material is an acid, a base, or neutral.

Acid: Let us look at the symbol of some acids. Vinegar or acetic acid (CH_3COOH), oxalic acid (HOOC-COOH), hydrochloric acid (HCl), sulphuric acid (H_2SO_4).

Where do the similarities lie in all these acids?

Note that all these substances contain one or more hydrogen atoms. These hydrogen atoms produce hydrogen ions (H^+) when in contact with water. Therefore, we can say that these chemical substances are acids if they have hydrogen atoms and generate H^+ in water.

$$HCl \xrightarrow{H_2O} H^+ + Cl^-$$

$$CH_3COOH \xrightarrow{H_2O} H^+ + CH_3COO^-$$

Is methane (CH_4) an acid

No, it is not an acid. Methane has four hydrogen atoms, it does not produce H^+ in water. Now let us look at two bases. For example, sodium hydroxide (NaOH) and calcium hydroxide [$Ca(OH)_2$].

Those chemical substances which have hydrogen and oxygen atoms and produce hydroxide OH^- in water are base.

$$NaOH \xrightarrow{H_2O} Na^+ + OH^-$$

$$Ca(OH)_2 \xrightarrow{H_2O} Ca^{2+} + 2OH^-$$

However, there are some chemical substances like calcium oxide or lime, ammonia (NH_3) which do not have oxygen and hydrogen atoms, but they produce OH^- in water. They are also called base.

$$CaO + H_2O \longrightarrow Ca(OH)_2$$

$$NH_3 + H_2O \longrightarrow NH_4OH$$

Base: You have known before that a base is a metal oxide or a hydroxide. There are some bases which dissolve in water. There are also some bases which do not dissolve in water. The bases which are dissolved in water are called alkali. Thus alkali is a special kind of base. NaOH, $Ca(OH)_2$ and NH_4OH are alkalis. These are also called base. On the other hand, aluminium hydroxide [$Al(OH)_3$] does not dissolve in water. That is why, it is a base but not an alkali. Therefore, we can say that all alkalis are base but all bases are not alkali.

Everyone knows that when you touch soap, it feels slippery. The reason is that soap contains base. Therefore, we can say that a common property of alkali and soap is that both of them are slippery. Again, both bases and alkalis taste basic. It is to be remembered that we should not examine the taste of an alkali in the laboratory.

Lesson 5-6 : Use of Acids and Bases

Do you know how commonly used bleaching powder is produced? It is produced by the chemical reaction between dry calcium hydroxide and chlorine gas (Cl_2) . Again the dilute solution of calcium hydroxide or lime water is used for the white washing of our buildings. On the other hand, the mixture of calcium hydroxide with water, known as milk of lime is used as an insecticide.

Do you know, what the antacid we take, when we have stomach acidity is?

Antacid medicine is basically magnesium hydroxide [$Mg(OH)_2$] which can be obtained both in suspension or as tablets. The magnesium hydroxide [$Mg(OH)_2$] suspension is more commonly called milk of magnesia. Sometimes antacids contain aluminium hydroxide [$Al(OH)_3$].

Acids found in fruits and vegetables are called organic acids. These are edible and some are essential for human body. For example, ascorbic acid is known as vitamin C. Without it, man suffers from scurvy. On the other hand, there are acids like hydrochloric acid (HCl), sulphuric acid (H_2SO_4), phosphoric acid (H_3PO_4), nitric acid (HNO_3), perchloric acid ($HC1O_4$) which are obtained from different mineral products gathered from nature. These are called mineral acids. These are not edible. We can rather say that these are harmful for human body. Mineral acids, when they come in contact with human skin, can cause significant damage.

You might have heard that some criminals in our society throw acid on human body causing serious burn. What types of acids are those? These are mineral acids.

Do you know what the punishment for throwing acid is? It is very severe and can lead to the death penalty.

By throwing acid, people are committing serious crimes and wasting valuable acids that could be used in industry. We need to organize protests against it and raise people's awareness. For this, we can make posters and distribute them among the people. We can thus try to save our society from the dangerous crimes like acid throwing and can prevent the wastage of our valuable mineral acids as well. There is no denying the fact that the use of acids in our day to day life and in. industries is indispensable. The chemical that we use to clean our toilets contain acid. The goldsmith uses nitric acid when he makes ornaments of gold. Sulfuric acid is used in batteries for various purposes, such as in IPS, cars, playing microphones, and generating solar power. You might have known that sometimes people use carbolic acid to protect their houses from snakes.

There is acid in our stomach to digest the food we eat, this is hydrochloric acid. One of the most important components in fertilizer industries is sulphuric acid. In addition, a significant amount of H_2SO_4 is used to prepare various chemicals, including detergents, paints, medicines, insecticides, paper, explosives, and rayon.

The state of a country’s progress in terms of industrial development is usually judged by the quantity of H_2SO_4 uses.

HCl is used in steel mills, medicine industries, leather industries etc. $HN0_3$ is used in fertilizer industry for the production of explosives, for extracting precious metals like gold from the mine and with fuels for rockets.

Lesson 7-10: Some Important Properties of Acid and Alkali

Activity: Observing the reaction of hydrochloric acid with limestone

Necessary Components: Limestone, spoon, dilute hydrochloric acid, dropper, apron

Methodology: Put on the apron. Grind the limestone. Take the clay powder in the spoon. Now, use a glass dropper to add the diluted hydrochloric acid to the spoon. Do you find any change? Are bubbles being created? Yes, there are bubbles creating foam. This happens because, when dilute hydrochloric acid is added to clay stone ($CaCO_3$) there is a chemical reaction between calcium carbonate and hydrochloric acid. This produces calcium chloride and carbon dioxide gas, which form bubbles. When the produced carbon dioxide is gone, we see a transparent solution of calcium chloride in water.

Instruction: The activity will be completed with the help and guidance of the teacher.

Almost all acids, like hydrochloric acid, react with carbonates to produce carbon dioxide gas.

$$CaCO_3 + 2HCl \longrightarrow CaCl_2 + H_2O + CO_2 \uparrow$$

You might be surprised to learn that this property of acids is often used to produce carbon dioxide to extinguish fire.

Can you say what reaction will take place between baking powder (NaHC03) and hydrochloric acid? The reaction between baking powder and hydrochloric acid produce sodium chloride, water and carbon dioxide gas.

$$NaHCO_3 + HCl \longrightarrow NaCl + H_2O + CO_2 \uparrow$$

You have learned in your previous class, about the reaction that occurs when lemon juice or vinegar is added to baking powder. Do you remember it? Write down the reaction that takes place in this case.

Activity: To observe what happens when acid is added to metals.

Necessary components: Zn as metal, dilute hydrochloric acid, spirit lamp, test tube, apron

Methodology: Put on the apron. Fill half of the test tube with dilute hydrochloric acid. Add a little amount of zinc to the test tube. Do you find bubbles coming out? If that's not the case, light a spirit lamp and apply gentle heat to the bottom of the test tube. Do you now find bubbles of gas?

Instruction: The activity will be completed with the help and guidance of the teacher.

This is bubble of hydrogen gas which is produced by the reaction between zinc and hydrochloric acid. You can test whether the gas is hydrogen by an experiment. Take a lighted match stick near the open end of the test tube. What do you see? It is burning with a sound. If it was any gas other then hydrogen, it would not produce any sound.

$$Zn + 2HCl \longrightarrow ZnCl_2 + H_2 \uparrow$$

Almost all acids, like hydrochloric acid, react with metals to produce hydrogen gas.

Activity: To observe the reaction between acid and lime water.
Necessary components: Lime,water, sulphuric acid, beaker, red litmus paper, stirrer, forceps, dropper
Methodology: Prepare lime water. Take 10 millimeter of lime water in a small beaker. Now dip red litmus paper in the lime water with the help of the forceps. The litmus paper turns blue from red. This proves that lime water is alkaline. Now add dilute sulphuric acid to it slowly using the dropper and go on stirring. By dipping litmus paper in the solution of the beaker ,find out what type of change in colour occurs. In this way, go on adding H_2SO_4 gradually and continue the test with litmus paper. At one state you will find that no change of colour occurs.
Instruction: The activity will be completed with the help and guidance of the teacher.

Why the colour of litmus paper is not changing?
The reason is that the calcium hydroxide [$Ca(OH)_2$] present in lime water by reacting with the added sulphuric acid H_2SO_4, produce calcium sulphate and water. As a result the amount of $Ca(OH)_2$ decreases gradually. When the amount of $Ca(OH)_2$ completes its reaction with H_2SO_4, the litmus paper no longer changes its colour.

$$\underset{\text{Base}}{Ca(OH)_2} + \underset{\text{Acid}}{H_2SO_4} \longrightarrow \underset{\text{Salt}}{CaSO_4} + \underset{\text{water}}{2H_2O}$$

Here the produced calcium sulphate is a salt. Thus we can say that base and acid reacts to produce mainly salt.
Let's see some salts formed by the reaction of alkalis and acids.

Base		Acid		Salt		Water
NaOH	+	HCl	$\longrightarrow$	NaCl	+	H_2O
KOH	+	HNO_3	$\longrightarrow$	KNO_3	+	H_2O

However, salt is not the only product of the reaction between an alkali and an acid. Other reactions may also produce salt. For example, reactions between metals and acids may produce salts.

$$Mg + 2HCl \longrightarrow MgCl_2 + H_2\uparrow$$
$$Na + 2HCl \longrightarrow NaCl + H_2\uparrow$$

Again acid reacting with carbonate, which is a salt, can produce salt.

$$Na_2CO_3 + 2HCl \longrightarrow 2NaCl + H_2O + CO_2\uparrow$$

Lesson 11-13 : Acid, Alkali and Salt Identification

Activity: To observe if there is change of colour on litmus paper when dipped in the ordinary salt solution in water.

Necessary Components: Beaker, stirrer, table salt,water, red and blue litmus paper, forceps

Methodology: Take 50 mililitre water in a beaker and add 10-15 gram of table salt to it. Stir it thoroughly with the stirrer. Now using the forceps, first dip the blue litmus paper and then the red litmus paper in the salt solution. Do you find any change in colour of the litmus papers? No change of colour will be observed. What is the reason?

Instruction: The activity will be completed with the help and guidance of the teacher.

The reason is that there is no acid or base in the solution. If there is acid, the blue litmus paper would turn red and if there is any base, the red litmus paper would turn blue.

This is only table salt dissolved in water, which is a neutral substance and therefore is neither acidic nor alkaline to cause a change in colour. There are other neutral salts, like table salt, which means they will not cause any change in the colour of litmus paper.

Sometimes, due to impurity, there can be acid or base in polluted water. In those cases, there can be a change in the color of litmus paper, although water is neutral in its pure form.

Activity: How to examine the acid or base prepared from the extracts of flowers and vegetables.

Necessary components: Petals from Joba, Baganbilash and yellow Krishnochura purple cabbage leaves, Beets, creeping herb, six beakers, stirrer, water, bunsen burner or gas burner, filter paper, bottle, paper and pencil, lemon juice, vinegar, sour card, lime water, baking powder, soap water, sodium hydroxide, hydrochloric acid, a piece of glass, dropper

Methodology: Collect the samples of different flowers and vegetables listed above. Taking samples from the individual flowers and vegetable in separated beakers add appropriate amount of water and then heat them in a burner. When the water reduces to half the original volume, cool down the mixtures. Filter and put the extracts in different bottles with specific marks. Now put lemon juice, lime water, sour curd, vinegar, soap water, baking powder, HCl, NaOH in different test tubes and mark them. Taking little extracts from each bottle add them to each test tube and shake well. Do you find any change in the colours of the extracts? Make a chart with identification of the substances as found out by the change of colour to red or blue. From this chart you can see which materials are acids and which materials are bases.

Instruction: The activity will be completed with the help and guidance of the teacher.

Write down in change of colour for each extract. Now examine each material with red and blue litmus paper and find out which of them are acids and which of them have the characteristics of a base. Materials are categorized as belonging to the same group when they change color in a similar way.

New words : Acid, base, indicators, litmus, lime water, antacid

What we have learned at the end of this chapter-

- When dissolved in water, the materials that produce hydrogen ions are sour or acidic.
- Acids turn blue litmus paper to red. Acid tastes sour.
- Metallic oxide or hydroxide is a base. Bases turn red litmus paper to blue.
- Alkalies are those bases which dissolve in water. Bases taste basic.
- The change of colour of indicators can tell whether a material is an acid, a base, or a neutral substance.
- Salt is a neutral material produced by the chemical reaction between an acid and a base.
- Salt, water, and carbon dioxide are produced when acid reacts with metallic carbonate or bicarbonate.
- Through the reaction between acids and metals, salt and hydrogen gas are produced

Sample Questions

Multiple Choice Questions

1. What type of acid is there in tomato?
   a. Acetic acid
   b. Oxalic acid
   c. Maleic acid
   d. Citric acid

2. Which acid is edible?
   a. HNO_3
   b. HCl
   c. H_2SO_4
   d. CH_3COOH

Read the following sentence and give answers to questions no. 3 and 4

Adil once carried out a reaction between zinc and hydrochloric acid.

3. In Adil's experiments-

   i. substition reaction occurs.
   ii. produced salt and water.
   iii. neutralization reaction occurs.

Which one of the following is correct?

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

4. What will be produced if there is a reaction between the limestome and the second compound?

a. H_2
b. O_2
c. CO_2
d. Cl_2

Creative Questions

1. Farah loves to eat oily food. Lately, she often feels stomach pain. The doctor said that she has acidity and advised her to change her food habit and take some medication.

a. What is salt?
b. Explain why aluminum hydroxide is a base but not an alkali.
c. What type of medicine did the doctor recommend? Explain.
d. The compound responsible for acidity mentioned in the stimulus—what type of compound is it and why? Analyze.

2. Mansura Khatun sometimes chews betel leaf. One day, she soaked lime in a pot and later noticed the pot had become hot. She also observed that when she breathed on the lime water, it turned cloudy.

a. What is a alkali?
b. Why does lime water turn cloudy? Explain.
c. Explain the uses of the compound soaked by Mansura Khatun.
d. Examine the probability that the compound produced in the stimulus shows the properties of both an alkali and base.

Short Answer Questions

1. What type of substance is ammonia? Explain.
2. Do pure water and salt solution change the colour of litmus paper? Give reasons for your answer.
3. What is the function of an indicator? Explain.

Task: Give a presentation of the list that you have prepared on the various acids, bases and salts that are used in our households.

Chapter Eleven

Light

When a ray of light crosses obliquely from one transparent medium into another transparent medium, it is bent at the interface. This is the refraction of light. In this chapter we will discuss various day to day phenomena where refraction of light is involved. These will include the total internal reflection and its application in the use of optical fibres. We will also discuss how a magnifying glass works and compare the function of our eyes with the function of a camera.





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

- discuss different phenomenon of refraction in daily life by drawing diagrams;
- explain total internal reflection ;
- explain how optical fibers work ;
- explain the function of a magnifying glass ;
- explain how spectacles work;
- explain the functions of camera and our eyes;
- appreciate the usefulness of light in performing the different activities in daily life.

Lesson 1: The Refraction of Light

Have you seen your image in a window glass? You must have marked that your image in the window glass is rather indistinct. Do you find a difference between this image and the image you see in the mirror?Why the image in the window glass is dull? The reason is that glass is transparent and most of the light falling on it passes through. Only a small fraction of the incident light is reflected back which forms the dull image.

Let us now see in detail how the direction of light changes when passes from one medium into another. First of all we begin with the following activity:

Activity: The concept of refraction

Necessary components: A long pencil, a drinking glass with water in it

Methodology: Take a glass which is 3/4 filled with water. You now put the pencil in the partially filled glass of water in an inclined way like the figure 11.1. How does the part of the pencil look under the water?

Observe the immersed part of the pencil. Write down the observed results. We know that we can see an object only when light reaches our eyes reflected from the object. You surely have seen that apparently the immersed part of the pencil look shorter, thicker and broken along the bottom of the glass.



Fig. 11.1 : Refraction of light

In the above experiment light from the bottom of the immersed part of the pencil reaches us after refraction. Before the light from the immersed part of the pencil reaches our eye it passes from the denser, transparent medium water to rarer medium air and is deflected on the surface. If light passes straight through two different medias, the pencil will appear straight. However, you observed that it seemed broken under water. The apparent bending of the pencil provides evidence that light is refracted at the surface between the two different media. This change in the direction of light is known as refraction of light. Light follows a straight path when the medium is constant and transparent. But light changes its direction as soon as it enters into another medium. This change will take place according to the density of the changes medium. It is to be noted that if light falls normally on the surface, there will be no change in the direction of light.

Lesson 2-3: Laws of Refraction of Light

Light rays follow the laws of refraction. First, conduct the follwing experiment.

Activity: Refraction of light of a glass slab.

Necessary components: Pins, glass slab, drawing board

Methodology: Fix a sheet of white paper on the drawing board. Place the glass slab at the center of the white paper and draw its boundary line. Now remove the glass slab and draw and incident ray AB. Fix two pins P and Q approximately 5 cm apart on the line AB. Put back the glass slab in the previous position and try to look at the pins P and Q from the opposite side of the slab. (Teachers help may be needed). Now, put two pins R and S on the opposite side in such a way that if you look from this side all the pins PQRS appear to be in a straight line through the slab. Remove the slab and draw the

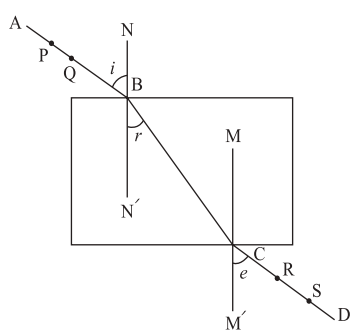


Fig. 11.2 : Refraction of light with respect to glass slab.

line CD through the points marked by the pins R and S. Draw the refracted ray BC, the normals MM´ and NN´ as in the figure. Using a protractor draw the incident angle ABN, the refracting angle CBN´, and the emergent angle DCM´.

What observations can you make from the above experiment? Here light is entering from rarer medium air to the denser medium of glass. From the measurement of angles, it is observed that the angle of incidence 'i' is greater than the angle of refraction 'r' and is equal to the emerging angle 'e'. Then you can decide.

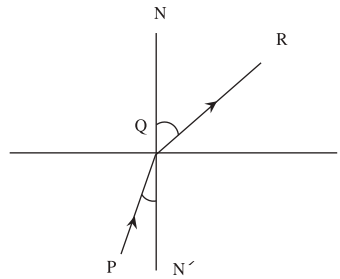


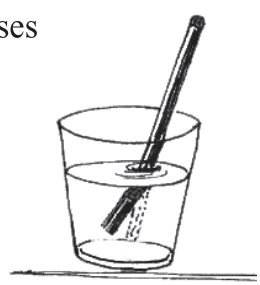
Fig.11.3: Refraction of light from dense medium to rarer medium.

- When a ray of light enters from a rarer medium to a denser medium then it bends towards the normal. In this case, the angle of incidence is greater than the angle of refraction.
- When light rays are reflected from one medium (like air) into another medium (like glass) and finally emerge out of the original medium, the angle of incidence is equal to the angle of emergence.
- The incident ray, the refracted ray and the normal drawn at the incident point on the surface separating the two media, all lie in the same plane.
- In addition to this, it is observed from the above experiment that light rays when passing from a denser medium to a rarer medium, bend away from the normal. In this case, the angle of incidence is smaller than the angle of refraction.
- When the ray of light is incident along the normal, then the angle of incidence, the angle of refraction and the angle of emergence are all zero. In this case there is no change in direction of the incident ray.

Lesson 4-5: Practical Application of Refraction

You will find the application of refraction in the following cases

1) When a straight rod is submerged obliquely in water and viewed at from above, how the part of the rod that is under water will appear? If you observe carefully, you will see that the rod appears smaller, thicker and raised upwards. In fact it appears so because of refraction. As you see in the figure, light is refracted from the denser medium of water into the rarer medium of air and enters your eyes. Every part of the emerged rod is raised upwards. As a result, the rod appears to be lifted upwards, reduced in lengths and increased in diameter.


Fig.11.4: Refraction of light

2) Take a steel mug or a ceramic cup. Place a coin in either the mug or in the cup. Keep your eyes in such a position that you just fail to see the coin. If someone pours water into the cup now, the coin will become visible at a certain point because of the refraction phenomenon. Due to refraction light bends in passing from the denser medium water into rarer medium air and create a virtual image of the coin which you see.



Fig11.5: Virtual image of a coin due to refraction of light

(3) Have you ever gone fishing? Does a fish stay at the position where you see it in clear water? Not at all. In fact, we observe the virtual image of the fish. The fish actually positioned at a bit lower than where it seems to be. If you hunt the fish with a spear, you have to aim it at a deeper and farther position than its apparent position. A similar effect occurs with the appearance of steps under clear water. The actual position of a step under water is lower than it appears when we view obliquely.

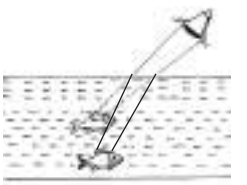


Fig.11.6: Change of image position of fishes due to refraction of light

(4) You must have noticed during the rainy season that ponds and banks become submerged. Where can we find the stairs leading down to the pond's edge in the clear water? In fact, they often appear to be at a lower level. Consequently, without a clear indication of the area, some people may fall in. Such events you can see if you visit the Sera Island of saint martin. The water there is very transparent. Stones and algae under water appear much closer to the eye than they really are. This happens due to refraction of light.

Lesson 6 -7: Total Internal Reflection and Critical Angle

When a ray of light enters a rarer medium from a denser medium, the refracted ray bends away from the normal line drawn at the point of incidence. As a result, the angle of refraction becomes larger than the angle of incidence. Thus, as the angle of incidence increases the corresponding angle of refraction also increases.

For a particular combination of a pair of media there is a certain value of the angle of incidence, which must be less than 90^o. In this case, the corresponding angle of refraction becomes 90^o indicating that the refracting ray travels along the surface of separating of the two media. The angle of incidence which corresponds to this situation is called the critical angle. Now, what will happen if the angle of incidence exceeds the critical angle? The angle of refraction can not, naturally, be greater than 90^o.

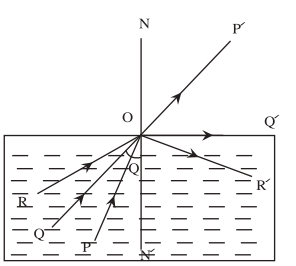


Fig. 11.7: Total internal reflection and critical angle

It has been observed experimentally that in this case the light ray instead of being refracted, is reflected back in the medium from the surface level. Thus the boundary surface here acts as a reflecting surface, and this reflection occurs according to the laws of ordinary reflection. This phenomenon is called total internal reflection.This means that the light ray from a denser medium, in this case is reflected at the boundary surface following the ordinary law of reflection and returns completely to the denser medium.

According to the figure the angle of incidence corresponding to the incident ray PO is less than the critical angle and the corresponding reflected ray is $\acute{OP}$. For the incident ray QO, the angle of incidence is equal to the critical angle, and the corresponding reflected ray is $\acute{OQ}$ which is traveling along the boundary surface. This means the corresponding angle of refraction is 90°. For the ray RO, the angle of incidence is greater than the critical angle. In this case the ray $\acute{OR}$ is reflected back due to the total internal reflection. Now the question is: what is the difference between ordinary reflection and total internal reflection?

In the case of ordinary reflection, there is always some partial refraction along with the reflection. However, in the total reflection, it is observed that the incident ray is completely reflected.

The conditions for total internal reflection

1) It occurs only when a light ray travels from a denser medium to a rarer medium.
2) The angle of incidence in the denser medium must be greater than the critical angle that corresponds to the selected pair of media.

Lesson 8: Optical Fibre and Magnifying Glass

Optical Fibre

The optical fibre is a very thin fibre of glass. It is even thinner than human hair and is flexible and extremely transparent. It serves as the carrier of the light rays. When light rays enter in this fibre, they undergo repeated total internal reflection at the walls of the fibre. This process continues till the rays reach the other end of the fibre. Usually, doctors use a bundle of optical fibres in a flexible tube to guide light rays for examining different internal parts of the human body like the stomach or colon. Another application of optical fibre is in optical communication. Since light consists of high frequency electro-magnetic waves, it can carry much more information. Signal strength loss is minimal in optical fiber, facilitating the transmission of information over long distances and along curved paths.

Magnifying Glass

A magnifying glass is a type of convex lens that makes objects appear larger. When an object is placed within a certain distance of a convex lens and viewed from the opposite side, an upright, magnified, and virtual image of the object is seen. The closer this image is formed to the eye, the larger the eye's viewing angle will be, making the image appear larger. However, if the image is formed closer than a point known as the "near point" (the closest distance at which the eye can see clearly), it will no longer appear sharp. When the image forms at this near point, it becomes most clearly visible to the naked eye.



Fig11.8 : Magnifying glass

When a beam of light that is parallel to the lens's axis strikes a convex lens, the point where the light rays converge is called the focal point. The distance from this focal point to the lens along its axis is known as the focal length. To magnify objects or text that are difficult to see with the naked eye, a convex lens with a short focal length is used. This lens, enclosed in a suitable frame, is known as a magnifying glass, reading glass, or simple microscope. This device dose not provide a high degree of magnification.

With the teacher's guidance, you can observe this type of magnifying glass.

Lesson 9-10: Human Eye

The eye is one of our five sense organs. We see things with our eyes. The functioning of the human eye is similar to that of a camera. The special parts of the human eyes are shown in the picture. Its main parts are described below.

a) Eye-ball: In the cavity of the eye there is a spherical object which can be rotated within a certain limit. This is known as eye ball.

b) Sclera: This is a white covering of the eye-ball which is hard, fibrous and opaque. It protects the eye from external harmful effects and preserves the shape of the eye.

c) Cornea: The frontal part of the sclera is called cornea. This part of the sclera is transparent and bulges outwards more than other parts.

d) Choroid: It is a black membrane that covers the inner body of sclera. Due to its blackness, the light entering the eye is not reflected.

e) Irish: It is an opaque membrane that remains just behind the cornea. This membrane can be various colours such as blue, deep brown, black etc. for different persons.

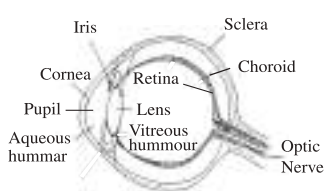


Fig. 11.9: Internal Structure of Human eye

f) Pupil: It is a circular hole at the centre of the cornea which is connected to muscular cells. The size of the pupil's aperture can be altered by the expansion and contraction of the muscles attached to it.

g) Crystalline convex lens: This is a convex lens made of soft jelly like material which is situated behind the cornea.

h) Retina: It is a light sensitive rose coloured translucent membrane located behind the eye-ball. When light falls on retina it creates some excitements in those nerves and produce the sensation of sight in the brain.

i) Aqueous humour and vitreous humour: The space between the lens and the cornea is filled with some kind of transparent watery substance. This is called aqueous humour. The space between the lens and the retina is filled with a jelly like substance. This is called vitreous humour.

Photographic Camera

This instrument is used to take photograps on photographic plates with the help of lenses. This is why it is called a Photographic Camera or in Short Camera. The different parts of the camera are: 1) Camera Box, 2) Camera lens, 3) Aperture, 4) Shutter, 5) Screen, 6) Photographic Plate, 7) Slide.

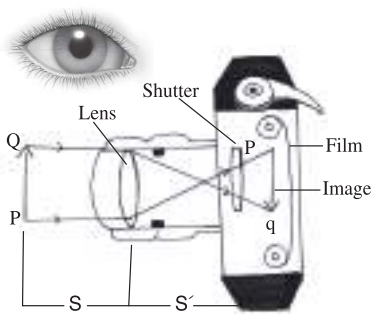


Fig 11.10: Photographic Camera

Function of a camera: Before taking the photograph of an object theground glass screen of the camera is directed toward the Object PQ and the shutter is opened. By adjusting distance between the lens and the screen the image Pq of the object is focused on the screen which is placed opposite to the object. The proper brightness of the image is obtained by adjusting the aperture. Next, the ground glass screen is removed, and the shutter is closed before the ground glass is replaced with the photographic plate. Then, the slide cover is removed, allowing the photographic plate to be exposed to a specific amount of light through the shutter and aperture. After that the aperture is again closed. This controlling of light is called the exposure. The incident light causes chemical reaction to the silver halide grains contained in the emulsion of the photographic plate.

Now the slide is covered and the photographic plate is taken to the dark room. Then, the photographic plate is removed from the slide and immersed in a chemical solution called developer. The parts of the film are chemically reduced from silver halide to metallic silver, resulting in a reduction process. The areas of the object that emitted more light result in a greater quantity of silver being deposited in those parts of the plate, which proportionately darkens the corresponding areas of the film. The thickness of the silver coating depends on the brightness of the light and the duration of exposure. After washing the film, it is dipped in hypo (sodium thiosulfite). As a result, the areas of the film that were not exposed to light have their silver halide dissolved. The film is then washed in water. Thus, we obtain the negative image of the photograph of the object. To create a positive image from the negative film, it is placed over photographic paper coated with silver halide and exposed to light for a short time. Afterwards, the paper is washed in hypo as before, and the positive image is achieved after washing and drying.

A comparison between an eye and a camera

Camera	Eye
1) It is a light proof closed box which is painted black inside. This black color prevents light from reflecting off its surface.	1) The eye acts as a light proof enclosure. Its walls are black so light falling on it is not reflected.
2) Using the shutter, the camera lens can be kept exposed to light for any duration.	2) With the help of the eyelid, the eye lens can be kept exposed to light, but the eyelid cannot remain exposed to light for any length of time.
3) The amount of light needed to form the picture can be controlled by adjusting the circular aperture of the camera.	3) Depending on the intensity of light the aperture of the cornea is automatically adjusted to allow the necessary light to form the image.
4) A camera has many lenses, and each lens has a specific focal length. The effective focal length of a lens can be changed by moving it backward and forward.	4) By adjusting the muscles connected to the eye lens, the focal length can be changed by altering its curvature.
5) The image of the object is formed by its convergent lens.	5) The cornea, aqueous humor, and eye lens, along with the vitreous humor, work together to create a system similar to a convergent lens that forms an image of an object.
6) A real inverted and reduced image of the object is formed on the photographic plate.	6) A real inverted and reduced image of the object is formed on the light sensitive retina.

New words: Refraction of light, total internal reflection, critical angle

What we have learnt at the end of this chapter-

- In a certain transparent medium, light travels in a straight line. However, when it enters a second medium with a different optical density, it bends by an amount that depends on the optical density of that second medium.
- When light falls perpendicularly and transparently on the surface separating the two media, its direction does not change.
- When light enters from a rarer medium into a denser medium, it bends towards the normal drawn at the point of incidence on the surface separating the media. When light enters from the denser medium into a rarer medium it bends away from the normal.
- For total internal reflection, the angle of the incidence in the denser medium must be greater than the critical angle that corresponds to the two media.
- There are many similarities between the working procedures of a human eye and those of a photography camera.

Sample Questions

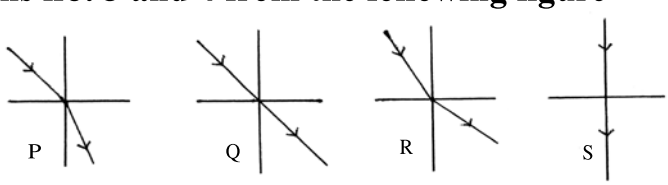
Multiple Choice Questions

1. What is the term used for the sclera in front of the eye?
   a. Lens b. Retina
   c. Cornea d. Iris
2. Optical fiber is used for -
   i. fuel
   ii. examining stomach
   iii. telecommunication

Which one of the following is correct?

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

Answer questions no. 3 and 4 from the following figure



3. In which figures light is propagating from denser medium into rare medium?
   a. P b. Q
   c. R d. S

4. In which of the figures the angle of incidence is equal to the refracting angle?

a. P & R b. Q & R

c. Q & S d. S & P

Creative Questions

1. One day Anis went to a pond to take a bath. He put his feet on the visible steps under the transparent water. But he fell, because it was deeper than he thought. Meanwhile, his younger brother was trying to catch fish with the fishing spear. But he failed because he aimed at the wrong spot.

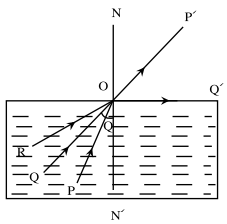
a. What is refraction of light?

b. Why does light change direction when it passes from one medium to another with a different density? Explain.

c. Explain why Anis fell into the pond.

d. What strategy should Anis's brother have used to catch the fish? Analyze with reasons.

2. Answer the following questions based on the stem below:



a. What is total internal reflection?

b. Why does a dry paper catch fire when sunlight passes through a magnifying glass? Explain.

c. Draw and explain the path of the RO ray with diagram.

d. Which ray in the figure creates critical angle? Explain.

Short Answer Questions

1. Why does light change its path when it passes through different media? Explain.
2. Why does a coin in a glass filled with water appear closer when viewed from above? Explain.
3. How is the critical angle formed? Explain.
4. Why can fish and aquatic animals see the sunset from under the water in a pond? Explain.

Chapter Twelve

The Outer Space and Satellites

We can see the sun in the sky during the day time. The cloudless sky of night surprises us. In a clear night sky there is the moon and innumerable twinkling stars. We are charmed by their beauty. Above us there is the limitless sky and infinite outer space. The sun, the moon, the planets, the stars, the Milky Way, the galaxies, and the outer space-altogether make up our universe. Everything that belongs to the universe is known as the object of the firmament. In this chapter, we will discuss about the universe.



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

- explain the outer space and the universe;
- explain natural and artificial satellites;
- explain the movement of satellites in the orbit;
- describe the uses and importance of artificial satellites;
- appreciate the benefits derived from artificial satellites.

Lesson 1 : The Outer Space

When we look at the sky, we see many distant objects. We can view the sun during the day and planets, satellites, and stars at night. By using binoculars, we can observe many more things. Jupiter continues to shine alongside its companion planets. When we look at space, the visible objects are referred to as substances, such as the Earth.

Where Does the Outer Space Begin?

The atmosphere of the earth rotates along with it. This is why the atmosphere is taken as a part of the earth and not as a part of outer space. Where does outer space begin and the atmosphere end? As the distance from Earth increases, the atmosphere becomes thinner. At about 160 km above the ground, space is almost empty. Most scientists agree that at 160 kilometers above Earth, the atmosphere ends and outer space begins.

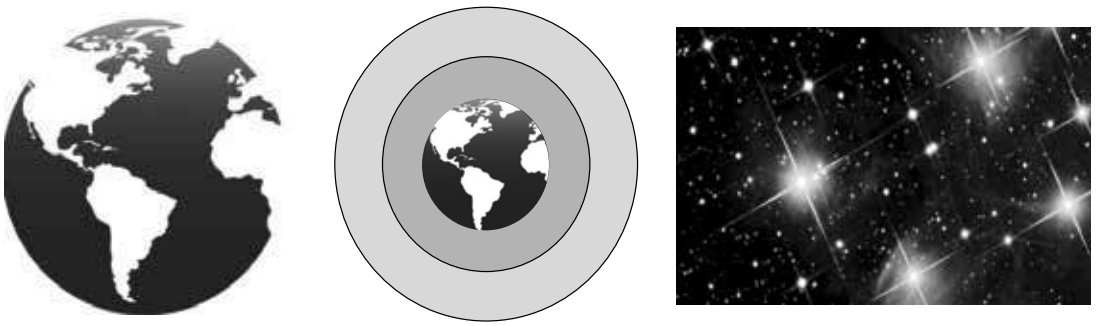


Fig. 12.1 : Earth, atmosphere and the outer space

How far does outer space go? Is there a limit to outer space? In the past, people believed that outer space had boundaries. They thought it extended as far as they could see and appeared to curve. Later, after binoculars were invented, people could see planets, stars, comets, and galaxies beyond their visual reach.

Activity: Learn about space from different books and magazines. What exists in space? Write down your findings in your notebook. Match your information with that of your friends. If there are any differences, present them in the classroom with the help of your teacher.

Lesson 2: The Universe

How the Universe is Defined

The Universe is composed of all existing matter and space as a whole. The earth, the planets, stars near and far, comets, galaxies, small insects, dust, and both visible and invisible things all comprise the Universe. Nobody knows how big the universe is. The shape and size of the universe are unknown to everyone. Many scientists think that there is no beginning and ending of the universe. However, some people believe that the universe has a size and shape. Humans are discovering new information about the universe now and then, but much of it is still beyond our understanding.

Although many things remain unknown to us, the existence of matters in some parts of the universe is higher than another part. The matters concentrated on a large volume in some parts of the universe is called a galaxy or star world. A galaxy is a large group of planets and stars. Our earth exists in the galaxy of Milky-Way. There are crores of galaxies in the universe where exists crores of stars.

The galaxies move in groups in the outer space. The stars of the galaxies seem very near in comparison to the unlimited outer space, but it is not true. They are so far from one another. Let us think about the distance among them. We know that light runs about 0.3 million km. way per second. The distance between the earth and the sun is about 150 million km; the sun light takes approximetly 8 minutes 20 seconds to reach the earth. On the other hand, the sunlight takes more than 4 years to reach Alpha Centerio, the nearest star from the sun. Light takes a few million of years to reach from a farthest star to another fasthest star. Now you can realize that what is the distance from one star to another star and how mammoth the universe is!

The solar system exists in the galaxy named Milky-Way. The stars are seen. twinkling and shining from the earth. Each of the stars is a mass of burning gas and so it has light and heat.The stars of the universe are divided into different colours like red, blue, yellow etc. according to the intensity of their light. Very large stars are red, medium stars are yellow and small stars are blue.The stars of the universe are divided into different colours like red, blue, yellow etc. according to the intensity of their light. Very large stars are red, medium stars are yellow and small stars are blue.

How is the Universe Created?

From the available evidence on the age of the universe, astronomers believe that the Universe started with a massive explosion, called the Big Bang Theory. According to this theory, the universe was once extremely hot and infinitely dense at certain points. According to the this theory, the universe spontaneously expanded very rapidly. The Big Bang occurred about 13.75 billion years ago, which is the age of the universe. The Big Bang Theory is one of the most tested theories that most scientists accept. It can accurately explain nearly all the events observed by astronomers. A huge explosion sent everything racing outwards in all directions. Before the Big Bang everything was packed incredibly close together to a point of high temperature and density. Over time it has expanded into the Universe we see today.

When scientists look at distant galaxies they see that other galaxies are moving away from our galaxy. More distant galaxies are moving away faster. In fact all the galaxies are moving away from each other. We say that the Universe is expanding. All the astrologers, including the famous physicist Stephen Hawking of the present time, have expressed their opinion in favour of this theory.

Lesson 3 : Natural Planet or Satellite

The galaxy we belong, to you know, is the Milky-Way. In this Milky-Way the sun is located along with its family members. They together form the solar system where 8 planets are revolving around the sun. The objects which revolve around the sun are called planets. These planets are Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune.

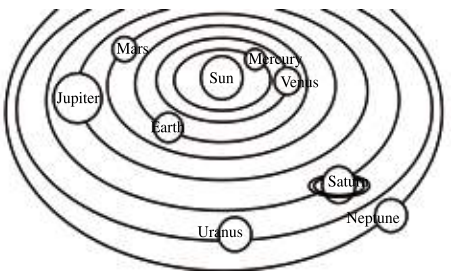


Fig 12.2: Solar System

Some planets have more than one satellite. The objects which revolve around the planets are called satellites. For example, the moon is revolves around the Earth and is called Earth's Satellite. Therefore, the earth is a planet of the sun and the moon is a satellite of the earth. Do the activity below and you will understand the motion of planets and satellite. anchos

Activity: Understanding about the motion of the planets and Satellites .
Methodology: Go to an empty spot inside or outside the classroom. Ask one of your friends to stand at a definite position. Draw a big circle with your friend at the center. You take your position at one point on the circumference of the circle. Ask another of your friends to move in a smaller circle around you at the center. Now if you move along the larger circle with your first friend at the center of the circle and your second friend revolves around the smaller circle with you at its center, your first friend represent as the sun, you can be considered the earth and your second friend can be considered the moon.

Astronomers believe that a few cosmic clouds revolved around a star when the planet was formed. They condensed due to the force of gravity and eventually solidified, transforming into planets. In this way, again satellites are formed around the planet. These satellites are natural satellites. The planets and satellites do not emit light or heat. Sunlight is reflected falling on them. The Earth has 1 satellite, Mars has 2 satellites, Jupiter has 67 satellites, Saturn has 62 satellites, Uranus has 27 satellites, and Neptune has 14 satellites*. They revolve around the planets due to the influence of the force of gravity of their respective planets.

Lesson 4 : Artificial Satellites and History of Their Development

A smaller body orbiting a larger one, usually a planet, is called a satellite. An artificial satellite is a space vehicle designed to orbit a large body, usually the earth.

The moon is a natural satellite of our earth. An artificial satellite is much smaller than the moon and moves in a much smaller orbit. For every orbit there must be a definite outward centrifugal acceleration of the satellite to balance the inward attraction due to gravity. For this the velocity of a satellite is smaller when its distance from the earth is larger. It then takes more time to complete one revolution round the earth. We know that the earth revolves on its axis once in 24 hours. If an artificial satellite revolves round the earth in 24 hours, it will appear to be at rest with respect to the earth.

The history of artificial satellite is not very old. The first journey into the outer space was initiated by the Soviet Union on 4th October, 1957 when they sent the artificial satellite Sputnik 1. The meaning of the word Sputnik is travelling mate. In the same year they sent Sputnik 2 on 2nd December. The first American artificial satellite was Explorer- I, which was launched on 2nd February 1958. Vostok-1 was the first manned space mission by Soviet Union which carried the first person in space Yuri Gagarin on 12th April, 1961. Valentina Tereshkova of USSR is the first woman who went to space on 16th June, 1963 in Vostok-6. Intelset-1 was launched as communication satellite for commercial use. For remote sensing the satellite Candset-1 was launched in 1972. A satellite, named Apollo Souz test project, was sent first on a mission in 1975 for international communication. Over 5000 satellites have been launched to transmit telephone, radio and television signals around the world. Under Bangladesh Satellite Company Limited (BSCL) 'Bangladesh Satellite-1' an artificial satellite, is orbiting the Earth. It was launched on May 12, 2018. Fewer than half are still orbiting and many have stopped working and are orbiting as space junk.

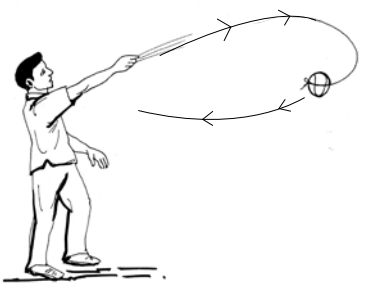
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Lesson 5 : Motion of an Artificial Satellite

For the orbital motion of a satellite around the earth there must be a centripetal force working inwards. This force comes from the earth's gravitational attraction. The calculation shows that to launch a satellite into an orbit round the earth a speed of about 8 kilometer per second is needed when the satellite is lifted above 250 kilometers parallel to the earth. But it is not an easy matter to apply so much velocity to an object at this height. Because the intense friction with the atmosphere will create as much temperature that the object will be burnt and turned into ashes. This speed is achieved by using a multi-stage launching system. As the first stage motor uses up its fuel, it drops off. So the second stage rocket does not carry its weights. The speed is increased stage by stage because at lower atmosphere the air friction is larger for the higher density of air. This can create enormous heat and burn the rocket. Then the artificial satellite begins to revolve around the earth. To understand how an artificial satellite orbits the earth you can do the following activity.

Activity: To understand the revolving motion of artificial satellites around the earth.

Methodology: Fix a tennis ball to the end of a thread about one meter long. Now holding the other end of the thread, throw the tennis ball in a plane parallel to the earth's space. You will notice that after passing a little distance it shows a tendency of circular movement. If you want to revolve the ball holding the end of the thread, the ball will revolve in circle due to tension of the thread. Here the inward pull on the thread is analogous to the gravitational force and the outward tension on the thread is centrifugal force due to the rotational motion of the ball. The circular path of the ball is analogous to the orbit of the satellite and the ball here is representing the satellite.



You can now see why the satellite revolves in definite orbits around the earth after launching.

Lesson 6-7 : The Importance and Uses of Artificial Satellites

Artificial satellites are used for different purposes. They are named according to their uses. For example – Communication Satellite, Weather Satellite, Earth Observation Satellite, Military Satellite, Navigation Satellite and Astronomical Satellite.

Communication Satellite

We often communicate with the outside world over the telephone. When we use the telephone, a radio wave is sent through a dish antenna from our country to an artificial satellite. The satellite transmits the radio signal to the antenna in the receiving country. From there it reaches the telephone of the person with whom we are talking to.

We also watch different cultural events, and sports like the World Cup or Olympic Games held in various countries using artificial satellites. It works in the same way where the signal is first sent to a satellite from a dish antenna which then sends it to our dish antenna. Finally, the information is shown in our television. Here, the satellite acts as a relay station. This satellite carries television programs and telephone news from one end of the earth to other end. For this reason the name of it is communication satellite. The 'Bangladesh Satellite-1' launched by Bangladesh is a Communication Satellite.

Weather Satellites

We listen to the weather forecast on television and the radio, and read newspapers. Where do these media sources get their weather news? The Weather Satellite helps forecast teams inform us about the weather for that day or the upcoming days, including where clouds are forming and moving, or when and where it might rain. To make forecasts, the satellite observes air flow, cyclone formation, cloud condensation, and potential storm areas. That is why this satellite is called a weather satellite.

Earth Observation Satellite

These satellites can provide us with clear images of Earth's surface. By observing and taking photographs, they can determine the locations of ships at sea, detect potential oil leaks that cause pollution, and identify polluted and dirty cities. They can also monitor agricultural fields and send photographs to assess where crops are thriving and where insect invasions are happening. Earth observation satellites also help locate forest fires and identify icebergs in ships' paths. The satellites can also detect soil, water, and air pollution.

Military Satellite

To assist in military intelligence, the satellite is called a military satellite. They are used to locate enemy positions, assess if there are preparations for invasion by the enemy, and determine if there are any secret attacks.

Navigation Satellite

We travel by cars, trains, ships, and planes. It detects what the vessels are doing at specific locations, where the airplane is staying, and what it is doing. It also helps us move from one country to another. Navigation satellites are used to determine the exact positions of vehicles, marine vessels, and airplanes.

Astronomical Satellite

The telescopes on the astronomical satellites are used to provide scientists with new information.

New words : Planets, Outer Space, Milky Way, Solar System, Artificial Satellite, Universe, Galaxy.

What we have learned at the end of this Chapter-

- Planets, Stars, and Milky Way existing in space are called the outer space.
- The sun, moon, planets, stars, outer space, and the galaxy that we can see and cannot see all make up the universe.
- Within the universe, the substances or objects that are collectively condensed are called a galaxy.
- The galaxy we live in is called the Milky Way. Our solar system is part of this galaxy.
- The sun is a star. It has eight planets: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune.
- The astronomical objects that revolve around the stars are called planets. The objects that revolve around the planets are called satellites.
- The objects that are sent by men to the outer space to revolve round the earth is called artificial satellite.
- Based on to the tasks carried out by the artificial satellites they are named as Communication Satellite, Weather Satellite, Earth Observation Satellite, Military Satellite, Navigation Satellite, Astronomical Satellite etc.

Sample Questions

Multiple Choice Questions

1. How many satellites are there in Jupiter?

   a. 14 b. 27

   c. 62 d. 67

2. galaxy is –

   i. a vast number of stars in the universe which are bound by the gravitational force.

   ii. the empty space between the planets and the stars.

   iii. the heavenly objects that revolve around a star.

Which of the following is correct?

   a. i b. ii

   c. i & iii d. ii & iii

Answer the questions no. 3 and 4 according to the table given below:

Artificial Satellite	Function
M	Determining the presence of ice-berg along the path of the ship.
N	Determining the position of a plane in the sky.
O	Exploring unknown information about the Universe.
P	Gathering information about the insects attacking crops by photography.

3. Which is the satellite N?

   a. Communication Satellite b. Navigation Satellite

   c. Astronomical Satellite d. Earth Observation Satellite

4. Based on the uses given in the table which two satellites are of the same type?

   a. M & N b. N & O

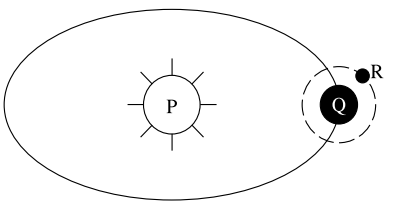
   c. O & P d. M & P

Creative Questions

1. Mishu often talks over phone to her father in England. This makes her curious. One day she learnt from a meteorologist that when he speaks with his father, a radio signal is sent from a dish antenna in that country to an artificial satellite. The satellite then transmits the signal to a dish antenna in another country. In this way, Mishu's message reaches his father. (She also watches the World Cup live on TV through the same type of satellite.)

a. What is an artificial satellite?
b. Which satellite helps determine the position of ships at sea? Explain.
c. Which satellite helps Mishu communicate with her father? Explain.
d. "It is possible to watch various World Cup games through artificial satellites." Explain with justification.

2. Answer the following questions based on the stem below:



a. What is space?
b. Why do artificial satellites revolve around the Earth? Explain.
c. What type of astronomical body is P? Explain.
d. Make a comparative analysis between Q and R.

Short Answer Questions

1. How did the origin of the universe happen? Explain.
2. How was the natural satellite formed? Explain.
3. "The Earth is a planet" – Explain.

Project: Design a model of solar system with the help of a teacher.

Chapter Thirteen
Food and Nutrition

At present there are thousands of species of animals living in this world. They show variation in their shape-size and characteristics as well as in life style, nature, food and feeding habits. Food is very essential for growth, energy and livelihood of every animal.Therefore, food is also essential for sound and healthy human body. Adequate knowledge about food and nutrition is the pre-condition of sound and healthy body. We eat organic compounds like proteins, carbohydrates, fats and oils etc. as food. We get nutrition from these food. Organic compounds which are used by organisms for their growth, repair and production of energy are called food. From these foods, living beings get obtain the nutrition they need.



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

- explain the nutritional value of different foods;
- describe different means to prevent malnutrition-related diseases;
- select food items based on requirements.

Lesson 1: Nutrition, Nutrition Value and Food Elements

To run an engine, fuels like coal, diesel, petrol, natural gas etc. are used. Can you say what these fuels are used for? These fuels are burnt to produce energy. This energy provides power to the vehicles. The vehicles are kept running by this energy. The human body is compared to an engine. Like other engines, energy is needed to run our body. Where do we get these energy from? Food fulfils the need for nutrition in our body and supplies energy.

The living organism is the main source of food. Food is mainly composed of different compounds. We get food mainly from plants and animals. By food we mean the organic elements used for the growth of body and production of energy for living beings. The ingredients of food or nutritive substances present in food perform mainly three functions of our body. For example

- Growth, repair and maintenance of the body.
- Providing heat and calorie.
- Preventing disease, ensuring sound health and controlling metabolic activities (such as digestion, respiration, excretion etc).

Nutrition and Nutrition Value

Nutrition is a process. In this process, food is digested after eating and complex food ingredients are broken down into simple ingredients suitable for absorption. The body absorbs these simple ingredients. After absorption, the nutrients reach all the cells of the body. As a result, every part of the body regenerates the damaged cells and forms new cells for the growth of the body. Besides, food also produces heat, provides nutrition to prevent diseases and maintenance of our body. All these activities of the body are part of the nutrition process. Therefore, the nutritional elements are the valuable components of foods. That provide energy and appropriate growth of the body, enhance merit and intelligence, prevent diseases, help for quick recovery from illness and make human beings active.

The nutritional value of any food depends on the types and amounts of elements present in it. For example, boiled rice contains 79% carbohydrates and 6% fats. Additionally, it contains a minute amount of proteins, vitamins and mineral salts. A 100-gram serving of rice provides about 345-349 kilocalories. Boiled rice contains carbohydrates, proteins, and vitamins, but it has a higher carbohydrate content. Therefore, rice is mainly a carbohydrate-based food.

In order to know the nutritional value of any food we need to know the nature of the food. The nature of food means whether it is a mixed food or pure one. In a mixed food, more than one nutrition elements are present. For example, egg, milk, hotchpotch, guava, etc. On the other hand, in a pure food only one element is found. For example, sugar, glucose. There are no other elements except carbohydrate in it.

Food Elements

Food is composed of a number of chemical elements. These chemical elements are called food nutrients. There is hardly any food which is made up of only one element. Based on its nutrients food is classified into three main groups. For example-

1. Proteins – repair, growth and developments of the body.
2. Carbohydrates – produce energy.
3. Lipids or fats – generates heat and energy.

Besides these, three other nutrients are also essential. For example-

1. Vitamins – helps in prevention of disease, increases energy and stimulates different physio-chemical reactions.
2. Mineral salts – they take part in different physiological activities.
3. Water – maintains water balance of the body, controls the qualities of the cells, and helps in thermoregulation.

Lesson 2-3 : Carbohydrate and Protein

Carbohydrate

We usually eat ruti, puffed rice (muri), chira, bread for breakfast. These are sources of carbohydrates. Carbohydrates are energy producing food. Among the different elements of our daily food, carbohydrate dominates. The carbohydrates are easily digested. All carbohydrates are composed of three basic elements, carbon, hydrogen and oxygen. In our body carbohydrates provide energy for work. Glucose is a kind of simple carbohydrate. Based on chemical composition, carbohydrates are divided into three groups. Only one carbohydrate molecule makes monosaccharide. This is also called simple carbohydrate. During digestion, disaccharides and polysaccharide are broken down into simple carbohydrates (monosaccharides) and then absorbed into the body. For proper nutrition of the body, simple carbohydrates are very important because human body, can only absorb them. Of the three main carbohydrates - glucose, fructose and galactose; glucose gets into the whole body through blood stream.

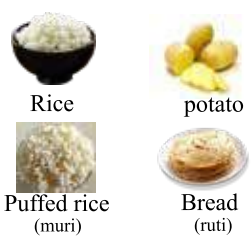


Fig. 13.1: Carbohydrate foods

Among carbohydrates, lipids and proteins, carbohydrate are the easiest to digest. Once absorbed in the body, they generate heat very quickly and supply energy to the body. One gram of carbohydrate can produce 4 kilocalories of heat. In a human body 300-400 grams of carbohydrates can be stored. This quantity of carbohydrate can produce 1200-1600 kilocalories heat and supply energy to our body.

The demand for carbohydrates depend on age, weight of the body, height and the amount of physical activity. An adult male person needs 4.6 grams of carbohydrates per kilogram of his body weight. An adult person weighing 60 kg requires (60 × 4.6) grams or 276 grams of carbohydrates daily on an average. Of the total requirement, we should intake 60-70 percent of calories from carbohydrate.

Activity : Identification of carbohydrate.
Necessary components : Rice starch, test tube, iodin, water, dropper etc
Methodology: Take a small amount of or rice starch into a test tube and mix little water in it. Now pour two to three drops of iodine solution into it. Observe what happens. The solution turns blue. From this experiment, the presence of carbohydrates can be determined.

Diseases Caused by Deficiencies

The intake of carbohydrate, be it more or less, both have negative impact on our body. Due to deficiency of carbohydrate malnutrition occurs. Fall of carbohydrate in blood creates metabolic disorder in the body. If there is a fall of carbohydrate in blood, symptom of hypoglycemia appears. For example– Feeling of appetite, Nausea, Excessive sweating, and Irregular heart beat.

Proteins

Protein is the composite element of our body. It is composed of carbon, hydrogen, oxygen and nitrogen. Proteins contain 16% of nitrogen. Therefore, in nutrition science protein is considered as a very important food nutrient. Protein is a complex compound of amino acids. During digestion, it turned into amino acids, suitable for the body to absorb. As of now a total of 22 types of amino acids have been found in the nature. The way we arrange Bangla or English alphabets to get numerous words, the proteins are produced in the same way after arranging 22 amino acids in different ways, number and types. For this reason, there are differences in the taste, smell, and colour of foods such as fish, milk, meat etc.

Some amino acids are very important for the growth, repair and balance of nitrogen of the body. These are called essential amino acids. These amino acids cannot be produced in the body.They must be obtained from food.

In food, if there is a deficiency of animal proteins i.e. essential amino acids, symptoms of various diseases arises. For example– nausea, increase of organic acid in urine, imbalance of nitrogen, etc.



Fig. 13.2: Protein foods

All proteins are not equally absorbed in the body. The digestibility factor of a protein is the percentage absorbed from the intestines after consumption. The nutritional value of proteins depends on their digestibility. After consuming proteins, the percentage of protein absorbed from the intestine is called the easily digestible quotient of the proteins. Proteins that are 100 percent absorbed by the body and promote growth and repair have an easily digestible quotient of 1. In this case, protein intake and absorption are equal. Simply put, the amount of protein taken by the organism is fully used by the body for growth and repair. If this is not the case, the easily digestible quotient is less than 1. The easily digestible quotient of breast milk and eggs is 1. The easily digestible quotient of other proteins is less than 1.

Activity : Identification of protein.

Necessary components : Egg albumin, spoon,water, test tube, sodium hydroxide, copper sulphate etc

Methodology : A little amount of protein(egg albumin) has to be stirred with the help of a spoon. For smooth stirring a little amount of water may be added to it. Now take a small amount of protein solution in the test tube. In this solution, add few drops of sodium hydroxide and copper sulphate solution. Can you see any changes in the solution?

The solution has taken violet colour following the mixing of the chemical elements with protein solution. This indicates the presence of protein.

Diseases Caused by Protein Deficiency

The body of children suffers from different protein deficiency related complications if food lacks sufficient proteins. The usual growth and developments of the body are also hampered. When children suffer from malnutrition, the growth of the body is stopped or delayed. The children suffer from kwashiorkor or merasmus disease due to protein deficiency.

Symptoms of Kwashiorkor Diseases

- Children lose their appetite.
- The muscle becomes scaly and weak, Moreover, the skin and hair lose their smoothness and colour.
- Children suffer from diarrhoea, and oedema.
- Stomach swells up.

Through proper treatment this disease can be cured, yet a kind of mental depression persists. If kwashiorkor becomes acute, it may cause death of the child.

Symptoms of Merasmus Disease

- The growth of the body is retarded due to deficiency of both proteins and calories.
- The body becomes lean and thin and reduced to a skeleton.
- The skin becomes rough and hanging down.
- Body loses the weight.

This state is dangerous for the children. Due to protein deficiency the elderly people lose their body's resistance and develop anemia.

Lesson 4-5 : Lipids

This is called energy producing ingredients. In lipids carbon, hydrogen and oxygen are found more in quantity. Since carbon has higher combustion quality the molecules of lipid substance release more heat energy. Lipids are a compound made up of fatty acid and glycerol. The fatty substance having digested tum into fatty acid and glycerol.

The fatty acids and glycerol are absorbed in the body through the lymph glands located in the villi of the intestine. In lipids 20 types of fatty acids are found. Fatty acids are of two types. For example: 1. Unsaturated fatty acids and 2. Saturated fatty acids.

Fatty acids are formed in liver. But the capacity of liver to produce fatty acid is very limited. On the other hand, there are some fatty acids essential for the body. These are mainly of plant origin. The usefulness of it cannot be measured by the quantity of fats present in food. Food, that contains more unsaturated fatty acids are more useful. For example: Soyabean oil, sunflower oil, com oil, sesame oil etc. The food made with these oils fall under the group of best fatty food. For example: mayonnaise, salad dressing, kasundi, oil pickles are included in the group of fatty food. The foods that contain more saturated fatty acids are called fat enriched food. For example- meat cheese, butter, dalda, chocolate, nuts, etc. According to nutrition science out of the daily required energy for the body, 20% - 30% energy is obtained from fats. We should include those fatty food in our daily food menu which can supply essential fatty acids and can dissolve vitamins in solution.

If food lacks fatty substances, deficiency of fat soluble vitamins occurs in the body. This will result in diseases due to the deficiency of vitamin. For example: skin will become dry and rough that will ruin the beauty of the body, the children will suffer form eczema caused due to the deficiency of essential fatty acids, and elderly people lose resistance against skin disease.



Fig. 13.3: Fatty foods

Activity : Identification of lipids.

Necessary components : Soyabean oil, ethanol and water

Methodology : Pour a few drops of soybean oil into a test tube. Mix it with a little ethanol. Now shake the test tube very well. Then pour a little water further into the test tube and shake it again. Observe what happens. The oil solution will be of somewhat muddy colour.

Do the same experiment using mustard, coconut and sesame oil and describe what happens.

Calorie and Work Energy of Food

The three nutrients of food-carbohydrates, proteins and fats -produce heat for the body. This heat provides energy in our body. To learn about the nutritive substance and their amount, the calorie of carbohydrates, proteins and fats must be determined. In this regard, the calorie value of vitamins, mineral salts and water is considered zero. In our body, metabolic activities such as digestion of food, respiration, blood circulation involved.

In our body

1 gram of carbohydrate can yield 4 kilocalorie of energy

1 gram of protein can yield 4 kilocalorie of energy

1 gram of fat can yield 9 kilocalorie of energy

The energy needed to run the metabolic activities is called basal metabolism. Additionally, energy is also spent during physical labour. We obtain energy from food. Again, the heat produced from food in the body is measured in calories. 1000 calories make 1 kilocalorie. Kilocalorie is the measuring unit of heat obtained from food. The requirement of energy for the body is also determined in kilocalories.

The need of calories varies for my body, yours, your younger brother and your father. In our bodies, energy is used in two ways. For example- 1. Inside the body e.g basal metabolism and 2. Physical activity. The demand of calorie or heat energy for a person depends mainly on age, height and weight of the body. Additionally, the amount of energy a person uses each day varies according to sex, body-size, occupation and special conditions such as pregnancy.

In the following chart the intake of calories and food demand is shown.

The amount of energy used each day by children, women and men of different age groups

Age (year)	Average weight (kilogram)	Average energy (kilocalorie)	Age (year)	Average weight (kilogram)	Average energy (kilocalorie)
infants			females		
0.0-5 Month	6	115	10-12	30	1900
6 Month - 1.0 year	9	100	13-15	42	2200
			16-19	51	2100
children			20-39	54	2000
1-3	13	1300	40-49	53	1900
4-6	20	1500	50-59	52	1800
7-10	28	1800	60-69	51	1600
			70+	51	1400
males			Extra		
10-12	40	2200	demand fo		
13-15	44	2500	pregnant		
16-19	67	3000	women for		
20-39	67	2700	first 3 months		+150
40-49	70	2400	2nd 3 months		+200
50-59	68	2300	3rd 3 months		+300
60-69	65	2200	Additional		
70+	65	1900	demand of lactating mothers		+400

How will we know how much energy a person requires daily? It depends on three factors. 1. Metabolism 2. physical labour and 3. Influence of food.

Our daily foods should match our needs. When selecting foods, we should keep in mind that the body can obtain the necessary amount of calories from food and it should also contain vitamins, mineral salts and other essential nutrients.

Lesson 6 : Vitamins

Through different investigations the scientists have proved that food contains a number of subtle nutrients other than carbohydrates, proteins, fats and mineral salts. In their absence body suffers from diseases like night blindness, beriberi, scurvy, etc. The term vitamin refers to an essential dietary factor which is required by the organism in small amounts and whose absence results in deficiency diseases. Thus, vitamin can be defined as potent organic compounds which must be available to the animals so that specific physiological processes (growth, replacing and repairing worn-out and damaged tissues or energy production) essential to life may proceed normally. The vitamins do not have active participation in body formation.

Types of Vitamin: Vitamins are classified into two sub-groups based on their solubility properties. For example:

1. Fat soluble vitamins, e.g.–vitamin-A, vitamin-D, vitamin-E and vitamin-K.
2. Water soluble vitamins, e.g.- vitamin B-complex group and vitamin C.

Sources of vitamins: Vitamins are found in green leaves, fresh branches, yellow and green leafy vegetables, fruits and seeds, etc.

Vitamin A

Sources: It is found largely in fish liver oil and animal fats. Vegetables rich in carotene such as red amaranth (lalshak), spinach (palongshak), vine spinach (puishak), tomatoes, carrots, beets and pumpkins, etc. are goods sources of vitamin-A. Different fruits like papaya, mango, and jackfruit contain vitamin-A, It is also found in small fish like carplet (mola), cotio (dhela) etc.

Functions of vitamins

To maintain good eyesight, keep skin and mucus membranes healthy, protect the body from various contagious diseases, aid digestion and stimulate appetite, maintain blood in a normal state, and support nutrition and growth.

Deficiency Related Diseases

1. Night blindness: The symptom of this disease is, one cannot see in inadequate (dim) light specially at night. The children are the main victims of this disease. If it continues for a long time, one might lose his eyesight. To prevent this disease, green vegetables and coloufull fruits should be added to the food menu of the children. Vitamin-A capsule can also prevent this disease. In our country, vitamin-A capsules are given to the children during vaccination days at different vaccination centres.

2. Xerophthalmia: If there is any deficiency of vitamin 'A', the cornea of one's eye may be affected. A dry layer appears on cornea. The eyes get dry and rolling of water from eyes also gets stopped. The eyes cannot tolerate light, pus accumulates in the eyes and the eye-lids become swollen. If proper treatment is done, the disease may be cured. However, if treatment is delayed, children could become blind. In addition, a vitamin A deficiency can hinder normal growth. Diseases such as cough, flu, and influenza may also occur due to this deficiency.

Vitamin B-Complex The function of vitamin B-complex group is to break down proteins, carbohydrates and fats as part of specific enzymes and help to release the energy from within.

Vitamin B1 (Thiamin): The main function of vitamin B1 is to participate in carbohydrate metabolism and release energy. Besides, it helps to maintain normal appetite and keeps the nervous system active.

Vitamin B2 (Riboflavin): It takes part in the metabolism of amino acid, fatty acid and carbohydrates and helps to produce energy.

Vitamin B6 (Pyridoxine): It helps in energy production.

Lesson 7 : Vitamin 'C'

Vitamin-C is a very essential nutrient for our body. This vitamin is water soluble and can be wasted with a little stroke of heat. Since it is not stored in the body, we should eat it everyday. It is found extensively in all citrus fruits like lemon, orange, shaddock, pine apple, guava, amloki, green vegetables like cabbage, cauliflower, tomato, and lettuce. Fresh vegetables and fruits contain more vitamin 'C' than the ripe ones.

Vitamin 'C' strengthens muscles and teeth, heals wounds and resists skin diseases, and prevents infection in throat and nose.

Deficiency Related Diseases

In adults, an acute shortage of vitamin C shows the following symptoms.

- Structure of bones cannot be strong.
- Bones become weak and fragile.
- Skin becomes dry, itches and the healing of wound is delayed.

Scurvy

- The gums swells up and becomes soft.
- The root of the teeth become loose and eventually bleeds.
- The enamel weakens, leading to tooth loss.Children and the elderly person suffer most from this disease.
- The glands swell up and mouthache is felt.
- Bleeding does not stop easily, and healing of wounds delayed.
- Other diseases like flue, and cough easily attack the body.

Remedy

At this stage consulting a doctor is very essential.

Prevention

A baby should be given, along with breast milk, other supplementary foods like fruit juice, vegetable soup etc.

Vitamin 'D'

Vitamin 'D' is found abundantly in edible oil, milk and milk products, different fish liver oil, egg yolk, butter, ghee, fats and hilsha fish.

Functions

- Forms structure of bones and teeth.
- Increases absorption of calcium in intestine.
- Controls the extent of calcium and phosphorous during blood circulation.

Deficiency Related Diseases

The deficiency of vitamin 'D' obstructed the absorption and accumulation of iron, and hamper hemoglobin formation.

Rickets

Symptoms of rickets

Due to the absence of vitamin 'D' and calcium the bones of the children become soft and their growth is hampered.

- The leg bones become curved like a bow and the other bones also get curved due to the pressure of the body.
- The bone joint of hands and legs swell up.
- The ribs also turn bent.

Remedy

At this stage a doctor should be consulted immediately.

Prevention

The children should be given vitamin 'D' enriched food. Vitamin D is obtained from the cholesterol of our skin under the influence of sunlight. Therefore, the children should be allowed to play in the sun for a while.

Osteomalacia

The rickets in elderly person is known as osteomalacia. The symptoms of this disease are as follows:

- Due to the deficiency of vitamin 'D' the absorption of calcium is hampered.
- The reserve of calcium and phosphorus reduces.
- There is a change in the function of thyroid gland.
- Since the bones weaken, their hardness also decreases, and as a result increasing the possibility of the bones breaking from a light stroke.

Remedy

If the above symptoms are visible, the advice of a doctor should be sought. Food containing appropriate amount of calcium and vitamin- D should be consumed. If needed, medicine should be taken for these food nutrients.

Prevention

- Ensure the consumption of vitamin -D and calcium enriched food for children.
- Children should be allowed to play in the sun for a while.

Vitamin 'E'

Edible oil is the best source of vitamin 'E'. Food grains, liver, fats of fish and meat contain Vitamin 'E'.

Functions

- Vitamin 'E' helps in cell formation.
- It takes part in some metabolic activities of the body.
- In very few cases the deficiency of Vitamin 'E' occurs and its deficiency symptoms are also negligible.

Vitamin 'K'

It is found in green vegetables, spinach, lettuce, cabbage, cauliflower, egg yolk, soyabean oil and liver.

Functions

- It produces the protein element prothrombin in the body.
- Prothrombin helps in blood coagulation.

Deficiency Related Diseases

The liver secretes bile and if there is difficulty in the secretion of bile, the absorption capacity of vitamin 'K' is reduced. The bleeding under the skin and inside the body due to the deficiency of vitamin 'K' if not stopped, may result in the death of the patient.

Due to vitamin- K deficiency bleeding of a patient, under operation is not stopped easily. Sometimes it might be fatal.

Fill in the following chequer board

Vitamin	Source	Function	Deficiency related diseases
'A'			
'B'			
'C'			
'D'			

Lesson 8 : Mineral Salt

We include salt in our daily rice and curry. Many other types of salt are also very important for our health. Like proteins, carbohydrates, and fats mineral salts do not produce energy in the body. However, salt is an essential elements for the body's cells and fluids. Food containing calcium, sodium, magnesium, phosphorus, chlorine, iodine, iron, sulphur etc. all get into the body and help in body formation. These elements are not found as basic elements in the body, they exist with other substances as organic and non-organic compounds. Mineral basically functions in two ways in our body. For example-they act as body forming elements and help control the internal activities of the body. Meat, egg, milk, green vegetables and fruits are the main sources of mineral salts.

Mineral salt forms part of the body and regulates its internal functions. For, the formation of bones, teeth, enzymes and hormones, as well as the stimulation of nerves, muscle contractions keeping the osmotic balance of the body and activating different enzymes, mineral salt is an essential element.

Necessity of Mineral Salts in Human Body

Calcium forms teeth and bones, coagulates blood and helps maintain the smooth functioning of the nervous systems. Phosphorus also forms teeth and bones and is necessary for making phospholipids. Iron forms the red blood corpuscles, helps the enzymes in their function. Iodine is essential for the thyroid gland and aids in maintaining a smooth metabolic process.

Lesson 9 : Deficiency Related Diseases

Rickets: Calcium is absorbed along with vitamin 'D' in the body. Its deficiency causes rickets. It has been described in the section of vitamin.

Goiter: It is also called ghag. The prevalence of this disease is higher in the northern part of our country especially in Rangpur, Dinajpur, Jamalpur and Mymensingh districts. In the absence of iodine in the body the thyroid gland becomes bigger and the throat gets inflated. This is called goiter or ghag.

The symptoms of this disease are as follows:

- Inflated thyroid gland.
- Sound produced during breathing.
- Hoarseness of voice.
- Feeling discomfort in the throat and trouble in swallowing of food.
- Patient feels dizziness and weakness.

Remedy

In the early stage of this disease, iodized salt, sea fish, fish liver oil and marine algae should be eaten. If necessary, a doctor should also be consulted for proper treatment.

Cretinism

Usually, children are exposed to this disease due to iodine deficiency.The symptoms of this disease are as follows:

- Growth of the body becomes slow.
- Thick skin and a deformed face.
- Thick lips, large tongue and risk of turning mentally retarded.

Remedy

Proper and timely treatment helps to overcome the problem and to maintain the normal growth of children.

Prevention

Iodized salt should be eaten regularly.

Anemia

Iron is the constituent elements of haemoglobin of red blood corpuscles. People If the children and pregnant women lack iron in their food, they suffer from anemia. Usually, children attacked with round worm may experience this disease.

Symptoms

- Weakness and drowsiness of head and body.
- Unusually rapid palpitation.
- Dizziness and difficulty breathing particularly even with light activity.
- Loss of weight and appetite.

Remedy

Vegetables enriched with iron, fruits, meat, egg yolk, liver, etc. should be eaten in ample quantities. If needed a doctor may be consulted for proper medication. If the disease turns acute, the rate of blood circulation through heart may goes up and one might be at the risk of heart attack following the stoppage of heart beat.

Water

Water is an essential nutrient for our livelihood. Our body contains 60- 70% water. In the formation of the body, the role of water is very much important. The water remains inside and outside the cells of bones, flesh, skin, nails, teeth etc. Almost all foods contain water. However, we meet our water needs by drinking it separately.

Apart from body formation, water controls all the internal activities of the body. Without water no chemical reaction can take place. Water acts as solvent in the body. Different mineral salts remain dissolved in water. The digestion of food goes on in presence of water. Again the food nutrients get absorbed in the body while they remain dissolved in water.

Function

- Water is responsible for blood circulation and thermal regulation of the body.
- Water releases waste materials from the body. For example urine, and sweats.

When cholera and diarrohea occur, a great quantity of water is released through defecation and vomit. As a result, the body suffers from water deficiency. If cholera or diarrohea occurs, the patient should be given oral saline or water-salt beverage (Shorbot). It is the easiest treatment for cholera or diarrohea. Besides, International Center for Diarrhoeal Disease Research of Bangladesh (ICDDRB) has produced packet oral saline for this disease. It is mixed with water and then given to the patient to drink. Recently a saline, named grain saline has been invented. This saline is made up of 1 litre water, 50 gm rice powder and a pinch of salt.

Task: Earlier you have learnt how to make oral saline. This time you again prepare oral saline. Write down what precautions you need to undertake while preparing oral saline.

Dryness

If there is a fall in the quantity of water in the body, the cells experience shortage of water. When the cell water is reduced one gets very thirsty, the blood pressure drops, blood circulation and digestion process are hindered. The body loses weight if there is water shortage and muscles and nerve cells become weaken. If the water level of the body goes below 20 percent, the normal body function hampered, the patient gets fainted and even may run the risk of death.

Roughage (Dietary fibre)

Roughage is the part of cereal grains, fruits and vegetables which is not digested. Roughage does not change inside the body. It is not a nutrition element. However, it is very essential to maintain a sound health. Roughage moves directly through the alimentary canal. Roughage in grains is called bran. Roughage in fruit and vegetables is the cellulose walls of plant cells. We get roughage from fibre foods.

Food Selection

The foods which meet the demand of the calorie of the body, maintain the growth and formation of tissue cells and control the metabolic activities of the body is called balanced diet. Therefore, by balanced food we mean the correct amount of food and the proper proportions of each (six) type of food that meet the demands of the body of a particular person.

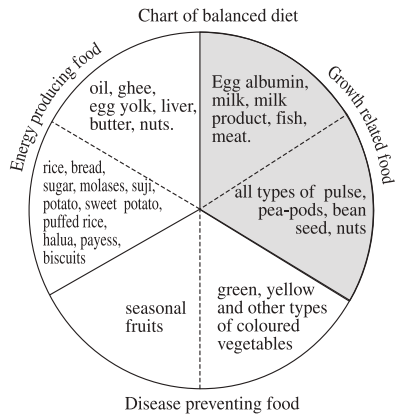
The necessary nutritional elements in food remain in specific quantities in a balanced diet depending on age, sex, physical condition, work load etc. A balanced diet chart should be made following some instructions. Such as-

1. In every single meal of the day the inclusion of six food elements including protein, carbohydrates and fats should be confirmed.
2. Food from each group has to be supplied based on age, sex and occupation.
3. Out of the total daily intake of calorie, 60-70% should come from carbohydrates, 10% from proteins and 30-40% from fats.

List of Balanced Diet

Following some guidelines we can make the list of balanced diet. For example:

1. Firstly the list has to be made based on the understanding that the requirements of different food elements vary according to age, occupation, and physical status of a particular person.
2. Meeting the calorific value of food according to physical needs of one's body.
3. The food should contain correct proteins needed for body formation and the prevention of its decay.
4. Ensure the presence of appropriate vitamins, mineral salts and water in food.
5. To acquire knowledge about the nutritional value and classification of food. First we have to select food from the main divisions of food. There should be variety in food selection.
6. There should be awareness about food habit while selecting food.
7. The food list has to be prepared matching with the financial ability of an individual and a family as well.
8. While preparing the list, season and weather condition should be taken into consideration.



New words : Protein, carbohydrate, lipid, vitamin, easily digestible quotient, amino acid, kwashiorkor, merasmus, xerophthalmia, scurvy, rickets, osteomalacia, prothrombin, cretinism, anemia.

What we have learned at the end of this chapter-

- The fundamental metabolism is the energy required to run metabolic process.
- Vitamins and mineral salts are not separate types of food. These all are obtained from other food-stuffs.
- Water is a very essential nutrient for the body. The digested foods, being dissolved in water, is transported to all parts of the body.

Sample Questions

Multiple Choice Questions

1. Which one produces heat and energy of the body?

   a. Water b. Vitamin

   c. Fats d. Mineral salts

2. The deficiency of which vitamin causes rickets in children?

   a. Vitamin 'A' b. Vitamin 'C'

   c. Vitamin 'D' d. Vitamin 'E'

Read the following paragraph and answer questions no. 3 & 4

Sumi does not like sour. Even she does not like green vegetables and tomatoes. Recently she has been experiencing bleeding from her gums.

3. What disease has attacked sumi?

   a. Scurvy b. Rickets

   c. Merasmus d. Kwashiorkor?

4. What happens to the elderly person due to the deficiency of foods mentioned in the paragraph?

   i. the bones becomes soft

   ii. the skin itches and wounds

   iii. pain in thoracic cage and ribs appears

Which one is correct?

   a. i & ii b. i & iii

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

Creative Questions

1. Sara nowadays doesn't want to eat anything. She has lost her appetite and often feels nauseous. Her skin is becoming rough. When she consulted a doctor, she was advised to eat more eggs and milk. Meanwhile, her grandmother is suffering from bone weakness due to a calcium deficiency.

a. What is food?
b. Why is Nyctalopia or night blindness dangerous? Explain.
c. What disease is Sara's grandmother suffering from? Explain.
d. If Sara does not follow the doctor's advice, what problems might she face in the future? Analyze.

2. Nurjahan Begum is very concerned about the physical growth of her 8-year-old son Bakul because he refuses to eat meat, milk, eggs, or fruits. As a result, he lacks the nutrient needed in various biological processes in his body. To ensure his growth and good health, she started giving him special types of food. However, she chose different foods for herself and for Bokul's father, grandfather, and grandmother.

a. What is protein?
b. Though roughage is not a nutrient, how it helps maintain health. Explain.
c. Explain the function of the nutrient that Bakul is lacking.
d. Analyze the logic behind Nurjahan Begum's different food choices for family members.

Short Answer Questions

1. Why is it good to expose children to sunlight for a short time? Explain.
2. Why is goiter more common in northern areas? Explain.
3. What is the function of Vitamin K? Explain.
4. What can happen due to iron deficiency in the blood? Explain.

Chapter Fourteen
Environment and Ecosystem

You know, our environment consists of everything around us. It is also known to you that, the living organisms and non-living matters of an area constitute the environment of that particular area. You must have observed that, there are different types of environment on earth. We may categorise them into three main heads, namely, fresh water, marine water and land. Each of these three environments also has special types of biotic and abiotic factors.

These living and non-living components are interrelated with each other. You know, among living components of the environment, there are plants and animals of different types. For survival, these plants and animals are interdependent and interrelated with each other.



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

- explain different environmental components and environmental types;
- explain the food chain and food web;
- explain the flow of energy in the ecosystem;
- analyze the role of ecosystems in maintaining environmental (ecological) balance;
- realize the impact of ecosystems on living beings and raise awareness about protecting ecosystem.

Lesson 1 : Ecosystem

There are different types of living organisms in different environment of the world. In different regions of each habitat, there exists a vast dissimilarity in their climatic conditions, weather and other abiotic and biotic factors. Due to these differences, the earth is inhabitated by many different types of organisms. The organisms you see in the forest are different from those inhabitated in the pond. There is a close relationship between biotic and abiotic components of these environment. Further, the animals, plants of an environment are dependent on one another for their survival. In this way, the living component of a particular environment is functioning and interacting with the abiotic components to form a relatively stable system, called ecosystem.

If you observe the environment, you will see there is a continuous action-reaction among different components of the ecosystem. The garden near your house or school is the example of a small ecosystem.

Lesson 2 : Components of Ecosystem

You already know that an ecosystem includes biotic (living) and abiotic (non-living) components.

Abiotic components: All non-living components of an ecosystem are abiotic components. These are classified into two categories: (a) Inorganic or physical components and (b) Organic substances. Inorganic component consists of minerals, soil, light, water, air, temperature, humidity, etc. Dead and decomposed organic materials of living organisms are known as organic substances. These inorganic and organic components are very essential for the survival of the living organism.

Biotic components: Biotic components include plants, animals and micro-organisms. As you have learned in lesson one, there is an interrelationship between biotic and abiotic components. To keep ecosystem functional, these living organisms play certain role and on the basis of their contribution biotic components are of three types, for example - (a) Producer (b) Consumer and (c) Decomposer.

(a) Producers: The green plants can produce food, so they are called producers of the ecosystem. They manufacture carbohydrate food in presence of sunlight by the process of photosynthesis. All animals in an ecosystem rely on this food, either directly or indirectly.

(b) Consumers: The animals that feed organic matters from plants or on other animals are called consumers. These consumers are further classified into three groups-

Primary consumers: All animals which consume plants or plant parts are known as primary consumers. They are also called herbivores. From small insects to many large animals, they are all included in the group of herbivores. For example, cows, goats, etc.

Secondary consumers: Those which live on eating primary consumers. For example frog, bird, man etc. They are also called carnivores.

Tertiary consumers: Animals which feed on secondary consumers are called tertiary consumers. For example- frog, tortoise, stork, man etc. Some of these animals take food from more than one food level (trophic level). They are called omnivores. When we take pulse, rice, potato etc. we are primary consumers or herbivore. But, when we eat fish and meat, we are secondary or tertiary consumers.

(c) Decomposers: These are wide range of microorganisms including bacteria and fungi. After the death of plants and animals these micro-organisms act on their bodies and decompose them. Finally, the decomposed bodies form different organic and inorganic components. They absorb some nutrients, while the rest are released into the soil and the air. The green plant again consumes those as part of a natural process. These actions and reactions, between the biotic and abiotic components of the nature, have created the ecosystem as a potential self-supporting ecological unit.

Lesson 3-5 : Types of Ecosystem

In a natural environment, there are two types of ecosystems. They are land ecosystems and water ecosystems. In this lesson, you will learn about land ecosystem and water ecosystem.

Land ecosystem: Land ecosystems can be of different types. For example- ecosystem of forest, ecosystem of desert, etc. The forest region of Bangladesh may be mentioned as the example of forest ecosystem. The forest of Bangladesh is divided into three main regions. (a) The forest of Sylhet and Chittagong hill tracts, (b) The Sundarbans forest of coastal region of Khulna, and (c) The shal forest of Tangail and Gazipur region.

A brief description of the ecosystem of Sundarbans are given below-

The Sundarbans is a single large forest of Bangladesh. The vegetation of Sunderbans is different from the vegetation of other forests. The Sundarbans is situated in the southern region of Khulna district skirting the coastal belt of the Bay of Bengal. In the ecosystem of the Sunderbans the soil is of high salt density. As salinity increases coastward in the tidal and sub-tidal areas, there is a transition of dense mangrove vegetation. The soil of the Sundarbans is very muddy, and not suitable for air passing. Therefore, the branch roots of the plants of this region grow erect and spread along the upper layer of the soil instead of inward. Root tip of these plants bear numerous spores through which atmospheric oxygen enters into the plant body for respiration. The sundari, garan, gewa, kewra, golpata, etc. are the major plants of the forest. They are the producers of the ecosystem. Insects, birds, deer, etc. are primary consumers.

Jackals, tortoises, cranes etc. are secondary consumers. Tiger, hogs, etc. are among the tertiary consumers. Among them hogs are omnivorous.The Royal Bengal Tiger, chita, monkey, spotted deer, wild hogs, crocodiles, different types of snakes, birds and insects are the major animals of the Sundarbans.

Aquatic ecosystem: Aquatic ecosystem is divided into three main types—

1. Ecosystem of ponds
2. Ecosystem of rivers
3. Marine ecosystem.

An ecosystem of a pond is described here briefly for your understanding. A classic example of an aquatic ecosystem is the ecosystem of a small pond. In fact, a pond is an ecologically independent and self-regulating unit. In a pond, there are both abiotic and biotic components. The abiotic components are water, dissolved oxygen, carbon dioxide and some organic matters. Organisms can use these elements directly. The elements that constitute the biotic components of a pond ecosystem are producers, primary consumers, secondary consumers, tertiary consumers and decomposers of different types. In a pond ecosystem, producers are minute floating or suspended small plants, known as phytoplankton. Water lily (Shapla), Eichhomia etc. are among floating macrophytes. Like minute floating plants, there are also some microscopic animals known as zooplankton. Aquatic insects, small fish, mussels, snails etc. feed on producer and is known as primary consumers. Medium sized fishes that eat the primary consumers, are called secondary consumers. Again, big fish, stork etc. who eat secondary consumers are tertiary consumers. Bacteria, fungi decompose dead organisms. The decomposed substances are reused by the producer of the pond ecosystem.

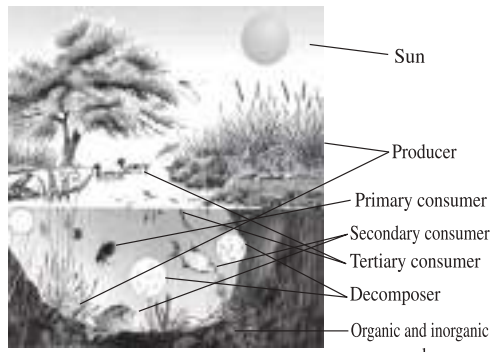


Fig. 14.1: Ecosystem of a pond

Lesson 6-7: Food Chain and Food Web

You know that living beings of an ecosystem cannot live alone. For survival, they depend on each other. All the components surrounding the living beings, influence the survival of organisms in different ways.

Food chain: Sunlight is the source of all energy of the earth. Green plants are the producer of the ecosystem. You know primary consumer depends on producer for food. Again, secondary consumer depends on primary consumers. Tertiary consumers live on eating secondary consumers. In this way, all organisms (both plants and animals) of an ecosystem, are interconnected

serially. Consequently, there develops a food chain. The transfer of food energy from producers through a series of food levels i.e. herbivores (primary consumers) to carnivores, carnivores (secondary and tertiary consumers) to decomposers in the ecosystem is called food chain. Thus, the food chain is a feeding relationship in which a carnivore eats a herbivore which eats plants.

For example : Grass ⟶ insect ⟶ frog ⟶ snake ⟶ eagle.

Food web: You must observe that there are numerous food chains in an ecosystem. A food chain does not work in isolation. Rather most food chains connect to other chains. Food chains are linked together to form a food web. Naturally in any ecosystem more than one food chain remains attached to each other and this complex food chain of more than one is known as food web.

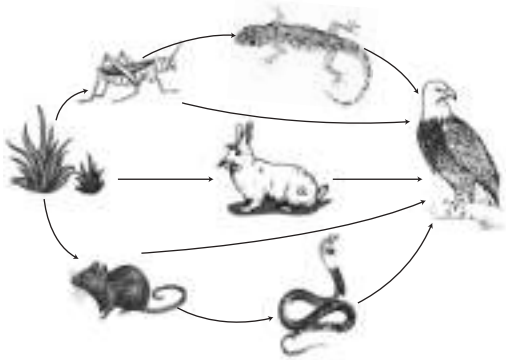


Fig. 14.2: Food web

Lesson 8-9 : Energy Flow in the Ecosystem

You have learned that all organisms living on earth depend on solar energy (sunlight). Therefore, the sun is the main source of energy for the living world. Green plants capture only 2% of the total energy reached on earth and produce carbohydrate food through photosynthesis. Green plants through photosynthesis process naturally convert solar energy into chemical energy. During this process, green plants use natural compounds like-water, nitrogen, carbon dioxide, iron, sulphur, etc. This process, establishes a bridge between the living and non-living worlds.

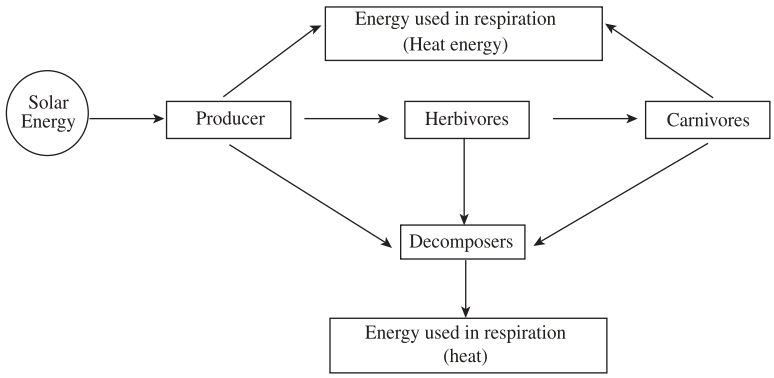


Fig. 14.3 : Linear flow of energy and cyclic movement of matters in the ecosystem.

The green plants receive the solar energy and convert it into chemical energy and initiates food chain. The flow of energy in the ecosystem takes place in this food chain. The energy content at successive trophic levels, from producers to tertiary consumers, gradually decreases. So, it is evident that energy flows from producers to herbivores; herbivores to secondary consumers and from secondary consumers to tertiary consumers. This is how the energy flows. When decomposers act on dead bodies or on garbage, different non-living nutritive substances of ecosystem are produced. The green plants reabsorbes them. It is understood that nutritive substances circulate, while the flow of energy is linear.

Lesson 10: Role of Ecosystem in Maintaining Balance of Nature

An ecosystem is a self-sufficient and self-regulating unit. The living organisms depend on one another. One living being connects another in the food chain. No single living organism can increase in number, or become extinct easily. Consequently, the number of living organisms at different trophic levels remains more or less constant. While different changes may occur in nature, still the balance of nature is maintained for longtime. Let us try to understand the matter with an example. Suppose, there are tigers, deer and hogs living in a forest. Tigers eat deer and hogs as their food. If, for any reason the number of deer and hogs get increased in nature, the number of tigers will increase. The reason is, tigers get enough food. Similarly, if the number of tigers get increased, the number of deer and hogs will be decreased. Thus, the number of tigers will be decreased due to inadequate food supply. Further, if the number of tigers is decreased, the number of deer and hogs will be increased. From the example it is clear that the number of increased organisms (tiger) will be reduced soon and it returns to the previous condition. In this way, natural balance of an ecosystem is maintained naturally.

Task: To prepare a report about the role of ecosystem in maintaining natural balance group. Prepare an example in your notebook for a particular environment regarding how ecosystem maintains the balance of nature. Present it in front of your class.

New words : Ecosystem, food chain, food web, phytoplankton, zoo plankton.

What we have learned at the end of this chapter-

- The interrelationship, action-reaction and interdependence between biotic and abiotic components of a particular environment constitute an ecosystem.
- Ecosystem consists of two main components, namely, biotic and abiotic components.
- Starting from plant sources the transfer of energy by eating and being eaten up by different animals, is known as food chain.
- In nature, most food chains are interconnected with others.This complex food chain of more than one is known as food web.

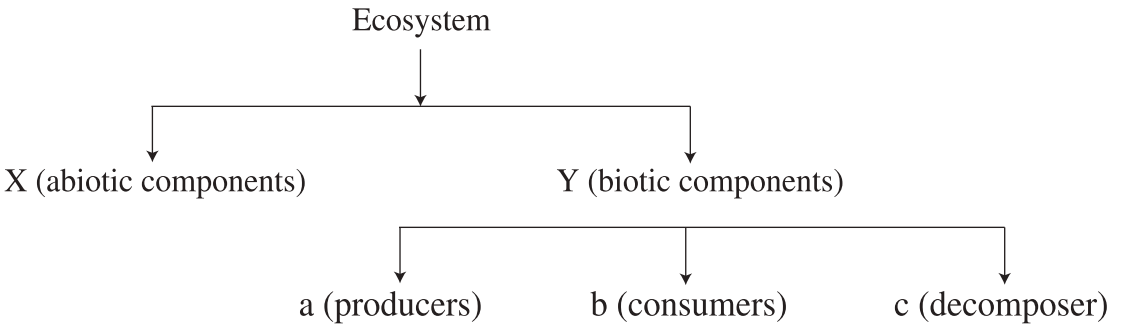
Sample Questions

Multiple Choice Questions

1. Which one of the following is primary consumer?
   a. Phytoplankton b. Snail
   c. Tiger d. Stork

2. Which one of the following food chain is correct?
   a. Phytoplankton → Small fish → Zooplankton
   b. Fruit → Insect → Bird.
   c. Grass → Tortois → Small Fish
   d. Khudepana → Fish → Snail.

Based on the following chart answer questions no. 3 and 4



3. Which one of the following is included under c?
   a. Phytoplankton b. Zooplankton
   c. Bacteria d. Insects

4. In the above chart-
   i. Y is dependent on X
   ii. 'b' is dependent on 'a'
   iii. 'a' and 'c' are interdependent.

Which one of the following is correct?

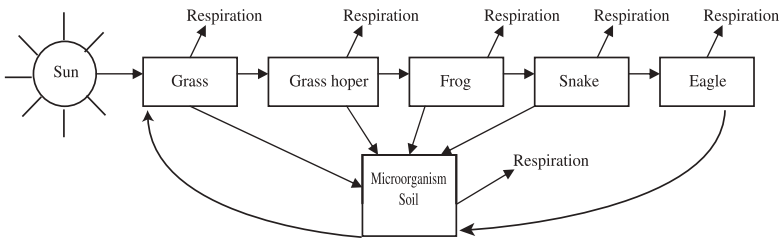
   a. i & ii b. i & iii
   c. ii & iii d. i, ii & iii

Creative Questions

1. Fahim went on a visit to a forest and noticed various animals living among different types of plants. These included rabbits, deer, monkeys, tigers, and pigs. He also observed that in an area where large trees had been cut down, the number of these animals was significantly lower.

a. What is an ecosystem?
b. What type of component is fungus in an ecosystem? Explain.
c. Make and explain a food chain using the animals that Fahim observed.
d. Analyze the environmental impact on the ecosystem that Fahim visited.

2. Answer the following based on the stem below:



a. What is a biotic component?
b. Why do the roots of Sundari trees grow above the ground? Explain.
c. How does energy flow through the above food chain? Explain.
d. What would the nutrient cycle be based on the stimulus? Analyze.

Short Answer Questions

1. What type of component is bacteria in an ecosystem? Explain.
2. What trophic level do grasshoppers belong to? Explain.
3. Why is a food chain called the smallest unit of a food web? Explain.

Project: Observe a couple of food chains of the environment. After observation, make a food web in a poster paper with the help of these food chains and show it to the classroom.

THE END

2026 Academic Year

Class Eight : Science

পরিশ্রম কখনও নিষ্ফল হয় না।



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